BC Geological Survey
Coal Assessment Report
1005

COAL ASSESSMENT REPORT TITLE PAGE AND SUMMARY

TITLE OF REPORT: Coal Mountain Phase 2 Property Coal Assessment Report 2015

TOTAL COST: $623,000

AUTHOR(S): M. ZRAL (P. Geo.), A. Hodgins

SIGNATURE(S):

"Signed and Stamped"

Martin Zral, P.Geo.

NOTICE OF WORK PERMIT NUMBER(S)/DATE(S): CX-5-008 (amended)

STATEMENT OF WORK EVENT NUMBER(S)/DATE(S):

YEAR OF WORK: 2015

PROJECT NAME: Coal Mountain Phase 2 Geotechnical Assessment Program

COAL LICENSE(S) AND/OR LEASES ON WHICH PHYSICAL WORK WAS DONE: DL 4589

COAL LICENSE(S) IN PROJECT AREA ON WHICH NO PHYSICAL WORK WAS DONE OVER THE CURRENT REPORTING PERIOD:
CL# 327736, 327797, 327798, 327799, 327800, 327801, 327802, 327803

BC MINERAL INVENTORY MINFILE NUMBER(S), IF KNOWN: Mine #1630133

MINING DIVISION: Fort Steele
NTS / BCGS:
LATITUDE: _____° _____' _____"
LONGITUDE: _____ ° _____' _____" (at center of work)
UTM Zone: 11 EASTING: 654308 NORTHING: 5497244

OWNER(S): Teck Coal Limited

MAILING ADDRESS: 609 Douglas Fir Rd, Sparwood, BC, V0B 2G0

OPERATOR(S) [who paid for the work]: Same

MAILING ADDRESS: Same

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

Interbedded sequence of sandstones, siltstones, silty shales, mudstones, and medium to high volatile bituminous coal from the Mist Mountain Formation. The region is structurally complex, containing extensive thrust and normal faulting and some folding.

REFERENCES TO PREVIOUS ASSESSMENT WORK AND ASSESSMENT REPORT NUMBERS:

[redacted]

[redacted]

[redacted]

SUMMARY OF TYPES OF WORK IN THIS REPORT		EXTENT OF WORK (in metric units)	ON WHICH TENURES
GEOLOGICAL (scale, area)			
	Ground, mapping	2000 metres	DL 4589
	Photo interpretation		
GEOPHYSICAL (line-kilometres)			
	Ground (Specify types)		
	Airborne		
	(Specify types)		
	Borehole		
	Gamma, Resistivity,	321 metres	DL4589
	Resistivity		
	Caliper	321 metres	DL4589
	Deviation	321 metres	DL4589
	Dip		
	Others (specify): Density	321 metres	DL4589
	Core		
	Non-core		
SAMPLING AND ANALYSES			
Total Number of Samples			
0	Proximate		

0	Ultimate		
0	Petrographic		
0	Vitrinite reflectance		
0	Coking		
0	Wash tests (lab scale)		
PROSPECTING (scale/area)			
PREPARATORY/PHYSICAL			
Line/grid (km)			
Trench (number, metres)		36 pits for 180 metres	DL4589
Bulk sample(s)			

Coal Mountain Phase 2 Property

Coal Assessment Report

2015 Geotechnical Assessment Program

Teck

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Statements of Author's Academic and Professional Qualifications

CERTIFICATE OF QUALIFIED PERSON

Name: Martin Zral, P.Geo.

Company: Teck Coal Limited

Address: 609 Douglas Fir Road
Sparwood, BC
VOB 2G0
Phone: (250) 425-8221

I, Martin Zral, P.Geo, am employed as a Senior Geologist, Supervisor at Teck's Sparwood Operations. This certificate applies to the report titled "Coal Mountain Phase 2 Property, Coal Assessment Report, 2015". I graduated from the University of Calgary with a Bachelor of Science Degree in Geology, 1978. I am a member of the Association of Professional Engineers and Geoscientists of British Columbia (#19033). Since 1978 I have worked as a Geologist in the coal mining industry in Canada. 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).

"Signed and Stamped"

Martin Zral, P.Geo.

Coal Mountain Phase 2 Property
Coal Assessment Report
2015

I. Introduction

1. General Geography and History

The Coal Mountain Phase 2 (CMO2), formerly Marten Wheeler, property is located approximately 10km south-east of the town of Sparwood, in the SE corner of British Columbia. The area of investigation is about 4kms north-to-south and 3kms east-to-west in dimension. It is geographically bounded by Hosmer Ridge to the west, Michel Creek to the east, Little Wheeler Creek to the north and Carbon Creek to the south. The CMO2 property is proposed to be a satellite pit for the Teck Coal Ltd., Coal Mountain Operation situated 15km to the south-east. Coal Mountain is some 1,175 kilometers, by rail, from the Vancouver, British Columbia coal ports. The climate at the property is characterized by moderate summers and cold snowy winters.

The CMO2 Property is 100% owned and managed by Teck Coal Ltd. The fee simple land was acquired from Crowsnest Resources, a subsidiary of Shell Canada, by Kaiser Resources Ltd. in 1969 as part of the Balmer Mine Operation. The BC government purchased the Balmer Mine from Kaiser in the late 1970's due to the attractiveness of high natural resource revenues. The BC Government placed the Balmer Mine within the operating jurisdiction of the Westar Group, a collection of publicly traded companies owned by the BC Government. The BC Government sold stocks of Westar Mining Ltd. on the BC Stock Exchange in an effort to spread the benefits of the profitable coal market throughout the province. The stocks were labeled as a lucrative and secure investment, and many people invested heavily. Through a series of poor financial investments in the petroleum sector, poor coal prices in the late 1980's and eventually a labour dispute in 1992, Westar Mining declared bankruptcy and the property was purchased by the Teck Corporation, in late 1992. In 2003, the property was part of an agreement to amalgamate all the coal mine operations in the Elk Valley and become Elk Valley Coal Corporation (EVCC). Teck Resources purchased majority ownership of EVCC in 2008 and the property is now managed by the Coal

Division, Teck Coal Ltd. At present time there are 1 District lot and 8 coal licenses associated with the CMO2 property, comprising 1,556 hectares.

Coal Mountain Phase 2 exploration activity dates back to the early 1970's when a joint venture was undertaken by the previous owner, Kaiser Resources Ltd. in partnership with Mitsui Mining of Japan. At that time, the focus was on Hosmer and Wheeler Ridges. Some twenty-five (25) holes were drilled and several adits driven in major coal seams. This early exploration included the Dominion Coal Block, Parcel 73 where some six (6) holes were drilled and adits were placed in 9 and 10 seams. Coal analyses, including coke tests, were done on select drill-hole and adit samples. At that time, analysis for CSR and CRI were not completed, as these two tests would not be developed until the mid-1980s. An underground mine was designed in 1974 on Hosmer and Wheeler Ridges for 3 seam, with financial costs determined, but the project never materialized. The CMO2 property lay dormant until 2003 when the newly formed Elk Valley Coal Corporation (EVCC) assumed control of the property from Teck's Elkview Operations (EVO). In 2003-04, the Coal Mountain Mine (CMO) geology group conducted an exploration campaign with the help of the EVCC Calgary corporate geology department.
No work was done in 2005. The 2006 exploration program was budgeted by CMO, with field assistance from the EVO geology group. In 2007, CMO once again managed and supervised the exploration program.
In 2008, the Teck corporate geology group (CSO) assumed control of the exploration work at CMO2. By the end of 2008, some 125 drill-holes had been completed and 36 adits existed between Hosmer, Wheeler and Marten Ridges (see fig. 6 Geology map). A geologic model had been developed via MineSight® computer software and was re-interpreted at the completion of each exploration field season. To determine the marketability of the deposit, several seventeen (17) inch, large-diameter, reverse flood (LDRF) holes were drilled to obtain sizable coal samples that could be lab processed for coking tests. Analyses results from these holes indicated the coal was of poorer quality than anticipated but in some instances, the processes for obtaining clean coal samples were deemed questionable. Until conclusive evidence could be brought forward, the coal was given a lower, more conservative market value.

No exploration work was done in 2009 or 2010. The drilling in late 2011 gave better definition to the previously interpreted fault-thickened portions of 9 and 10-seams in Wheeler Ridge; the fault-

thickened 3-seam in the upper Wheeler Creek valley; and fault-repeated 5-seams on Marten Ridge. Better control of coal seam position and thickness and overall structural integrity was achieved throughout the project area. Due to a late start in 2011, the designed 15,000 m reverse circulation (RC) drilling campaign was subsequently completed in 2012. Geologic data from the 2011-12 exploration work was used to update the geologic model in late 2012 through early 2013. Geotechnical core drilling, in potential open-pit mining areas, for high-wall stability determinations resulted in six (6) sites being completed in 2012, for some 2,500 m drilled. Drill core geologic data was also incorporated into the 2013 model update.

At the end of 2012, the CMO2 geologic data base (excluding Hosmer Ridge and Parcel 73) contained 169 exploration drill holes (148 RC and 21 core). There are 36 coal adits and 62 outcrop mapping points.

Laboratories used to perform the coal analyses include: Elk Valley Environmental Services, Birtley Laboratory, Pearson Petrography, Maxxam Laboratory and CANMET. All samples do not get sent to every laboratory but representative amounts have been processed by each.

In 2013, exploration drilling consisted of thirty-three (33) RC drill-holes, some 7,751 m total, to evaluate the 5 and 7 seam thrust overlap on Marten Ridge; better delineation of faulting in Wheeler Creek drainage and the eastern flank of Wheeler Ridge. As well (6) LDRF drill-holes, 391 m total, were completed to obtain bulk coal samples which would be processed at laboratory scale to produce adequate clean coal, at specified ash values, for coking tests. Seams collected were 30, 81, 91, 92 and 100; the total volume of these five seams constitute some 85% of the coal volume in Wheeler Ridge.

No coal exploration work was done in 2014 or 2015.

2. Access

The CMO2 property is accessed by road and is located 15 km south of Sparwood, B.C. Entrance is via the Wheeler Creek Forestry Road which branches off the Coal-Leach Forestry Road located 8 km south, along the Corbin Road, from BC Provincial Highway 3.

Reference:

i) Illustration No. 1a: Index Map – Coal Property Lease

II. Geology

1. **Stratigraphy**

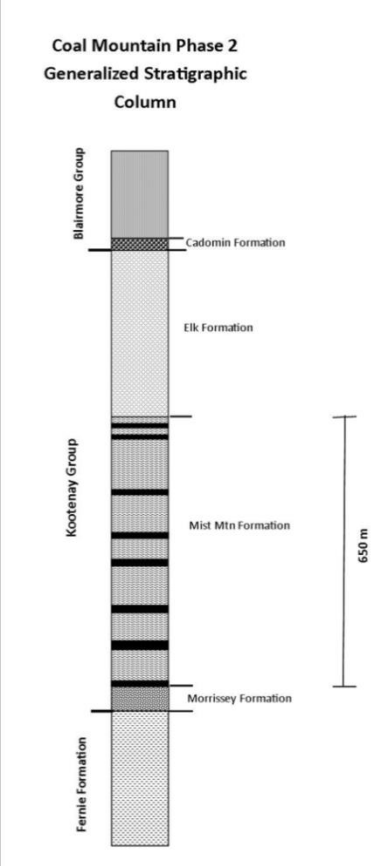
The Mist Mountain Formation of the Kootenay Group of Jurassic-Cretaceous age consists of inter-bedded sandstones, siltstones, mudstones and coal seams of economic interest. On the CMO2 property, the Mist Mountain Formation averages 650 metres in thickness and contains some 15 major coal seams, ranging from 1m to 8m thick. Seams are ordered in a top-down sequence, the uppermost seams below the Elk Formation are identified as the 1 seam package, and the lowermost is the 12 series on top of the Moose Mountain sandstone. The primary mineable zones of thick, continuous coals are seams 3, 5, 7, 8, 9 and 10. Through depositional processes, these

major seams can appear as a zone of multiple, sub-seam splits that are greater than 1.0m in thickness. Due to this lenticular nature of the seams, cumulative coal thickness, on average, is 75 metres, with individual mineable seams ranging from 1 to 10 metres thick. Seams range in rank from medium to high volatile bituminous (from stratigraphic bottom to top).

The Mist Mountain Fm is conformably overlain by the Elk Formation; a 600m thick sequence of inter-bedded sandstones, siltstones, mudstones and sporadic, very thin, uneconomic coal seams.

The Elk Fm is conformably overlain by the Blairmore Group; a sequence of sandstones and siltstones with a basal cliff-forming conglomerate, Cadomin Formation, which dominates the landscape at the southern edge of the Coal Mountain Phase 2 property.

Table 1 - CMO2 Stratigraphy



1. Structure

The area of interest is structurally bound, in an up-thrust block of Kootenay Group sediments that are folded along a north-south trending and south plunging syncline axis, lying between Wheeler and Hosmer Ridges. The northern half of the east limb of the syncline dips gently, less than 20 degrees, to the west-southwest and is contained within Wheeler Ridge. The southern half of the east limb, within both Marten and Carbon Ridges, dips more steeply to the west, generally 25 to 30 degrees. Hosmer Ridge comprises the west limb of the syncline, where the strata dip south-east to easterly. Within the CMO2 project area, the syncline structure is further complicated by several small, west dipping, thrust faults. The thrust faults caused thickening coal strata by overlapping and drag folding. The thrust faults generally dip west to

southwest at inclinations of 20 to 50 degrees. Further, Wheeler and Marten Ridges are structurally separated by the Wheeler normal fault; trending N-S with a westerly dip of 65 degrees and a western down-dropped, vertical displacement of some 225 metres. The vertical movement along the Wheeler normal fault adds to the complexity by creating disjointed blocks of coal. Generally, the geologic structure is more complex than previously interpreted, with areas of rapidly changing seam orientations and thicknesses. This is most evident on the western flank of Marten Ridge, in the Wheeler Fault zone. These characteristics imply that the CMO2 deposit should be categorized as "complex" to reflect its type and geological complexity according to GSC Paper 88-21.

A key criterion for defining resources is the classification of the deposit and geology type. The classification of a coal deposit and geology will determine the search criteria and methodology to be applied during the calculations of resources.

Reference:

i) Illustration No. 1b: General Geology Map

III. 2015 Geotechnical Assessment Project

1. Objective

The objective of the 2015 CMO2 geotechnical drilling and test pit program was to 1) evaluate the foundation material for suitability for construction of the proposed CMO2 mine lower facility (office, shops and coal stockpiles), lying between the Coal-Leach Forestry Road (83-85km zone) and the Michel Creek and 2) evaluate the foundation material in the proposed mine waste spoil footprints and 3) drill test wells for potable water sources for the lower facility.

As recommended by a previously completed engineering study, to maintain bridge integrity, stream banks to be upgraded along the Michel Creek, in the immediate vicinity of the Michel Creek Bridge, located on Coal-Leach Forestry Road (82.5km).

No coal exploration work was scheduled.

2. Summary of Work Done

In 2015, eight (8) reverse circulation holes (508m) were drilled; three (3) for potential potable water source and five (5) for foundation material studies, all for the proposed CMO2 lower office and shop facilities. In conjunction with the drilling, thirty-six (36) test pits were dug; eighteen (18) to assess foundation material for proposed waste spoils, six (6) for foundation material along the proposed new mine access road, three (3) for foundation material in Wheeler Creek for water containment structure placement, five (5) for foundation material in the proposed lower facility location, four (4) for percolation study for a facility septic system.

Rotary drilling was performed by Good Earth Drilling Services (Airdrie, AB) using a GEFCO 30K truck-mounted rig. The holes drilled for potential water supply were geophysically logged through the drill pipe using the gamma-neutron method. Holes that remained open following the removal of the drill pipe were logged for down-hole deviation, caliper and gamma-density. The geophysical logs were produced by Century Wireline Services (Appendix C). Thirty-three (33) of the test pits were mechanically dug with a 345 Caterpillar back-hoe, owned and operated by Teck Coal Ltd, Coal Mountain Mine operation and three (3) were dug by hand. Management of the assessment project was done with direction and supervision from both the geology and mine planning groups of the Teck Coal Ltd., Sparwood Office.

Material samples gathered via rotary drilling and grab sampling from test pits were sent to Golder Associates Laboratory and ALS Environmental (ALS Canada Ltd), both in Calgary, AB. Results are discussed and reported in Golder and Norwest reports. (Appendix D).

Access roads and drill-site locations were laid out by Silenus Resource Management Inc., Cranbrook, BC. Road and drill-site construction was completed by Coal Mountain Operations

(CMO), Sparwood, BC. No timber harvesting services were required. Coal Mountain Operations and Golder Associates, Calgary, AB provided collar locations, for all drill-holes and test pit location surveys.
All drill-holes and test pits were within District lot #4589. Locations are given in Appendix B and C.

The stream-bank rip-rap re-construction was completed using a 330D Caterpillar back-hoe, rented from Fiorentino Brothers Construction, Cranbrook, BC and operated by CMO operators. Rip-rap was brought to the bridge site from CMO by Glenwest Express, Fort Macleod, AB using Super B, 8 axle highway trucks. A 988 Caterpillar loader, owned and operated by Glenwest Express, was available at the bridge site.

No coal exploration work was completed. As some of the geotechnical program was done well outside the property coal measures, the eastern project boundary of the geologic resource model was adjusted to include the work done along Coal-Leach Road. No other model work was necessary.

Reference:

i. Illustration No. 1a: Index Map - Coal Properties
ii. Illustration No. 2a: 2015 Completed Geotechnical Program – Map
iii. Illustration No. 3a: 82km Michel Creek Bridge Stamped As-built Dwg

3. Results

The primary goal of the 2015 geotechnical assessment program at CMO2 was to evaluate the foundation material for the proposed office \ shop facilities, mine access road, water management structures and waste spoil footprints.

The sample locations and lithologic descriptions were entered into the geologic data base.

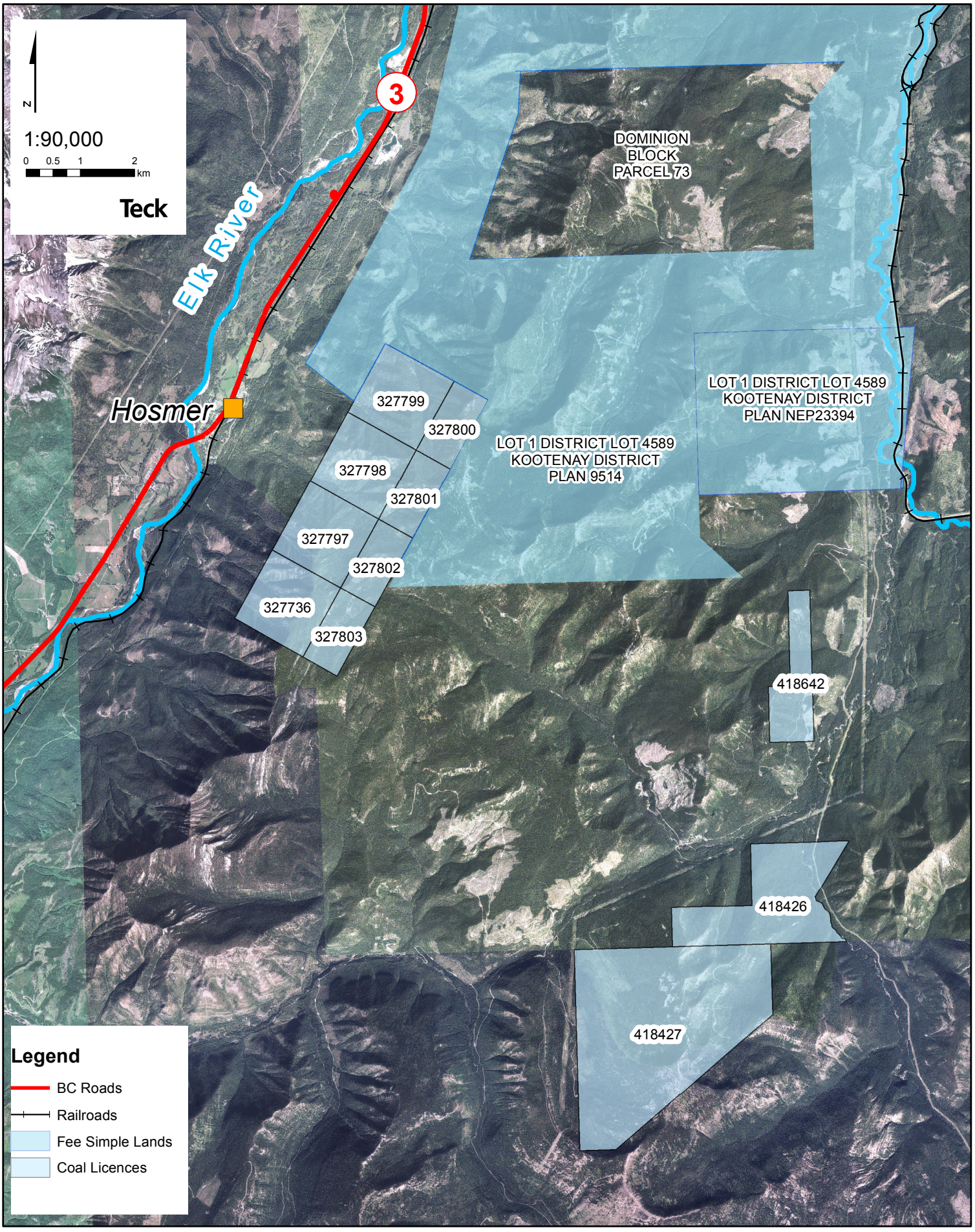
Analyses of the sample materials has increased the knowledge of the integrity of foundations for each proposed function and assists with the long term mine plan for the property (available analyses is given in the reports in Appendix D).

Michel Creek stream-banks were successfully re-constructed, as per engineered drawing design.

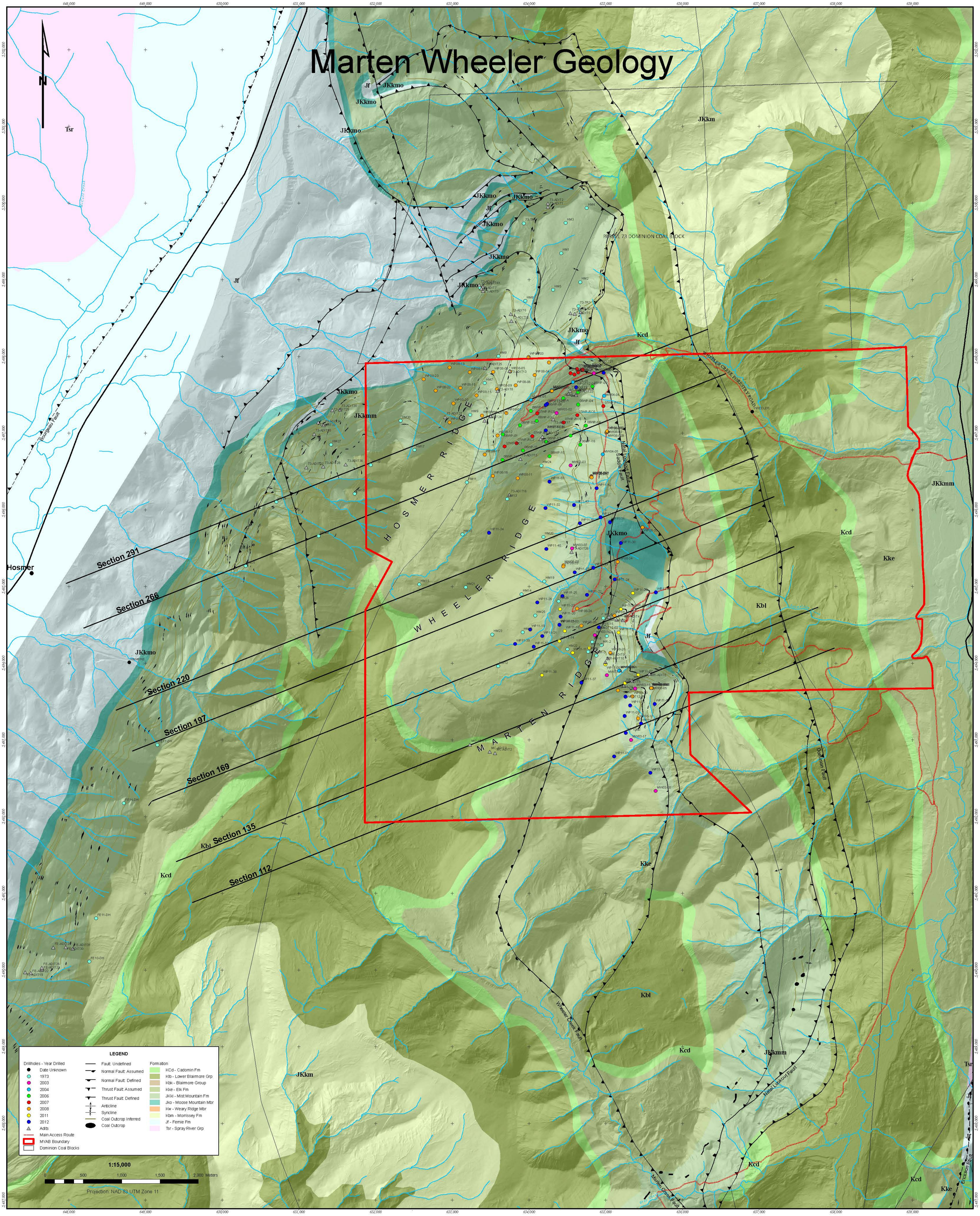
IV. Conclusion

The 2015 geotechnical assessment program has successfully created a database of foundation material types, for consideration, during the planning phase of the CMO2 mine infrastructure. The program has increased geologic and geomorphologic knowledge of the property.

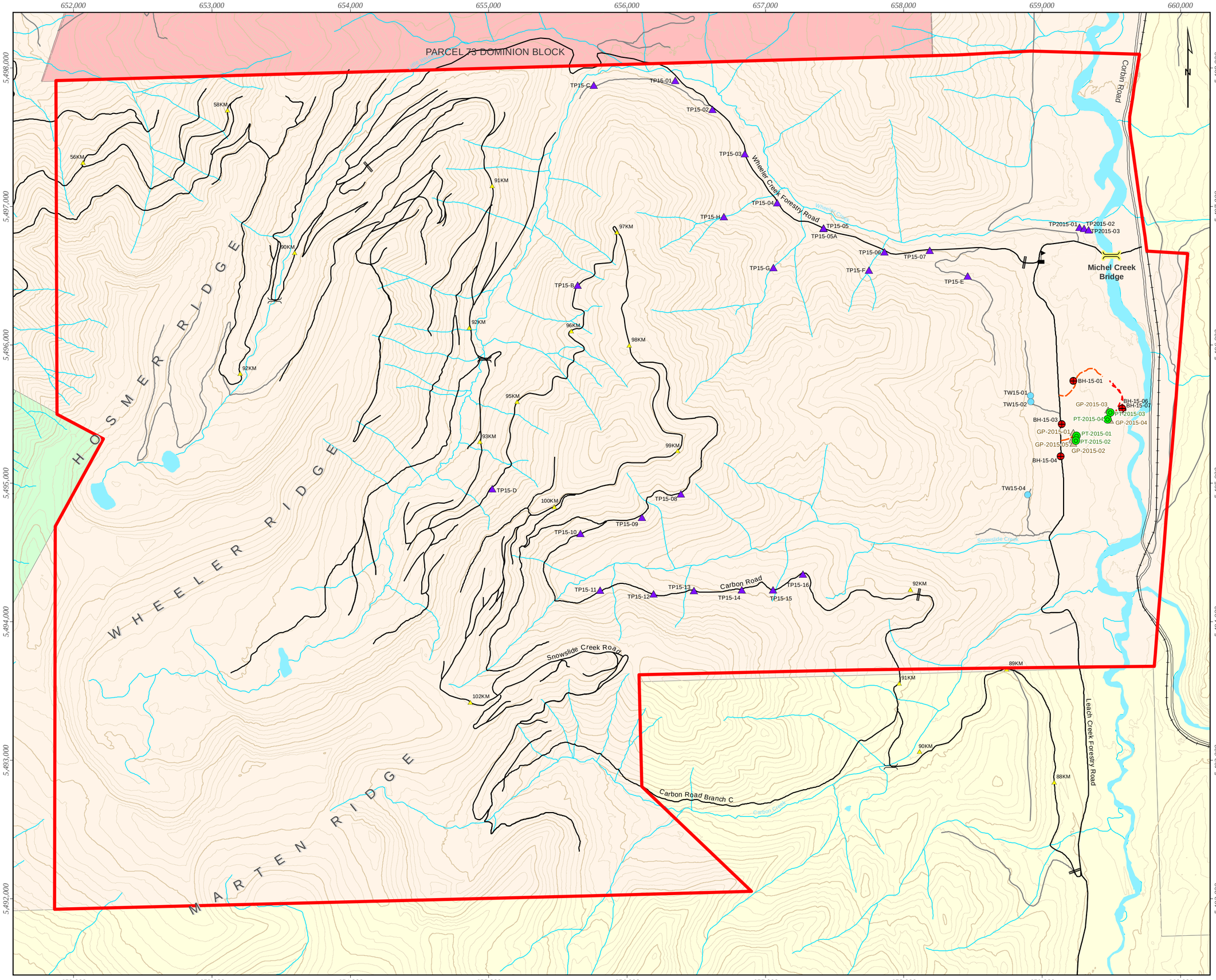
These results have allowed the update of the economic assessment and viability of the property. As a result of changed pricing in the coal industry, the proposed development of an open pit mine on the CMO2 property has been put on hold.


N
1:90,000
0 0.5 1 2
km
Teck
3
Elk River
Hosmer
DOMINION
BLOCK
PARCEL 73
LOT 1 DISTRICT LOT 4589
KOOTENAY DISTRICT
PLAN NEP23394
LOT 1 DISTRICT LOT 4589
KOOTENAY DISTRICT
PLAN 9514
327799
327800
327798
327801
327797
327802
327736
327803
418642
418426
418427
Legend
BC Roads
Railroads
Fee Simple Lands
Coal Licences

Marten Wheeler Geology



Summary of Work for 2015



Legend

- Borehole
- Water Well
- Granular Test Pit
- Percolation Test
- Test Pit
- New Trail
- Trail Upgrade
- Bridge
- km marker
- Office
- Gate
- Paved Road
- Existing Access
- Other Trails
- MYAB Boundary
- Teck Freehold
- Dominion Coal Block
- Private Land
- Crown Surveyed Land

PROJECT:

Coal Mountain Phase 2

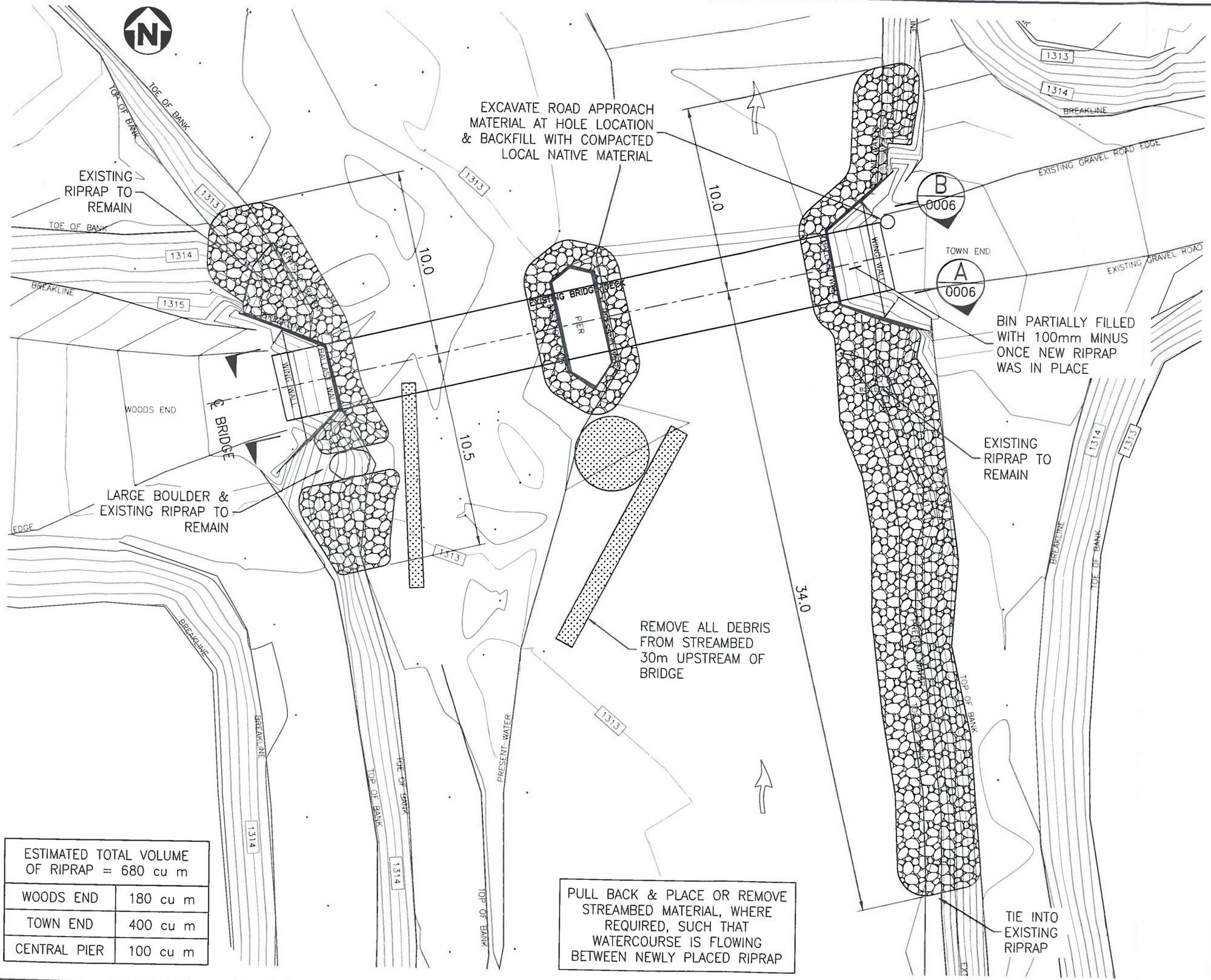
Teck

0 0.25 0.5 0.75 1 1.25 km

Projection: Universal Transverse Mercator Zone 11N
Datum: NAD 83

LOCATION: Sparwood, B.C.		CONTOUR INTERVAL: 20 meters
DRAWN BY: DJG	CHK BY:	PROJECT: Coal Mountain Phase 2
SCALE: 1:20,000	DATE: 12/15/2015	FILE NAME: Summary of Work Map.pdf

\\teckcominco\cgo\Groups\TCGIS\Data\Operations\CGO\MartenWheeler\MXDs\2015 Exploration\Summary of Work Map.mxd



ESTIMATED TOTAL VOLUME OF RIPRAP = 680 cu m	
WOODS END	180 cu m
TOWN END	400 cu m
CENTRAL PIER	100 cu m

NOTES:

1. RIPRAP GRADATION, CLASS & THICKNESS AS SHOWN ON DRAWINGS.
2. RIPRAP SHALL BE ANGULAR & SHALL NOT HAVE ITS LENGTH EXCEEDING 3 TIMES ITS THICKNESS.
3. RIPRAP SHALL BE OF DURABLE QUALITY & NOT EASILY FRACTURED.
4. ALL RIPRAP TO BE UNDERLAIN WITH NON-WOVEN GEOTEXTILE (ARMTEC 250 OR APPROVED EQUIVALENT).
5. SOURCES OF RIPRAP SHALL BE APPROVED BY THE COORDINATING REGISTERED PROFESSIONAL PRIOR TO SOURCE DEVELOPMENT.
6. FOLLOWING REMOVAL OF MATERIAL FROM AN APPROVED SITE, SIDE SLOPES MUST BE DRESSED TO THE NATURAL ANGLE OF REPOSE BUT IN NO CASE GREATER THAN 45 DEGREES UNLESS MATERIAL IS SOLID ROCK.

BILL OF MATERIALS:

ITEM	QNTY	DESCRIPTION
-		

amec foster wheeler

REFERENCE DRAWINGS:

SECTIONS & DETAILS	B-000-C-0002
CROSS SECTIONS	B-000-C-0006

PROJECT No.: 179362

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA

NO.	DATE (YYYY/MM/DD)	REVISION	BY	CHK	ENG
1	2015/09/23	FIELD RECORD	JPW	JET	JET
0	2015/06/12	ISSUED FOR CONSTRUCTION	JPW	JET	JET
A	2015/06/09	ISSUED FOR APPROVAL	JPW		JET

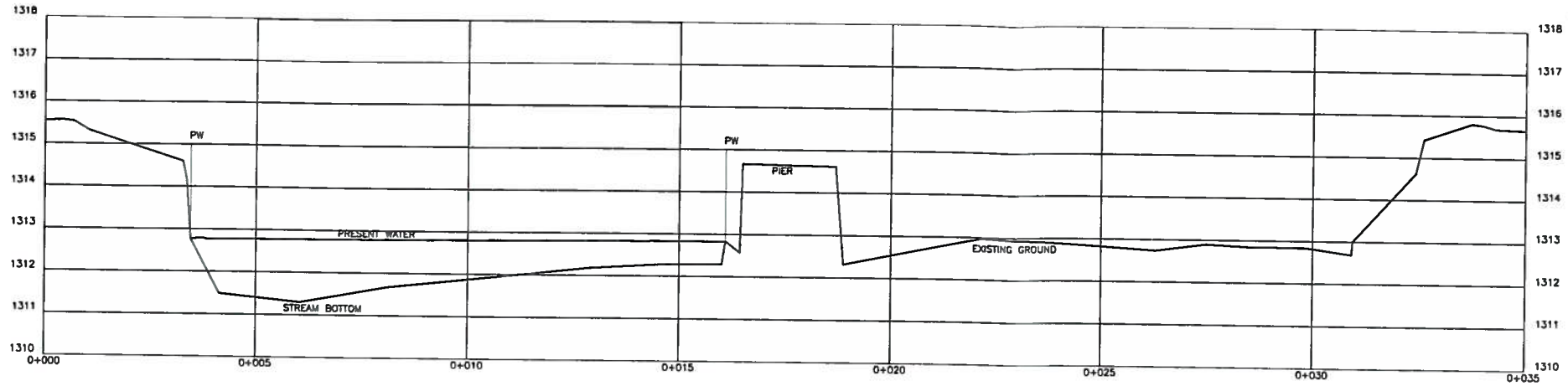
SCALE:	DRAWN BY: DATE	CHECKED BY: DATE	ENGINEER: DATE
1:200	JPW 2015/06/04	JET 2015/06/12	JET 2015/06/12

Teck

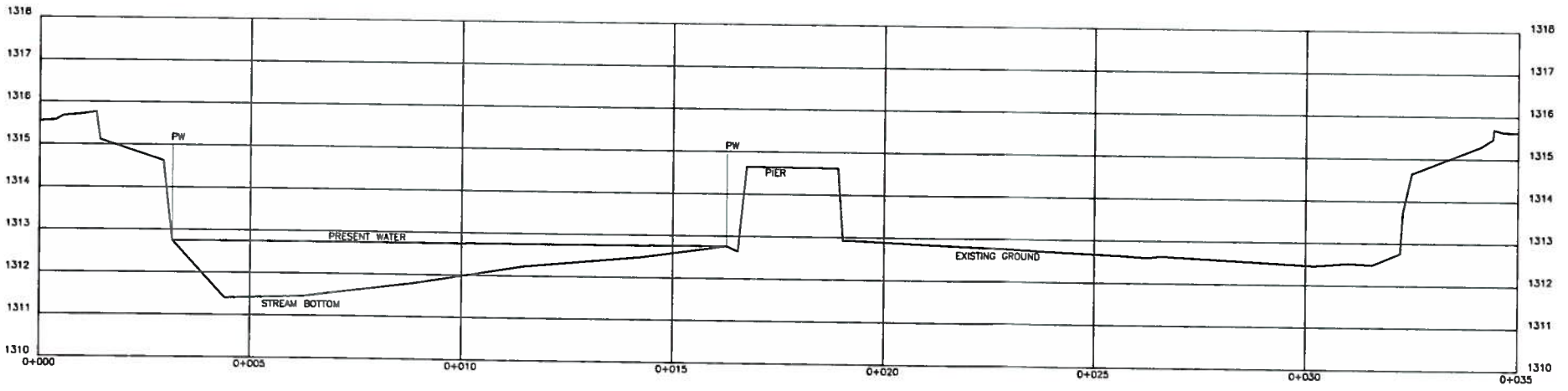
TECK COAL - COAL MOUNTAIN

TITLE:
MICHEL CREEK BRIDGE REPAIRS
KM 82.5, COAL LEACH ROAD

DRAWING NUMBER:	REV.
179362-B-000-C-0001	1



SECTION A
1:150
0001



SECTION A
1:150
0001

NOTES:

1. SEE DRAWING 179362-B-000-C-0001 FOR NOTES.

BILL OF MATERIALS:

ITEM	QNTY	DESCRIPTION
–		

amec foster wheeler

REFERENCE DRAWINGS:

OVERALL PLAN	B-000-C-0001
SECTIONS & DETAILS	B-000-C-0002

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA
JOHN E. TRESEND
SEPT 23/15

PROJECT No.: 179362

NO.	DATE (YYYY/MM/DD)	REVISION	BY	CHK	ENG
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SCALE:	DRAWN BY: DATE	CHECKED BY: DATE	ENGINEER: DATE
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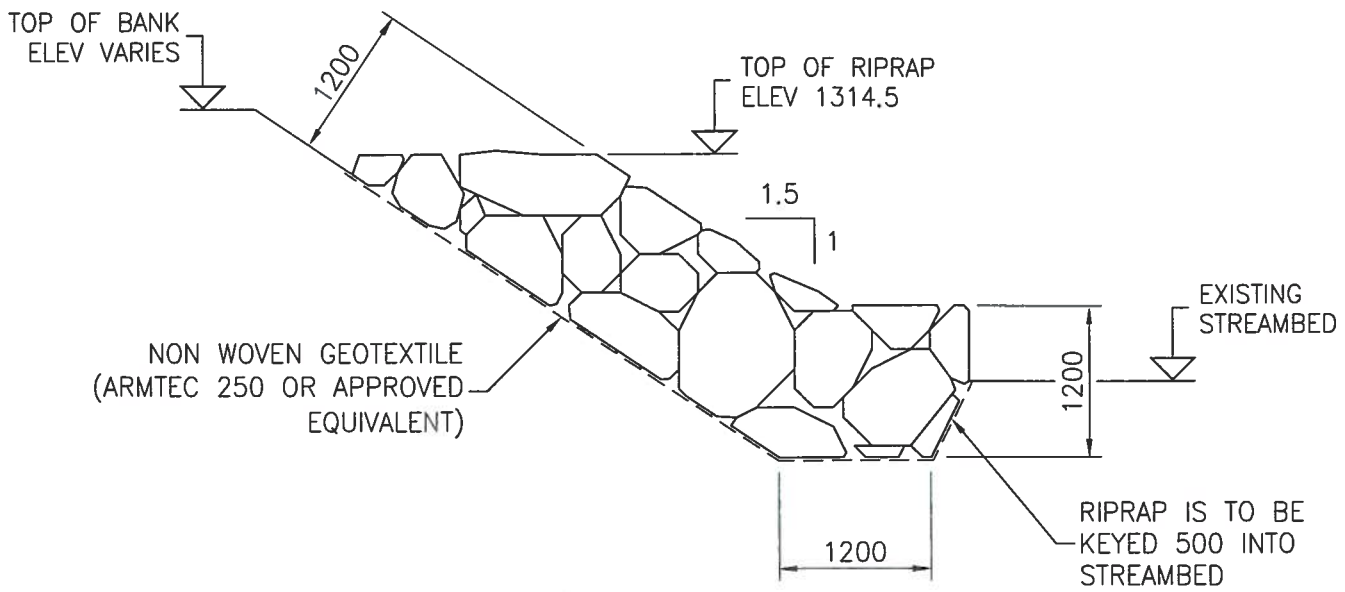
Teck

TECK COAL – COAL MOUNTAIN

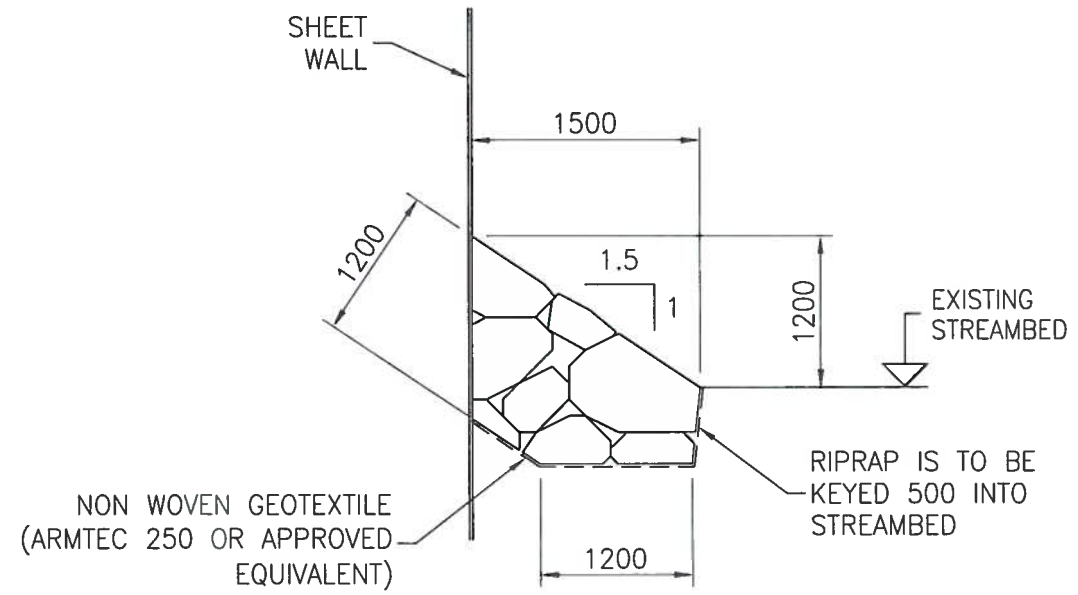
TITLE:
MICHEL CREEK BRIDGE REPAIRS
KM 82.5, COAL LEACH ROAD

DRAWING NUMBER: 179362-B-000-C-0001 REV. 1



SECTION AGAINST BANK

NTS



SECTION AGAINST SHEET WALL

NTS

RIPRAP TABLE

CLASS OF RIPRAP (kg)	NOMINAL THICKNESS OF RIPRAP (mm)	ROCK GRADATION: PERCENT SMALLER THAN GIVEN ROCK MASS						
		15%		50%		85%		<100%
500	1200	50kg	330mm	500kg	715mm	1500kg	1030mm	1220mm

NOTES:

1. SEE DRAWING 179362-β-000-C-0001 FOR NOTES.

BILL OF MATERIALS:

ITEM	QNTY	DESCRIPTION
-		

amec foster wheeler

REFERENCE DRAWINGS:

OVERALL PLAN	B-000-C-0001
CROSS SECTIONS	B-000-C-0006

PROJECT No.: 179362

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA J.E. RAWLINSON Sept 23/15

NO.	DATE (YYYY/MM/DD)	REVISION	BY	CHK	ENG
1	2015/09/23	FIELD RECORD	JPW	JET	JET
0	2015/06/12	ISSUED FOR CONSTRUCTION	JPW	JET	JET
A	2015/06/09	ISSUED FOR APPROVAL	JPW		JET

SCALE:	DRAWN BY: DATE	CHECKED BY: DATE	ENGINEER: DATE
NTS	JPW 2015/06/05	JET 2015/06/12	JET 2015/06/12

Teck

TECK COAL - COAL MOUNTAIN

TITLE:
MICHEL CREEK BRIDGE REPAIRS
KM 82.5, COAL LEACH ROAD

DRAWING NUMBER:	REV.
179362-B-000-C-0002	1

Appendix A Coal Mountain Phase 2 Coal Licences

Code	Parties	Jurisdiction	Type	Status	Grant Date	Expiry Date	Official Area Value	Official Area Unit
327797	TECK COAL LIMITED (100.0000%)	British Columbia	CLI (BC)	Active	7/3/1986	11/30/2015	259	Ha
327798	TECK COAL LIMITED (100.0000%)	British Columbia	CLI (BC)	Active	7/3/1986	11/30/2015	259	Ha
327799	TECK COAL LIMITED (100.0000%)	British Columbia	CLI (BC)	Active	7/3/1986	11/30/2015	259	Ha
327800	TECK COAL LIMITED (100.0000%)	British Columbia	CLI (BC)	Active	7/3/1986	11/30/2015	130	Ha
327801	TECK COAL LIMITED (100.0000%)	British Columbia	CLI (BC)	Active	7/3/1986	11/30/2015	130	Ha
327802	TECK COAL LIMITED (100.0000%)	British Columbia	CLI (BC)	Active	7/3/1986	11/30/2015	130	Ha
327803	TECK COAL LIMITED (100.0000%)	British Columbia	CLI (BC)	Active	7/3/1986	11/30/2015	130	Ha
327736	TECK COAL LIMITED (100.0000%)	British Columbia	CLI (BC)	Active	7/3/1986	11/30/2015	259	Ha
418426	TECK COAL LIMITED (100.0000%)	British Columbia	CLI (BC)	Active	9/11/2013	9/11/2015	439	Ha
418427	TECK COAL LIMITED (100.0000%)	British Columbia	CLI (BC)	Active	9/11/2013	9/11/2015	988	Ha
418642	TECK COAL LIMITED (100.0000%)	British Columbia	CLI (BC)	Active	9/5/2014	9/11/2015	155	Ha

TEST PIT LOCATIONS 2015

test pit	easting	northing	elevation
TP15-01	656,348	5,497,910	1454
TP15-02	656,616	5,497,703	1461
TP15-03	656,851	5,497,382	1449
TP15-04	657,084	5,497,027	1449
TP15-05	657,420	5,496,843	1449
TP15-05a	657,419	5,496,846	1444
TP15-06	657,859	5,496,674	1401
TP15-07	658,186	5,496,684	1396
TP15-08	656,387	5,494,923	1885
TP15-09	656,105	5,494,754	1864
TP15-10	655,661	5,494,639	1832
TP15-11	655,803	5,494,227	1764
TP15-12	656,189	5,494,202	1726
TP15-13	656,482	5,494,223	1709
TP15-14	656,828	5,494,229	1674
TP15-15	657,053	5,494,230	1674
TP15-16	657,270	5,494,344	1651
TP15-B	655,642	5,496,432	1842
TP15-C	655,758	5,497,877	1529
TP15-D	655,024	5,494,961	1811
TP15-E	658,460	5,496,497	1440
GTP-2015-F	657,748	5,496,542	1460
GTP-2015-G	657,057	5,496,558	1494
GTP-2015-H	656,697	5,496,927	1550

test pit	easting	northing	elevation
GP-2015-01	659,226	5,495,359	1364
GP-2015-02	659,234	5,495,303	1364
GP-2015-03	659,480	5,495,527	1357
GP-2015-04	659,475	5,495,460	1358
GP-2015-05	659,215	5,495,312	1364
PT-2015-01	659,249	5,495,344	1364
PT-2015-02	659,242	5,495,308	1365
PT-2015-03	659,483	5,495,515	1357
PT-2015-04	659,473	5,495,465	1358
TP2015-01	659,268	5,496,852	1318
TP2015-02	659,303	5,496,842	1317
TP2015-03	659,335	5,496,830	1319

DRILL HOLE LOCATIONS 2015

drill hole	easting	northing	elevation
BH-15-01	659,226	5,495,740	1363
BH-15-03	659,141	5,495,428	1370
BH-15-04	659,133	5,495,198	1372
BH-15-06	659,581	5,495,536	1358
BH-15-07	659,580	5,495,542	1358
TW15-01	658,914	5,495,633	1386
TW15-02	658,919	5,495,591	1385
TW15-04	658,894	5,494,917	1417

Coal Mountain Phase 2 Lower Facility Geotechnical Report

Submitted to:
Teck Coal Limited

Project Number: 324-28

Date:
September 4, 2015

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1 INTRODUCTION

Norwest Corporation (Norwest) completed a geotechnical investigation of foundation conditions at the Teck Coal Limited (Teck) Coal Mountain Phase 2 (CMO2) Lower Facility area to support the feasibility level evaluation and design of the CMO2 infrastructure. This report presents results and conclusions from the foundation investigation and provides recommendations for foundation design of key area infrastructure. The scope of work for this project is defined in the Norwest project proposal "Proposal for CMO2 Geotechnical Investigation", April 23, 2015.

2 BACKGROUND

2.1 Project Area

Teck's CMO2 site is located in southeastern British Columbia, in the East Kootenay Regional District, approximately 20 km south of Sparwood. The property is situated approximately 19 km northwest of the existing Coal Mountain Operations (CMO) site along Corbin Road, off of B.C. Highway 3. Figure 2-1 is a regional site location map.

New infrastructure is required to support the Coal Mountain Phase 2 mining operations project, including maintenance facilities that are necessary for the mining equipment and truck fleet. The Phase 2 mine will be developed in coal deposits found in nearby steep mountainous terrain where it is not practical to construct mine and maintenance facilities. The low-lying generally flat area on the west side of Corbin Road and parallel to Michel Creek was previously identified as the most viable location for the mine facilities infrastructure as well as a Run of Mine (ROM) coal stockpile and transfer areas. The Lower Facility location relative to the Phase 2 mining area is shown on Figure 2-2.

2.2 Lower Facility Infrastructure

The Lower Facility area will be located at the main access point to the Phase 2 operation. A plan view of Lower Facility infrastructure is shown in Figure 2-3. The planned Lower Facility and adjacent area includes the following infrastructure:

- **Mine Truck Maintenance Shop**: The heated truck maintenance building is approximately 60 m x 50 m andis located at 1,372 masl in the southwest corner of the Lower Facility area and includes the maintenance shop with attached dry and offices. The maintenance shop will consist of four bays, with three bays for maintenance of Komatsu 930E mining trucks and one welding bay. The dry building will be attached to the maintenance shop. Current options for maintenance building structures include tensioned fabric and pre-engineered steel structures for the maintenance shop, and a one- or two-storey, modular building for the dry and offices.
- **Truck Wash Building**: The heated truck wash facility is approximately 30 m x 25 m and is located at 1,372 masl in the southwest corner of the Lower Facility area. The facility is intended to support a single Komatsu 930E truck and will include a truck wash system with pressure water pumps, monitors, a water recycle system (collecting and settling pits, an oil skimmer and filters). Current options for the truck wash building include tensioned fabric and pre-engineered steel structures.

- **Warehouse**: The heated warehouse building is 30 m x 30 m, is located at 1,372 masl north of the truck maintenance building and includes multi-level storage racks and bins, a receiving area, and an office/parts counter. Current options for the truck wash building include tensioned fabric and pre-engineered steel structures.
- **Guard House and Drug Testing Center**: This 8 m x 5 m heated building is located on the east side of the Lower Facility area at approximate 1,360 masl and will be a combined guard house and drug-testing facility in a single-storey modular structure. A 20 m x 5 m parking area immediately east of the guard house is planned for construction on compacted structural fill with no asphalt or concrete surface.
- **Tire Change/Repair Shop**: The unheated tire change area is a 30 m x 30 m concrete slab located at 1,372 masl south of the truck maintenance building. The slab is planned to support a single Komatsu 930E haul truck as well as six sea cans containing tire change supplies.
- **Laydown Area**: The laydown area is roughly 115 m x 45 m and is located at approximate 1,370 masl and northeast of the truck maintenance building. It is intended for use as a storage area for large mining equipment repair components. The laydown is expected to be constructed on compacted structural fill with no asphalt or concrete surface.
- **Gasoline and Diesel Fuel Facilities**: A fuel farm will be constructed at approximate 1370 masl and north of the laydown and parking areas to store 240,000 L of diesel and 35,000 L of gasoline. Diesel fuel will be stored in three horizontal steel tanks of 80,000 L each on a 15 m by 15 m footprint. Gasoline will be stored in a single horizontal steel tank on a 8 m by 8 m footprint. Both fuels will be stored in separate lined and bermed cells on impermeable compacted structural fill. Loading and unloading pumps will be installed adjacent to each fuel area, and will include a concrete pad and sump connected to an oil/water separator.
- **Parking**: A 68-space 60 m x 40 m parking area is planned to be constructed at approximate 1370 masl and north of the warehouse building. The area is planned to be constructed on compacted structural fill with no asphalt or concrete cover.
- **Haul Truck Road**: The ROM haul truck road connects the active mining area to the Lower Facility ROM stockpile area, the maintenance building and other infrastructure. The On-Road Haul Truck Road is planned to connect the Lower Facility and the ROM Coal Stockpile and Transfer Station to Corbin Road via a bridge over Michel Creek. Haul truck road design criteria are summarized in Table 2.1 and Table 2.2.

Table 2.1
ROM Haul Truck Road Design Criteria

Design Criteria	Value	Units	Comments
Minimum Radius of Curvature	10	degrees	Excepting switchbacks
Number of Lanes	2		
Road Allowance	44 or 40	m	See Figure 5-1
· Minimum Running Surface	28	m	
· Safety Berm Width	8	m	2 berms when necessary
· Ditch Width	0.8 to 4	m	2 – 1 ditch each side
Cross Slope	4	%	
Maximum Ramp Design Slope	8	%	Prefer 5% or less if reasonable
Fill Slope Angle	37	degrees	See cross sections
Cut Slope Rock	50	degrees	See cross sections

Table 2.2
On-Road Haul Truck Road Design Criteria

Design Criteria	Value	Unit	Comments
Minimum Radius of Curvature	25	m	Longer vehicle requirements
Number of Lanes	2	#	-
Road Allowance	18 or 20	m	-
Minimum Running Surface	14	m	-
Safety Berm Width	2	m	2 berms when necessary
Ditch Width	1	m	2 – 1 ditch each side
Cross Slope	2	%	-
Maximum Ramp Design Slope	8	%	Prefer 5% or less if reasonable
Fill Slope Angle	37	degrees	See cross-sections
Cut Slope Rock	50	degrees	See cross-sections

- **Access Roads**: Access roads are planned for construction in and around the Lower Facility area on compacted structural fill capped with granular material for the running surface as required.
- **Mine Truck Ready Line**: A mine truck ready-line will be constructed at approximate 1,370 masl and immediately west of the truck maintenance building. The truck ready-line is planned for construction on compacted structural fill.

- **Electrical Substation**: A 69 kV electrical substation is planned for construction at approximate 1,360 masl and northeast of the laydown area. The substation area is approximately 40 m x 30 m and may include a small heated modular structure on the west side. The electrical substation is planned for construction on compacted structural fill.
- **Sedimentation Ponds***: Three sedimentation ponds, the North ROM Pond at approximately 1,360 masl, the South Pond at approximately 1,360 masl and the Road Pond at approximately 1,345 masl are planned for construction north, east and southeast of the Lower Facility area respectively.
- **Stockpiles and Loadout Areas***: The ROM coal stockpile and loadout area is planned for construction at approximate 1,360 masl and north of the Lower Facility area. A topsoil stockpile is planned for construction northwest of the ROM Stockpile at approximate 1,365 masl.
- **Natural gas pipeline, distribution centre and regulating station***: Three large-diameter pipelines are in place east of the Lower Facility area across Michel Creek. A local supply pipeline is planned for construction from the main line northward to the Lower Facility with smaller branch lines to each building as required. The pipeline will include a transmission /distribution, pressure metering and regulating station east of the Lower Facility area.
- **Septic Field***: A 40 m x 30 m septic field for disposal of domestic sewage will be constructed north of the guard house at approximate 1,360 masl.
- **Michel Creek Bridge*:** A bridge crossing is planned to span Michel Creek and provide access from Corbin Road to the Lower Facility area.

  *Foundation design recommendations for these areas are beyond the scope of this report and are not included herein.

A planned Upper Facility infrastructure area closer to the mine pit will include a combined mine dry and office complex, and emergency services garage. This area will be developed along with the haul truck road access as an expansion zone into the hillside. Investigation and assessment of this area was not completed for this report.

2.3 Geology, Hydrogeology and Geohazards

2.3.1 Regional Geology

The CMO2 site is located in the Rocky Mountain foreland thrust and fold belt of southeast British Columbia. The Phase 2 Mine project is targeting the Elk Valley coal-

field found in the coal bearing Mist Mountain formation, a sedimentary sequence of the Lower Cretaceous Kootenay Group. The Mist Mountain Formation consists of interbedded mudstones, siltstones, and sandstones and thick, bituminous coal seams. The mudstones typically occur as thin beds within a few metres of the coal seams, and the majority of the rocks in the sedimentary sequence consist of competent siltstones and sandstones. The Mist Mountain Formation overlies Moose Mountain sandstone, the upper member of the Morrissey Formation. The Morrissey Formation is mainly composed of sandstone, but also contains beds of mudstone, shale and bituminous coal within the Moose Mountain member.

The Phase 2 project area lies on the eastern limb of a broad, open syncline that is part of a complex synclinorium that forms the Fernie Basin. The syncline plunges toward the south at a very shallow inclination.

Lower lying valley floor areas in the region are characterized by alluvium and colluvium deposits as well as glacial till with bedrock which occurs near surface in some areas and at depths greater than 50 m near river and stream channels.

2.3.2 General Site Geology and Topography

The shallow subsurface in the Lower Facility area generally consists of an organic topsoil layer that includes finer grained soils and rootlets to a depth ranging from 0.3 m to 0.45 m. That layer is underlain by a poorly sorted, loose, coarse sand and gravel that extends to a depth of 2 m to 5 m.

Shallow gravel and sand deposits are underlain by beds of sand, silt and clay with some interbedded gravel, particularly at depths greater than 10 m from surface. Depth to bedrock is not well established, however depths greater than 50 m are expected. Lower Facility area topography varies from 1,360 masl to 1,373 masl from north to south respectively and from 1,357 masl to 1,373 masl from east to west respectively. The average surface elevation in the area is approximately 1,365 masl.

2.3.3 Area Hydrogeology

In the Elk Valley region, the majority of groundwater flow is transmitted though quaternary deposits. The major aquifers in the alpine region consist of surface colluvium situated along the flanks of the valley slopes. Surficial groundwater flow in these areas is highly seasonal because it is rapidly recharged during periods of snow-melt and high rainfall.

Aquifers along the creek beds within the Elk Valley are typically alluvial, experience groundwater flow throughout the year, and regulate flow of watercourses in the valley

bottom. Quaternary deposits in the Elk Valley also include tills, lacustrine deposits, and organic soils that are expected to behave as aquitards.

2.3.4 General Site Groundwater Conditions

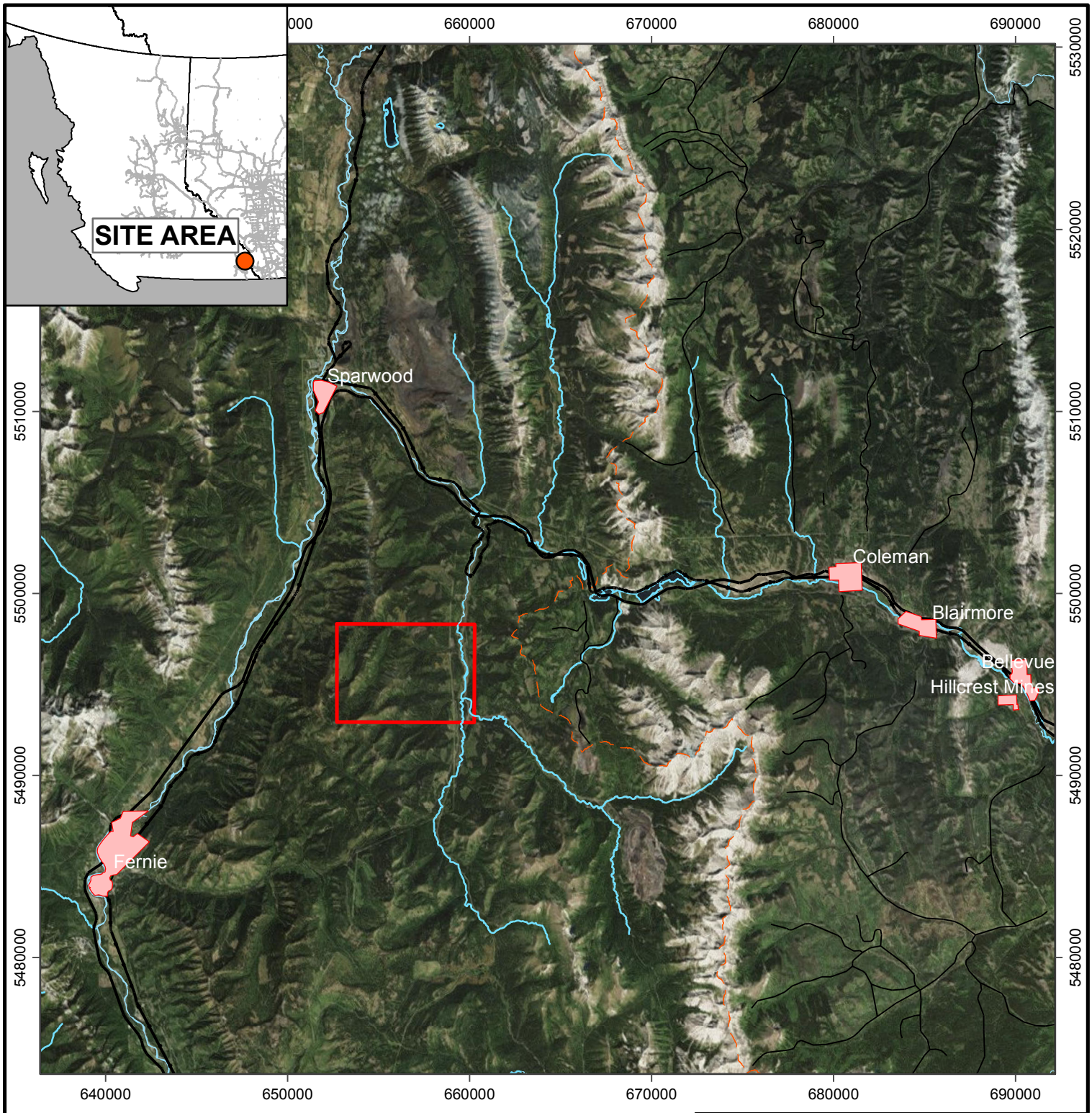
The observed depth-to-water in boreholes and test pits ranged from 0.8 m to 3.5 m. Water table measurements were made in early May which is a seasonal high-level period, and the effects of the spring melt were likely still present in the shallow, surface soils and average water levels may be lower.

Shallow foundation materials are dominated by the presence of extremely permeable coarse sand and gravel layer that extends to 2 to 5 m depth.

Two wells were recently drilled in the area to 135 mbgs and 146 mbgs for groundwater production and monitoring, respectively. Both wells returned artesian flows within a few hours of development which may indicate the potential for comparatively high groundwater pressures in foundation bedrock.

2.3.5 Adjacent Terrain and Potential Geo-hazards

Steep mountainous terrain which is characterized by high snowpack and the presence of other geotechnical hazards occurs west of the generally flat lying Lower Facility area and could potentially impact its design and operation. A terrain and geo-hazard assessment for the Phase 2 project area was completed by Golder Associates Ltd. (Golder) in February 2013. The assessment identified hazards in the Lower Wheeler Creek area (near the Lower Facility site). A review of available information and field reconnaissance with respect to geotechnical hazards identified rockslides, rock falls, debris flows, and snow avalanches as potential risks to development in the area. A stream cut slope is also located immediately east of the Lower Facility area above Michel Creek which shows recent evidence of erosional cut activity and indicates the potential for local slumping and sliding ground movements. Comments and recommendations resulting from Golder's Terrain and Geo-hazard Assessment report can be found in the Feasibility Report Appendix C-1.1.



Legend

- TOWNS
- PRIMARY TRANSPORT
- SECONDARY TRANSPORT
- RIVERS AND LAKES
- PROVINCIAL BORDER
- SITE AREA

N

7,500 0 7,500

Meters

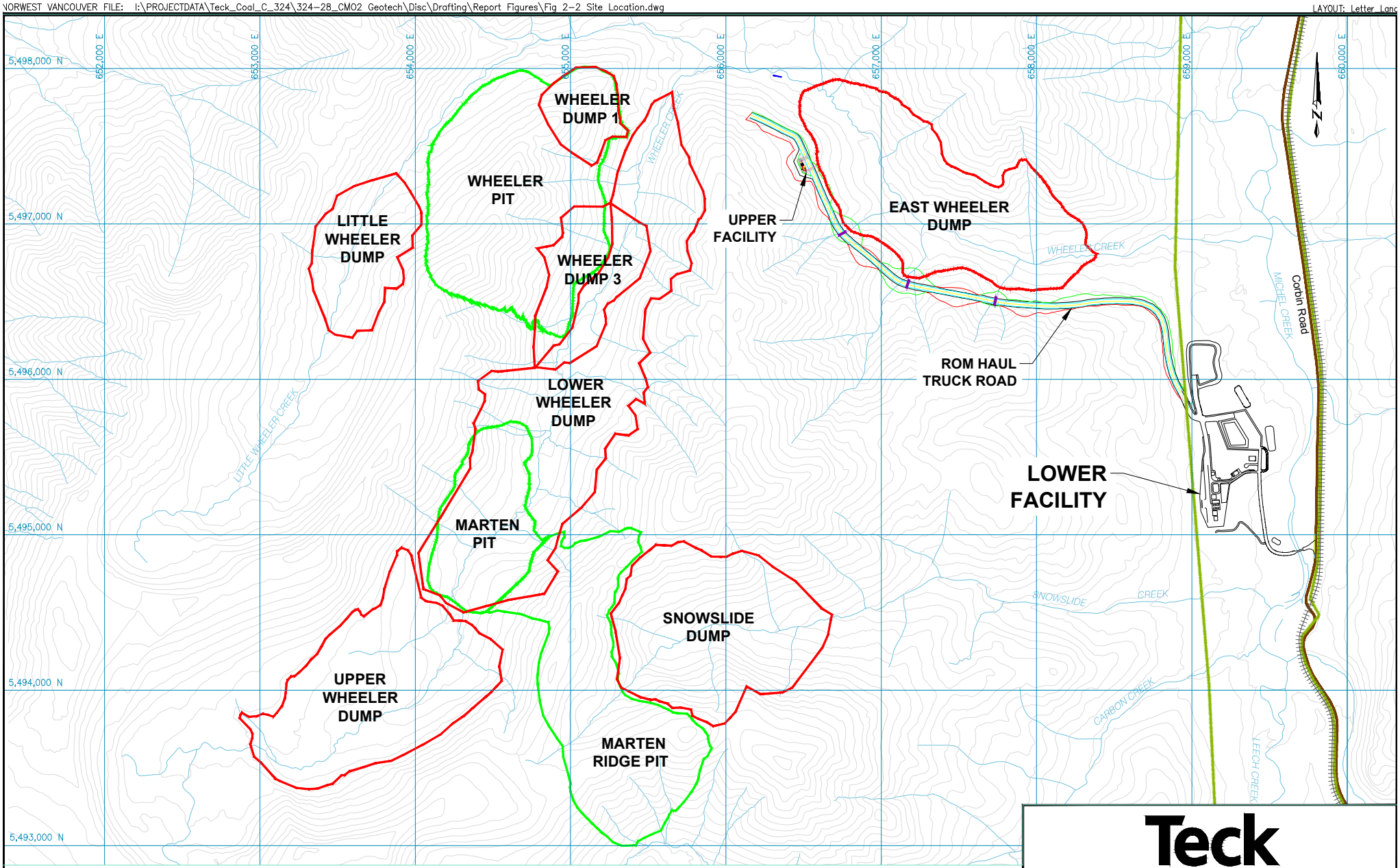
Teck

CMO2 LOWER FACILITY
GEOTECHNICAL REPORT

REGIONAL LOCATION

FIGURE 2-1

DRAWN BY: R.A.M. CHKD BY: S.B. DATE: 17 08 14	FILE: Fig 1 Site Location Map ...\Teck_Coal_C_324\324-28_CMO2 Geotech\Reports\Draft\Figures	NORWEST CORPORATION



LEGEND

- CONTOUR 25 m
- RIVER AND CREEK
- RAILWAY
- POWER LINE
- PIT OUTLINE
- DUMP OUTLINE

1000 600 200 0 500 1000
Metres

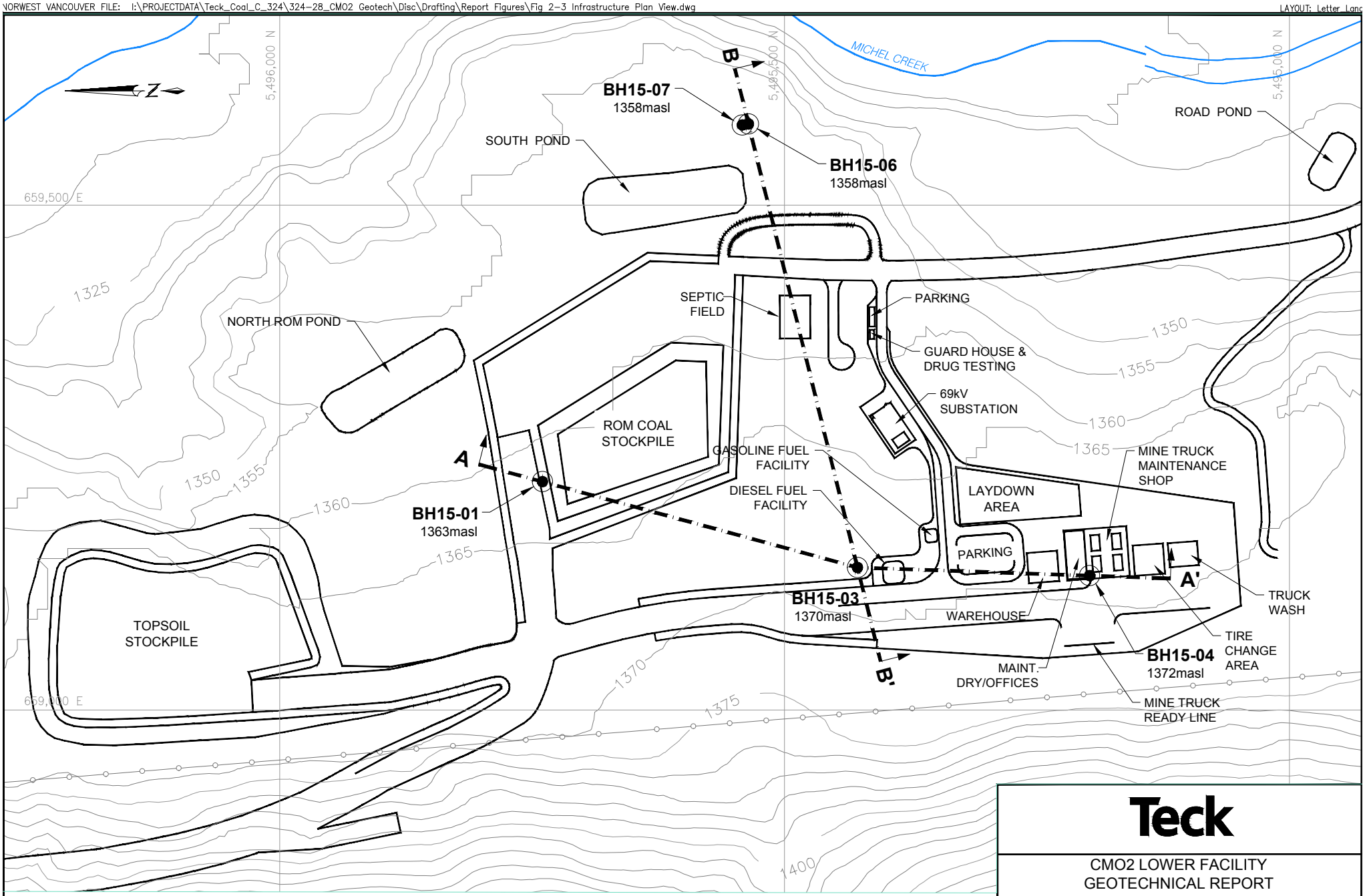
Teck

CMO2 LOWER FACILITY
GEOTECHNICAL REPORT

SITE LOCATION

FIGURE 2-2

DRAWN BY: A.W. CHK'D BY: S.B DATE: 14 08 17	FILE: Fig 2-2 Site Location.dwg ...\Teck_Coal_C_324\324-28_CMO2 Geotech\Reports\Draft\Figures	NORWEST CORPORATION



LEGEND

- CONTOUR 5 m
- POWER LINE
- GEOTECHNICAL BOREHOLE
- FACILITIES AND INFRASTRUCTURE
- SECTION LINE

100m 50 0 100 200 300m

SCALE 1:5000

Teck

CMO2 LOWER FACILITY
GEOTECHNICAL REPORT

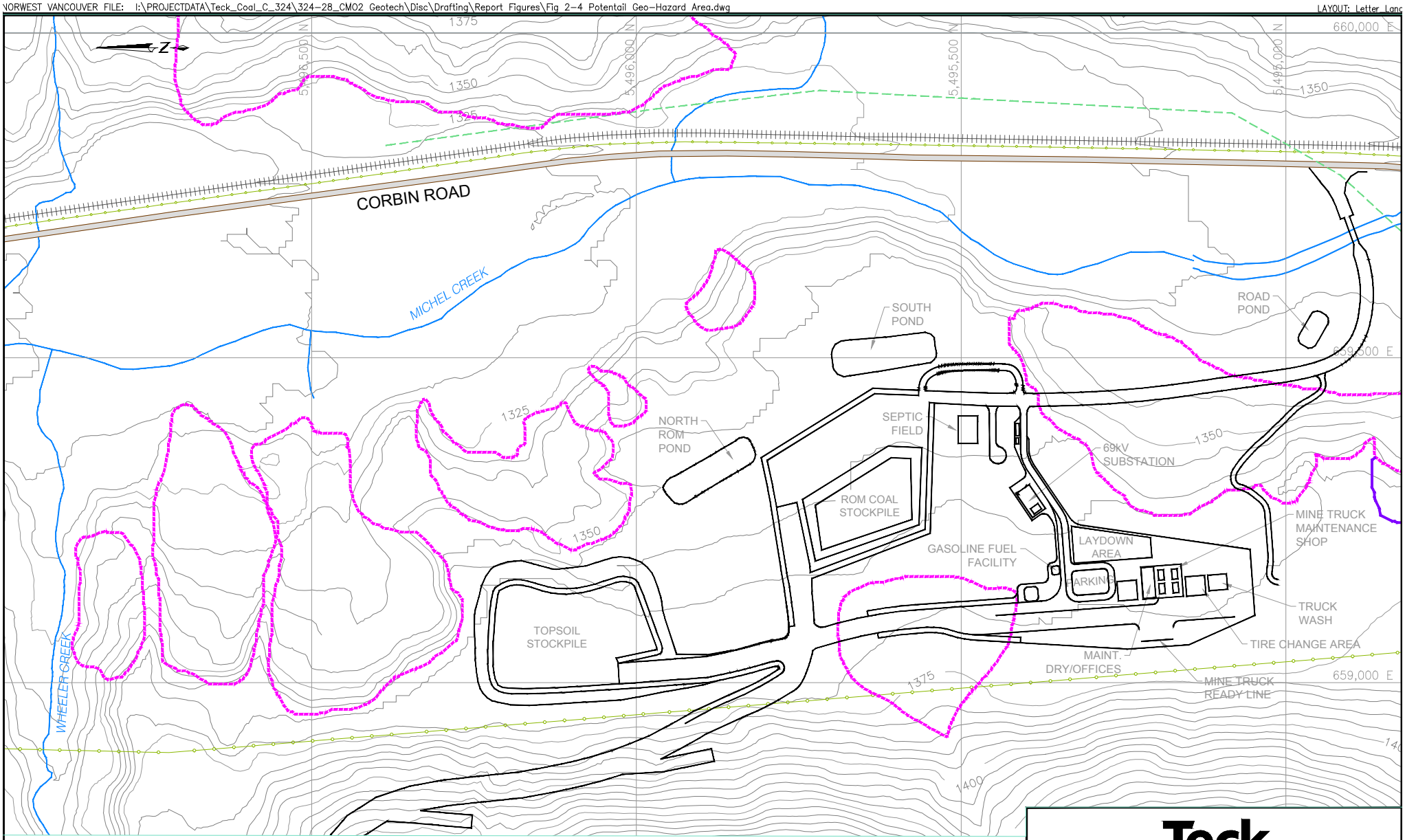
INFRASTRUCTURE PLAN VIEW

FIGURE 2-3

DRAWN BY: A.W. CHK'D BY: S.B DATE: 14 08 17	FILE: Fig 2-3 Infrastructure Plan View.dwg ...\Teck_Coal_C_324\324-28_CMO2 Geotech\Reports\Draft\Figures	NORWEST CORPORATION

NORWEST VANCOUVER FILE: I:\PROJECTDATA\Teck_Coal_C_324\324-28_CMO2 Geotech\Disc\Drafting\Report Figures\Fig 2-4 Potentail Geo-Hazard Area.dwg

LAYOUT: Letter_Land



LEGEND

- CONTOUR 5 m
- POWER LINE
- GAS LINE
- RAILWAY
- FACILITIES AND INFRASTRUCTURE
- AREA GEOHAZARD
- LINEAR GEOHAZARD

200m 100 0 200

SCALE 1:8000

Teck

CMO2 LOWER FACILITY
GEOTECHNICAL REPORT

POTENTIAL GEOHAZARD AREAS

FIGURE 2-4

DRAWN BY: A.W. CHK'D BY: S.B DATE: 14 08 17	FILE: Fig 2-4 Potential Geohazard Area ...\Teck_Coal_C_324\324-28_CMO2 Geotech\ Reports\Draft\Figures	NORWEST CORPORATION

3 FOUNDATION GEOTECHNICAL INVESTIGATION

A site investigation was carried out from May 14 to 30, 2015, to assess the geotechnical foundation conditions in the Lower Facility area. The drilling was completed by Good Earth Drilling Services using ODEX Air Rotary Hammer and split spoon sampling methods in the surficial material and diamond coring to drill bedrock. Borehole logging, data collection, photography and sampling was completed by Norwest field personnel.

3.1 ODEX Drilling and Standard Penetration Tests (SPTs)

Five geotechnical boreholes were completed (BH15-01, BH15-03, BH15-04, BH15-06, and BH15-07) to depths ranging from 22 m to 59 m. Boreholes were completed to a minimum depth of 22 m. Figure 3-1 shows the locations of the foundation investigation boreholes. A summary of the location and total depth of each borehole is provided in Table 3.1.

Table 3.1
Summary of Completed Boreholes

Borehole ID	UTM NAD 83 Coordinate		Elevation (masl)	Total Depth (m)
	Easting	Northing		
BH15-01	659,226	5,495,739	1,363	21.90
BH15-03	659,141	549,5427	1,370	24.86
BH15-04	659,133	5,495,197	1,372	24.86
BH15-06	659,580	5,495,535	1,358	59.95
BH15-07	659,579	5,495,541	1,358	30.80

Note: Coordinates were recorded by Teck survey instruments.

All boreholes were completed using ODEX hammer drilling in the surficial materials. The surficial materials recovered in the ODEX cuttings and split spoon samples were characterized according to the Norwest soil logging procedures which combine elements of the Unified Classification System (American Standard for Testing and Materials (ASTM) D2488-93) and the Canadian Foundation Engineering Manual.

Standard Penetration Testing (SPT) was carried out in surficial materials at 1.5 m intervals where ground conditions permitted. SPTs were completed to identify penetration resistance, define soil density and to collect samples for material classification and laboratory testing. SPTs were performed by recording the number of blows delivered by an automatic hydraulic hammer to advance a split spoon sampler into the ground over four continuous 150 mm (6-inch) increments. The sampler was driven to a total depth of 600 mm, or until refusal (50 hammer

blows). The SPT 'N' value was calculated as the number of blows required to advance the sampler from 150 mm to 450 mm. The following information was routinely recorded for each SPT sample depth test interval; blow counts for each 150 mm interval, SPT 'N' value, and recovery length.

All split spoon samples were described, photographed and collected at defined intervals. Possible weak zones (low blow count zones) were further sampled using Shelby Tube sampling methods to collect and characterize the soft silt and clay deposits beneath the coarser surficial materials.

Borehole logs and SPT results were previously provided in the Norwest July 2015 Geotechnical Investigation Data Report and are included as Appendix A.

3.2 Core Drilling

The drill rig was converted to diamond coring when bedrock was encountered in BH15-06. Bedrock was subsequently cored with an HQ3 diamond drill bit using a standard wireline set-up and a 1.5 m triple tube core barrel. Norwest field personnel logged, photographed and sampled the bedrock core.

Detailed geotechnical logging of the bedrock drill core was carried out in BH15-06 to characterize the rock mass. The following information was collected:

- Core recovery;
- Run depth interval;
- Rock quality designation (rqd);
- Lithological description;
- Moisture/groundwater conditions;
- Field estimated unconfined compressive strength (UCS) from hammer blows; and
- Number of discontinuities, discontinuity types, joint condition of discontinuities (i.e. Roughness, aperture, infilling, weathering, etc.).

3.2.1 Rock Mass Classification

The Rock Mass Rating (RMR) classification system developed by Bieniawski (1989) was used to assess the bedrock encountered during borehole drilling. The RMR logging system assesses five rock mass parameters as follows:

- Uniaxial compressive strength (UCS) or rock hardness was estimated in the field based upon geological hammer blows. RQD was determined for each drilled run by summing the lengths of all intact core pieces greater than 10 cm in length and calculating the ratio of intact core to the total run length.
- Discontinuity spacing was determined by counting the number of naturally occurring fractures per length of drill run.
- Discontinuity condition was determined by assessing fracture persistence, roughness, infilling, aperture, and weathering. Persistence was conservatively assigned a rating of 0 (high persistence).
- Groundwater conditions are assessed qualitatively in the field as ranging from completely dry to flowing conditions.

The sum of the rock mass parameter values is the Rock Mass Rating which provides an estimate of rock mass quality as follows:

- VERY GOOD rock – RMR: 81 to 100;
- GOOD rock – RMR: 61 to 80;
- FAIR rock – RMR: 41 to 60;
- POOR rock – RMR: 21 to 40; and
- VERY POOR rock – RMR: less than 20.

3.3 Sampling and Laboratory Testing

Representative foundation material samples were selected from geotechnical investigation boreholes. Split spoon samples were inspected in the field and stored in moisture-proof bags. Shelby Tube samples remained undisturbed and were further sealed to reduce moisture loss. Representative samples were selected and transported to the Golder Associates Laboratories in Calgary, Alberta. The following laboratory testing was carried out:

- Particle Size Analysis (PSA): 12 tests were completed to assess the gradation characteristics of the materials. Particle size analyses were carried out in accordance with ASTM D422 and D6913 procedures. Hydrometer analyses were used to determine the silt and clay fractions of samples with more than 12 % fines content.
- Atterberg Limits: 12 tests were completed in accordance with the ASTM D4318 liquid and plastic limits test procedure.

- Natural Water Content: 14 tests were completed in accordance with the ASTM D2216 testing procedure.
- Minimum and Maximum Density: five tests were completed to identify soil density. Due to the loose condition of most soil samples, density testing was only completed on more compact samples to identify the probable range of soil density.
- Direct Shear: three tests were completed in accordance with the ASTM D3080 direct shear-consolidated drained, peak and residual test procedure.
- Triaxial Compression: one test was completed in accordance with the ASTM D4767 testing procedure.
- Standard Oedometer: one test was completed in accordance with the ASTM D2435 test procedure.
- Water Soluble Sulphate: two tests were completed in accordance with CSSS CH15/EPA 6010B.

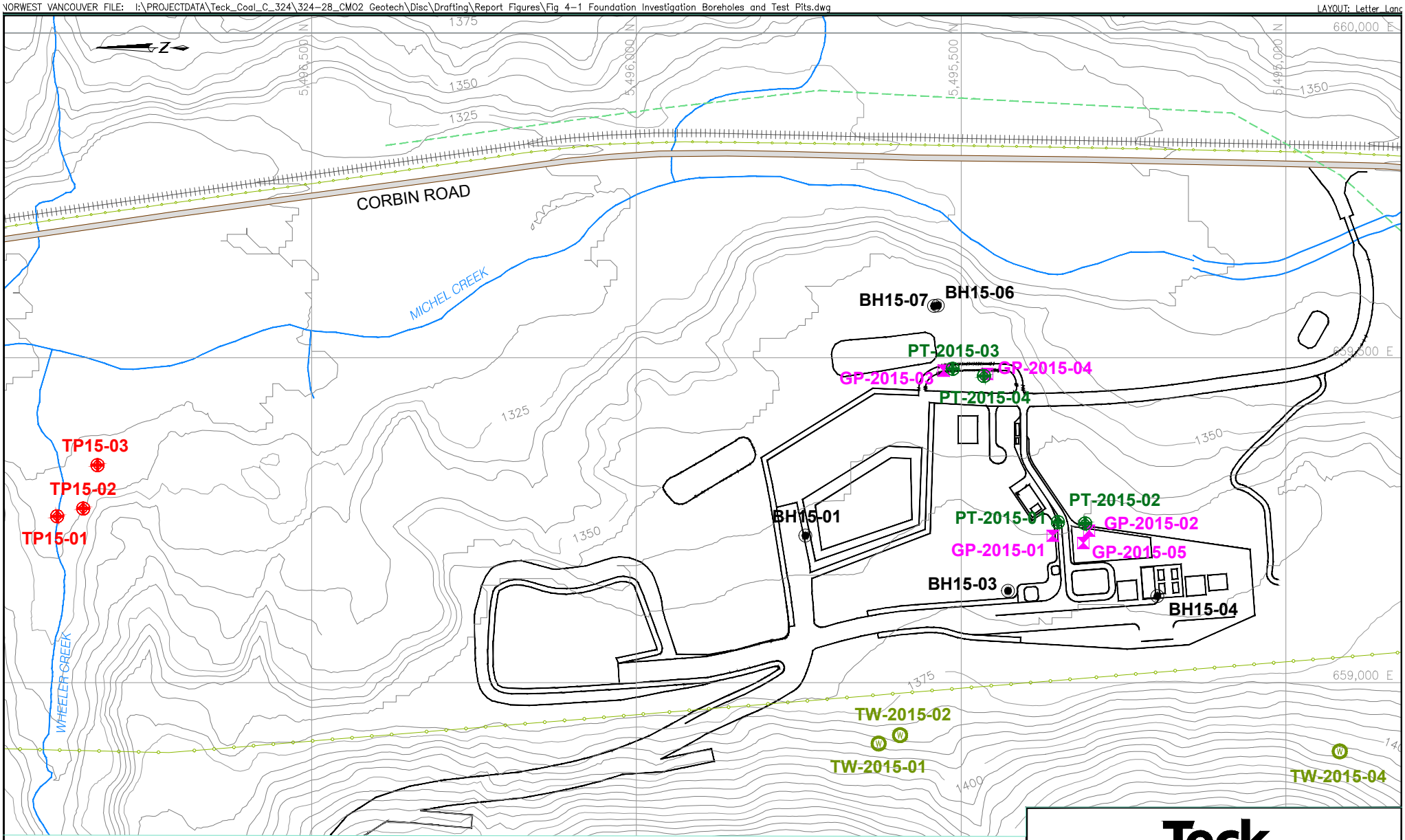
Laboratory testing results are provided as Appendix B.

4 ADDITIONAL INFORMATION

In addition to technical documents cited in the reference section of this report, the following related information and documents were reviewed to assess the Lower Facility area and support design recommendations:

- Two of the five geotechnical investigation boreholes were also used to provide information for a Golder hydrology work scope. These boreholes (BH15-06 and BH15-07) were drilled with SPTs, logged, photographed and sampled for geotechnical conditions and groundwater monitoring wells were installed. The monitoring wells were drilled approximately 5 m apart, with BH15-06 targeting and penetrating bedrock stratum to a depth of approximately 3 m, and the second, shallower well, targeting a highly permeable foundation layer.
- A site investigation for assessment of a sewage area was carried out by Norwest in the Lower Facility area which included four test pits (PT-2015-01, PT-2015-02, PT-2015-03 and PT-2015-04). Figure 4-1 provides the location of test pits and results are provided as Appendix C.
- A site investigation for hydrogeological assessment was carried out by Norwest in the Lower Facility area which included three boreholes (TW-2015-01, TW-2015-02 and TW-2015-04). All boreholes were geophysically logged including natural gamma, normal resistivity and borehole deviation. Borehole TW-2015-04 was completed but deemed unsuitable for well development and abandoned. Figure 4-1 provides the location of boreholes and results are provided as Appendix D.
- A test pit program was carried out by Teck personnel near the lower reaches of East Wheeler Creek (south of the Lower Facility area) to identify foundation conditions in the area of a proposed sedimentation pond and dam. Three test pits (TP15-01, TP15-02 and TP15-03) were logged, photographed, sampled and laboratory testing was carried out for representative samples of foundation materials (moisture content, grain size and Atterberg limits). Figure 4-1 identifies the location of these test pits and results are provided in a data report as Appendix E.
- Coal Mountain Operations 2 - Project Feasibility Study – Draft Water Management Plan, Norwest, July 22, 2015.
- Coal Mountain Operations Phase 2 Projects: Prefeasibility Study, December 2013, Teck Coal Limited.
- Teck Coal Limited CMO2 Feasibility Study, Section 7, Infrastructure and Section 9, Water Management, AMEC Foster Wheeler, Norwest, August 2015.

- Geotechnical Pre-Feasibility Study, Teck Coal Marten Wheeler Project Pit Slopes Geotechnical and Hydrogeological Field Investigation Data Report, Golder Associates, February 6, 2013.
- Building Construction Plans, AMEC Foster Wheeler/Norwest Corporation, May 2015 including:
    - Structural Truck Maintenance Foundation and Ground Floor Slab Plans (Option – 8, Pre-Eng.);
    - Structural Truck Maintenance Foundation Details (Option – 8, Pre-Eng.);
    - Structural Truck Wash Building Foundation and Ground Floor Slab Plans (Option– 2, Pre-Eng.);
    - Structural Truck Wash Building Foundation Sections; and
    - Structural Warehouse Foundation & Ground Floor Slab Plans and Details (Pre-Eng.).



LEGEND

- CONTOUR 5 m
- POWER LINE
- GAS LINE
- RAILWAY
- FACILITIES AND INFRASTRUCTURE
- GEOTECHNICAL BOREHOLE
- SOIL INFILTRATION TESTING
- WATER WELL BOREHOLE
- HYDRO TEST PIT
- EAST WHEELER CREEK LOWER SEDIMENT POND TEST PIT

200m 100 0 200

SCALE 1:8000

Teck

CMO2 LOWER FACILITY
GEOTECHNICAL REPORT

FOUNDATION INVESTIGATION BOREHOLES AND TEST PITS

FIGURE 4-1

DRAWN BY: A.W. CHK'D BY: S.B DATE: 14 08 17	FILE: Fig 4-1 FoundationInvestigationBH&TP ...\Teck_Coal_C_324\324-28_CMO2 Geotech\ Reports\Draft\Figures	NORWEST CORPORATION

5 FOUNDATION ASSESSMENT RESULTS

The Lower Facility foundation materials were assessed using geological and geotechnical information collected from the borehole data including SPTs and laboratory testing. The USCS system was also used to describe and categorize surficial materials as it allows for correlation to approximate shear strength, permeability, compaction characteristics, and volume change potential and may further indicate the effects of water, frost, and other conditions.

Geological and geotechnical interpretations were limited by split spoon sampling frequency, split spoon and core recovery and ODEX casing advancement. In particular, the characterization of the wet fine grained silty sands and sandy silts encountered beneath the surficial sand and gravel layer was inhibited by the percussive nature of the ODEX drilling that caused running sand conditions. Due to this, the SPT blow counts recorded in the wet fine sands and sandy silts are very low and are not considered to be representative of the in situ density. This has been taken into account in our foundation recommendations, but should be confirmed by additional investigations at the building locations for the next level of design.

5.1 Stratigraphy

Geological descriptions from the boreholes and test pits identified the following foundation materials:

- Thin (0.3 m to 0.5 m) topsoil.
- A competent gravel and sand unit with maximum thickness of 3 m beneath area topsoil.
- Below the gravel unit, a saturated unit of fine grained silty sand and sandy silt ranging in thickness from 13 m to 17 m. A more competent clay and silt with sand unit lies below the silty sand unit which contains a greater sand and gravel fraction (interbedded zones) and grades into a gravel zone.
- A competent gravel unit with clay, silt and sand which ranges in thickness from 2 m to 16 m.
- Additional clay, silt, sand and gravel units of varying thicknesses and depths. These strata occurred at depths greater than 22 m and were logged in one borehole.
- Siltstone bedrock was encountered at 52 m (el. 1305.5 m) in borehole BH15-06.

Details of the foundation units are presented in Table 5.1. Cross-sections with more detailed descriptions of foundation units are presented as Figure 5-1.

Table 5.1
Foundation Zones Summary

Foundation Unit Description	Range of Depths to Unit Top (mbgs)	Range of Depths to Unit Bottom (mbgs)	Range of Unit Thickness (m)
Topsoil and Humic Layer	Surface	0.3 - 0.5	0 - 0.5
Sand and Gravel	0 - 0.5	1 - 4.5	1.5 - 4.5
Sand and Silt with Clay, Less Competent	1 - 4.5	13 - 20	13 - 17
Silt and Clay with Sand, More Competent	13 - 20	19 - 23	2 - 10
Gravel with Clay, Silt and Sand*	19 - 23	22 -30	2 - 16
Bedrock	52	NA	NA

*Thicker gravels (>3 m) were only identified at boreholes 06 and 07

5.2 SPT $(N_1)_{60}$ Results

Upon completion of the site investigation, SPT data was corrected for overburden pressure. These corrections were calculated based on Liao and Whitman's *Overburden correction factors for SPT in sand* (1986) and results are presented in Appendix A. Several assumptions were made to correct for the overburden pressure, including estimation of the groundwater surface and the unit weight of the materials. There were no available measurements of the SPT hammer energy and corrections for energy loss were not applied. The results of SPT testing and corrected values are presented in Table 5.2.

Table 5.2
SPT Summary

Foundation Unit Description	Range of SPT N Values	Average SPT N Value	Range of SPT $N1_{60}$ Values	Average SPT $N1_{60}$ Value
Sand and Gravel	6 - 46	23	9 - 74	35
Sand and Silt with Clay, Less Competent*	0 - 10	3	0 - 13	3
Silt and Clay with Sand, More Competent	20 - Refusal (+50)	47	14 -57	32
Gravel with Clay, Silt and Sand	23 - Refusal (+50)	56	17 - 43	31

*N values may be artificially low due to drilling disturbance

5.3 Laboratory Classification Testing

Laboratory testing was carried out to define the material properties of the foundation soil units.

5.3.1 Grain Size Analysis

Grain size analysis was carried out for the less competent sand and silt with clay unit, and the deeper more competent clay and silt with sand unit. A summary of these results is presented in Table 5.3.

Table 5.3
Grain Size Summary

Foundation Unit Description	Range of % Gravel	Average % Gravel	Range of % Sand	Average % Sand	Range of % Silt	Average % Silt	Range of % Clay	Average % Clay
Sand and Gravel*	10 - 40	25	10 - 60	35	15 - 50	30	5 - 20	10
Sand and Silt with Clay, Less Competent	0	0	1 - 30	11	65 - 89	80	6 - 15	10
Silt and Clay with Sand, More Competent	0	0	1 - 8	4	65 - 78	73	20 - 27	23
Gravel with Clay, Silt and Sand*	10 - 40	30	10 - 20	15	10 - 45	30	10 - 45	25

*Estimated from borehole log descriptions and limited laboratory testing

High sand and silt content is common in weaker and shallower foundation materials with lesser clay fractions and no gravel. A larger clay fraction is present in more competent foundation materials.

5.3.2 Atterberg Limits

Atterberg Limits testing was carried out for the less competent sand and silt with clay unit, and deeper more competent clay, silt, sand and gravel units. A summary of these results is presented in Table 5.4.

Table 5.4
Atterberg Limits Summary

Foundation Unit Description	Range of LL (%)	Average LL (%)	Range of PL (%)	Average PL (%)	Range of PI	Average PI	Plasticity Descriptor	USCS Descriptor
Sand and Gravel*	-	-	-	-	-	-	Non	SM, SP-SM, GM, GW, GW-GM, GP-GM
Sand and Silt with Clay, Less Competent	0 - 26	5	0 - 18	4	0 - 8	2	Non- Low	ML, CL
Silt and Clay with Sand, More Competent	26 - 40	31	17 - 20	18	9 - 20	13	Low	CL
Gravel with Clay, Silt and Sand*	-	-	-	-	-	-	Non	GM, GC, GP, GW-GC, GP-GC

*No testing carried out for these zones.

Most foundation materials were identified as non to low plastic. Lower liquid and plastic limits and plasticity indexes were measured in less competent clay and silt foundation material.

5.3.3 Moisture Content

Natural moisture content testing was carried out for the shallow gravel and sand unit, the less competent sand and silt with clay unit, and the deeper more competent clay and silt with sand unit. A summary of results is presented in Table 5.5.

Table 5.5
Moisture Content Summary

Foundation Unit Description	Range of Moisture Content (%)	Average Moisture Content (%)
Sand and Gravel	12 - 14	13
Sand and Silt with Clay, Less Competent	28 - 32	30
Silt and Clay with Sand, More Competent	17 - 31	24
Gravel with Clay, Silt and Sand*	15 - 30	-

*Estimated from laboratory tests for similar samples and borehole descriptions

The results of moisture content testing indicate that lower moisture contents occur in the surface gravel and sand deposits, higher moisture contents are common in the less competent sand and silt with clay unit and lower moisture contents are found at greater depths in more competent materials.

5.3.4 Density

Laboratory testing was carried out for representative samples to identify wet and dry density. Moist Unit Weight was estimated. Results are presented in Table 5.6.

Table 5.6
Density Summary

Foundation Unit Description	Average Dry Density (kg/m^3)	Average Wet Density (kg/m^3)	Dry Density from SPT $N1_{60}$ (kg/m^3)	Moist Unit Weight (kg/m^3)**
Sand and Gravel	-	-	2022*	2114
Sand and Silt with Clay, Less Competent	1452	1854	-	1378
Silt and Clay with Sand, More Competent	1967	2195	-	1922
Gravel with Clay, Silt and Sand	-	-	1951*	2082

*Values interpolated from laboratory density testing and SPT $N1_{60}$ results

**Estimated from Bowles

Note: Very low density values for sand-silt-clay materials may not be representative but due to low blow counts in strata disturbed by drilling.

5.3.5 Soluble Sulphates

Laboratory testing was carried out for near surface samples to assess foundation soils for the presence of higher concentrations of sulphate which can contribute to the deterioration of concrete foundations. Test results are provided in Table 5.7.

Table 5.7
Sulphate Summary

Foundation Unit Description	Sample Zone (m)	Sulfur (as SO4) (mg/kg)	% Sulphate	Cement Type
Sand and Gravel	1.5 - 2.0	18.0	0.002	ASTM C150 Type I*
Sand and Gravel	3.0 - 3.5	14.1	0.001	ASTM C150 Type I*

*No requirement – negligible sulphate measured in tested samples

The results of sulphate testing indicate that negligible sulphate is present in near surface foundation materials. Based upon these results, sulphate attack should not be a concern in the area and no specific concrete type requirements are necessary.

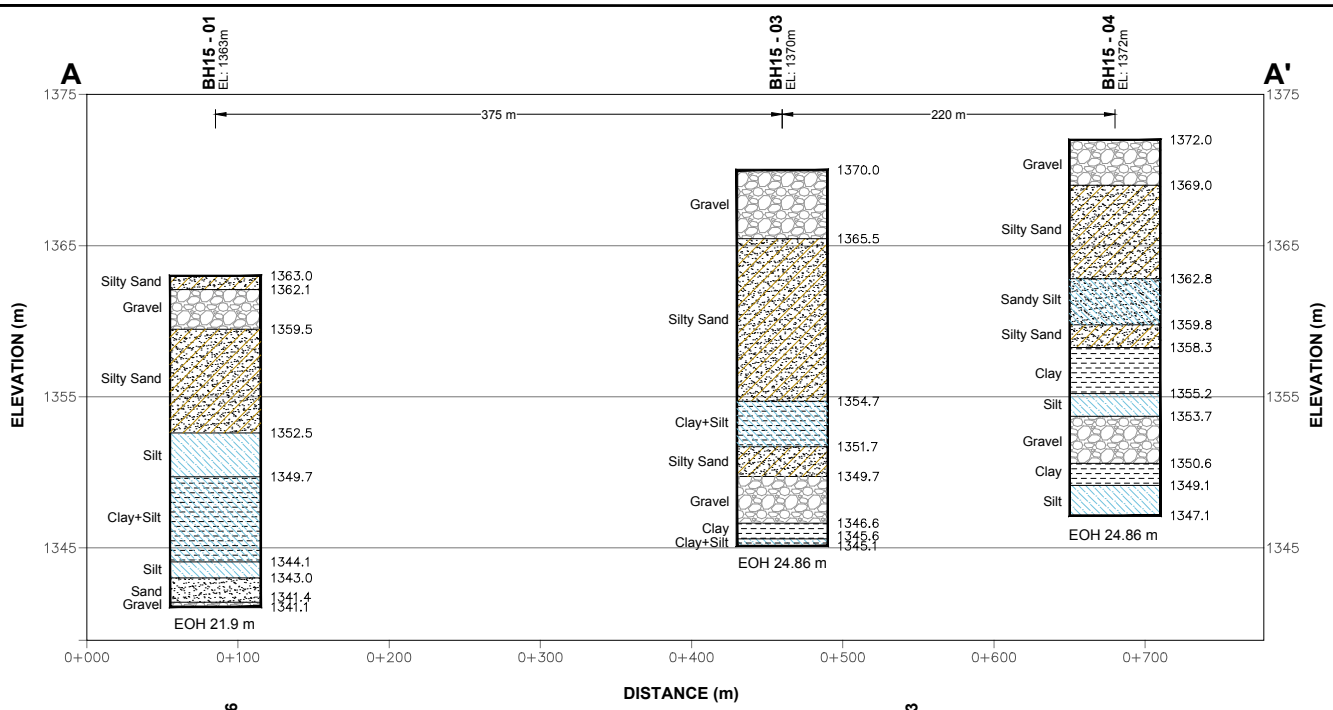
5.4 Bedrock Foundation Materials

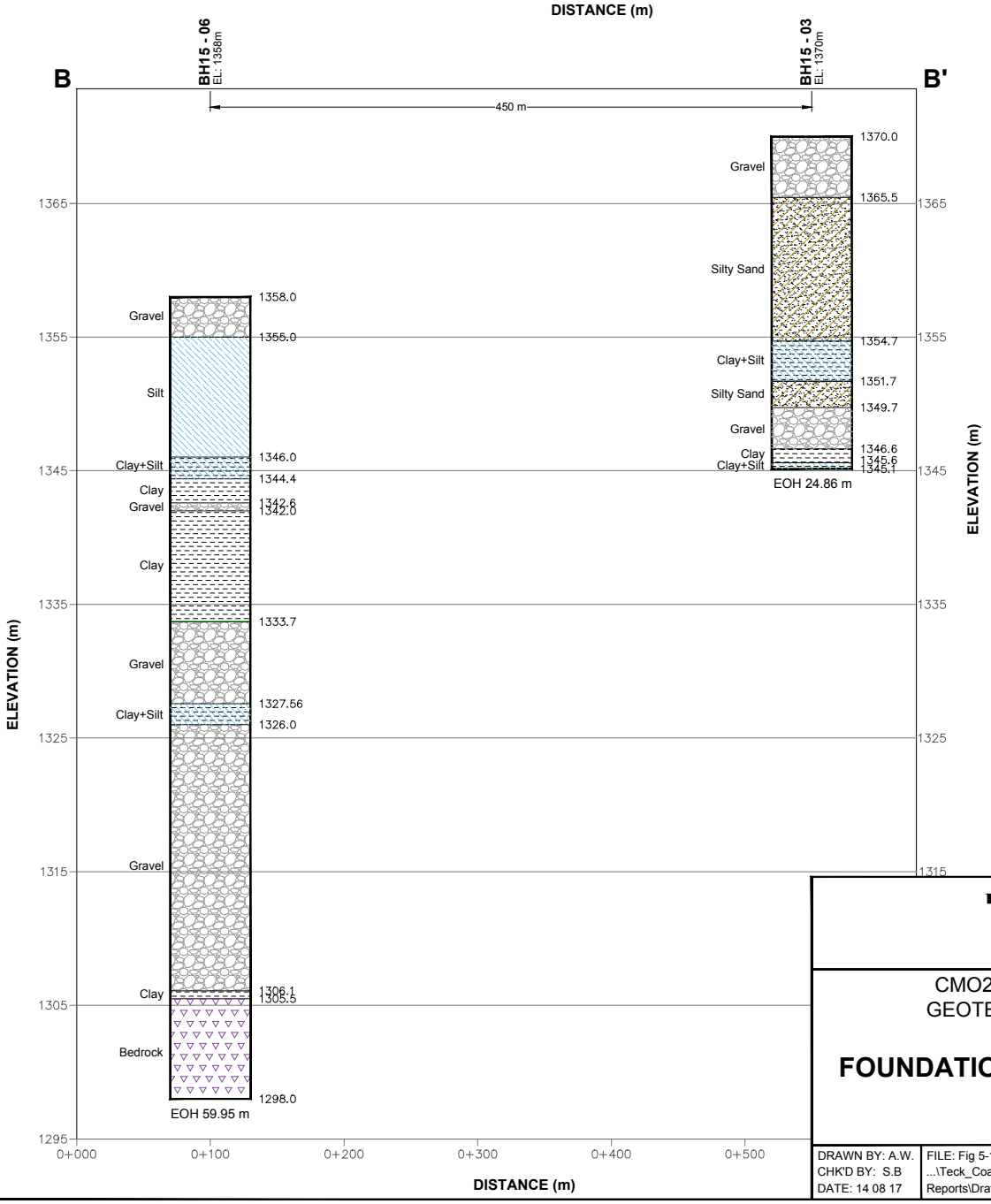
BH15-06 was drilled approximately 3 m into bedrock to confirm depth to bedrock and record rock mass properties. Contact bedrock was identified as claystone and/or siltstone, which at the soil/bedrock contact was highly fractured with minimal intact rock core greater than 10 cm in the first two runs. Three 1 m runs were drilled with resultant RQD values of 17%, 0% and 73% respectively. The rock strength indicated by geological hammer blows ranged from R1 to R2 depending on intensity of factures and gouge percentage in the discontinuities. The bedrock was fine grained, damp, with rough and weathered fracture surfaces. A possible fracture zone was identified between 56.5 m to 56.8 m which contained clay gouge.

Calculated RMR values from logged samples ranged from 40 to 60 RMR, consistent with FAIR rock mass quality. No laboratory testing of bedrock material properties was completed, however the Golder Geotechnical Pre-Feasibility Study Pit Slopes Geotechnical Data Report (February 2013) identified average point load strength indexes (I_{s50}) of 3.04 MPa and a range of wet density values of 2527- 2694 kg/m^3 for siltstone bedrock.

5.5 Depth to Groundwater

The depth to the water table in each of the five boreholes was identified at approximately 3 m below surface; however the ability to measure the precise depth to ground water was hampered by the use of water to lubricate the drill bit during advancement. Other area investigations (boreholes and test pits) identified water table depths which range from 0.8 m to 2.7 m. Hydrogeological wells drilled to 135 m to 146 m depth upslope of the Lower Facility area recorded sustained artesian flows shortly after completion.





LEGEND

- Gravel
- Sand
- Silt
- Clay
- Silty Sand
- Sandy Silt
- Clay+Silt
- Bedrock

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FOUNDATION CROSS-SECTIONS

FIGURE 5-1

DRAWN BY: A.W. CHK'D BY: S.B DATE: 14 08 17	FILE: Fig 5-1 Foundation Cross-Sections.dwg ...\Teck_Coal_C_324\324-28_CMO2 Geotech\ Reports\Draft\Figures

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6 FOUNDATION DESIGN PARAMETERS AND RECOMMENDATIONS

Based upon assessment of the results of the foundation investigation and review of additional related information, Norwest has developed preliminary geotechnical parameters for foundation design. Foundation subgrade improvement will likely be required where the surficial more competent sand and gravel unit is less than 5 m thick. This assumption should be confirmed by further investigations at the Truck Shop, Warehouse, Truck Wash, Dry and Office Building sites for the next level of design. Where the surficial sand and gravel unit is less than 5 m thick, sub-excavation will be required to remove less competent and frost susceptible wet silty sands to at least 2 m below the base of foundations and replacement with engineered structural fill.

6.1 Shear Strength Parameters

Shear strength parameters were developed for the foundation materials based on the results of the geotechnical investigation and laboratory results, the USCS classification system and typical representative parameters for foundation materials.

Table 6.1
Soil Shear Strength Parameters

Material Description	USCS Classification	Unit Weight KN/m^3	Friction Angle (degrees)	Cohesion (kPa)	Poissons Ratio	Youngs Modulus (MPa)
Structural Fill	GW-SW	21	36	0	0.3	100
Sand and Gravel	GP-GM	21	36	0	0.3	100
Sand and Silt with Clay	SP-SM	18	25	0	0.3	30
Silt and Clay with Sand	ML-CL	19	30	0	0.3	50
Gravel with Clay, Silt and Sand	GP-GC	21	36	0	0.3	50

Note: All Young's Modulus values estimated from Direct Shear and Triaxial Test Results

6.2 Allowable Bearing Pressures for Shallow Foundations

Current Lower Facility infrastructure plans call for construction of most structures on in-situ surficial material or structural fill as required dependent upon foundation conditions. Allowable bearing capacities, q_{allow}, were estimated by applying a factor of safety to the ultimate bearing capacities, q_{ult}, for each type of foundation, i.e.

$$q_{allow} = q_{ult}/3$$

The ultimate bearing capacities were determined using the bearing capacity equations as per Vesic (1975).

$$q_{ult} = c' N_c S_c + q_s N_q S_q + 1/2\gamma B N_\gamma S_\gamma$$

Where:

q_{ult} = Ultimate Bearing Capacity of the subgrade material (MPa)

c' = Cohesion of subgrade material (kPa)

γ = Dry unit weight of subgrade material (kN/m^3)

B = Width of footing (m)

q_s = $\gamma \times D$ (kPa)

D = Embedment depth of the foundation (m)

N_i = Dimensionless bearing capacity factors as per Hansen (1970) & Meyerhof (1963)

S_i = Dimensionless modification factors for foundation shape, inclination, depth, tilt and ground shape, as per Vesic (1975)

Allowable bearing capacities for the Lower Facility infrastructure founded on a minimum of 2 m of in-situ sandy gravels or engineered Structural Fill are summarized in Tables 6.2 and 6.3 for strip and spread footings respectively.

Table 6.2
Allowable Bearing Capacities (kPa)

Foundation Depth (m)	Strip Footing Width (m)			
	1	2	3	4
2	130	140	155	170
2.5	145	160	175	190
3	160	180	195	205

Table 6.3
Allowable Bearing Capacities (kPa)

Foundation Depth (m)	Rectangular Footing Width (m)			
	1	2	3	4
2	120	140	150	160
2.5	140	150	165	180
3	160	170	185	195

6.3 Estimated Settlements for Shallow Foundations

The total settlements for spread and strip footings for the foundation widths and applied bearing pressures shown in Tables 6.2 and 6.3, placed on at least 2 m of in-situ sand and gravel or engineered structural fill over less competent silty sand and sandy silt were estimated to be less than 10 mm.

6.4 Earth Pressure Coefficients

Coefficients of lateral earth pressure have been estimated for probable foundation subgrade materials as summarized in Table 6.4. The estimates assume a vertical retaining wall with free draining subgrade material placed behind the wall in horizontal lifts, as the silty sand and sandy silt beneath the surficial sand and gravel is not suitable for use as backfill.

Table 6.4
Earth Pressure Coefficients

Material Description	USCS Classification	Coefficient of Earth Pressure at Rest (K_0)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Passive Earth Pressure (K_p)
Structural Fill	GW-SW	0.4	0.25	3.8
Gravel with Clay, Silt and Sand	GP-GM	0.4	0.3	3.5

6.5 Modulus of Subgrade Reaction for Foundations on In-Situ Surficial Materials or Structural Fill

The modulus of subgrade reaction for in-situ overburden and Structural Fill can be estimated for various footings using the formula below:

$$Ks = q/s$$

Where

Ks = modulus of subgrade reaction (kPa/m)

q = applied pressure

s = settlement of footing under applied pressure q

The modulus of subgrade reaction for the Lower Facilities structures for footings with an embedment depth of 2.5 m (recommended embedment depth as per Section 6.7.1) is estimated

to be 10 kPa/mm for footings on at least 2 m of Structural Fill or in-situ sand and gravel over less competent silty sand.

6.6 Foundation Piles

Due to the relatively light loadings expected from the fabric structures and the significant thickness of the sensitive silty sand and sandy silt unit beneath the surficial sand and gravel, as well as an expected depth to bedrock of over 50 m, piled foundations are not recommended at this time. Based on the disturbance noted during the ODEX drillhole investigations, when running sand was encountered, the driving of piles through the sensitive wet silty sand unit could be expected to cause significant disturbance and loss of lateral support. Similarly, augered and cast in place piles would be difficult to install through the wet running silty sand.

6.7 Frost Action

Frost heave and frost jacking may impact area infrastructure as a result of surficial material freezing. Surficial material heaving may occur as a result of:

- Freezing temperatures in surficial materials;
- Ground or surface water impacts; and
- Frost-susceptible surficial material.

Frost heaving may be mitigated in foundations by burying foundations at depths below frost penetration depth, excavation to estimated frost penetration depth and replacement of susceptible material with non-frost susceptible structural fill and the use of drainage and thermal protection measures. The probable depth of frost penetration and adfreeze pressure recommendations follow.

6.7.1 Frost Penetration Depth

Many factors influence the depth of frost penetration below foundations for heated structures. Some of these factors may include the subgrade condition, moisture condition at or below the foundation grade, temperature inside the building during cold weather, whether the building is continuously heated during cold weather, and the rate of heat transfer from the building to footing grade.

Preliminary frost penetration depths of approximately 2.5 m for in-situ material and Structural Fill material were estimated using the methodology provided in the Canadian Foundation Engineering Manual, 4th Edition (2006).

6.7.2 Foundation Frost Protection

Concrete footings should not be placed on frozen surficial material and the surficial material beneath the footings should not be allowed to freeze during or after construction. Concrete footings should be protected from the inclement weather and proper curing conditions should be established as outlined in the Canadian Standards Association concrete specifications (CSA, 2009).

6.7.3 Adfreeze Pressures

Adfreeze pressures against concrete and steel surfaces are affected by the surficial material type, moisture content, surficial material temperature and rate and magnitude of heave at the surface. The Canadian Foundation Engineering Manual (2006) suggests average adfreeze bond stresses (determined from field tests) typically range from 65 kPa for fine grained surficial materials frozen to wood or concrete and up to 100 kPa for fine grained surficial materials frozen to steel. Adfreeze stresses in saturated very cold, coarse grained surficial materials frozen to steel can reach up to 150 kPa. The silty sand and sandy silt materials encountered at the site are highly frost susceptible and are not suitable for re-use as backfill. This assumption should be verified by geotechnical engineers during future site investigations.

6.8 Cut and Fill

Recommendations for subgrade preparation, cut slopes for excavation and structural and common fill specifications are presented in the following sections.

6.8.1 Foundation Subgrade Preparation

Shallow foundations are to be placed a minimum of 2.5 m below grade for frost protection. At this depth it is likely that some foundations will penetrate the surficial sand and gravel unit and encounter the wet silty sand and sandy silt unit beneath. Where this occurs, the silt and sand unit should be sub-excavated to 2 m below foundation level, a layer of geotextile should be placed over the base of the foundation excavation and then structural fill should be compacted up to foundation level. It is recommended that additional investigations are carried out at all building locations to confirm where this sub-excavation will be required. In particular, if less than 2 m of competent surficial sand and gravel is encountered under slabs on grade that will support haul trucks, sub-excavation and replacement with structural fill will be required.

Where the weaker wet silty sands and sandy silts are encountered near the surface along haul road alignments, it is recommended that a layer of geotextile is placed over

the weaker materials, followed by 1 m of structural fill, then a layer of geogrid followed by another 1 m of structural fill as a haul road sub-base.

6.8.2 General Subgrade Preparation

All areas to be graded should be cleared of organic material and topsoil removed and stockpiled. After the topsoil has been removed, the in-situ soil subgrade material should be scarified to a minimum depth of 150 mm, moisture conditioned, if necessary, and compacted to a minimum 95% Standard Proctor maximum dry density. Following moisture conditioning and compaction, the subgrade should be proof-rolled to identify weak or soft areas. Local soft and/or wet materials should be removed and replaced with Structural Fill in layers of 150 mm compacted thicknesses or as directed by the Geotechnical Engineer.

Full time monitoring and compaction testing should be provided during any fill placement or proof-rolling to confirm that the specifications are being achieved. Qualified geotechnical personnel, independent of the contractor, should perform this monitoring.

6.8.3 Cut Slopes in Soils

Temporary cut slopes in natural soils should be sloped no steeper than 1.5H:1V. Where cut slopes are excavated into the wet silty sand and sandy silt unit, temporary cuts will likely need to be sloped at 2H:1V or less. In addition, groundwater seepage into the excavations will need to be controlled by pumping from sumps. In the surficial sand and gravel, steeper slopes up to 1H:1V may be possible provided the slope height does not exceed the heights stipulated by Worksafe BC regulations. Permanent cut slopes in natural soils should not exceed 2H:1V or as required by the Ministry of Energy and Mines permitting requirements and reclamation objectives.

6.8.4 Placement/Fill

Full time monitoring and compaction testing should be provided during any fill placement or proof-rolling to confirm that compaction and other design specifications are met. Qualified geotechnical personnel, independent of the contractor, should perform this monitoring.

6.8.4.1 Structural Fill

Structural Fill should consist of reasonably well-graded hard, durable, free draining, crushed sands and gravels. It should be free of organics, frozen material and other deleterious debris and should have a Plasticity Index less

than 6. The following Structural Fill material gradation specification is recommended:

- Structural Fill should contain between less than 5% passing a 0.075 mm sieve and maximum aggregate size not exceeding 100 mm.
- Non-frost susceptible Structural Fill (if required) should have the following gradation limits:

Table 6.5
Non-Frost Susceptible Structural Fill Specifications

Sieve Size or Particle Size (mm)	Percent Passing by Weight
75	100
25	50 – 100
4.75	20 – 60
1.18	10 – 40
0.075	0 – 10

Structural Fill materials should be moisture conditioned for compaction before and/or during placement. The material should be placed, spread, and levelled and compacted in lifts not exceeding 300 mm. Each lift should be compacted to a minimum 98% Standard Proctor Maximum Dry Density (ASTM D698) or 75% of maximum relative density for granular materials.

Where Structural Fill material is used as a foundation under structures, the fill should project a minimum of 2 m from the edge of the proposed footing at a maximum slope of 1H:1V to allow for distribution of stresses.

6.8.4.2 Common Fill

Compacted common fill (coarse grained soils with fines) may be used for general backfill outside of the influence footprint of structures. The common fill maximum particle size should be less than 300 mm and should contain less than 30% fines (passing a 0.075 mm sieve). The silty sand and sandy silt unit beneath the surficial sand and gravel unit in the area of the structures has a high moisture content and is not recommended for use as common fill.

Common fill material should be placed in maximum 500 mm lifts. Each lift of fill should be moisture conditioned prior to compaction to within 2 percent of the optimum moisture content for compaction, and should be compacted to minimum 95% Standard Proctor Maximum Dry Density (ASTM D698).

6.9 Site Drainage

The final surrounding grades should be sloped so that surface water is directed away from the buildings and towards existing site drainage pathways. Foundation drains should be provided for all below grade walls and should consist of 150 mm continuous, perforated PVC drain pipe, placed in a minimum 300 mm by 300 mm of 20 mm minus drain rock. Filtration, consisting of continuous layer of geotextile fabric, should be provided between the drain rock zone and the adjacent native soils. Where possible, the permanent foundation drainage system should be provided with clean-outs to allow for future maintenance and inspection.

During drilling and test investigations, relatively shallow groundwater was encountered. This will need to be controlled during foundation excavation by pumping from sumps. To help reduce groundwater infiltration into the area, both during construction and following construction, consideration should be given to installing a perimeter drain to the west of the buildings that would drain by gravity around the buildings to outlets downslope to the east.

7 PROJECT LIMITATIONS AND RISKS

Five boreholes were drilled over a large area during the foundation site investigation with a single borehole at the location of the main building structures. Little or no foundation investigation had been carried out in the project area prior to this investigation. Given the scope and extent of the Lower Facility infrastructure and the results of foundation investigation completed to date, additional investigation and design assessment is recommended prior to detailed design and construction. Additional foundation assessments should include at a minimum:

- Four Cone Penetration Tests (CPTs) to a minimum depth of 25 m in critical infrastructure areas – one each within the planned footprint of the truck maintenance building, the truck wash building, the fuel facilities and the electrical substation.
- Two sonic or similar boreholes to identify the depth to bedrock and bedrock conditions and to sample critical foundation and bedrock units (low blow count or otherwise identified weak units) for material strength testing. Boreholes should be drilled in the footprint of the truck wash building and the truck maintenance building.
- 21 test pits – four to target the corners of the truck maintenance building, two each to target the ROM coal and topsoil stockpiles and the north ROM, south and road sedimentation pond areas and one each to target the tire change area, warehouse, fuel facilities, electrical substation, laydown area, guardhouse and septic field area to identify depths of competent material.
- Laboratory testing of materials for grain size, Atterberg limits, moisture content, specific gravity, material strength (direct shear, triaxial), consolidation, Standard Proctor, soil resistivity and other relevant geotechnical properties.

Additional geotechnical investigation of the east and west abutment areas for the planned Michel Creek bridge should also be carried out. The investigation should include a minimum of two boreholes (one on each abutment) and any other geotechnical investigation as needed to determine required parameters for possible piling placement.

It is noted that the site is in a zone of seismic activity and the low SPT blow counts recorded in the silty sand and sandy silt unit suggest that this unit is potentially liquefiable. Further investigations and testing should be directed towards determining to what extent the fine grained and wet silty sands and sandy silts beneath the site could be impacted by a seismic event.

8 CLOSURE

This report provides results of the geotechnical foundation investigation and recommendations for foundation design of the mine facilities and infrastructure at the Teck Coal Limited CMO2 Lower Facilities area. All geotechnical information and recommendations contained herein have been reviewed and interpreted by, or under the direct supervision of, Steven Bundrock, P.Eng., with review by Tim Peterson, P.Eng. and Sean Ennis, P.Eng. As mutual protection to Teck Coal Limited, the public, and ourselves, this report is submitted for exclusive use by Teck Coal Limited. We specifically disclaim any responsibility for losses or damages incurred through the use of our work for a purpose other than as described in the report. Our reports and analyses should not be reproduced in whole or in part without our express written permission, other than as required in relation to this permit application.

NORWEST CORPORATION

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Appendix A
Borehole Logs and SPT Results

NORWEST CORPORATION

Project: 324-28

Borehole #: BH-15-01

Borehole location (m) E: 659226.1	N: 5495739.7	Date drilled: May 18th 10:00 to May 19 11:30hrs
Ground elev (m): 1362.9	Casing elev (m): 1.42m	Contractor / rig type: Good Earth Drilling Services/ODEX/Air Hammer Drill
Borehole dia (in): 6	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (ft): 21.9	Logged by: L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
0	0.45	0	0.45	SS	7	7	8	15		0	-		No recovery-rock in shoe of SS
0.45	0.91	0.45	0.91	SS	6	10	13	23		23	6200		SAND (SM) silty, fine to coarse grained, some gravel(20%), subrounded to subangular-max particle 5cmx3.5cm, loose, damp, light brown, musty odour, minor roots
0.91	1.37	0.91	1.37	SS	12	17	27	44		2	-		Very wet silty GRAVEL (GM) fine to coarse grained, subrounded to subangular, some cobble, angular(poor recovery, no sample taken, photo taken)
1.37	3.05										GS		Grab Sample GW: angular, cut from drill
3.05	4.5	Casing Down											
		3.53	3.98	SS	2	2	4	6		36	6201		Poorly Graded SAND with silt (SP-SM) some clay, fg-mg, subrounded, non-plastic, very soft consistency, dark brown, wet to saturated, laminated with organic silt/clay, 1-2mm, rapid dilatancy
4.5	6	Casing Down									GS		Fine-very coarse GRAVEL (GW)
		4.95	5.41	SS	1	2	2	4		35	6202		Poorly graded SAND with silt (SP-SM) 70% fg, subrounded, poorly graded, 30% fines, dark brown in colour, rapid dilatancy, wet, max size coarse sand, carbonaceous material.
6	7.5	Casing Down											

Notes: WT: ~3.5m

NORWEST CORPORATION

Project: 324-28

Borehole #: BH-15-01

Borehole location (m) E: 659226.1	N: 5495739.7	Date drilled: May 18th 10:00 to May 19 11:30hrs
Ground elev (m): 1362.9	Casing elev (m): 1.42m	Contractor / rig type: Good Earth Drilling Services/ODEX/Air Hammer Drill
Borehole dia (in): 6 inch	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (ft): 72ft/21.9m	Logged by: L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
		5.79	6.24	SS	1	1	2	3		33	6203		Top 20cm (SM) well graded silty SAND, some fines (15%), sand fg, subangular to subrounded, brown, non-plastic fines, carbonaceous material ~3mm. Lower 13cm inorganic SILT with sand (ML) low plasticity,some clay, fg sand, poorly graded, slow dilatancy, low toughness, laminated <5mm
7.5	9	Casing Down											
		7.39	7.84	SS	1	1	2	3		52	6204		Poorly Graded SAND, silty (SM) 15-20% fines, fg sand, subangular to subrounded, laminated with 1mm clay/silt laminae, up to 1cm thick beds > 10cm apart, grey brown in color, wet, fines have non to low plasticity, rapid dilatancy, low toughness, 3cm fragmented coal laminae in top of sample.
9	10.5	Casing Down											
		8.99	9.44	SS	1	1	2	3		65	6205		Top 29cm of 65cm: Silty SAND (SM) with 20% fines, trace gravel, poorly sorted subangular to rounded, thinly bedded non-plastic fines, max 1.5cm subrounded. Middle 30cm: SILT with sand (ML) 20% subrounded, fg sand, poorly sorted, grey in colour. Very soft, wet-saturated, thinly laminated, slow dilatancy, none to low plasticity. Bottom 16cm: Lean organic CLAY(CL) some silt, low plasticity, rapid dilatancy, low toughness
15.1	16.5	Casing Down											

Notes:

NORWEST CORPORATION

Project: 324-28

Borehole #: BH-15-01

Borehole location (m) E: 659226.1	N: 5495739.7	Date drilled: May 18th 10:00 to May 19 11:30hrs
Ground elev (m): 1362.9	Casing elev (m): 1.42m	Contractor / rig type: Good Earth Drilling Services/ODEX/Air Hammer Drill
Borehole dia (in): 6 inch	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (ft): 72ft/21.9m	Logged by: L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	Description
		10.49	10.9	SS	1	1	2	3		66.5	6206		Clayey SILT (ML/CL) grey, wet-saturated, low plasticity, trace fg sand, rapid dilatancy, low toughness
10.5	11.9	Casing Down											
		11.8	12.4	SS	1	1	1	2		53	6207		SILT (ML) clayey (35%), non to low plasticity, very soft, grey, wet- saturated, structureless, rapid dilatancy, toughness is low
11.9	13.4	Casing Down											
		13.3	13.8	SS	1	1	1	2		57	6208		SILT (ML) and clay (40%), low plasticity, very soft, grey, wet-saturated, structureless, rapid dilatancy, low toughness
13.4	15.1	Casing Down											
		15.08	15.5	SS	1	1	1	2		66.5	6209		SILT (ML) and clay (45-55%) interbedded, silt 25cm beds, 2-3cm clay beds, low plasticity in silty beds, low-med plasticity in clay beds, very soft to soft consistency, grey, wet to saturated, thinly laminated with dark <1mm silt laminations, rapid dilatancy, low strength in silt beds,medium toughness in purer clay beds
16.5	18.4	Casing Down											

Notes:

NORWEST CORPORATION

Project: 324-28

Borehole #: BH-15-01

Borehole location (m) E: 659226.1	N: 5495739.7	Date drilled: May 18th 10:00 to May 19 11:30hrs
Ground elev (m): 1362.9	Casing elev (m): 1.42m	Contractor / rig type: Good Earth Drilling Services/ODEX/Air Hammer Drill
Borehole dia (in): 6 inch	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (ft): 72ft/21.9m	Logged by: L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	Description
		18.92	19.4	SS	1	1	1	2		66.5	6210		Clayey SILT (ML/CL) low-medium plasticity, soft consistency, wet-saturated, laminated dark <1mm striations grey clays, low dilatancy, medium toughness.
18.4	20	Casing Down									GS		Grab Sample-Clayey GRAVEL (GC) drilled
		19.98	20.4	SS	3	5	5	10		20	6211		Top 12cm: SAND (SW) fg-mg, trace silt and gravel, loose compactness, max particle 4mm, subangular to subrounded, brown, wet. Bottom 8cm: Well Graded GRAVEL with clay(GW-GC) fines 40%, low plasticity, loose to compact, wet, subangular to subrounded, max particle 2cm, homogeneous.
20	21.5	Casing Down									GS		Grab Sample-Clayey GRAVEL(GC)
		21.48	21.9	SS	14	17	13	30		15	6212		Top 10cm: Well graded SAND (SW) trace silt, fg-cg sand, homogeneous, max 3mm, subrounded to subangular, brown in color, wet. Bottom 5cm: Well graded gravel with CLAY(GC) fine to coarse grained, subangular, non-low plastic fines(45%), grey, soft consistency, wet, homogeneous, structureless.
													TD: 21.9m

Description
Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other

Notes: Grey sandstone cobble in shoe. Hole sloughing under rig, hazardous-moving rig to next hole

NORWEST CORPORATION

Project: 324-28 Teck CM02 Geotech

Borehole #: BH-15-03

Borehole location (m)	E: 659141.1	N: 5495427.7	Date drilled: May 29/15 14:30 - May 30/15 16:30
Ground elev (m):1370.1		Casing elev (m): 1.5m	Contractor / rig type: Good Earth Drilling Services - Airhammer
Borehole dia (in): 6		**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m): 24.86		Logged by. Paul Brown	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	Description
0	1.5	Casing Down											
		1.5	1.95	SS	11	22	24	46		23	6278		SILTY GRAVEL (GM) fine-coarse grained, trace cobble, well graded, max 3cm, loose, subangular, brownish grey, no odour, wet, no structure
1.5	3										GS		GRAB SAMPLE-Silty gravel, fines washed away
		3	3.45	SS	3	11	12	23		28	6279		SILTY GRAVEL (GM) fine-coarse grained, trace cobble, well graded, max 3cm, loose, angular to subangular, brownish grey, no odour, wet, no structure, trace oxidation
3	4.5	Casing Down									GS		GRAB SAMPLE-Silty gravel, fines washed away
		4.55	5	SS	8	6	4	10		30	6280		SILTY SAND (SW-SM) some gravel, fine grained, subangular, fine-coarse grained gravel, well graded, max 2cm, loose-compact, no odour, wet, no structure, brown-light brown
4.55	6.13	Casing Down									GS		GRAB SAMPLE-Silty gravel, fines washed away
		6.13	6.58	SS	2	2	3	5		40	6281		SILTY SAND (SP-SM) fine grained, trace gravel, max 3cm, poorly graded, loose-compact, dark brown, no odour, wet, no structure, trace carbonaceous material
6.13	7.63	Casing Down									GS		Grab Sample-SILTY SAND, trace gravel

Notes: Grab Samples not indicative of grain size or structure due to hammer drills, water from surface; WT: ~3m

NORWEST CORPORATION

Project: 324-28 Teck CM02 Geotech

Borehole #: BH-15-03

Borehole location (m)	E: 659141.1	N: 5495427.7
Ground elev (m): 1370.1		Casing elev (m): 1.5m
Borehole dia (in): 6		**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston
Total depth (m): 24.86		Logged by. Paul Brown

Date drilled: May 29/15 14:30 - May 30/15 16:30

Contractor / rig type: Good Earth Drilling Services - Airhammer

Drill interval		Sample/log interval		Sample type	SPT Blows 0-6" A	SPT Blows 6-12" B	SPT Blows 12-18" C	SPT N B+C	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
(m)	(m)	(m)	(m)		blows	blows	blows	blows					
		7.63	8.07	SS	1	1	1	2		60	6282		SILTY SAND (SP-SM) some clay, very fine grained, poorly graded, compact, brown-dark brown, no odour, wet-saturated, no structure, trace carbonaceous material.
7.63	9.19	Casing Down											Grab Sample - SILTY SAND, trace gravel
		9.19	9.65	SS	1	1	2	3		46	6283		SILTY SAND (SP-SM) trace clay, fine to very fine grained, poorly graded, compact, brown-dark brown, no odour,saturated, no structure
9.19	10.69	Casing Down											Grab Sample - SILTY SAND, trace clay
		10.69	11.2	SS	1	2	5	7		60	6284		SILTY SAND (SP-SM) trace clay, fine to very fine grained, poorly graded, compact, brown-dark brown, no odour,saturated, no structure, trace carbonaceous material.
10.69	12.24	Casing Down									GS		Grab Sample - SILTY SAND, trace coarse grained sand
		12.24	12.7	SS	1	1	1	2		65	6285		SILTY SAND (SP-SM) fine to very fine grained, some clay, poorly graded, compact, brown, no odour, saturated, no structure, clay increases downward, trace carbonaceous laminae.
12.24	13.74	Casing down											Grab Sample- SILTY and CLAY, some vf grained sand

Notes:

NORWEST CORPORATION

Project: 324-28 Teck CM02 Geotech

Borehole #: BH-15-03

Borehole location (m)	E: 659141.1	N: 5495427.7	Date drilled: May 29/15 14:30 - May 30/15 16:30
Ground elev (m): 1370.1		Casing elev (m): 1.5m	Contractor / rig type: Good Earth Drilling Services - Airhammer
Borehole dia (in): 6		**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m): 24.86		Logged by. Paul Brown	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
		13.74	14.2	SS	1	1	2	3		65	6286		SILT and SAND (ML) some clay, fine grained sand, non-plastic, very soft, greyish brown, no odour, wet, vague bedding, no dry strength, rapid dilatancy, trace carbonaceous material.
13.74	15.29	Casing down									GS		No grab sample - no recovery
		15.29	15.74	SS	1	-	1	1		65	6287		SILT and CLAY(ML) trace fine grained sand, low plasticity, firm, greyish brown, no odour, moist, rapid dilatancy, low dry strength, trace carbonaceous material, laminated.
15.29	16.79	Casing down									GS		GRAB SAMPLE- SILT and CLAY, some gravel
		16.79	17.24	ST	SHELBY TUBE					15	6288		SILT AND CLAY - 15cm recovery
16.79	18.3	Casing down									GS		GRAB SAMPLE- SILT and CLAY, trace gravel
		18.3	18.74	SS	14	14	40	54		30	6289		SAND and SILT (SP-SM) some clay, fine grained sand, rock fragments at bottom, dark brown and greyish brown, light grey rock fragments, poorly graded, loose, wet, no odour, no structure.
18.3	19.8	Casing down									GS		Grab Sample - GRAVEL and SILT, fines washed away

Notes:

NORWEST CORPORATION

Project: 324-28 Teck CM02 Geotech

Borehole #: BH-15-03 *Page 4 of 4*

Borehole location (m)	E: 659141.1	N: 5495427.7	Date drilled: May 29/15 14:30 - May 30/15 16:30
Ground elev (m): 1370.1		Casing elev (m): 1.5m	Contractor / rig type: Good Earth Drilling Services - Airhammer
Borehole dia (in): 6		**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m): 24.86		Logged by. Paul Brown	

Drill interval (m)	Drill interval (m)	Sample/log interval (m)	Sample/log interval (m)	Sample type	SPT Blows 0-6" A blows	SPT Blows 6-12" B blows	SPT Blows 12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	Description
		19.8	20.26	SS	5	11	9	20		29	6290		SILTY SAND (SP-SM) some gravel, fine grained, poorly graded, max 20cm, subrounded, dark brown, no odour, wet, no structure.
19.8	21.36	Casing down											Grab Sample - SILTY GRAVEL, coarse grained sand
		21.36	21.81	SS	-	-	-	-		-	-		Hole sloughed in 1m, no SPT taken. No sample, SPT landed at 20.36m.
21.36	22.86	Casing down											Grab Sample - SILTY GRAVEL, fines washed away
		22.86	23.31	SS	16	24	26	50		-	-		SPT got stuck in hole, tip/catcher lost downhole. No sample, drilled through sample interval.
		23.36	23.82	SS	9	21	4	25		50	6291		SILTY CLAY(CL) trace gravel, low plastic, very stiff, brownish grey, no odour, damp, no dry strength, no dilatancy, no structure.
22.86	24.42	Casing down									GS		Grab Sample - SILTY CLAY
		24.42	24.86	SS	10	20	30	50		51	6292		SILT and CLAY(ML-CL) some gravel, non-plastic, hard, brownish grey, no odour, no dry strength, no dilatancy, moist, no structure, trace oxidation, trace carbonaceous debris.

Notes:

Field log v2004.1

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-04

Borehole location (m) E: 659133.1

N: 5495197.7

Date drilled: May 28/15 14:00hrs - May 29/15 12:00

Ground elev (m): 1371.9

Casing elev (m): 1.5m

Contractor / rig type: Good Earth Drilling Services-Air Hammer Drill

Borehole dia (in): 6

Sample type: AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston

Total depth (m): 24.86

Logged by L. Gielen

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
0	1.5	Casing Down											
		1.5	1.95	SS	7	8	5	13		29	6263		Poorly graded GRAVEL with silt and some sand (GM) 15% silt (fines non-plastic) 15% fg-mg subangular sand, loose-compact, angular to subrounded, light brown, wet, no structure.
1.5	3	Casing Down									GS		GRAB SAMPLE-fg-cg GRAVEL, fines washed away
		3	3.45	SS	1	1	2	3		28	6264		Poorly graded SAND and silt (30%) (SM) homogeneous, very soft compactness, max particle 3mm, flat elongated gravel, organic silt stringers 1mm in upper 5cm, light brown, moist to wet, rapid dilatancy
3	4.55										GS		Grab Sample-silt, sandy gravel
		4.55	5	SS	1	1	2	3		35	6265		Poorly graded SAND and silt (30%) (SM) fg-mg, subangular to rounded sand, bedded 3-10cm, black, laminae, light brown, organic odor, wet, rapid dilatancy (fines non- plastic)
4.55	6.13	Casing Down									GS		Grab Sample - silty sand
		6.13	6.58	SS	1	1	1	2		45	6266		Poorly graded SAND, silty (20%) (SM) fg-mg bedded 3-10cm, organic silt laminae 1-3cm stringers, 3mm high plastic laminae at 18cm, max particle cg sand, light brown-orange, organic odour, wet, rapid dilatancy, very soft consistency.

Notes: Grab Samples not indicative of grain size or structure-due to hammer drill. WT: ~3.0 m

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-04

Borehole location (m)	E: 659133.1	N: 5495197.7	Date drilled: May 28/15 14:00hrs - May 29/15 12:00
Ground elev (m): 1371.9		Casing elev (m): 1.5m	Contractor / rig type: Good Earth Drilling Services-Air Hammer Drill
Borehole dia (in): 6		**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m): 24.86		Logged by L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	Description
6.13	7.63	Casing Down									GS		Grab Sample - silty sand
		7.63	8.07	SS	1	1	1	2		55	6267		Poorly graded SAND and silt (30%) (SM) increasing grain size downhole, fg-mg, bedded 3-10cm, high plastic clay beds at 25cm(<0.5cm thick) and 48cm(1cm thick), very loose compactness, subangular to rounded shape, light brown-orange, wet, rapid dilatancy
7.63	9.19	Casing Down									GS		Grab Sample - too fine
		9.19	9.65	SS	1	1	1	2		66.5	6268		Sandy SILT (ML) (0-40cm), fg sand (35%) non-plastic, very soft consistency, dark brown, musty odour, wet to saturated, rapid dilatancy. 40-43cm-high plastic CLAY bed 3cm thick. 43-66cm: Silty SAND (SM), fg - mg, bedded >10cm, very loose consistency, max particle fg gravel, 35% silty, subangular, brown, wet to saturated.
9.19	10.69	Casing Down									GS		No Grab Sample - too fine
		10.69	11.2	ST	SHELBY TUBE						ST		No Sample - Attempted Shelby Tube, sediment did not hold, fell out of tubing
10.69	12.24	Casing Down									GS		No Grab Sample - too fine

Notes:

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-04

Borehole location (m) E: 659133.1

N: 5495197.7

Date drilled: May 28/15 14:00hrs - May 29/15 12:00

Ground elev (m): 1371.9

Casing elev (m): 1.5m

Contractor / rig type: Good Earth Drilling Services-Air Hammer Drill

Borehole dia (in): 6

Sample type: AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston

Total depth (m):24.86m

Logged by L. Gielen

Drill interval		Sample/log interval		Sample type	SPT Blows				Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
					0-6" A	6-12" B	12-18" C	SPT N B+C					
(m)	(m)	(m)	(m)		blows	blows	blows	blows					
		12.24	12.7	SS	0	0	0	0		66.5	6269		0-30cm: Silty SAND (SP-SM) poorly graded, fines increasing downhole, fg-mg, trace black organic silt laminations 1-5mm, very loose compactness, brown colour, saturated, sharp contact with high plastic CLAY bed at 30-31.5cm, thinly laminated clay, varved, medium toughness, high dry strength. 31.5-66.5cm SILT (ML) low plasticity, very soft consistency, grey to dark grey color, saturated, rapid dilatancy, thinly laminated, low toughness, dry strength low, trace clay.
					Note: Weight of hammering tool pushed 18": no blow count								
12.24	13.74	Casing Down									GS		Grab Sample - silt (no sample)
		13.74	14.19	ST	SHELBY						6270		SHELBY: Top-Silt Bottom-CLAY
													Transition zone
13.74	15.29	Casing Down									GS		Grab Sample - Clayey gravel
		15.29	15.74	SS	5	9	19	28		28	6271		CLAY (CL) gravelly (20%) angular to subangular, cg, max particle 2cm, fines low-medium plasticity, varved, soft consistency, grey, musty odour, wet, no structure
15.74	16.79	Casing Down									GS		Grab Sample- Gravel - fines not captured
		16.79	17.24	SS	18	50/R				20	6272		SILT (ML) some fg sand, fines non-plastic, soft-firm consistency, light grey with orange weathered silt blebs, organic odour, damp, trace gravel, angular 2cm, structureless, no dilatancy. Large cobble cut in top of run. Refusal at 4" into 6-12".
					Refusal at 4"								

Notes:

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-04

Borehole location (m) E: 659133.1	N: 5495197.7	Date drilled: May 28/15 14:00hrs - May 29/15 12:00
Ground elev (m): 1371.9	Casing elev (m):1.5m	Contractor / rig type: Good Earth Drilling Services-Air Hammer Drill
Borehole dia (in): 6	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m):24.86m	Logged by L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
16.79	18.3	Casing Down									GS		Grab Sample- Silty Gravel
		18.3	18.7	SS	8	11	37	48		29	6273		SILT (ML) sandy (25%) fg-mg, trace gravel(10%), subrounded, max particle 2cm, trace clay (10%) fines low plasticity (less in sandier zones-sand increases downhole-10cm bed) soft to firm consistency, brown grey with light orange brown blebs, musty odour, moist, thinly bedded silty and sandy zones, 10cm.
18.3	19.8	Casing Down									GS		GRAB SAMPLE-silty/clayey gravel
		19.8	20.3	SS	50/R					16	6274		Refusal at 4" for 0-6 inch. GRAVEL with clay and sand (GP-GC) fines (25%) low plasticity, sand (35%) gravel fg - cg, poorly graded, subangular to subrounded, compact to dense, max particle size 2cm, subangular, light grey with weathered silt blebs, structureless, moist
					Refusal at 4"								
19.8	21.36										GS		Grab Sample - Clayey Gravel
		21.4	21.8	SS	30	45	50/R			45	6275		CLAY (CH) with trace silt (10%) grey/white color, trace fg sand (10%) some gravel fg-cg (20%) fines high plastic, stiff to very stiff, multi-coloured, organic/musty odour, moist, structureless, no dilatancy, medium toughness, dry strength high, moderately weathered.
							Refusal at 2"						
21.36	22.86	Casing Down									GS		Grab Sample - Silty/Clayey Gravel

Notes: Pictures for run #13 sample number incorrect-should be sample 6274

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-04

Borehole location (m) E: 659133.1	N: 5495197.7	Date drilled: May 28/15 14:00hrs - May 29/15 12:00
Ground elev (m): 1371.9	Casing elev (m):1.5m	Contractor / rig type: Good Earth Drilling Services-Air Hammer Drill
Borehole dia (in): 6	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m): 24.86m	Logged by L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
		22.86	23.3	SS	15	27	30	57		53	6276		SILT (ML) trace clay, trace fg sand, some subangular fg-cg gravel (20%) non-low plastic fines, firm consistency, light brown and multicoloured, weathered slightly to moderately, damp to moist, low dry strength, no dilatancy.
22.9	24.4	Casing Down									GS		Grab Sample- Silty/Clayey gravel
		24.74	24.9	SS	30	36	30	66		51	6277		CLAYEY SILT (ML/CL) medium plasticity, trace sand and gravel (fg), firm to stiff consistency, light brown and multicoloured, moderately weathered, moist, no dilatancy, medium toughness, medium dry strength.

Notes:

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-06

Borehole location (m) E: 659580.5

N: 5495535.7

Date drilled: May 19/15 09:00 - May 26/15 14:00

Ground elev (m): 1357.9

Casing elev (m): 1.5m

Contractor / rig type: Good Earth Rig Services - Air Hammer

Borehole dia (in): 6

Sample type: AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston

Total depth (m): 59.95m

Logged by: L. Gielen

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
0	0.45	0	0.45	SS	6	9	10	19	18	32	6213		SILTY GRAVEL(GM), poorly graded, some fg sand(15%), loose density,angular to subrounded, damp, dark brown, 7mm silt bed at 7-14cm, orange/brown in color, laminated 3mm silt beds, no structure in gravel, roots present throughout, non-plastic fines.
0	1.50	Set Casing(Halfway)				W=Ground water at 1.5m					GS		Grab Sample-From Drill SILTY GRAVEL(GM), grain size not accurate due to drill method
		1.49	1.95	SS	7	12	9			30	6214		GRAVEL (GW) well graded (0-19cm), fg-cg, angular to subrounded, loose density, multi-colored gravel, moist-wet, homogeneous, no structure. 19-30cm Silty GRAVEL (GM) well graded, trace fg sand, angular to subangular in shape, 20% fines non plastic, wet, homogeneous, no structure.
1.5	3.00	Set Casing									GS		Grab Sample- (GM) SILTY GRAVEL-drilled and flushed
		2.99	3.45	SS	1	0	0	0	18	32	6215		CLAYEY SILT(ML/CL) low-medium plasticity, very soft consistency, grey with dark organic silt less then 1mm laminations every 5cm, wet, thinly bedded, varved, rapid dilatancy, dry strength is med, low toughness (top 5cm sub angular silty gravel)
3	4.50	Set Casing(Halfway)									GS		Grab Sample-none-too fine grained/flushed

Notes: Grab Sample lithology not accurate-drilled grain size skewed and fines washed away. WT: ~3.0m

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-06

Borehole location (m) E: 659580.5

N: 5495535.7

Date drilled: May 19/15 09:00 - May 26/15 14:00

Ground elev (m): 1357.9

Casing elev (m): 1.5m

Contractor / rig type: Good Earth Rig Services - Air Hammer

Borehole dia (in): 6

Sample type: AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston

Total depth (m): 59.95m

Logged by: L. Gielen

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	Description
		4.49	4.95	SS	1	0	0	0		66.5	6216		SILT (ML) with sand, 15% fg and clay, low plasticity in silty lower 2/3, grain size decreasing downhole to clayey silt, 2cm high plastic clay bed, wet to saturated, laminated <6mm beds, rapid dilatancy, low toughness.
4.5	6	Set Casing									GS		Grab Sample- None-too fine
		5.99	6.45	SS	1	0	0	0		66.5	6217		CLAYEY SILT (ML/CL) low plasticity, very soft consistency, wet to saturated, laminated 2mm beds with dark silty stringers from 20-25cm, varved, rapid dilatancy, dry strength is low, low toughness
6	7.7	Set Casing(Halfway)									GS		No Grab Sample- too fine
		7.62	8.07	SS	1	1	0	1		66.5	6218		CLAYEY SILT (ML/CL) low plasticity, very soft consistency, wet to saturated,thinly laminated, varved, 1-2mm dark silt stringers, rapid dilatancy, dry strength is low, low toughness
7.7	9.2	Casing Down									GS		No Grab Sample
		9.06	9.83	SS	1	0	0	0		66.5	6219		CLAYEY SILT (ML/CL) low-medium plasticity, soft consistency, grey, wet, laminated bedding 1mm dark grey 1mm silt laminations in top 20cm, rapid dilatancy, dry strength is low-medium, low-medium toughness, clay bed at 10 - 13cm, medium to high plasticity
9.2	10.7	Set Casing halfway									GS		No Grab Sample

Notes: Run #5 Pictures have run #4 depths on white board

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-06

Borehole location (m) E: 659580.5

N: 5495535.7

Date drilled: May 19/15 09:00 - May 26/15 14:00

Ground elev (m): 1357.9

Casing elev (m): 1.5m

Contractor / rig type: Good Earth Rig Services - Air Hammer

Borehole dia (in): 6

Sample type: AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston ST=Shelby Tube

Total depth (m): 59.95

Logged by: L. Gielen

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	Description
		10.7	11.15	SS	1	1	3	4		66.5	6220		SILT (ML) low plasticity, very soft consistency, grey, organic odour, wet-saturated, thinly laminated <1mm dark silt (organic) laminations, rapid dilatancy. 3cm clay bed at 36-39cm, medium plasticity, low toughness, dry strength is medium
10.7	12	Casing Down									GS		No Grab Sample
		11.98	12.44	SS	1	1	3	4		64.0	621		Interbedded SILT and CLAY (ML/CH) silt low plasticity, clay high plasticity, silt beds 10-20cm thinly laminated with 1-4cm claybeds at 13cm (1cm), 30-33cm and 53-57cm. Silt soft consistency dark grey, wet-saturated, rapid dilatancy, low toughness and dry strength medium. Clay beds high plasticity, rapid dilatancy, medium toughness, dry strength of medium to high.
12	13.7	Casing Halfway									GS		No Sample
		13.6	14.14	SS	1	2	5	7		66.5	6222		CLAY (CH) trace silt, high plasticity, soft to firm consistency, dark grey, wet, homogeneous, varved, slow dilatancy, medium to high toughness, dry strength is very high
13.7	14.4	Casing down									GS		No Grab Sample
		14.4	14.8	ST	Shelby Tube					Full	6223		ST Sample: Top CLAY (CL), Bottom: Gravelly CLAY (CL) 2cm subangular
14.4	15.4	Casing Down									GS		Grab Sample- Gravel and Clay- not representative accurately

Notes: Run 11 depths are incorrect on photos

Field log v2004.1

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-06

Borehole location (m) E: 659580.5	N: 5495535.7	Date drilled: May 19/15 09:00 - May 26/15 14:00
Ground elev (m): 1357.9	Casing elev (m): 1.5m	Contractor / rig type: Good Earth Rig Services - Air Hammer
Borehole dia (in): 6	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m): 59.95	Logged by: L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
		15.4	15.8	SS	9	11	12	23		26.0	6224		Top 16cm: GRAVEL (GM) cg, clayey, some fg-cg sand, poorly graded, angular to subrounded, grey, wet, homogeneous, no structure, max particle 2.5cm, 20% fines, low to medium plasticity.
													Bottom 16-26cm: Gravelly lean CLAY (CH) high plasticity, 30% gravel, poorly graded, subangular to rounded, stiff consistency, grey, moist to wet, homogeneous, none to slow dilatancy, toughness is high, dry strength is medium, max particle 1cm
15.4	16.8	Casing Down									GS		Grab Sample-Gravel: drilled grain size, not reliable
		16.8	17.2	SS	10	18	27	45		35.0	6225		Sandy Lean CLAY with gravel (CH) high plasticity, sandy and gravely, fg-cg, stiff consistency, moist, grey, homogeneous, none to slow dilatancy, high toughness, dry strength is high, maximum particle 1.5cm, sub-rounded to angular, gap graded.
16.8	18.4	Casing Down											No Grab Sample
		18.4	18.8	SS	25	32	40	62		36.0	6226		Sandy Lean CLAY with gravel (CH) medium to high plasticity, sandy and gravelly, stiff consistency, moist-wet, grey, homogeneous, none to slow dilatancy, high toughness, max particle 4cm, angular to subrounded, gap graded, dry strength is high (homogeneous with mg-cg sandy 1-2cm beds 10cm apart)

Notes:

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-06

Borehole location (m) E: 659580.5	N: 5495535.7	Date drilled: May 19/15 09:00 - May 26/15 14:00
Ground elev (m): 1357.9	Casing elev (m): 1.5m	Contractor / rig type: Good Earth Rig Services - Air Hammer
Borehole dia (in): 6	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m): 59.95	Logged by: L. Gielen	

Drill interval (m)	Drill interval (m)	Sample/log interval (m)	Sample/log interval (m)	Sample type	SPT Blows 0-6" A blows	SPT Blows 6-12" B blows	SPT Blows 12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
18.4	19.8										GS		Grab Sample - Clayey Gravel
		19.8	20.2	SS	16	25	28	53		39.0	6227		Sandy lean CLAY with gravel (CH) high plasticity, fg-cg sand, fg-cg gravel, subangular to rounded, firm to very stiff consistency, grey, moist to wet (wet in top of tube), homogeneous, none to low dilatancy, high toughness, high dry strength, silt blebs.
19.8	21.4	Casing									GS		Grab Sample - Gravelly Clay
		21.3	21.8	SS	10	23	35	58		45.5	6228		Sandy lean CLAY with gravel (CH) high plasticity, fg-cg sand increasing grain size downhole, fg-cg gravel, sub-rounded, flat to well rounded, gap graded, clay firm to very stiff consistency, grey, damp, homogeneous but sandier bed in last 10cm. No dilatancy, high toughness, high dry strength.
21.4	22.8	Casing									GS		Grab Sample - Clayey Gravel
		22.7	23.24	SS	9	20	27	47		52.0	6229		Sandy lean CLAY with gravel (CH) high plasticity, fg-cg sand, subangular to rounded (20%), fg-cg gravel subangular to well rounded, gap graded some flat and elongated. Clay has very stiff consistency, grey, damp, homogeneous, no dilatancy, high toughness, high dry strength
22.8	24.4	Casing									GS		Grab Sample - Clayey Gravel

Notes: Grab sample photo for run 15 - meters incorrect, should be 18.4-19.8m

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-06

Borehole location (m) E: 659580.5	N: 5495535.7	Date drilled: May 19/15 09:00 - May 26/15 14:00
Ground elev (m): 1357.9	Casing elev (m): 1.5m	Contractor / rig type: Good Earth Rig Services - Air Hammer
Borehole dia (in): 6	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m): 59.95	Logged by: L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
		24.3	24.8	SS	16	28	38	66		8.0	6230		Clayey GRAVEL with sand (GC) poorly graded, 40% mg-cg subrounded sand, angular to subrounded gravel, fg-cg max particle 2cm, dark brown, clayey odour, saturated, homogeous, no structure, low plasticity. Low recovery, possible rock in shoe.
24.4	25.9										GS		Grab Sample - clayey gravel
		25.8	26	SS	50	-	-	-		10.0	6231		Refusal 50 blows - Clayey GRAVEL (GC) and fg-mg sand, subrounded gravel, high plasticity fines, possibly washed away, dark brown, wet to saturated, no structure, minimal recovery - rock refusal
25.9	27.4	Casing									GS/A		Grab Sample Clayey Gravel - drilled
											GS/B		Gravel with clay - very angular - cut from drill
27.4	28.9	Casing									GS		Grab Sample - Gravel - angular, chewed from bit, 2nd sample increasing grain size fg-2cm fragments with >50% sandstone rock fragments (cobble).
28.9	30.5	Casing									GS		Grab Sample - Clayey GRAVEL, high plasticity, fines
		30.4	30.9	SS	12	21	25	46		45.0	6232		Top 4cm - Clayey GRAVEL (GC) fg-cg and some cg sand, well graded, subangular to subrounded, sharp contact with 4-45cm (btm) of interbedded sandy SILT and clay: medium plasticity, 1-3mm clay bands with <1mm silt laminae, up to 1cm of fg sandy silt laminae, up to 1cm of fg sandy silt, laminated silt/clay beds <6mm, no dilatancy, firm, medium toughness, dry strength is medium. Clay, grey, silt grey brown, moisture content damp in (CL/ML) and saturated in top gravel

Notes: Run 19 - picture sample # crossed out - should be 6231

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-06

Borehole location (m) E: 659580.5	N: 5495535.7	Date drilled: May 19/15 09:00 - May 26/15 14:00
Ground elev (m): 1357.9	Casing elev (m): 1.5m	Contractor / rig type: Good Earth Rig Services - Air Hammer
Borehole dia (in): 6	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m): 59.95	Logged by: L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	SPT Blows 6-12" B blows	SPT Blows 12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
30.5	32	Casing									GS		Grab Sample - high plastic clay blebs(assumed silt washed away)
		31.9	32.4	SS	23	30	50/R			36.0	6233		Refusal from 12 to 18", Top 1-22cm SAND (SW) some subangular to subrounded gravel, sand is fg-cg, subangular to well rounded, coarsening down, increasing in gravel, sharp contact with 22-27cm CLAYEY GRAVEL which overlies a 3-4cm clayey silt bed, low plasticity. Bottom 3cm - sandstone fragment stuck in shoe
32	33.5	Casing Down									GS		Grab Sample - CLAYEY GRAVEL - drilled
		33.5	33.9	SS	40	50/R	-	-		20.0	6234		Top 15cm - Poorly graded GRAVEL with silt and sand (GP-GM), brown loose compactness, sub-angular to subrounded, some elongated and flat, max particle size 3.5cm, wet, no structure, homogeneous. Bottom 5cm - highly fractured sandstone rock/cobble
						3 inches							
33.5	35	Casing									GS		Grab Sample - Gravel with silt
		35	35.5	SS	20	50/R	-	-		27.5	6235		Refusal at 6-12" Poorly graded GRAVEL with silt and sand (GP-GM) fine to coarse gravel, angular to subrounded, very loose, max particle 3.5cm, subangular in shape, brown, wet, structureless
						5 inches							
35	36.5	Casing Down									GS		Grab Sample - sandy GRAVEL

Notes:

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-06

Borehole location (m) E: 659580.5	N: 5495535.7	Date drilled: May 19/15 09:00 - May 26/15 14:00
Ground elev (m): 1357.9	Casing elev (m): 1.5m	Contractor / rig type: Good Earth Rig Services - Air Hammer
Borehole dia (in): 6	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m): 59.95	Logged by: L. Gielen	

Drill interval		Sample/log interval		Sample type	SPT Blows				Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
					0-6" A	6-12" B	12-18" C	SPT N B+C					
(m)	(m)	(m)	(m)		blows	blows	blows	blows					
		36.49	36.95		30	40	45	85		44.0	6236		Top 5cm - Well graded SAND (SW) fg-cg, subangular to rounded, orange brown, wet, very loose, grades into a silty sandy gravel. Bottom 5-44cm - Poorly graded GRAVEL with silt and sand (GP-GM) fg-cg, angular to subrounded, loose, max particle 2.5cm, subangular in shape, wet, shale bed/fragments from 15-18cm, highly fractured, fines content increasing down hole.
36.5	38	Casing Down									GS		Grab Sample - Gravel
		37.99	38.45	SS	16	50/R	-	-		20.0	6237		Refusal at 6-12" (4 inches refused) rock in shoe. Sandy GRAVEL (GW) grading into a silty GRAVEL (GW-GM) downhole from 5-20cm. Upper gravel well graded, fg-cg well sorted subrounded sand, fine grain gravel, sharp contact into poorly sorted silty gravel, fg-cg, subangular to rounded, 30% fines, non plastic, no structure, loose, max particle 3.5cm, elongated and rounded, grey brown, wet-saturated
						4 inches							
38	39.5	Casing Down											
		39.4	39.95	SS	40	50/R	-	-		17.0	6238		Refusal at 6-12" (4 inches in) Poorly graded GRAVEL with silt and sand (GP-GM) fg-cg, angular to subrounded, sandy 25% and silty, non-plastic fines increasing downhole, loose to compact, max particle 3cm, subrounded, light brown, sandier beds overlying silty beds (10cm each) wet
						4 inches							
39.5	42.5	Casing 14x3.05m									GS		Grab Sample - Gravel

Notes:

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-06

Borehole location (m) E: 659580.5	N: 5495535.7	Date drilled: May 19/15 09:00 - May 26/15 14:00
Ground elev (m): 1357.9	Casing elev (m): 1.5m	Contractor / rig type: Good Earth Rig Services - Air Hammer
Borehole dia (in): 6	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m): 59.95	Logged by: L. Gielen	

Drill interval (m)	Drill interval (m)	Sample/log interval (m)	Sample/log interval (m)	Sample type	SPT Blows 0-6" A blows	SPT Blows 6-12" B blows	SPT Blows 12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
		42.49	43	SS	10	50/R				24.0	6239		Refusal at 6-12" (4 inches) Poorly graded GRAVEL with silt and sand, (GP-GM), fg-cg, subangular to subrounded gravel some silt (15%), non plastic, some sand (20%) subrounded, sandier beds 5cm overlying siltier beds 10cm. Loose to compact, light brown, wet-saturated, max particle 3.5cm, sub-rounded. Rock/cobble stick in shoe of split spoon.
						4 inches							
42.5	45.7	Casing down									GS		Grab sample-Silty GRAVEL
		45.7	46.2	SS	50/R	-	-	-		22.0	6240		Refusal at 5". Top 8cm Silty GRAVEL (GM) cg, poorly sorted, loose compactness, angular to subangular, multicolored, wet, no stucture. Lower 8-20cm Clayey GRAVEL (GC), fg-cg, angular to subrounded, homogeneous, no structure, compact, grey, musty smell, damp, clay is highly plastic.
					5 inches								
45.7	48.7	Casing Down									GS		Grab Sample - silty Gravel
		48.69	49.1	SS	45	50/R	-	-		26.0	6241		Refusal at 6-12" (5 inches) Poorly graded GRAVEL with silt and sand (GP-GM) clayey near bottom, thinly bedded 4cm silt/clay/Gravel. Lower portion-loose to compact, brown-orange weathered silt and sand, white-grey silt blebs, angular to subangular gravel, moist to wet, highly fractured gravel or cobble throughout.
						at 5 inches							
48.7	51.8	Casing down									GS		GRAB SAMPLE- GRAVEL

Notes:

NORWEST CORPORATION

Project: 324-28 Teck

Borehole #: BH-15-06

Borehole location (m) E: 659580.5	N: 5495535.7	Date drilled: May 19/15 09:00 - May 26/15 14:00
Ground elev (m): 1357.9	Casing elev (m): 1.5m	Contractor / rig type: Good Earth Rig Services - Air Hammer
Borehole dia (in): 6	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m): 59.95	Logged by: L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
		51.79	52.2	SS	21	50/R				29.0	6242		Refusal at 6-12"(3 inches in) Top 13cm: Silty GRAVEL (GM), fg-cg, some sand, poorly graded, no structure, loose, max particle 2cm, subangular to subrounded, multi-colored, light white-grey silt blebs and dark brown silt blebs, grading into a gravelly CLAY with sand (CL) low plasticity, firm consistency, red-orange, organic odour, damp, structureless, no dilatancy, medium to high toughness, dry strength medium, carbonaceous material
						3 inches							
51.8	53.3	Casing down									GSA		Grab Sample A(51.8-52.5m) Red Clay with GRAVEL
											GSB		Grab Sample B(52.5-53.3m) Grey mudstone fragments
		53.28	53.7	SS	50/R					20.0	6243		Refusal 0-6" 0" Advancement recovery in shoe(not SS) clayey silt bed, low plasticity, medium grey, soft consistency, damp, structureless, dry strength very high (pulverized claystone bedrock)
					0 inches								
53.3	56.3	finished casing to set to core									GSA		Grab Sample A at 53.3m, claystone fragment
											GSB		Grab Sample B at 54.5m, claystone fragments - smaller in size-grey minor quartz fragments(vein?)

Notes: Driller noticed change at 52.5m while setting ODEX casing - sample taken before (clay) after (mudstone)

NORWEST CORPORATION

Project: 324-28 Teck			Borehole #: BH-15-06
Borehole location (m)	E: 659580.5	N: 5495535.7	Date drilled: May 19/15 09:00 - May 26/15 14:00
Ground elev (m): 1357.9		Casing elev (m): 1.5m	Contractor / rig type: Good Earth Rig Services - Air Hammer
Borehole dia (in): 6		**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (m): 59.95		Logged by: L. Gielen	

Drill interval (m)	Drill interval (m)	Sample/log interval (m)	Sample/log interval (m)	Sample type	SPT Blows 0-6" A blows	SPT Blows 6-12" B blows	SPT Blows 12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
56.3	57.17	Coring						RQD=16.6%					Claystone: 0-10cm rock fragments of claystone. 10-25cm intact claystone with two 60 degree dipping discontinuities with 8mm of soft gouge infill. 25-52cm Clay gouge, grey. 52-64cm highly fractured intact rock. 64-71cm highly fractured intact rock, 71-80cm intact claystone with slickensided discontinuities, R0 strength. 80-90cm highly fractured RO intact rock, grey with trace red weathered clay
57.2	58.95	Core Run #2						RQD=0%					3 pieces of intact core in top: 3,5,7cm claystone/siltstone, 15-90cm highly fractured, angular mudstone/siltstone with pieces of core from <1-5cm, rock strength R2, weak rock,
	cut: 1.78m recovered: 0.90m												
59	59.95	Core Run #3						RQD: 73%					Claystone, grey, 0-40cm, R1, very weak rock, very fine grained, slickensided, fracture surfaces with weathered clay, slightly weathered and damp. 40-100cm: weathering increases to moderate
	cut: 1m recovered: 1m												
													TD: 59.95m

Notes:

NORWEST CORPORATION

Project: 324-28 Teck CMO2 Geotech

Borehole #: BH-15-07

Borehole location (m) E: 659579.5	N: 5495541.75	Date drilled: May 25/15 09:00 - May 26/15 14:00
Ground elev (m):1357.8	Casing elev (m): 2.5m	Contractor / rig type: Good Earth Rig Services/Air Hammer Drill
Borehole dia (in): 6	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (ft): 30.8m	Logged by: L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	Description
0	2.5	Casing Down									GS		Grab Sample - GRAVEL
		2.48	2.94	SS	5	4	2	6		15	6244		Well graded GRAVEL with silt and sand (GW-GM) fg-cg, angular to subrounded, multicolored gravel, fines non-plastic, sand fg-cg, subangular to rounded, very loose, light brown, wet to saturated, no structure.
2.5	4.64	Casing Down									GS		Grab Sample -GRAVEL (finer)
		4.62	5.08	SS	1	2	1	3		55	6245		SILT (ML) sandy 25% fg, silt non-plastic, very soft consistency, grey with dark grey/black organic silt stringers, organic smell, wet to saturated, rapid dilatancy. 2cm clay bed at 15-17cm, medium plasticity
4.64	6.14	Casing Down									GS		No sample taken, very fine grained
		6.14	6.6	SS	1	0	0	0		66.5	6246		SILT (ML) trace clay, non plastic, very soft consistency, grey, wet-saturated, no structure, rapid dilatancy, dry strength is low
6.14	7.64	Casing Down									GS		No sample taken, too fine grained
		7.64	8.1	SS	1	1	0	1		66.5	6247		SILT (ML) trace clay, non-plastic, very soft consistency, grey with black organic silt stringers, wet-saturated, non structure, rapid dilatancy, dry strength is low

Notes: Grab Samples not a good indicator of in-situ material at specific depth due to air hammer drilling and flushing fines while pushing casing down.
WT: ~3.0 m

NORWEST CORPORATION

Project: 324-28 Teck CMO2 Geotech

Borehole #: BH-15-07

Borehole location (m) E: 659579.5	N: 5495541.75	Date drilled: May 25/15 09:00 - May 26/15 14:00
Ground elev (m): 1357.8	Casing elev (m): 2.5m	Contractor / rig type: Good Earth Rig Services/Air Hammer Drill
Borehole dia (in): 6	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston ST: Shelby Tube	
Total depth (ft): 30.8m	Logged by: L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	Description
7.64	9.14	Casing Down									GS		No grab sample-too fine grained
		9.14	9.85	SS	1	1	0	1		66.5	6248		SILT (ML) some clay (20%) low plasticity, very soft consistency, grey with black organic silt laminae, wet-saturated, rapid dilatancy, low toughness, dry strength is low, thinly laminated.
9.14	10.6	Casing Down									GS		No grab sample-too fine grained
		10.6	11.07	SS	1	1	0	1		66.5	6249		SILT (ML) and clay (40%) medium plasticity, very soft consistency, grey with black organic silt laminations, organic odour, wet, thinly laminated 1mm, rapid dilatancy, low toughness, dry strength low-medium
10.6	12.1	Casing Down									GS		No grab sample-too fine grained
		12.1	12.59		SHELBY TUBE 1						6250		SHELBY SAMPLE-clayey silt in top and bottom ends
12.1	13.7	Casing Down									GS		No grab sample
		13.7	14.13	SS	1	4	16	20		66.5	6251		CLAY (CH) high plasticity, trace gravel in bottom 5cm, soft to firm consistency, grey, no structure, moist, slow-rapid dilatancy, medium to high toughness, dry strength is high
13.7	14.5	Casing Down									GS		No grab Sample

Notes:

NORWEST CORPORATION

Project: 324-28 Teck CMO2 Geotech

Borehole #: BH-15-07

Borehole location (m): E: 659579.5 | N: 5495541.75 | Date drilled: May 25/15 09:00 - May 26/15 14:00

Ground elev (m): 1357.8 | Casing elev (m): 2.5m | Contractor / rig type: Good Earth Rig Services/Air Hammer Drill

Borehole dia (in): 6

Sample type: AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston

Total depth (ft): 30.8m | Logged by: L. Gielen

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A (blows)	SPT Blows 6-12" B (blows)	SPT Blows 12-18" C (blows)	SPT N B+C (blows)	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
		14.5	14.9		SHELBY TUBE 2						6252		SHELBY SAMPLE-Clay (CL) with some gravel
14.52	15.2	Casing Down									GS		No grab sample
		15.18	15.64	SS	4	10	11	21		17	6253		CLAY (CL) some gravel (15%) medium plasticity, soft consistency, grey, wet, varved, slow-rapid dilatancy, low toughness, dry strength is high. Gravel angular to subrounded, fg-cg, max particle 4cm.
15.2	16.76	Casing Down									GS		Grab Sample-Gravel, washed (not representative of in-situ)
		16.78	17.24	SS	10	18	28	46		29	6254		CLAY (CH) gravelly (15%) medium to high plasticity, firm to stiff consistency, light brown, musty odour, damp to moist, slow dilatancy, medium to high toughness, dry strength medium. Gravel fg-cg subangular to subrounded, max particle 2cm.
16.76	18.26	Casing Down									GS		Grab Sample-Clayey Gravel
		18.23	18.69	SS	37	50/R	-	-		23	6255		Refusal at 6-12"-CLAY (CH) sandy and gravelly (25%), high plasticity, firm to stiff consistency, light grey, moist, varved, slow dilatancy, medium toughness, dry strength medium, fg-cg gravel subangular to subrounded, max particle 0.5cm, trace (10%) sand.
18.26	19.76	Casing Down									GS		Grab Sample: Gravel-chewed from bit

Notes:

NORWEST CORPORATION

Project: 324-28 Teck CMO2 Geotech

Borehole #: BH-15-07

Borehole location (m) E: 659579.5

N: 5495541.75

Date drilled: May 25/15 09:00 - May 26/15 14:00

Ground elev (m): 1357.8

Casing elev (m): 2.5m

Contractor / rig type: Good Earth Rig Services/Air Hammer Drill

Borehole dia (in): 6

Sample type: AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston

Total depth (ft): 30.8m

Logged by: L. Gielen

Drill interval		Sample/log interval		Sample type	SPT Blows				Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
					0-6" A	6-12" B	12-18" C	SPT N B+C					
(m)	(m)	(m)	(m)		blows	blows	blows	blows					
		19.76	20.2	SS	27	50	32	82		28	6256		Gravelly lean CLAY with sand (CL) medium plasticity, stiff consistency, light grey, moist, slow dilatancy, medium toughness, dry strength is high. 25% fg-cg sand, fg-cg gravel, subangular to rounded. 2cm blebs of "beach sand" at 10cm , max particle 3cm, possible sandstone cobble-diameter of SS.
19.76	21.31	Casing Down									GS		Grab Sample-Clayey Gravel
		21.3	21.76	SS	7	16	28	44		46	6257		Sandy lean CLAY with gravel (CH) high plasticity, sandy fg-cg subrounded, gravel fg-cg, subrounded, firm to stiff consistency, grey, moist, varved, slow dilatancy, medium to high toughness, dry strength medium.
21.31	22.81	Casing Down									GS		Grab Sample-Clayey Gravel
		22.8	23.26	SS	11	20	31	51		38	6258		Sandy lean CLAY with gravel (CH) high plasticity, 10-15% fg-mg sand, some (20%) subrounded to rounded gravel, firm consistency, grey, moist, varved, slow dilatancy, medium to high toughness, dry strength of clay is high, (one 3cm sand bed in top of SS with fg-cg sand, multicolored)
22.81	24.36	Casing Down									GS		Grab Sample-Clayey Gravel

Notes:

NORWEST CORPORATION

Project: 324-28 Teck CMO2 Geotech

Borehole #: BH-15-07

Borehole location (m)	E: 659579.5	N: 5495541.75	Date drilled: May 25/15 09:00 - May 26/15 14:00
Ground elev (m): 1357.8		Casing elev (m): 2.5m	Contractor / rig type: Good Earth Rig Services/Air Hammer Drill
Borehole dia (in): 6		**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (ft): 30.8m		Logged by: L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
		24.35	24.81	SS	18	28	33	61		37	6259		Sandy lean CLAY with gravel (CH) high plasticity, fg-cg sand, increasing to 25-30% gravel. 20% subangular to rounded, firm consistency, dark brown to grey, moist, slow dilatancy, homogeneous, medium toughness, dry strength is high.
24.36	25.86	Casing Down									GS		GRAB SAMPLE-Gravel with clay
		25.85	26.36	SS	9	33	35	68		45	6260		Sandy lean CLAY with gravel (CH) high plasticity, 20% fg-cg sand subrounded gravel, firm to stiff consistency, dark brown, moist, slow dilatancy, varved, toughness is medium to high, dry strength is high.
25.86	27.42	Casing Down									GS		Grab Sample -GRAVEL multicolored
		27.4	27.88	SS	22	50/R 4"	-	-		30	6261		Refusal at 6-12" at 4 inches - Poorly graded SAND with clay and gravel (SC) fines (35%) low plasticity, fg-cg subrounded gravel, compact, 2.5cm max particle subangular, dark brown, moist, varved, gap graded.
27.42	28.92	Casing Down									GS		Grab Sample-Gravel (chewed and flushed)

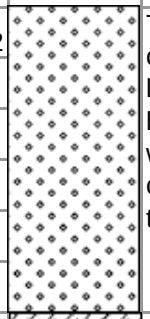
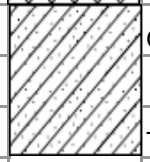
Notes: Driller noticed change from clay to sand/gravel at 26.75m

NORWEST CORPORATION

Project: 324-28 Teck CMO2 Geotech

Borehole #: BH-15-07 *Page 6 of 6*

Borehole location (m) E: 659579.5	N: 5495541.75	Date drilled: May 25/15 09:00 - May 26/15 14:00
Ground elev (m):1357.8	Casing elev (m): 2.5m	Contractor / rig type: Good Earth Rig Services/Air Hammer Drill
Borehole dia (in): 6	**Sample type:** AS=Auger BS=Block sample CS=Core DC=Dynamic cone GS=Grab sample PB=Pitcher Barrel SC=Static cone SS=Split spoon TO=Thin wall open TP=Thin walled piston	
Total depth (ft): 30.8m	Logged by: L. Gielen	

Drill interval (m)		Sample/log interval (m)		Sample type	SPT Blows 0-6" A blows	6-12" B blows	12-18" C blows	SPT N B+C blows	Penetration total length (in)	Recovery (cm) or chamber press (psi)	Sample number	Stratigraphy and piezo tips	**Description** Group name, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
		28.9	29.4	SS	17	27	40	67		54	6262		Top 0-3cm: Well graded fg-cg SAND (SW) trace silt, very loose compactness, subangular to subrounded, max particle 4mm, light brown/orange, musty odour, moist-wet, rapid dilatancy, homogeneous. Sharp contact with SILT (ML), some clay (15%), low plasticity, soft to firm consistency, light brown to grey, damp, homogeneous, low toughness, dry strength low.
28.92	30.8	Casing Down									GS		Grab Sample-Sandy CLAY
													TD: 30.8m

Notes:

Field log v2004.1

BH-15-01

GWL 0.9m (estimated)

Ground Elevation (m) 1363

Depth bottom (m)	Elevation (m)	N	Normalized (N1)60
0.5	1362.6	15	23
0.9	1362.1	23	35
1.4	1361.6	44	66
4.0	1359.0	6	7
5.4	1357.6	4	5
6.2	1356.8	3	3
7.8	1355.2	3	3
9.4	1353.6	3	3
10.9	1352.1	3	3
12.4	1350.6	2	2
13.8	1349.2	2	2
15.5	1347.5	2	2
19.4	1343.6	2	1
20.4	1342.6	10	7
21.9	1341.1	30	20

Zones

Shallow Sand and Gravel Zone
Shallow Less Competent Zone
Deeper More Competent Zone
Gravel

BH-15-03

GWL 0.5m (estimated)

Ground Elevation (m) 1370

Depth bottom (m)	Elevation (m)	N	Normalized (N1)60
2.0	1368.1	46	74
3.5	1366.6	23	31
5.0	1365.0	10	13
6.6	1363.4	5	6
8.1	1361.9	2	2
9.7	1360.4	3	3
11.2	1358.9	7	6
12.7	1357.3	2	2
14.2	1355.8	3	2
15.7	1354.3	1	1
18.7	1351.3	54	39
20.3	1349.7	20	14
23.3	1346.7	50	32
23.8	1346.2	25	16
24.9	1345.1	50	31

Zones

Shallow Sand and Gravel Zone
Shallow Less Competent Zone
Deeper More Competent Zone
Gravel

BH-15-04

GWL 0.5m (estimated)

Ground Elevation (m) 1372

Depth bottom (m)	Elevation (m)	N	Normalized (N1)60
2.0	1370.1	13	21
3.5	1368.6	3	4
5.0	1367.0	3	4
6.6	1365.4	2	2
8.1	1363.9	2	2
9.7	1362.4	2	2
12.7	1359.3	0	0
15.7	1356.3	28	22
17.2	1354.8	50	-
18.7	1353.3	48	34
20.3	1351.7	50	-
21.8	1350.2	50	-
23.3	1348.7	57	37
24.9	1347.1	66	41

Zones

Shallow Sand and Gravel Zone
Shallow Less Competent Zone
Deeper More Competent Zone
Gravel

BH-15-06

GWL 1.5m

Ground Elevation (m) 1358

Depth bottom (m)	Elevation (m)	N	Normalized (N1)60
0.5	1357.6	19	29
2.0	1356.1	21	29
3.5	1354.6	0	0
5.0	1353.1	0	0
6.5	1351.6	0	0
8.1	1349.9	1	1
9.8	1348.2	0	0
11.2	1346.9	4	4
12.4	1345.6	4	3
14.1	1343.9	7	6
15.8	1342.2	23	17
17.2	1340.8	45	33
18.8	1339.2	62	43
20.2	1337.8	53	36
21.8	1336.2	58	38
23.24	1334.76	47	30
24.8	1333.2	66	41
26.0	1332.0	50	-
30.9	1327.1	46	25
32.4	1325.6	50	-
33.9	1324.1	50	-
35.5	1322.5	50	-
37.0	1321.1	85	43

Zones

Shallow Sand and Gravel Zone
Shallow Less Competent Zone
Deeper More Competent Zone
Gravel

BH-15-07

GWL 0.5m (estimated)

Ground Elevation (m) 1358

Depth bottom (m)	Elevation (m)	N	Normalized (N1)60
2.9	1355.1	6	9
5.1	1352.9	3	4
6.6	1351.4	0	0
8.1	1349.9	1	1
9.9	1348.2	1	1
11.1	1346.9	1	1
14.1	1343.9	20	16
15.6	1342.4	21	16
17.2	1340.8	46	34
18.7	1339.3	50	-
20.2	1337.8	82	57
21.8	1336.2	44	29
23.3	1334.7	51	33
24.8	1333.2	61	38
26.4	1331.6	68	41
27.9	1330.1	50	-
29.4	1328.6	67	39

Zones

Shallow Sand and Gravel Zone
Shallow Less Competent Zone
Deeper More Competent Zone
Gravel

Appendix B
Laboratory Results

General Lab Testing Summary

Project No.: 1413549 | Phase: 2000
Short Title: NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing | Sched: B508
Tested By: CG | Date: 12-Jun-15

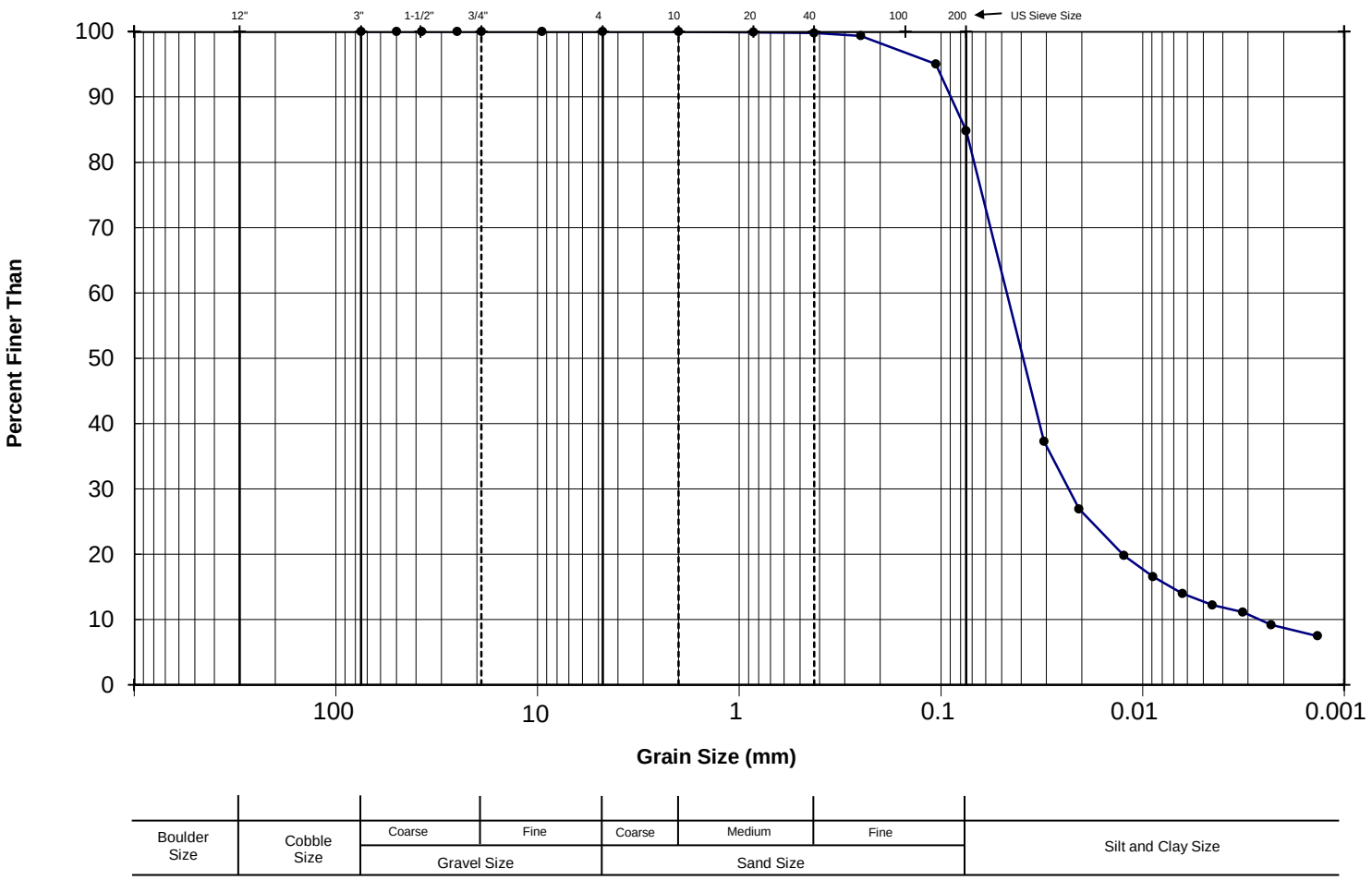
Sample Identification					Laboratory Test Results					
Borehole No.	Sample No.	Depth (m)		Lab No.	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	SPMDD (kg/m^3)	Optimum w (%)
		from	to							
BH15-01	6210	18.92	19.39	B50-01	27.9	NP	NP	NP		
BH15-03	6279	3.00	3.45	B50-02	11.7					
	6282	7.63	8.07	B50-03	31.0	NP	NP	NP		
	6286	13.74	14.20	B50-04	27.6	NP	NP	NP		
	6288	16.79	17.24	B50-05	25.9	33	18	15		
	6291	23.36	23.82	B50-06	17.2	40	20	20		
BH15-04	6263	1.50	1.95	B50-07	14.2					
	6270	13.74	14.19	B50-08	30.7	26	17	9		
BH15-06	6217	5.99	6.45	B50-09	28.5	NP	NP	NP		
	6219	9.06	9.83	B50-10	32.0	NP	NP	NP		
	6221	11.98	12.44	B50-11	30.3	26	18	8		
	6223	14.40	14.80	B50-12	24.2	27	17	10		
BH15-07	6250	12.10	12.59	B50-13						
	6252	14.50	14.90	B50-14	17.5	30	17	13		
	6253	15.18	15.64	B50-15						
	6251	13.68	14.13	B50-16	29.7	31	18	13		

Reviewed By:_____

Project No.:	1413549.2000	Lab No.:	B508-01
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	BH15-01	Sample No.:	6210
Depth:	18.92-19.39 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	99.9
0.425	99.8
0.250	99.4
0.106	95.0
0.075	84.8
0.031	37.3
0.021	26.9
0.012	19.8
0.009	16.6
0.006	14.0
0.005	12.2
0.003	11.1
0.002	9.2
0.001	7.5

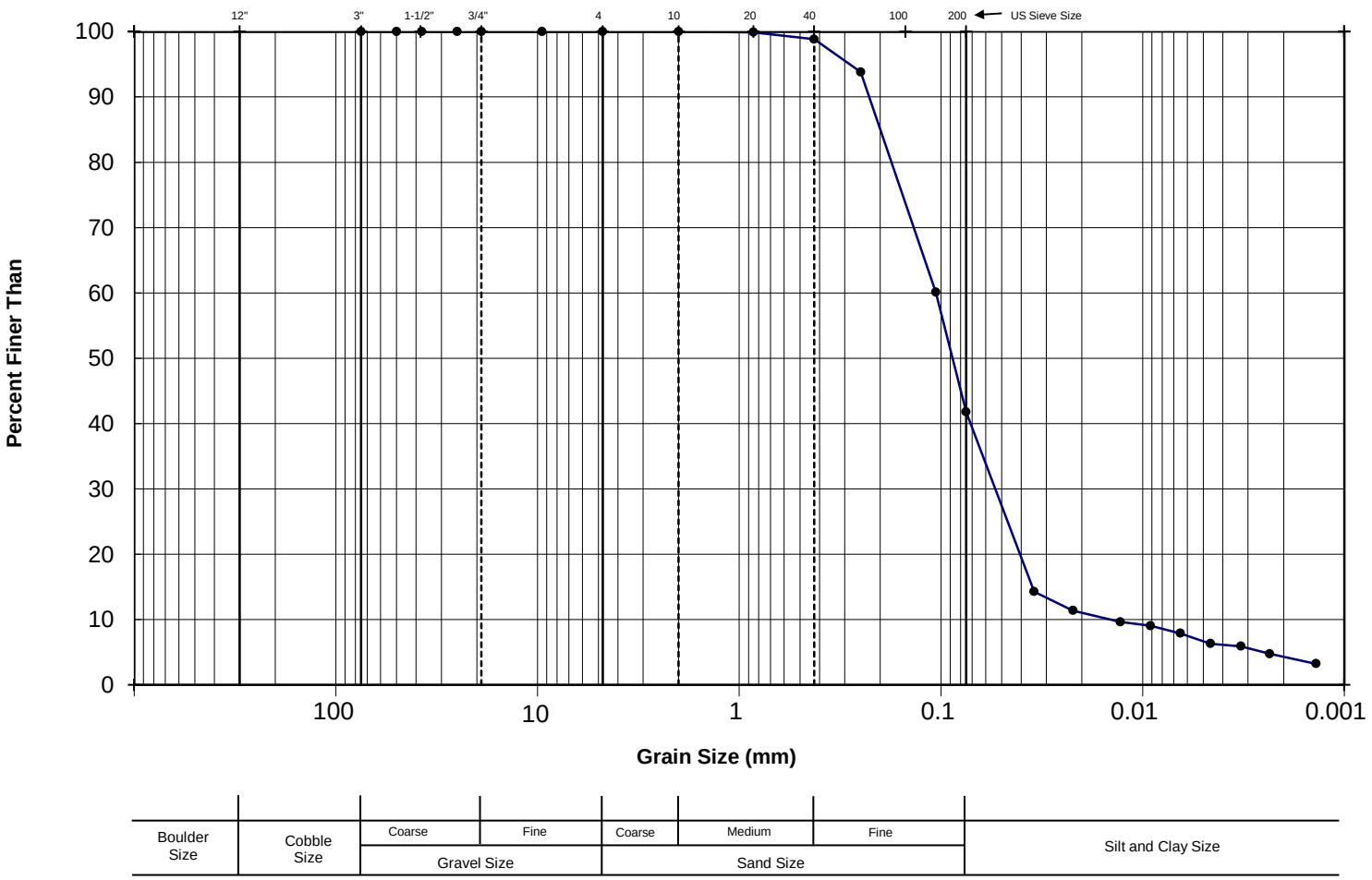
Comments:

Reviewed:

Project No.:	1413549.2000	Lab No.:	B508-03
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	BH15-03	Sample No.:	6282
Depth:	7.63-8.07 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	99.9
0.425	98.8
0.250	93.8
0.106	60.1
0.075	41.8
0.034	14.3
0.022	11.4
0.013	9.6
0.009	9.1
0.007	7.9
0.005	6.3
0.003	5.9
0.002	4.8
0.001	3.2

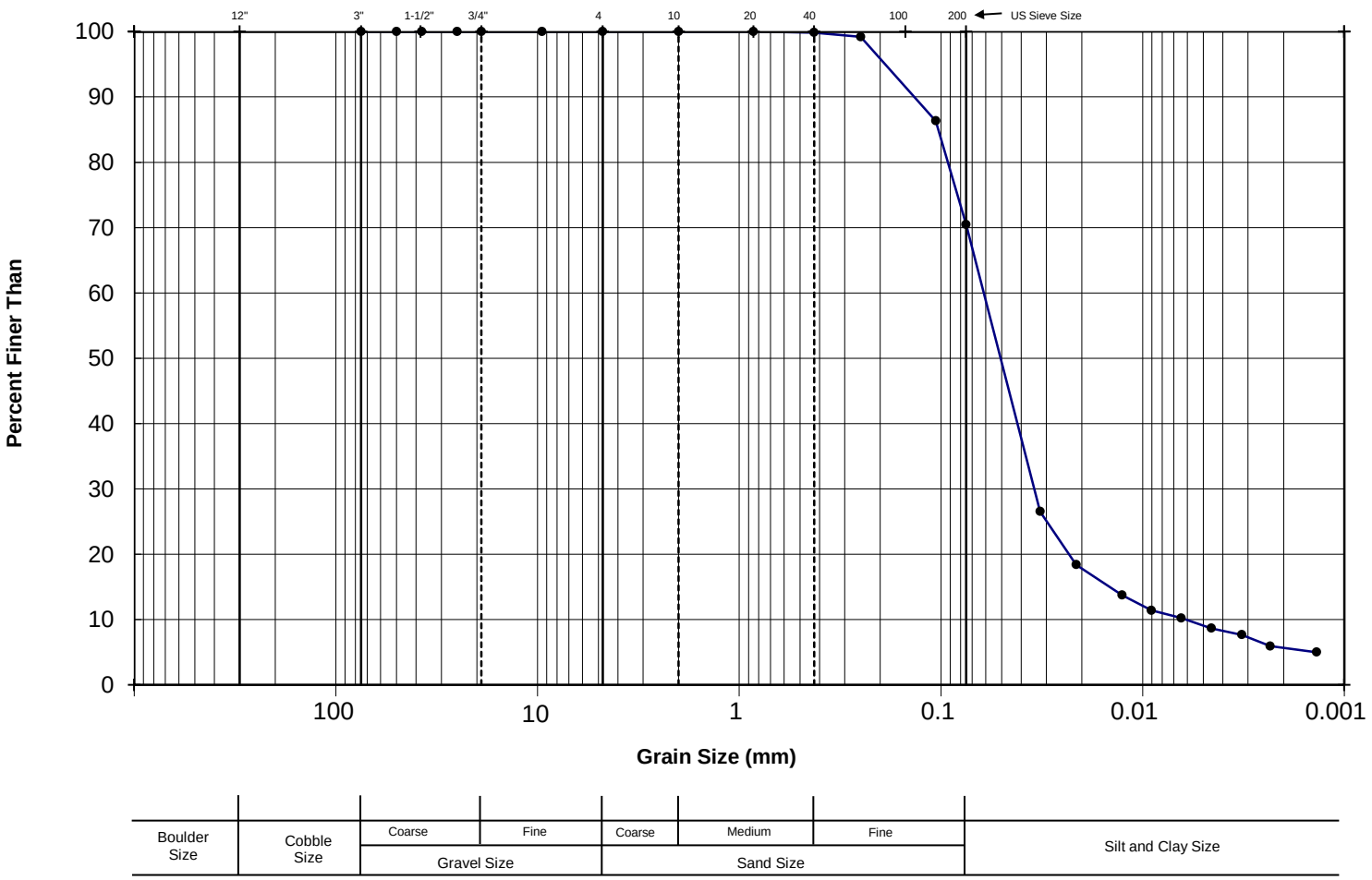
Comments:

Reviewed: _____

Project No.:	1413549.2000	Lab No.:	B508-04
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	BH15-03	Sample No.:	6286
Depth:	13.74-14.20 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	100.0
0.425	99.8
0.250	99.2
0.106	86.3
0.075	70.4
0.032	26.5
0.021	18.4
0.013	13.7
0.009	11.4
0.006	10.2
0.005	8.7
0.003	7.7
0.002	5.9
0.001	5.0

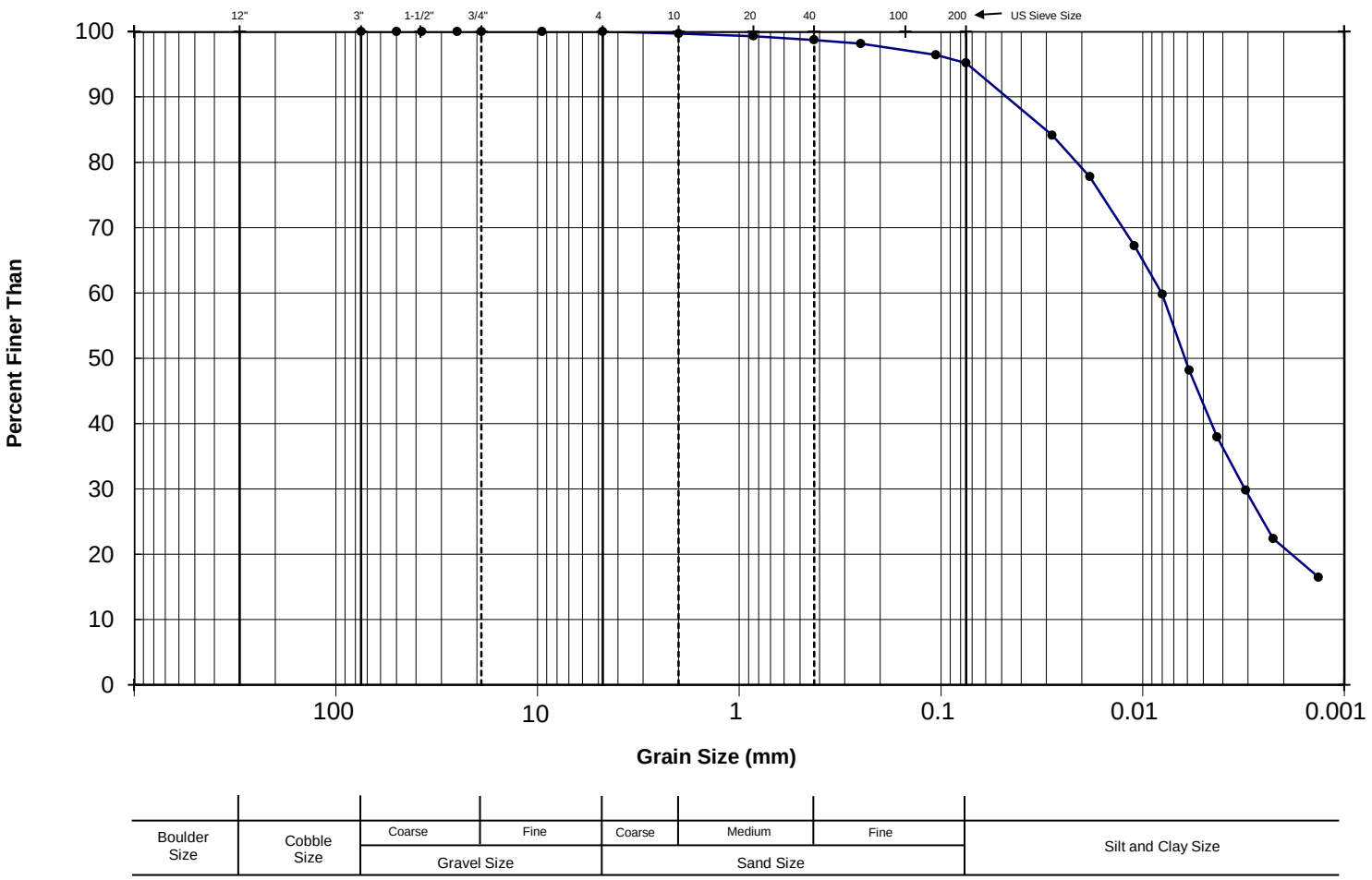
Comments:

Reviewed:

Project No.:	1413549.2000	Lab No.:	B508-05
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	BH15-03	Sample No.:	6288
Depth:	16.79-17.24 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.7
0.850	99.3
0.425	98.7
0.250	98.2
0.106	96.4
0.075	95.2
0.028	84.1
0.018	77.8
0.011	67.2
0.008	59.8
0.006	48.2
0.004	37.9
0.003	29.8
0.002	22.4
0.001	16.5

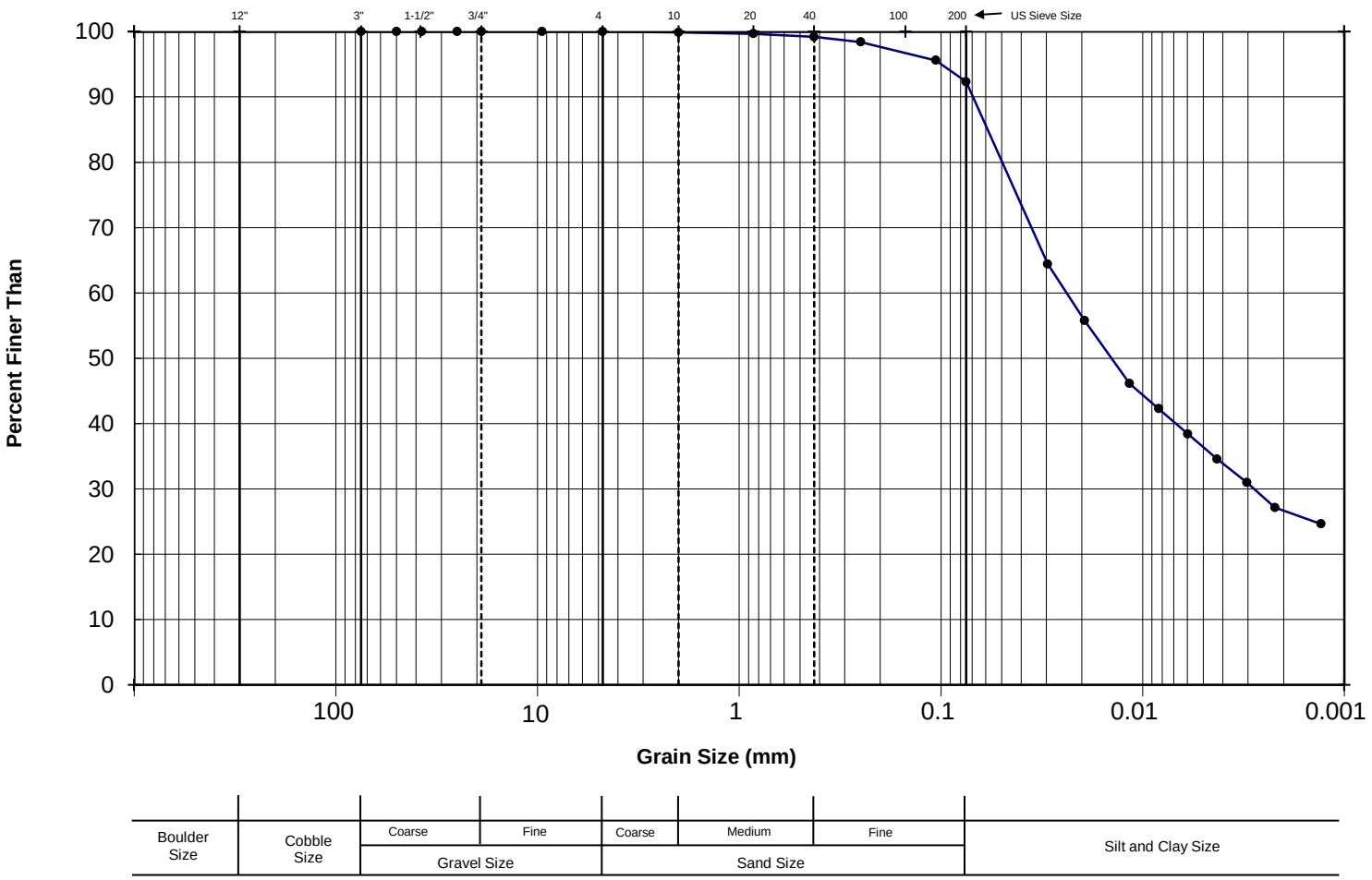
Comments:

Reviewed:

Project No.:	1413549.2000	Lab No.:	B508-06
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	BH15-03	Sample No.:	6291
Depth:	23.36-23.82 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.9
0.850	99.7
0.425	99.2
0.250	98.4
0.106	95.6
0.075	92.3
0.030	64.4
0.019	55.7
0.012	46.1
0.008	42.3
0.006	38.4
0.004	34.6
0.003	31.0
0.002	27.1
0.001	24.6

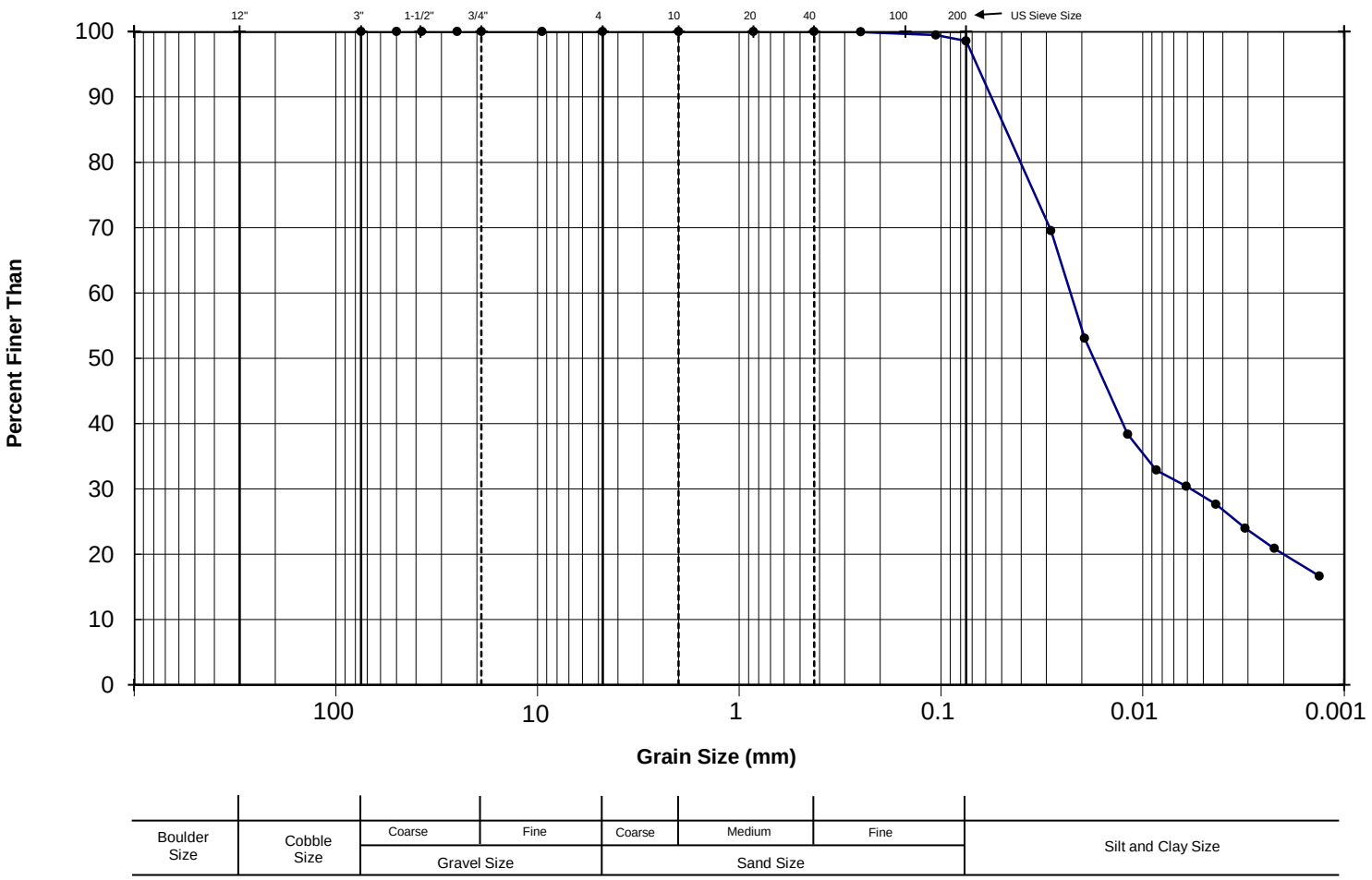
Comments:

Reviewed: _____

Project No.:	1413549.2000	Lab No.:	B508-08
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	BH15-04	Sample No.:	6270
Depth:	13.74-14.19 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	100.0
0.425	100.0
0.250	99.9
0.106	99.5
0.075	98.6
0.028	69.5
0.019	53.0
0.012	38.4
0.009	32.9
0.006	30.4
0.004	27.6
0.003	24.0
0.002	20.9
0.001	16.7

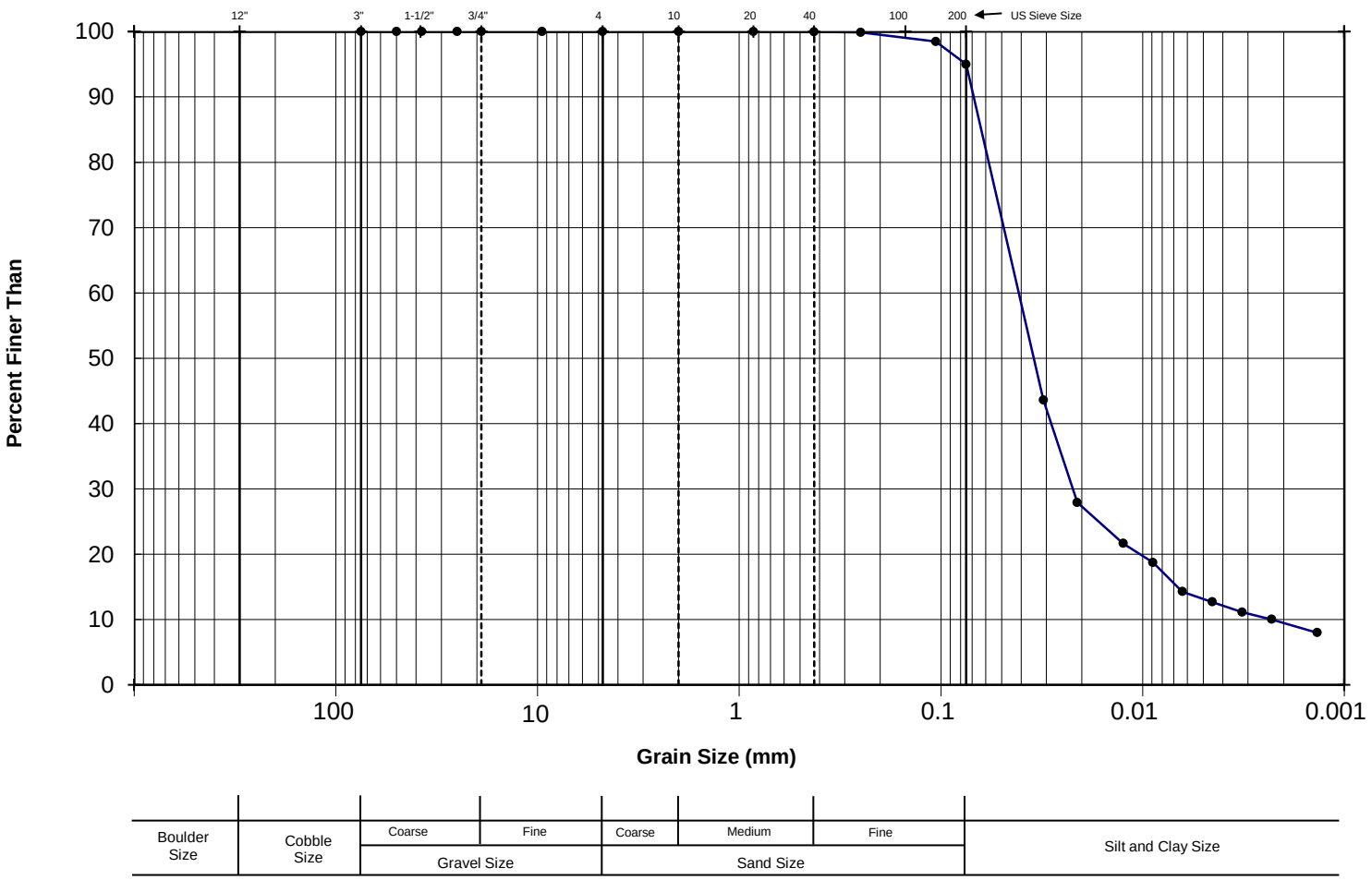
Comments:

Reviewed:

Project No.:	1413549.2000	Lab No.:	B508-09
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	BH15-06	Sample No.:	6217
Depth:	5.99-6.45 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	100.0
0.425	100.0
0.250	99.9
0.106	98.5
0.075	95.0
0.031	43.6
0.021	27.9
0.012	21.6
0.009	18.7
0.006	14.3
0.005	12.7
0.003	11.1
0.002	10.0
0.001	8.0

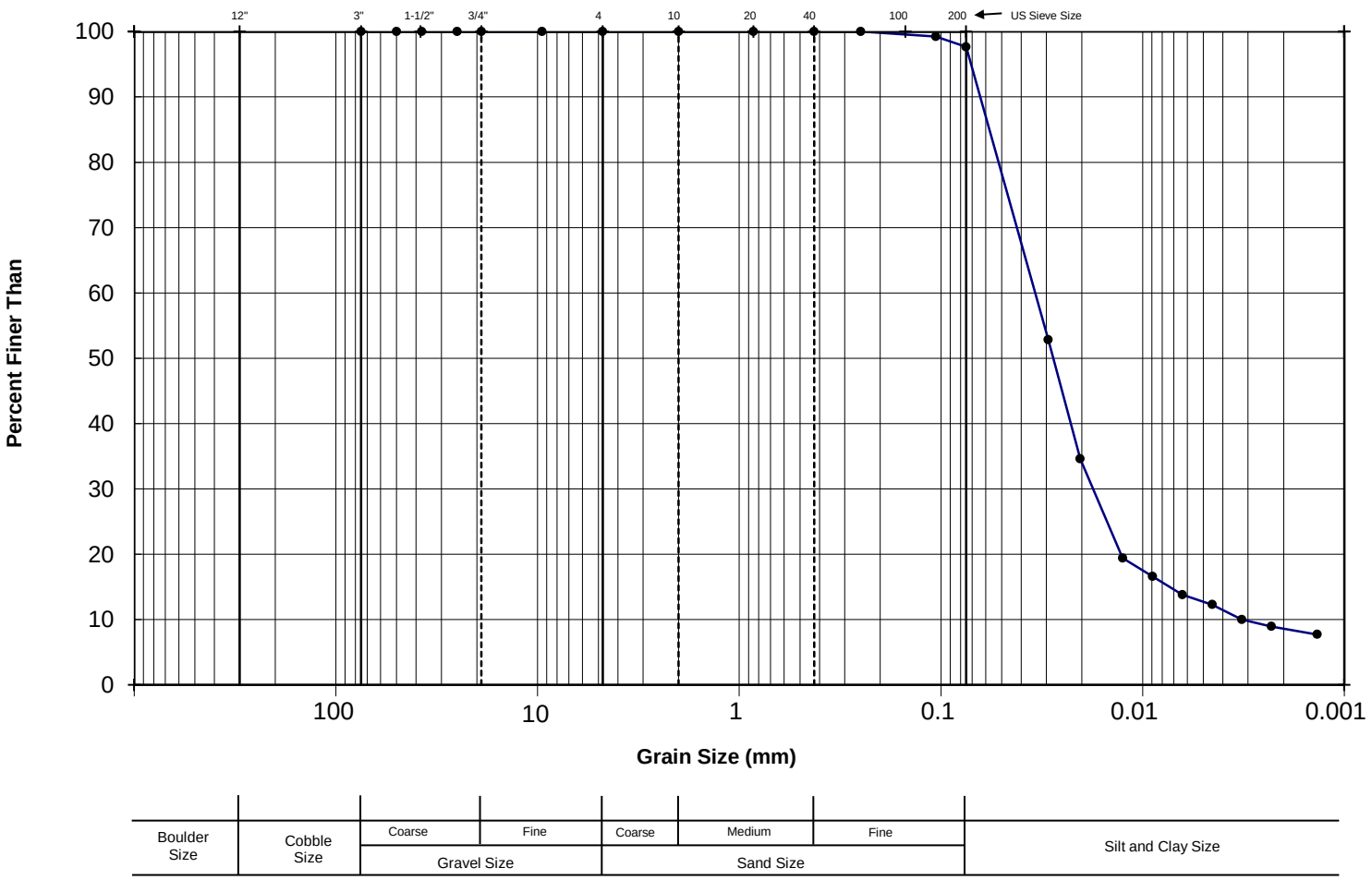
Comments:

Reviewed:

Project No.:	1413549.2000	Lab No.:	B508-10
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	BH15-06	Sample No.:	6219
Depth:	9.06-9.83 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	100.0
0.425	100.0
0.250	100.0
0.106	99.2
0.075	97.6
0.029	52.8
0.020	34.6
0.013	19.4
0.009	16.6
0.006	13.8
0.005	12.3
0.003	10.0
0.002	8.9
0.001	7.7

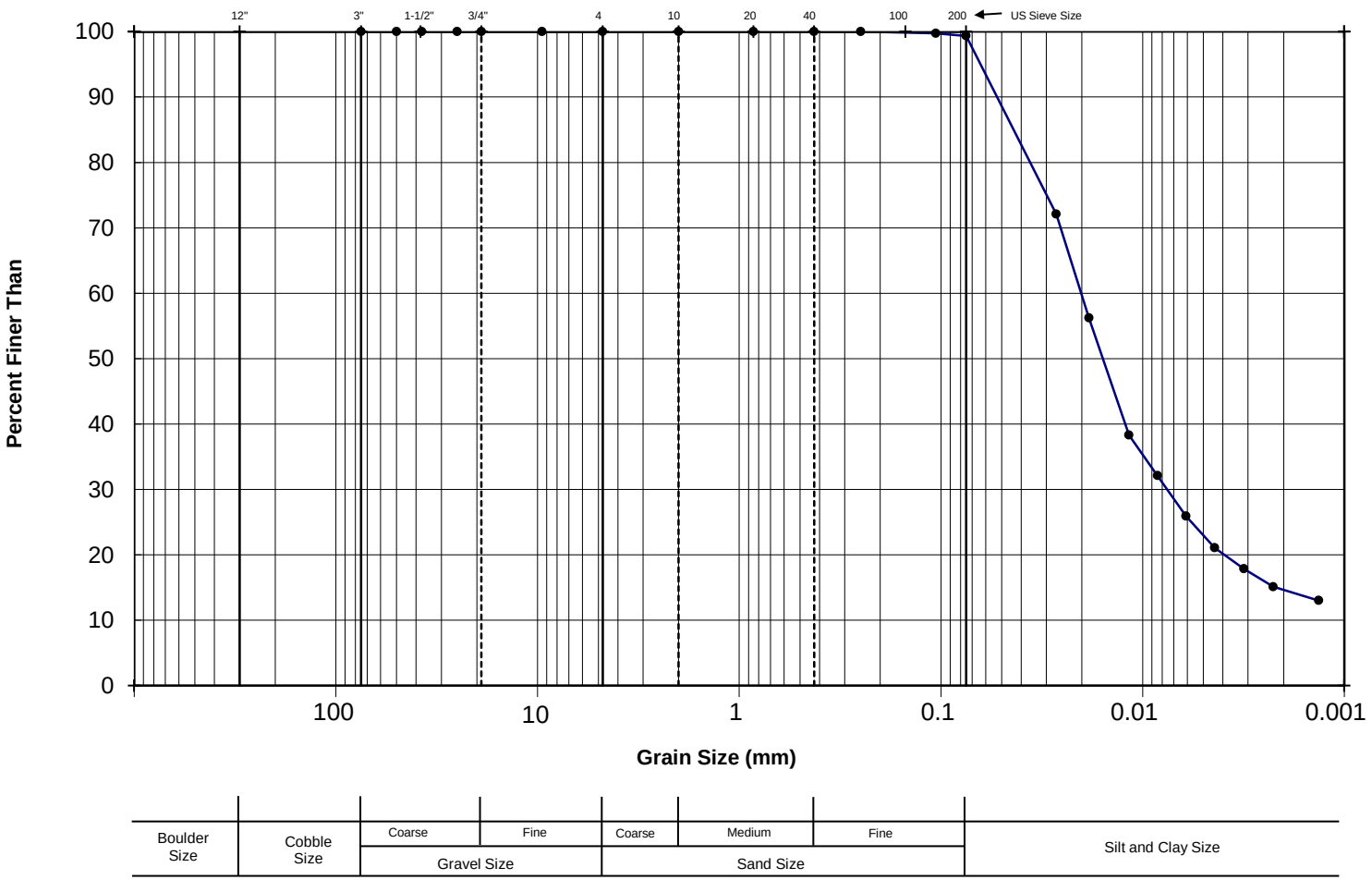
Comments:

Reviewed:

Project No.:	1413549.2000	Lab No.:	B508-11
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	BH15-06	Sample No.:	6221
Depth:	11.98-12.44 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	100.0
0.850	100.0
0.425	100.0
0.250	100.0
0.106	99.7
0.075	99.3
0.027	72.1
0.018	56.2
0.012	38.3
0.008	32.1
0.006	25.9
0.004	21.1
0.003	17.8
0.002	15.1
0.001	13.0

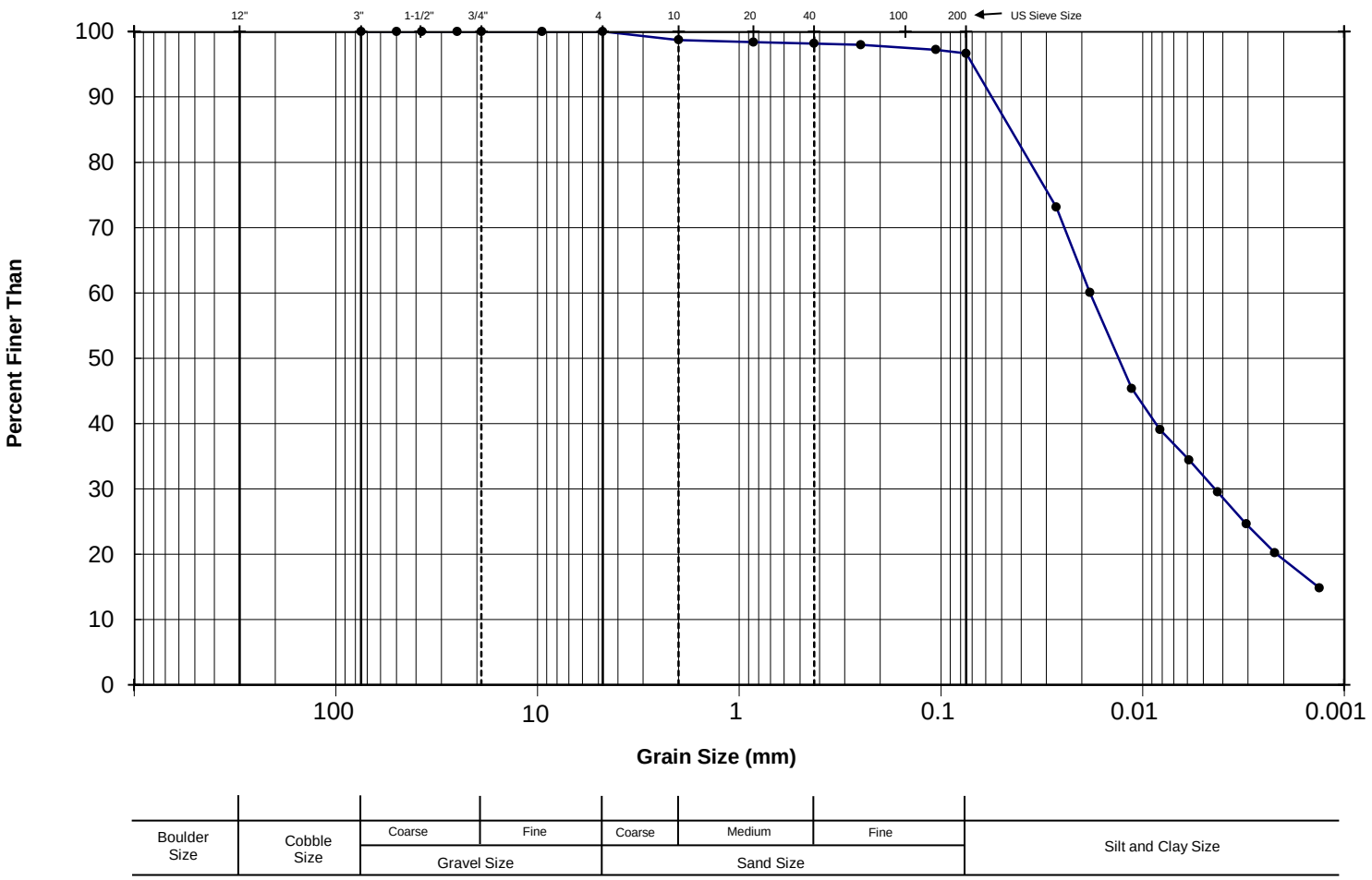
Comments:

Reviewed:

Project No.:	1413549.2000	Lab No.:	B508-12
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	BH15-06	Sample No.:	6223
Depth:	14.40-14.80 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	98.7
0.850	98.4
0.425	98.2
0.250	98.0
0.106	97.2
0.075	96.7
0.027	73.1
0.018	60.1
0.011	45.4
0.008	39.1
0.006	34.4
0.004	29.5
0.003	24.6
0.002	20.2
0.001	14.8

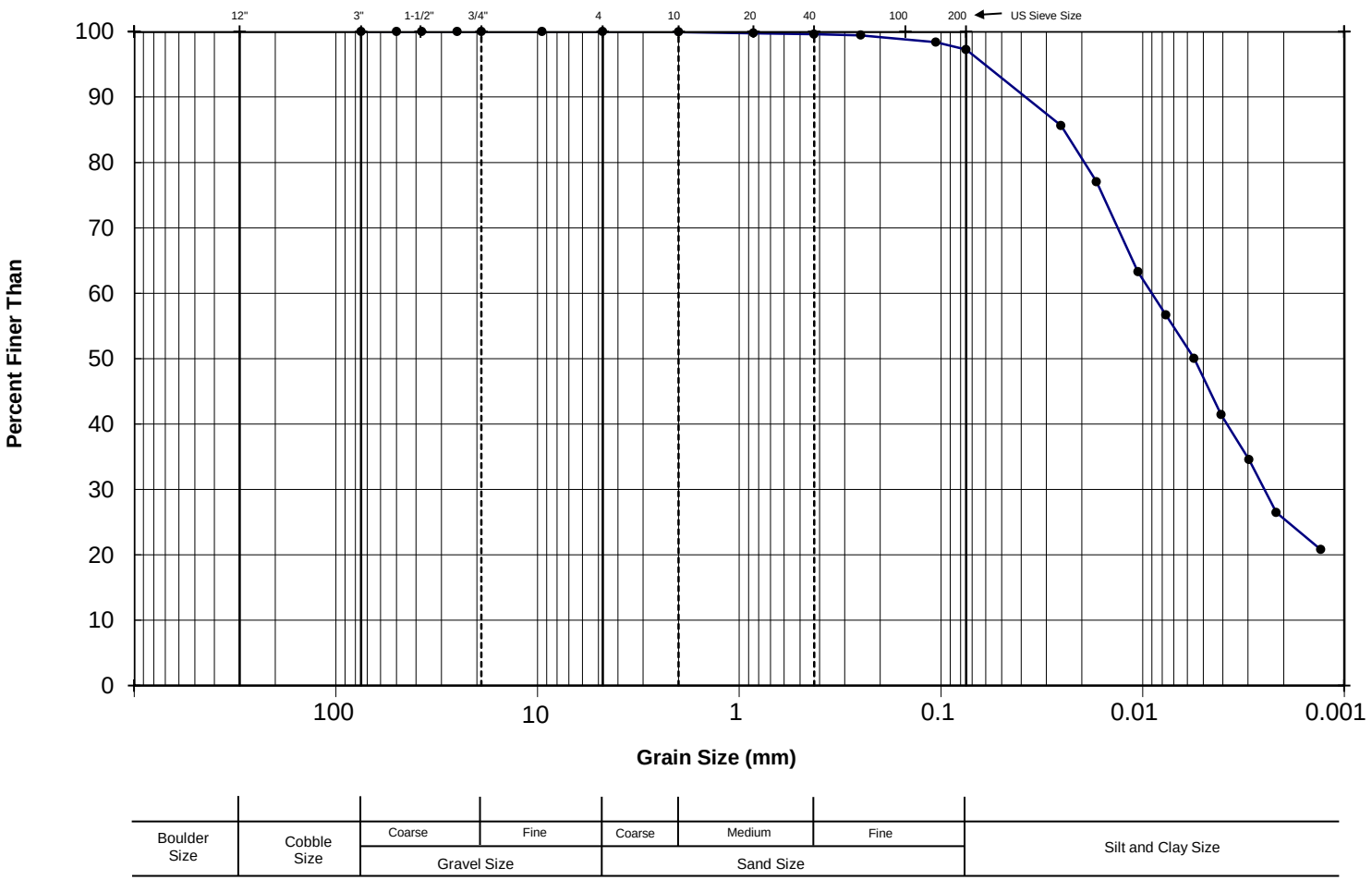
Comments:

Reviewed: _____

Project No.:	1413549.2000	Lab No.:	B508-16
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	BH15-07	Sample No.:	6251
Depth:	13.68-14.13 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.9
0.850	99.8
0.425	99.6
0.250	99.4
0.106	98.4
0.075	97.2
0.025	85.6
0.017	77.0
0.011	63.3
0.008	56.6
0.006	50.0
0.004	41.4
0.003	34.5
0.002	26.5
0.001	20.8

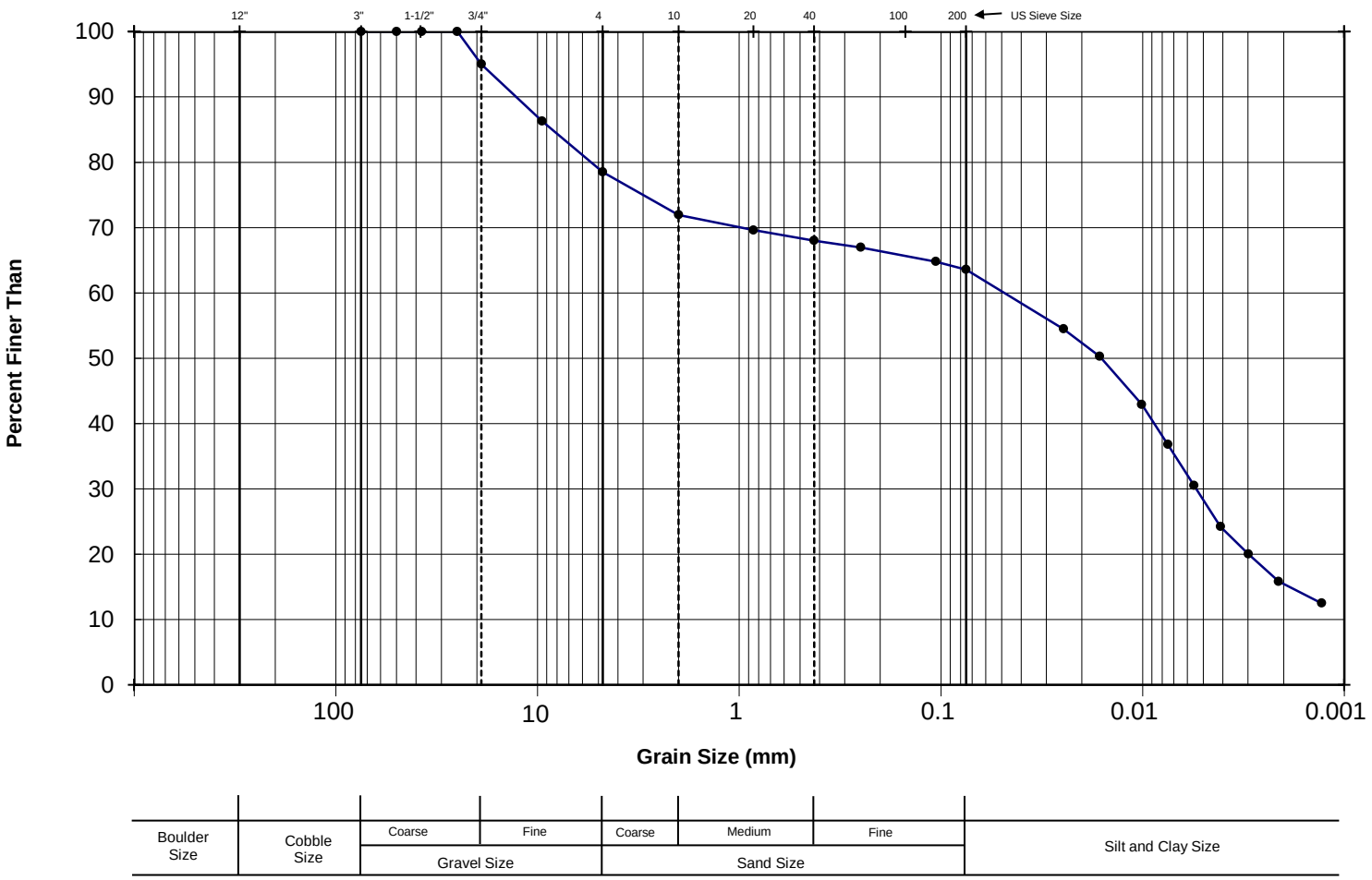
Comments:

Reviewed:

Project No.:	1413549.2000	Lab No.:	B508-14
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	BH15-07	Sample No.:	6252
Depth:	14.50-14.90 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	95.0
9.5	86.3
4.75	78.5
2.0	71.9
0.850	69.6
0.425	68.0
0.250	67.0
0.106	64.8
0.075	63.6
0.025	54.5
0.016	50.3
0.010	42.9
0.007	36.8
0.006	30.5
0.004	24.2
0.003	20.0
0.002	15.8
0.001	12.5

Comments:

Reviewed: _____

GOLDER ASSOCIATES - Calgary Lab

Bay #8, 820 28 St. NE

Calgary, AB, T2H 2K1

ASTM D3080-04 Direct Shear Testing of Soils Under Consolidated Drained Conditions

Sample Identification

Project No.:	1413549.2	Lab No.:	B508-05
Client:	Norwest Corporation	Borehole:	BH15-03
Project:	Norwest/Lab Testing/CGY-CMO2 Teck Geotech	Sample:	6288
Location:	-	Depth:	16.79-17.24m

INITIAL - Sample Dimensions

Test No.	1	2	3
Shear Box Geometry	Circle	Circle	Circle
Diameter, mm	63.13	63.13	63.13
Depth, mm	25.40	25.40	25.40
Area, cm^2	31.30	31.30	31.30
Volume, cm^3	79.51	79.51	79.51

Weight Volume Relationships

Test No.	1	2	3
Sample Type	Undisturbed	Undisturbed	Undisturbed
Initial Wet Wt, g	147.75	154.73	147.75
Initial Dry Wt, g	118.2	122.8	116.7
Initial w, %	24.99	26.01	26.58
Final w, %	20.40	20.51	18.74
Initial γ_{dry}, kg/m^3	1487	1544	1468
Final γ_{dry}, kg/m^3 (after consolidation)	1565	1629	1667
Specific Gravity (assumed)	2.65	2.65	2.65
Initial Void Ratio, e	0.782	0.716	0.805
Initial Saturation, %	84.6	96.3	87.5

Equipment Description - DS-KWSOIL

Axial LPT	Serial #	KW-DT2
Normal Load Cell	Serial #	KW-PT1
Shear Load Cell	Serial #	KW-LC1
Vertical LPT	Serial #	KW-DT1

Remarks

Area correction applied to normal and shear stress calculation

Sample Description: (CI) SILTY CLAY, low to medium plasticity; brown; cohesive, w>Pl, firm.

Tested By: FC/KP Date Completed: 20-Jun-15

Checked By: DJH

GOLDER ASSOCIATES - Calgary Lab

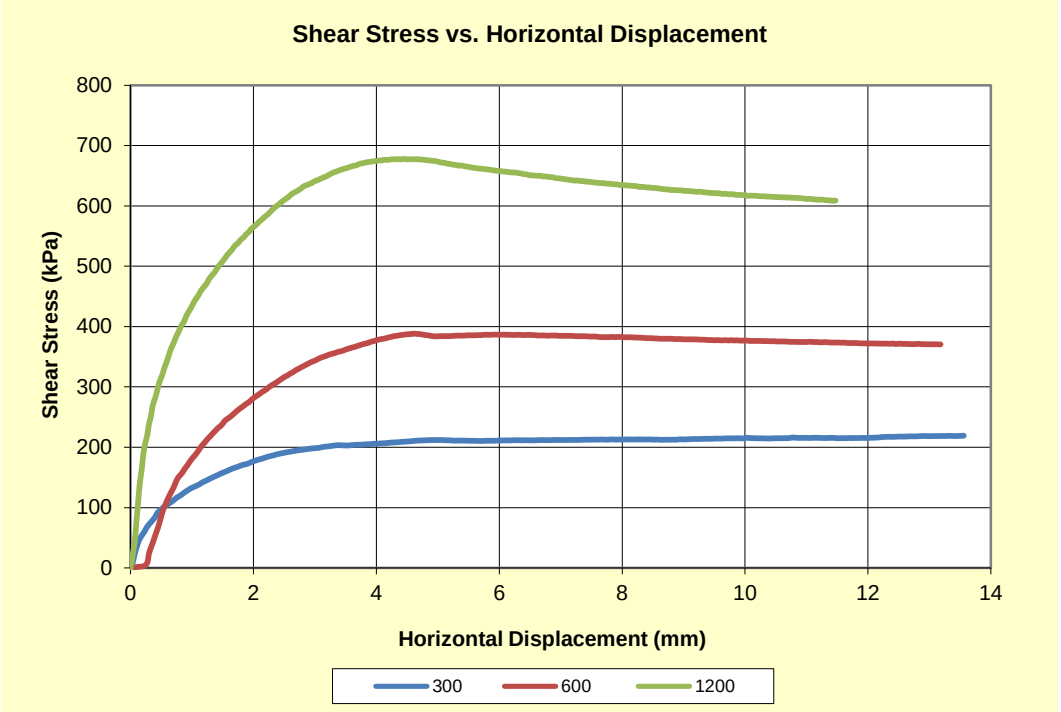
Bay #8, 820 28 St. NE

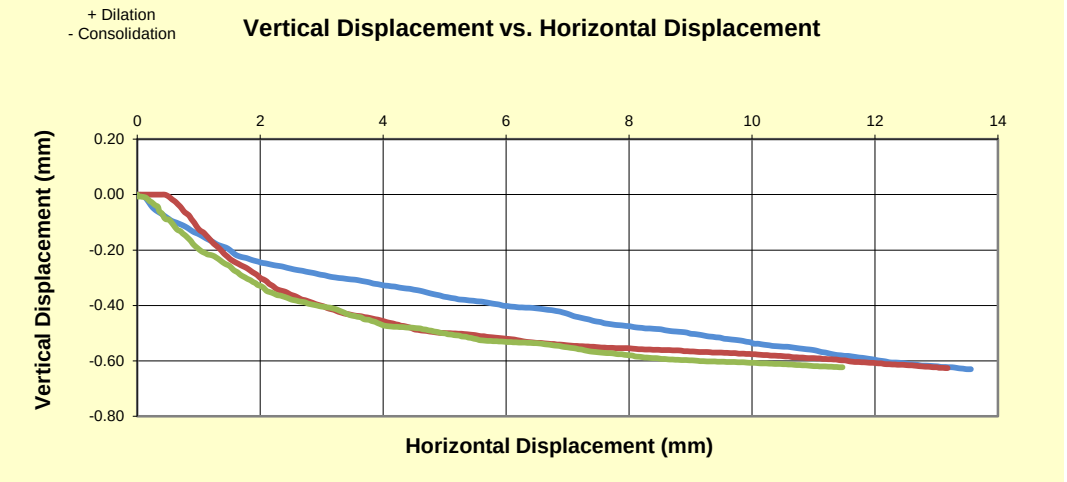
Calgary, AB, T2H 2K1

ASTM D3080-04 Direct Shear Testing of Soils Under Consolidated Drained Conditions

Sample Identification

Project No.:	1413549.2	Lab No.:	B508-05
Client:	Norwest Corporation	Borehole:	BH15-03
Project Title:	Norwest/Lab Testing/CGY-CMO2 Teck Geotech	Sample:	6288
Location:	-	Depth:	16.79-17.24m





Tested By: FC/KP Date Completed: 20-Jun-15

Checked By: DJH

GOLDER ASSOCIATES - Calgary Lab

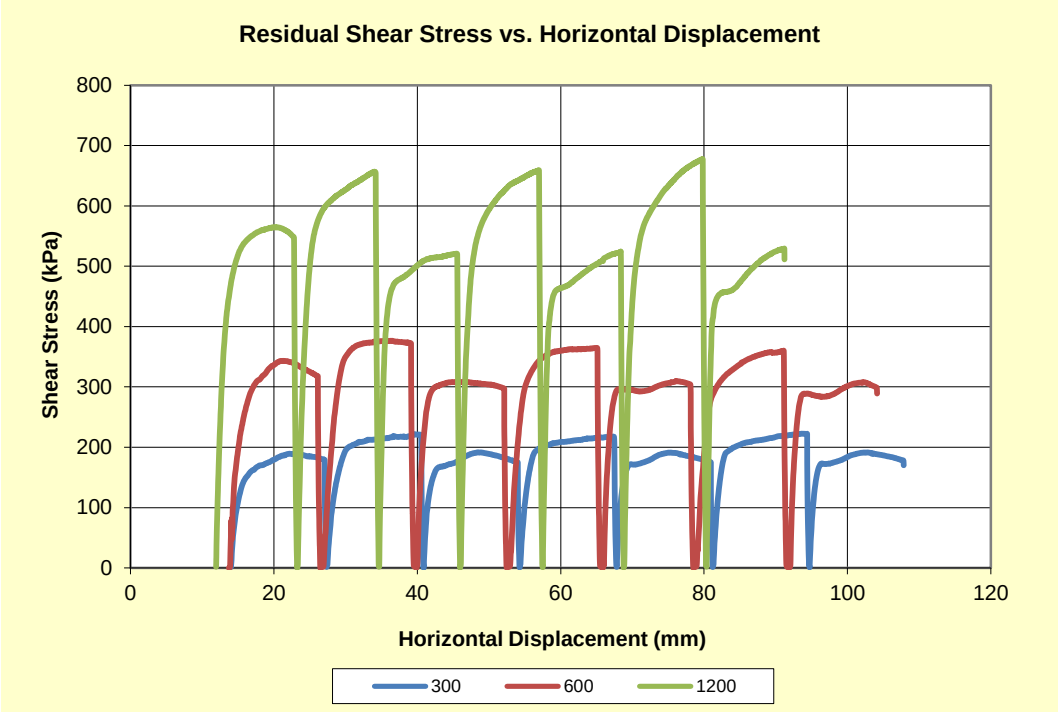
Bay #8, 820 28 St. NE

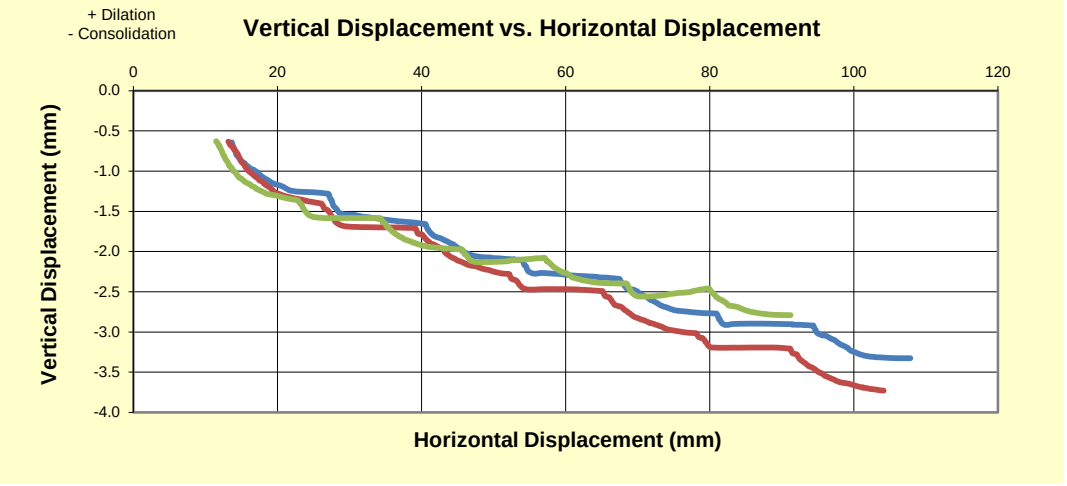
Calgary, AB, T2H 2K1

ASTM D3080-04 Direct Shear Testing of Soils Under Consolidated Drained Conditions

Sample Identification

Project No.:	1413549.2	Lab No.:	B508-05
Client:	Norwest Corporation	Borehole:	BH15-03
Project Title:	Norwest/Lab Testing/CGY-CMO2 Teck Geotech	Sample:	6288
Location:	-	Depth:	16.79-17.24m





Tested By: FC/KP Date Completed: 20-Jun-15

Checked By: DJH

GOLDER ASSOCIATES - Calgary Lab

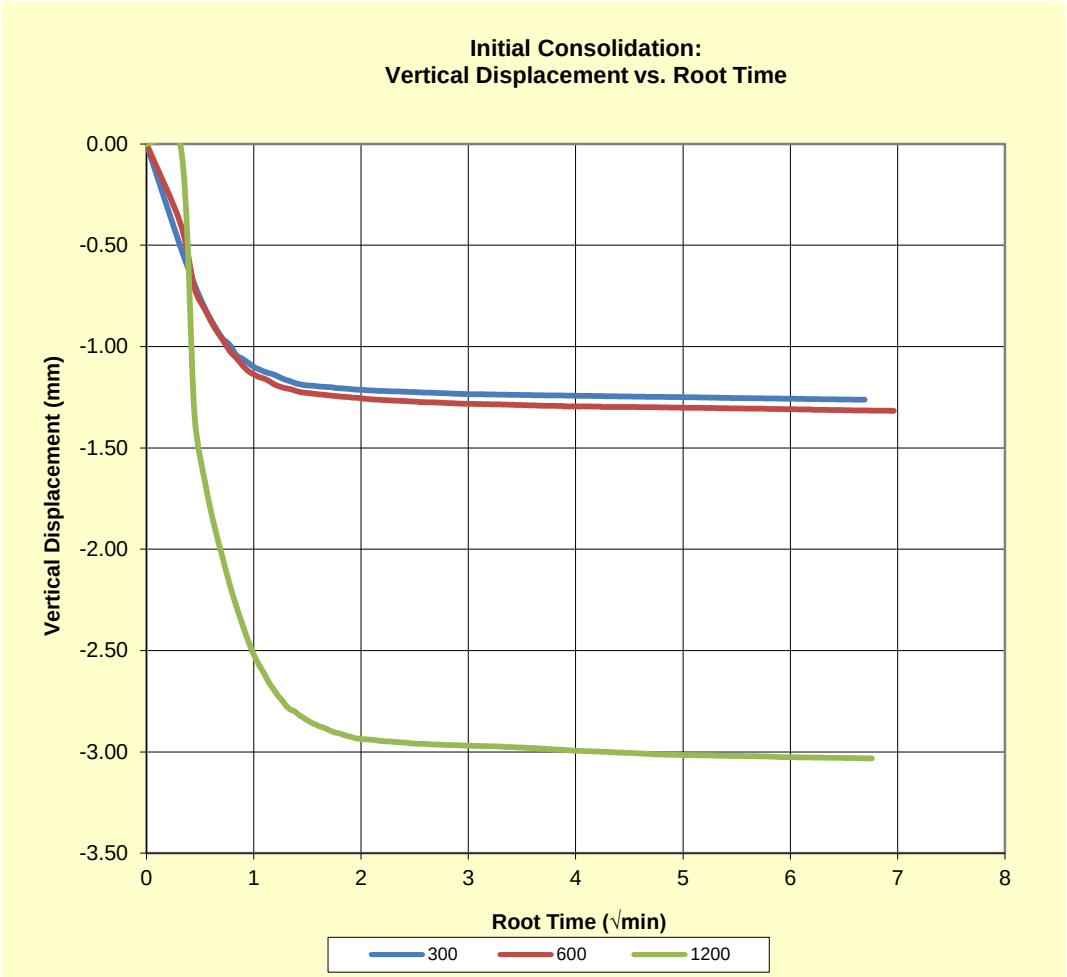
Bay #8, 820 28 St. NE

Calgary, AB, T2H 2K1

ASTM D3080-04 Direct Shear Testing of Soils Under Consolidated Drained Conditions

Sample Identification

Project No.:	1413549.2	Lab No.:	B508-05
Client:	Norwest Corporation	Borehole:	BH15-03
Project Title:	Norwest/Lab Testing/CGY-CMO2 Teck Geotech	Sample:	6288
Location:	-	Depth:	16.79-17.24m



Consolidation Results

Test No.	1	2	3
Normal Stress, kPa	300	600	1200
t_{90} (Taylor Method), min	2.89	2.89	2.89
Calculated t_{50}, min	0.68	0.68	0.68
Change in height ΔH_c, mm	-1.262	-1.317	-3.032

Tested By: FC/KP Date Completed: 20-Jun-15

Checked By: DJH

GOLDER ASSOCIATES - Calgary Lab

Bay #8, 820 28 St. NE

Calgary, AB, T2H 2K1

ASTM D3080-04 Direct Shear Testing of Soils Under Consolidated Drained Conditions

Sample Identification

Project No.:	1413549.2	Lab No.:	B508-08
Client:	Norwest Corporation	Borehole:	BH15-04
Project:	Norwest/Lab Testing/CGY-CMO2 Teck Geotech	Sample:	6270
Location:	-	Depth:	13.47-14.19m

INITIAL - Sample Dimensions

Test No.	1	2	3
Shear Box Geometry	Circle	Circle	Circle
Diameter, mm	63.13	63.13	63.13
Depth, mm	25.40	25.40	25.40
Area, cm^2	31.30	31.30	31.30
Volume, cm^3	79.51	79.51	79.51

Weight Volume Relationships

Test No.	1	2	3
Sample Type	Undisturbed	Undisturbed	Undisturbed
Initial Wet Wt, g	146.73	144.10	155.57
Initial Dry Wt, g	113.0	111.1	121.7
Initial w, %	29.80	29.69	27.78
Final w, %	26.96	25.94	20.03
Initial γ_{dry}, kg/m^3	1422	1398	1531
Final γ_{dry}, kg/m^3 (after consolidation)	1462	1491	1789
Specific Gravity (assumed)	2.65	2.65	2.65
Initial Void Ratio, e	0.864	0.896	0.731
Initial Saturation, %	91.4	87.8	100.8

Equipment Description - DS-KWSOIL

Axial LPT	Serial #	KW-DT2
Normal Load Cell	Serial #	KW-PT1
Shear Load Cell	Serial #	KW-LC1
Vertical LPT	Serial #	KW-DT1

Remarks

Area correction applied to normal and shear stress calculation

Sample Description: (CL) SILTY CLAY, low plastic fines; brown; moist, soft.

Tested By: FC/KP Date Completed: 18-Jun-15

Checked By: DJH

GOLDER ASSOCIATES - Calgary Lab

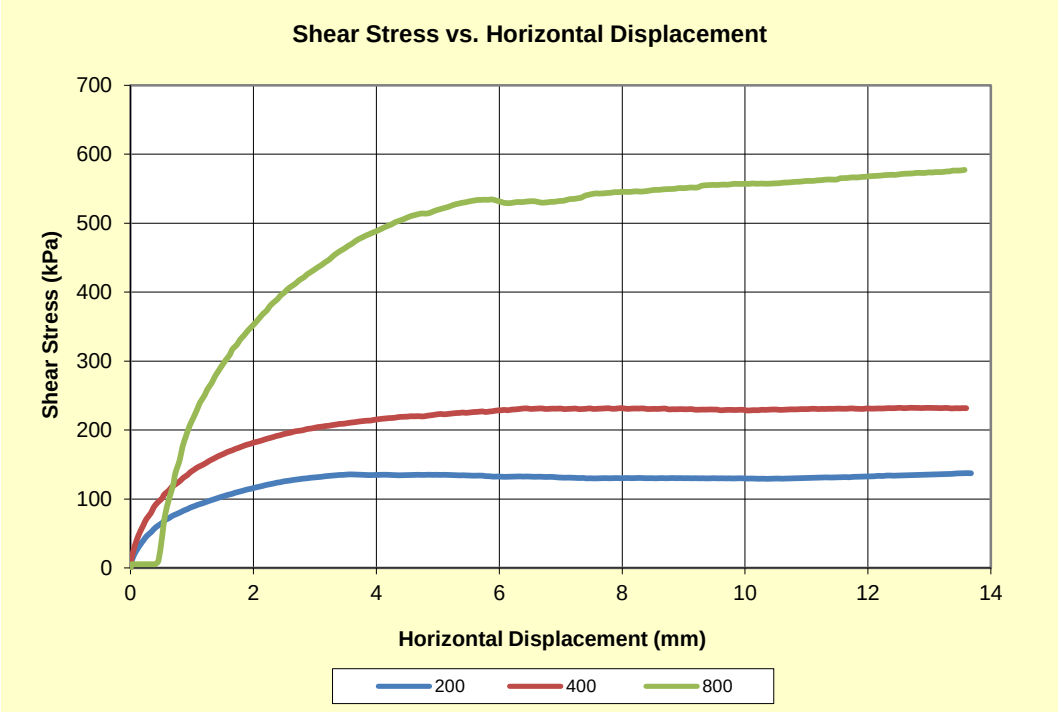
Bay #8, 820 28 St. NE

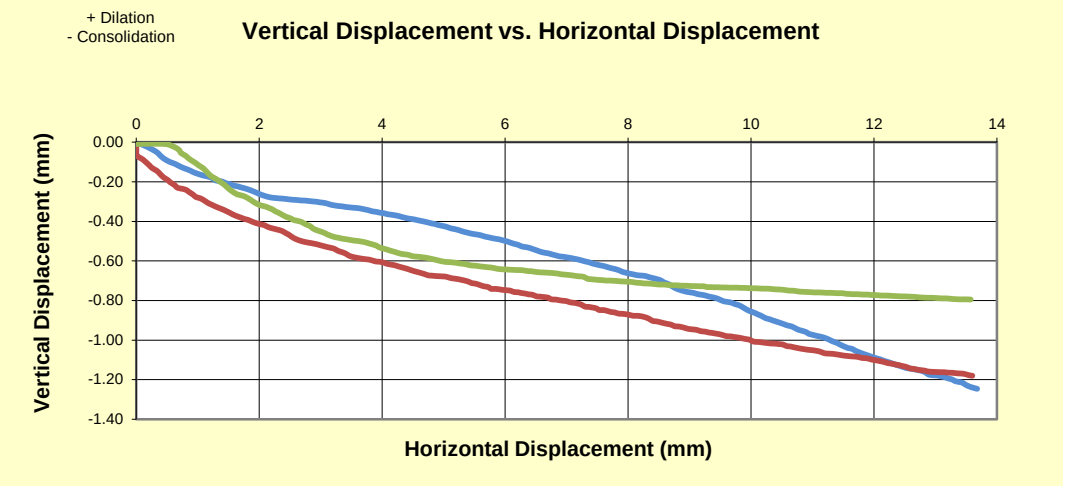
Calgary, AB, T2H 2K1

ASTM D3080-04 Direct Shear Testing of Soils Under Consolidated Drained Conditions

Sample Identification

Project No.:	1413549.2	Lab No.:	B508-08
Client:	Norwest Corporation	Borehole:	BH15-04
Project Title:	Norwest/Lab Testing/CGY-CMO2 Teck Geotech	Sample:	6270
Location:	-	Depth:	13.47-14.19m





Tested By: FC/KP Date Completed: 18-Jun-15

Checked By: DJH

GOLDER ASSOCIATES - Calgary Lab

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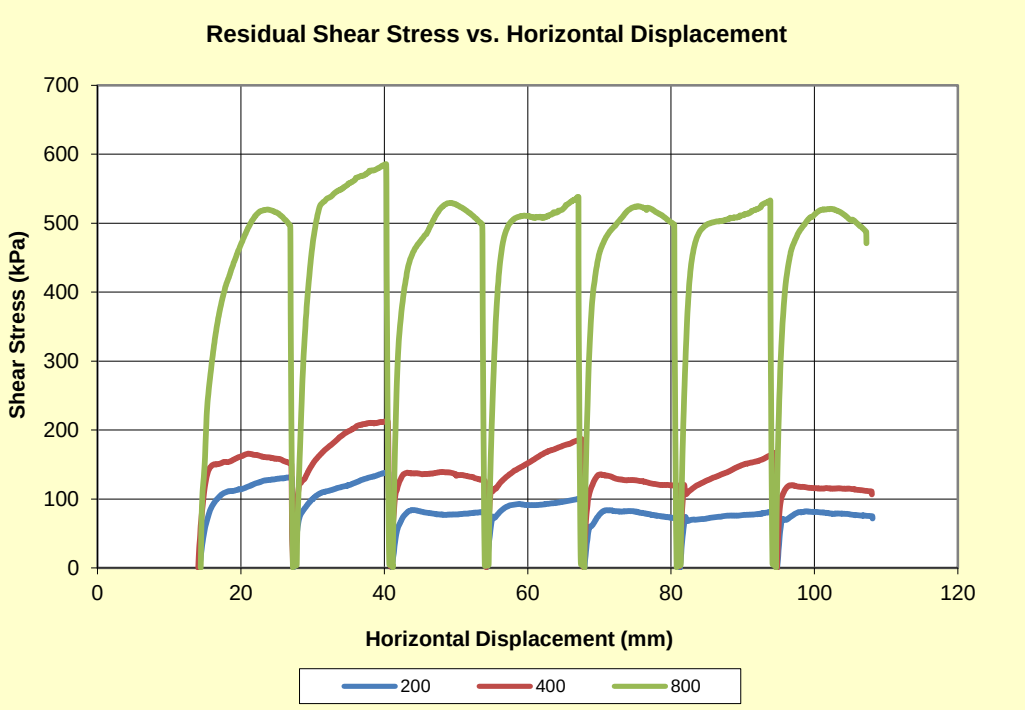
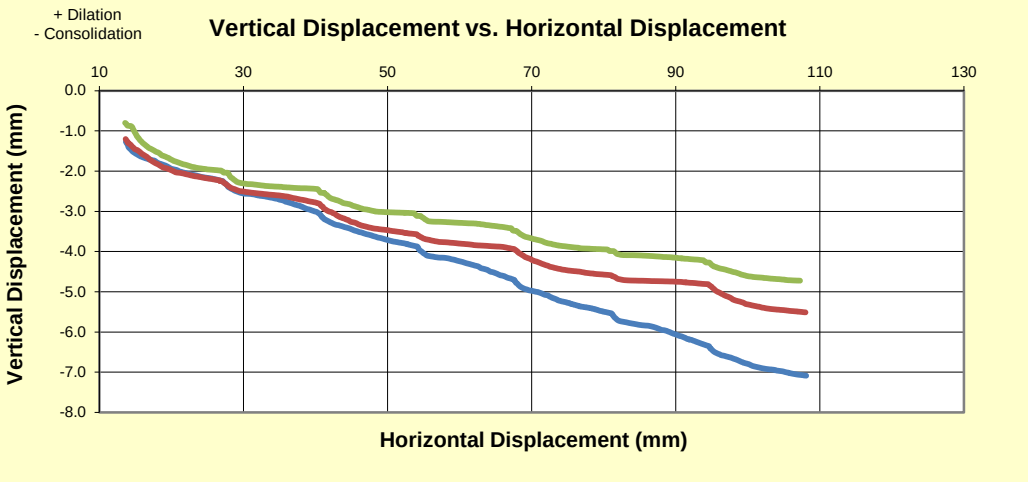
Calgary, AB, T2H 2K1

ASTM D3080-04 Direct Shear Testing of Soils Under Consolidated Drained Conditions

Sample Identification

Project No.:	1413549.2	Lab No.:	B508-08
Client:	Norwest Corporation	Borehole:	BH15-04
Project Title:	Norwest/Lab Testing/CGY-CMO2 Teck Geotech	Sample:	6270
Location:	-	Depth:	13.47-14.19m





Tested By: FC/KP Date Completed: 18-Jun-15

Checked By: DJH

GOLDER ASSOCIATES - Calgary Lab

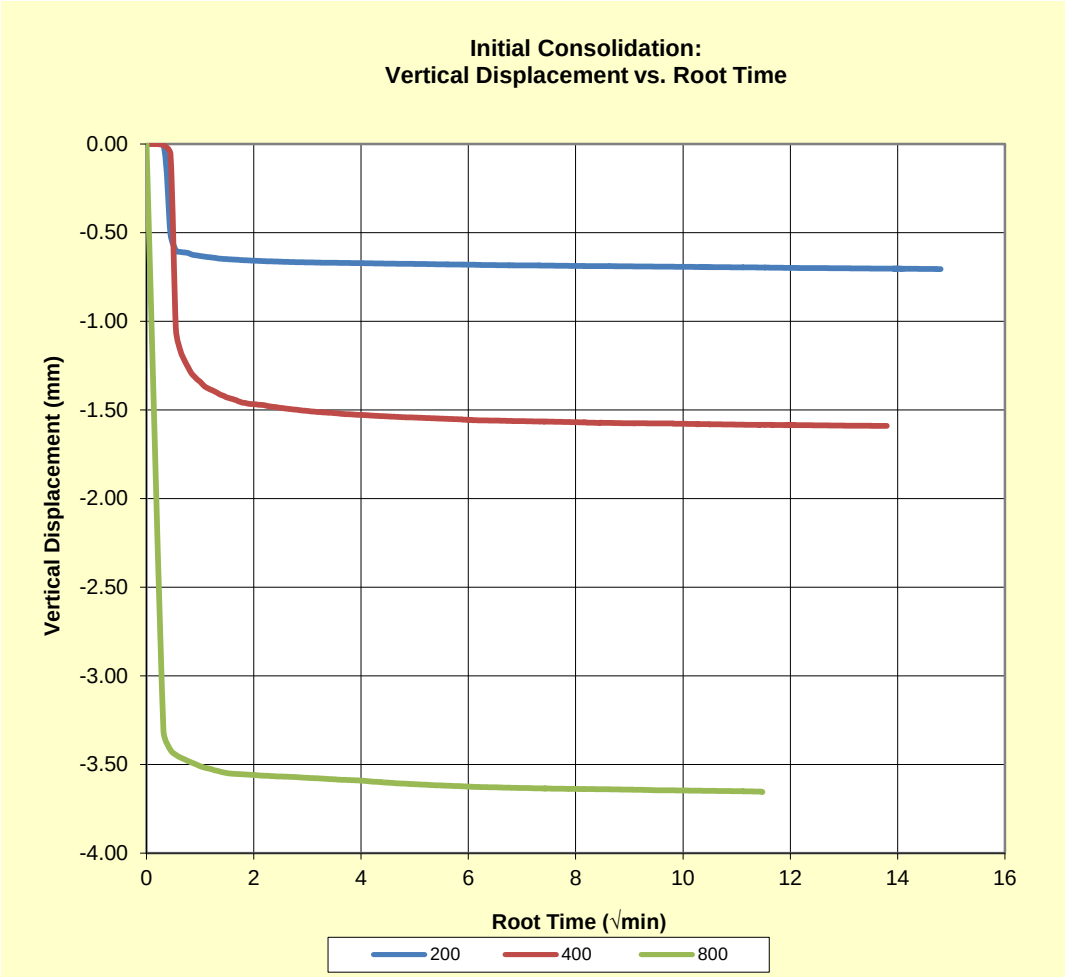
Bay #8, 820 28 St. NE

Calgary, AB, T2H 2K1

ASTM D3080-04 Direct Shear Testing of Soils Under Consolidated Drained Conditions

Sample Identification

Project No.:	1413549.2	Lab No.:	B508-08
Client:	Norwest Corporation	Borehole:	BH15-04
Project Title:	Norwest/Lab Testing/CGY-CMO2 Teck Geotech	Sample:	6270
Location:	-	Depth:	13.47-14.19m



Consolidation Results

Test No.	1	2	3
Normal Stress, kPa	200	400	800
t_{90} (Taylor Method), min	2.72	3.24	3.24
Calculated t_{50}, min	0.64	0.76	0.76
Change in height ΔH_c, mm	-0.706	-1.590	-3.655

Tested By: FC/KP Date Completed: 18-Jun-15

Checked By: DJH

TRIAXIAL COMPRESSION TEST-CONSOLIDATED UNDRAINED SUMMARY

(ASTM D4767-04)

Project Identification

Project #	1413549	Phase:	1000
Project Title:	Norwest/Lab Testing/Calgary Ab		
Tested By:	FC	Date:	15-Jun-15

Initial Sample Parameters

Lab Number	B508-12
Location ID	BH15-06
Sample Number	6223
Depth (m)	14.4-14.8
Sample Type	Undisturbed
Initial Diameter (cm)	6.92
Initial Height (cm)	14.02
Initial Mass (g)	1260.44
Initial Moisture Content (%)	24.40
Initial Void Ratio	0.38
Wet Density (kg/m3)	2390
Dry Density (kg/m3)	1922
Sample Description	(CL) SILTY CLAY, medium plasticity;brown; cohesive, W<PL, soft.

Test Parameters

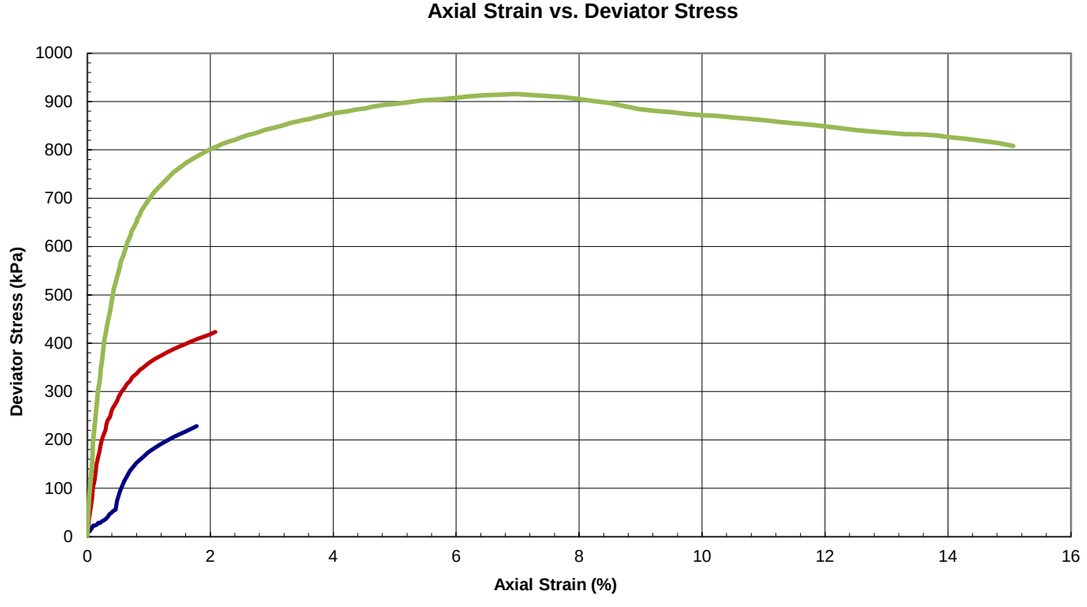
Cell Pressure (kPa)	700	900	1300
Pore Pressure (kPa)	500	500	500
Effective Stress (kPa)	200	400	800
"B" Parameter	98	98	98
Consolidation Volume Change (%)	4.34	5.91	8.07
Consolidated Diameter (cm)	6.78	6.75	6.71
Consolidated Height (cm)	13.99	13.92	13.81
Final Moisture Content (%)	-	-	18.07
Final Void Ratio	-	-	0.479

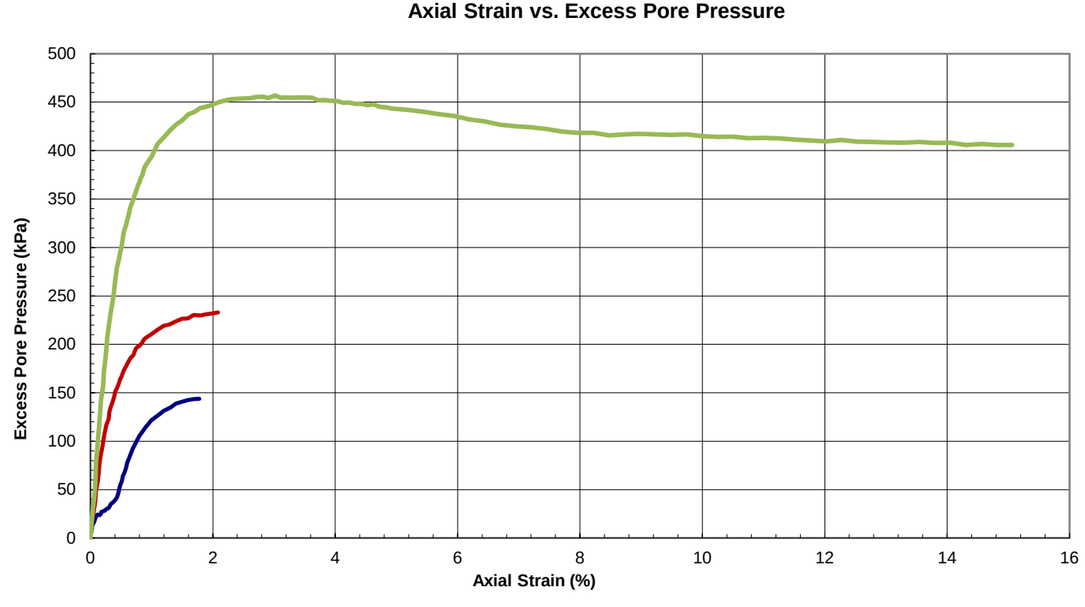
Comments/Observations

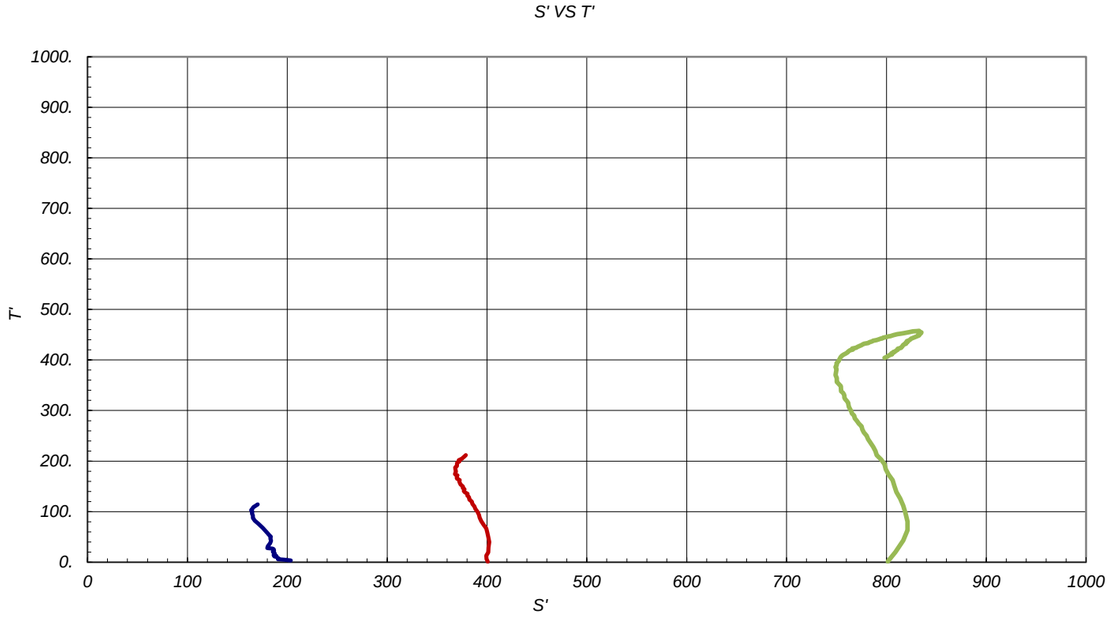
Bay 7, 820 - 28th Street NE
Calgary, AB

Reviewed: _____

TRIAXIAL COMPRESSION TEST-CONSOLIDATED UNDRAINED SUMMARY
(ASTM D4767-04)







Project Number	1413549		
Short Title	Norwest/Lab Testing/Calgary Ab		
Loacation ID	BH15-06		
Sample Number	6223		
Depth (m)	14.4-14.8		
Graph Line Style			
Effective Stress (kPa)	200	400	800
B Pressure Parameter	98	98	98
intitial Moisture Content (%)	24.40	-	-
Initial Void Ratio	0.38	-	-
Intial Wet Density (kg/m^3)	2390	-	-
Intial Dry Density (kg/m^3)	1922	-	-
Final Moisture Content (%)	-	-	18.07
Final Void Ratio	-	-	0.48

TRIAXIAL COMPRESSION TEST-CONSOLIDATED UNDRAINED PHOTOGRAPHS

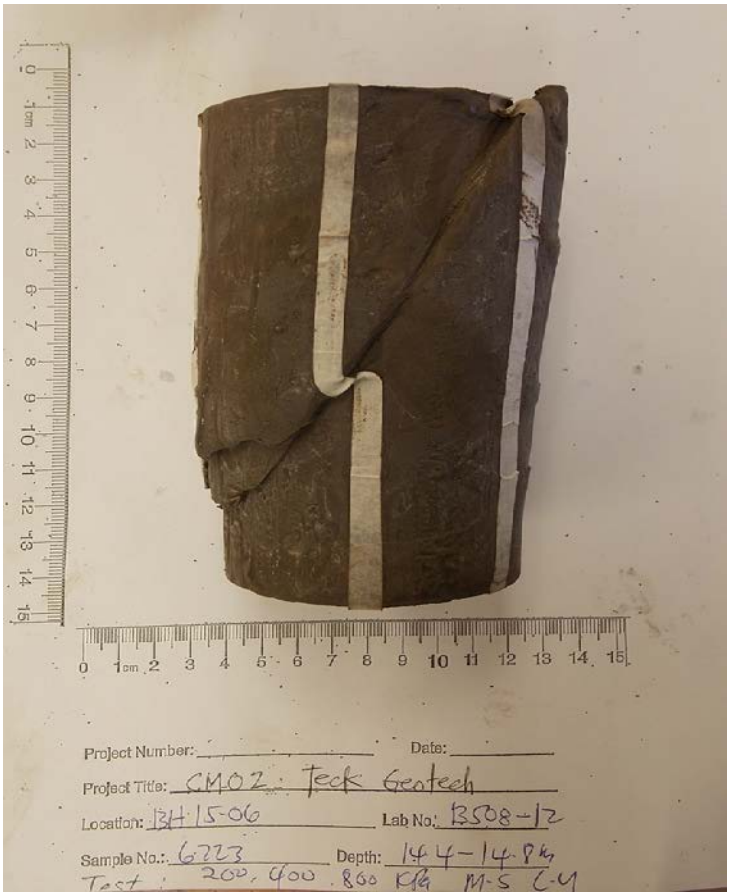
(ASTM D4767-04)

Project Identification

Project #	1413549	Phase:	1000
Project Title:	Norwest/Lab Testing/Calgary Ab		
Tested By:	FC	Date:	15-Jun-15

Lab Number:	B508-12
Location ID.:	BH15-06
Sample No.:	6223
Depth(m):	14.4-14.8
Effective Stress:	200, 400, 800 kPa

Pretest **Posttest**



GOLDER ASSOCIATES - Calgary Lab

Bay #8, 820 28 St. NE

Calgary, AB, T2H 2K1

ASTM D3080-04 Direct Shear Testing of Soils Under Consolidated Drained Conditions

Sample Identification

Project No.:	1413549.2	Lab No.:	B508-13
Client:	Norwest Corporation	Borehole:	BH15-07
Project:	Norwest/Lab Testing/CGY-CMO2 Teck Geotech	Sample:	6250
Location:	-	Depth:	12.1-12.59m

INITIAL - Sample Dimensions

Test No.	1	2	3
Shear Box Geometry	Circle	Circle	Circle
Diameter, mm	63.13	63.13	63.13
Depth, mm	25.40	25.40	25.40
Area, cm^2	31.30	31.30	31.30
Volume, cm^3	79.51	79.51	79.51

Weight Volume Relationships

Test No.	1	2	3
Sample Type	Undisturbed	Undisturbed	Undisturbed
Initial Wet Wt, g	147.58	146.26	151.73
Initial Dry Wt, g	115.0	110.6	115.2
Initial w, %	28.31	32.26	31.69
Final w, %	23.50	23.88	21.42
Initial γ_{dry}, kg/m^3	1447	1391	1449
Final γ_{dry}, kg/m^3 (after consolidation)	1520	1466	1684
Specific Gravity (assumed)	2.65	2.65	2.65
Initial Void Ratio, e	0.832	0.905	0.829
Initial Saturation, %	90.2	94.4	101.3

Equipment Description - DS-KWSOIL

Axial LPT	Serial #	KW-DT2
Normal Load Cell	Serial #	KW-PT1
Shear Load Cell	Serial #	KW-LC1
Vertical LPT	Serial #	KW-DT1

Remarks

Area correction applied to normal and shear stress calculation

Sample Description: (CL) SILTY CLAY, low cohesive fines; brown; moist, soft.

Tested By: FC/KP Date Completed: 18-Jun-15

Checked By: DJH

GOLDER ASSOCIATES - Calgary Lab

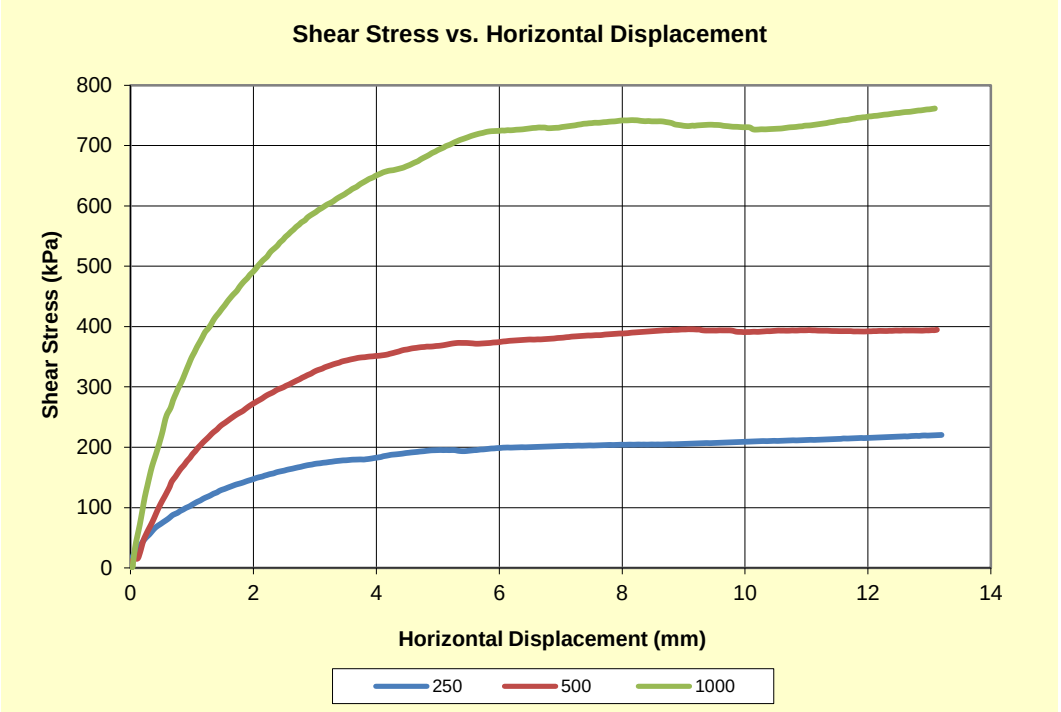
Bay #8, 820 28 St. NE

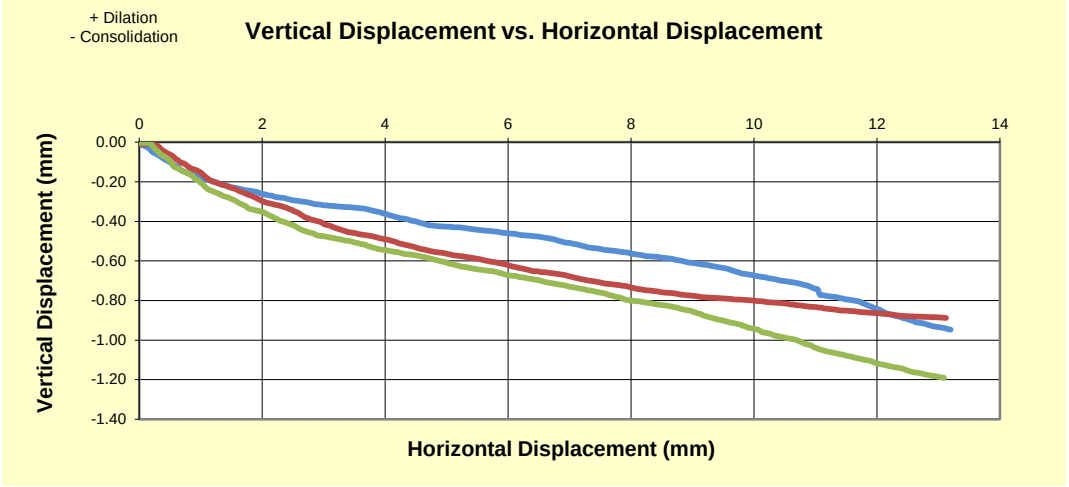
Calgary, AB, T2H 2K1

ASTM D3080-04 Direct Shear Testing of Soils Under Consolidated Drained Conditions

Sample Identification

Project No.:	1413549.2	Lab No.:	B508-13
Client:	Norwest Corporation	Borehole:	BH15-07
Project Title:	Norwest/Lab Testing/CGY-CMO2 Teck Geotech	Sample:	6250
Location:	-	Depth:	12.1-12.59m





Tested By: FC/KP Date Completed: 18-Jun-15

Checked By: DJH

GOLDER ASSOCIATES - Calgary Lab

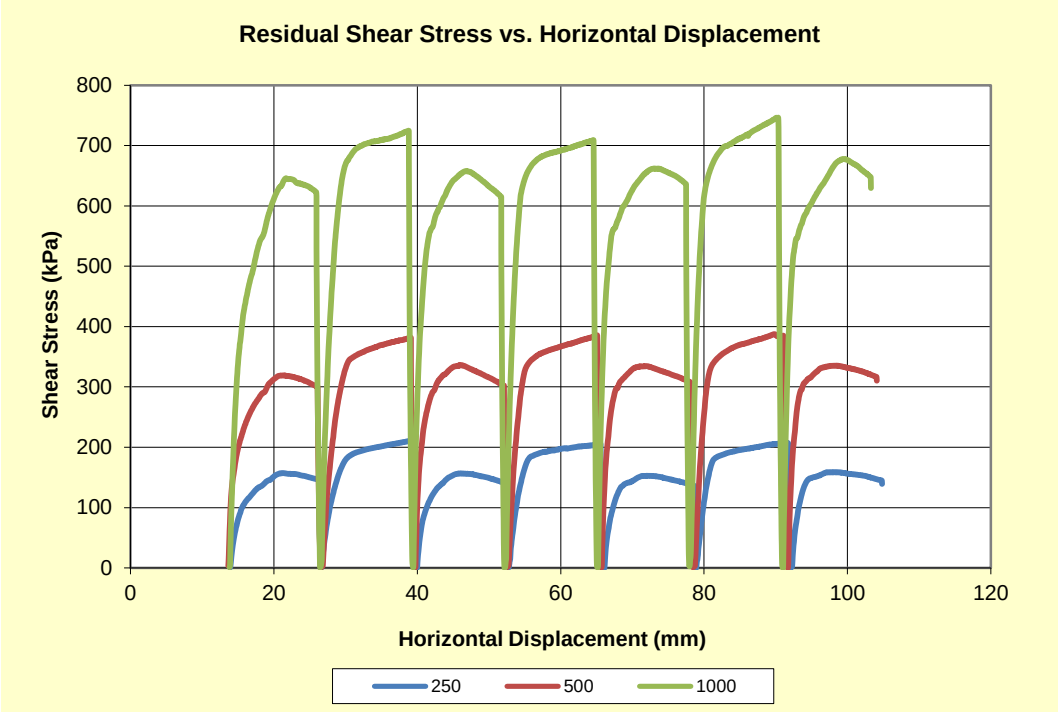
Bay #8, 820 28 St. NE

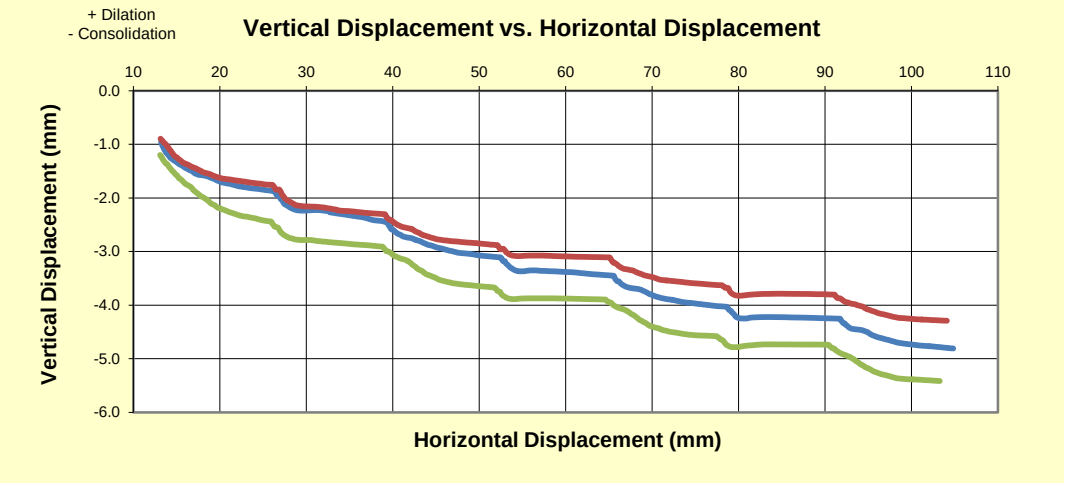
Calgary, AB, T2H 2K1

ASTM D3080-04 Direct Shear Testing of Soils Under Consolidated Drained Conditions

Sample Identification

Project No.:	1413549.2	Lab No.:	B508-13
Client:	Norwest Corporation	Borehole:	BH15-07
Project Title:	Norwest/Lab Testing/CGY-CMO2 Teck Geotech	Sample:	6250
Location:	-	Depth:	12.1-12.59m





Tested By: FC/KP Date Completed: 18-Jun-15

Checked By: DJH

GOLDER ASSOCIATES - Calgary Lab

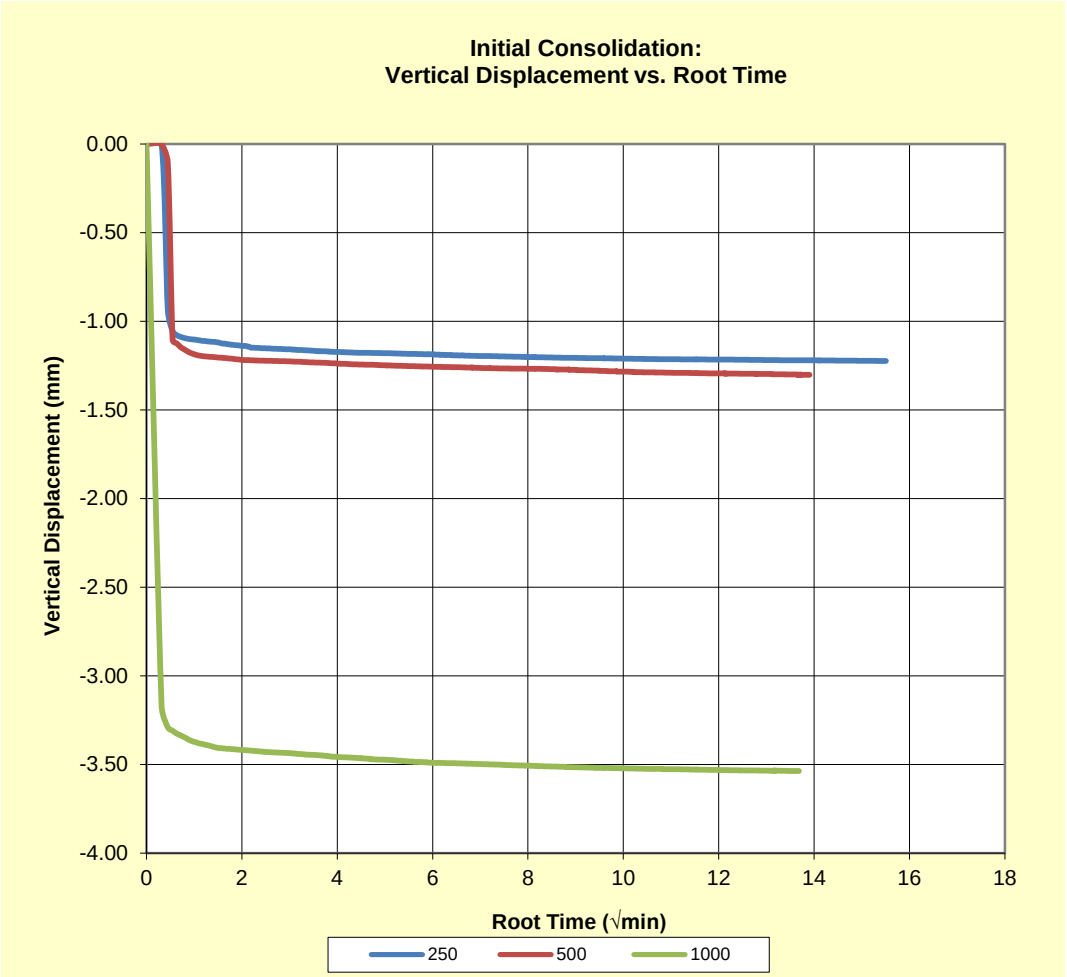
Bay #8, 820 28 St. NE

Calgary, AB, T2H 2K1

ASTM D3080-04 Direct Shear Testing of Soils Under Consolidated Drained Conditions

Sample Identification

Project No.:	1413549.2	Lab No.:	B508-13
Client:	Norwest Corporation	Borehole:	BH15-07
Project Title:	Norwest/Lab Testing/CGY-CMO2 Teck Geotech	Sample:	6250
Location:	-	Depth:	12.1-12.59m



Consolidation Results

Test No.	1	2	3
Normal Stress, kPa	250	500	1000
t_{90} (Taylor Method), min	3.24	3.61	3.24
Calculated t_{50}, min	0.76	0.84	0.76
Change in height ΔH_c, mm	-1.224	-1.302	-3.536

Tested By: FC/KP Date Completed: 18-Jun-15

Checked By: DJH

Consolidation Test

Project Number	1413549		Initial Water Content	24.32	%	Initial Wet Density	2021	kg/m^3
Borehole	BH15-06		Initial Height	19.00	mm	Inital Dry Density	1626	kg/m^3
Field Tag No.	6223		Initial Mass	147.77	g	Initial Void Ratio	0.649	
Depth	14.4-14.8m		Sample Diameter	70.00	mm	Initial Saturation	100.49%	
Lab No.	B508-12		Specific Gravity (assumed)	2.68		Height of Solids	11.524	mm
			Final Water Content	19.19	%	Final Void Ratio (from ht)	0.538	
			Final Height (Measured)	17.72	mm	Area	0.00385	m^2
Loading Cap	1.19	kPa	Final Mass	148.02	g	Initial Dry Mass	118.86	g

Load No.	H_{sample} (mm)	H_{D50} (mm)	Stone Correction	$H_{corrected}$	$D50_{corrected}$	t_{50} (min)	Stress (kPa)	Void Ratio	Strain (%)	Incremental Work (kJ/m^3)	Cumulative Work (kJ/m^3)	Stress Point (kPa)
1	18.997		0.003	19.000			1.19	0.649	0.00	0.00	0.00	1.19
2	18.836		0.019	18.855			9.14	0.636	0.77	0.04	0.04	9.14
3	18.649		0.078	18.727			25.07	0.625	1.44	0.12	0.16	25.07
4	18.433		0.131	18.564			56.94	0.611	2.29	0.36	0.51	56.94
5	18.227		0.177	18.404			120.67	0.597	3.14	0.77	1.28	120.67
6	17.913		0.225	18.138			248.12	0.574	4.54	2.66	3.94	248.12
7	17.577		0.275	17.852			503.03	0.549	6.04	5.92	9.86	503.03
8	17.165		0.344	17.509			1012.84	0.519	7.85	14.56	24.42	1012.84
9	16.818		0.398	17.216			1650.11	0.494	9.39	22.35	46.77	1650.11
10	16.931		0.319	17.250			503.03	0.497	9.21			
11	17.090		0.256	17.346			120.67	0.505	8.70			
12	17.280		0.190	17.470			25.07	0.516	8.05			

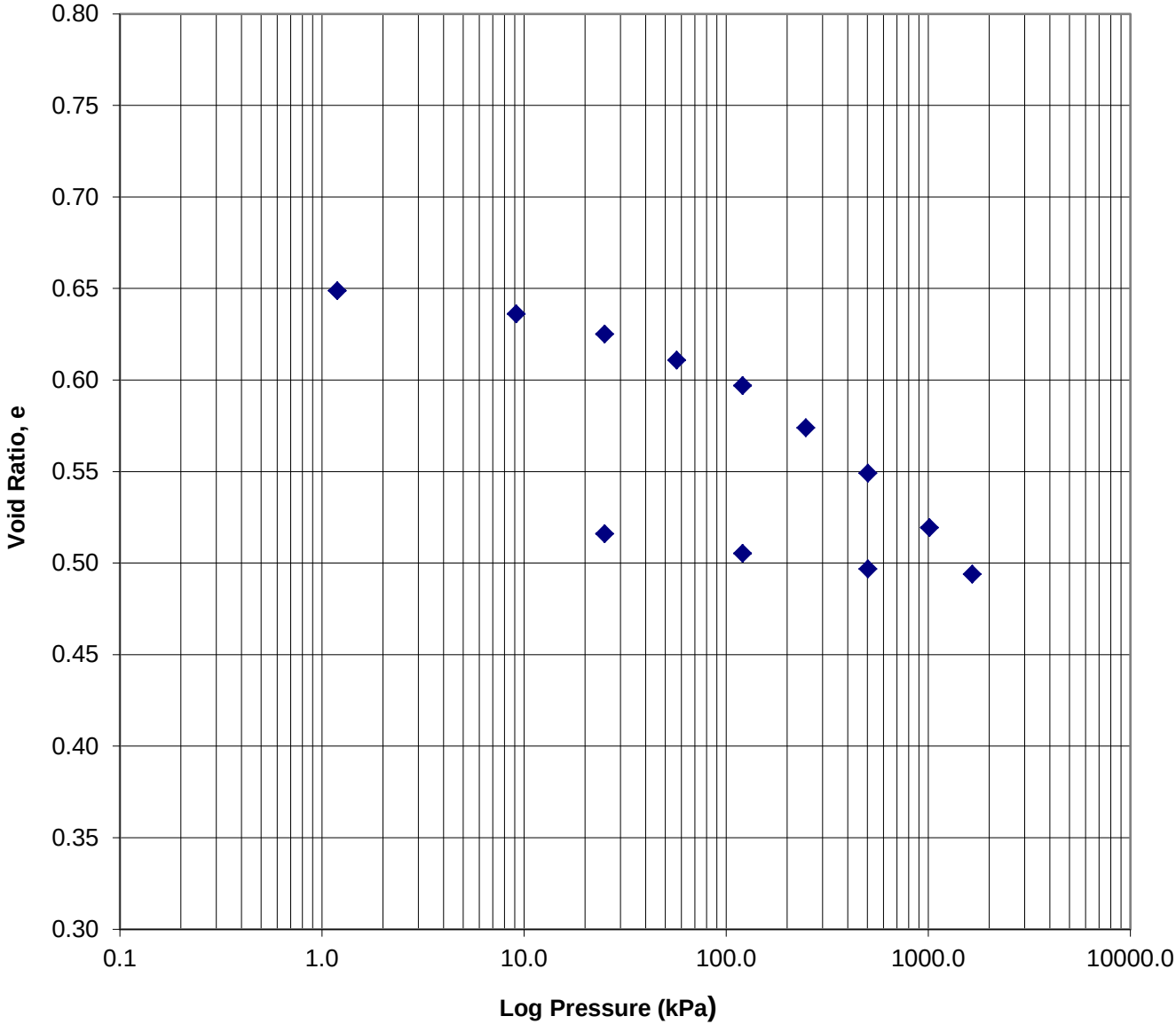
Reviewed: _____

Golder Associates

CONSOLIDATION TEST
(ASTM D2435)

Project No.:	1413549
Lab No.:	B508-12
BH No.:	BH15-06
Sample No.:	6223
Depth:	14.4-14.8m

Void Ratio vs. Log Pressure

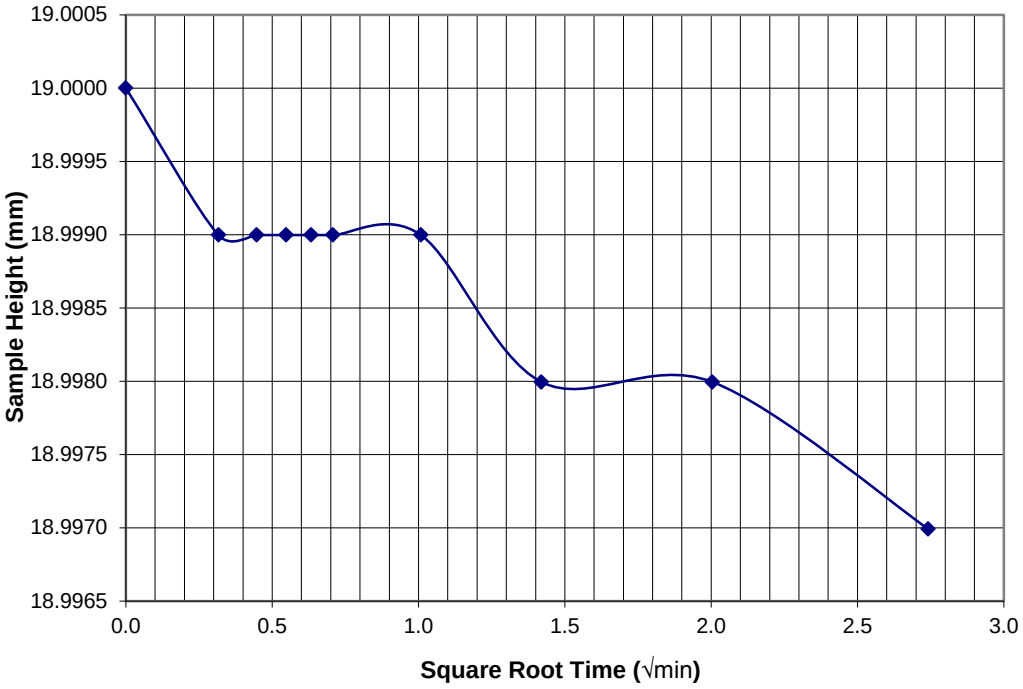


Golder Associates

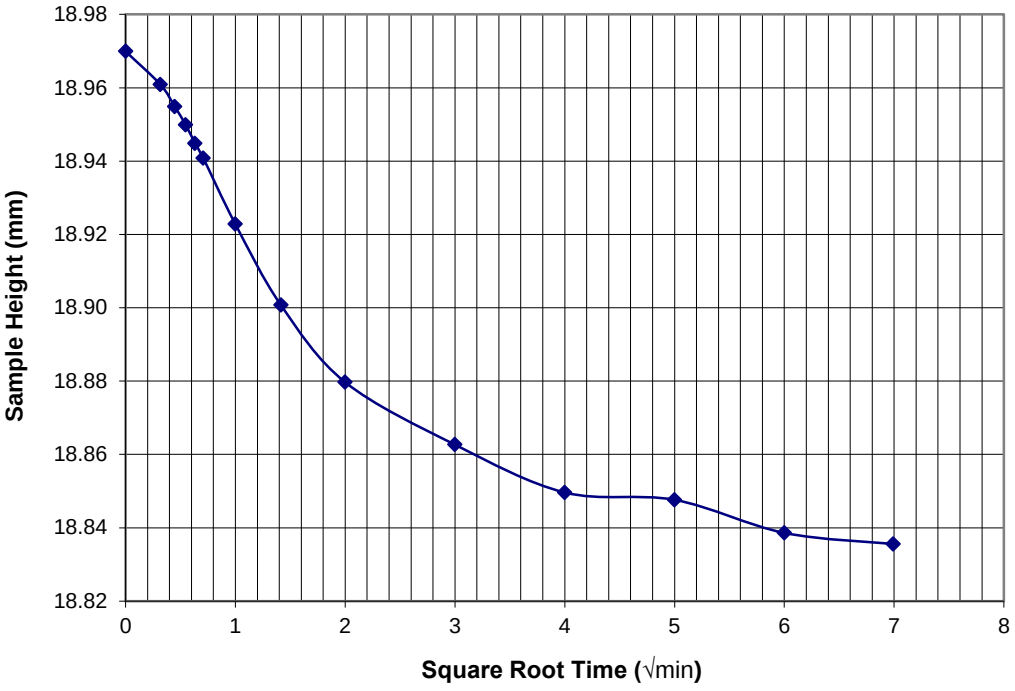
CONSOLIDATION TEST
(ASTM D2435)

Project No.:	1413549
Lab No.:	B508-12
BH No.:	BH15-06
Sample No.:	6223
Depth:	14.4-14.8m

SAMPLE HEIGHT vs. SQUARE ROOT TIME



Total Stress: 1.19 kPa



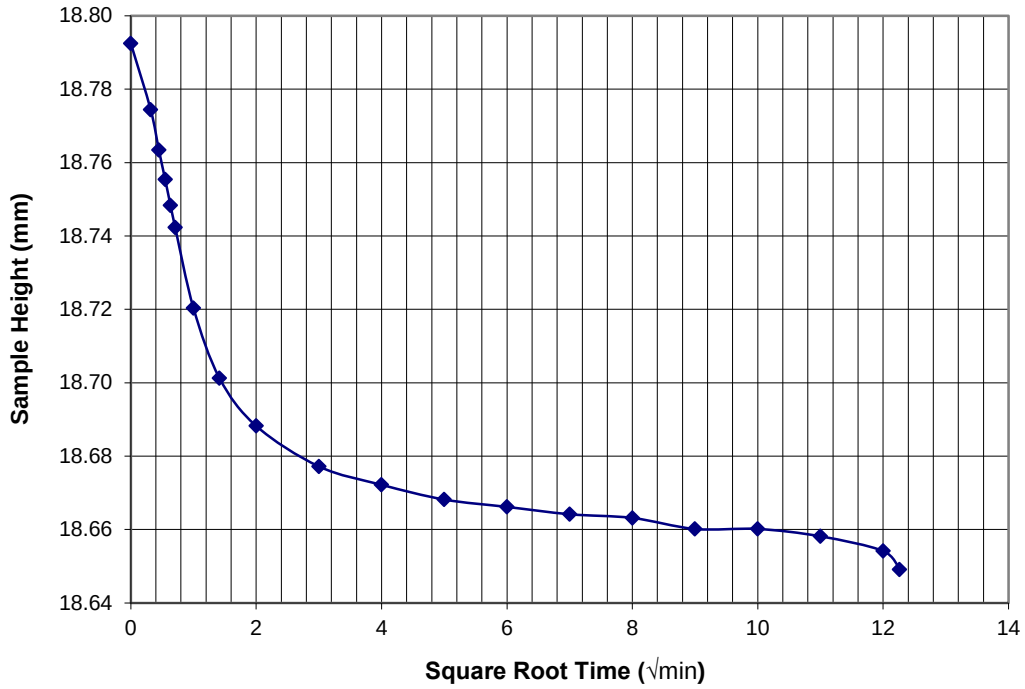
Total Stress: 9.14 kPa

Golder Associates

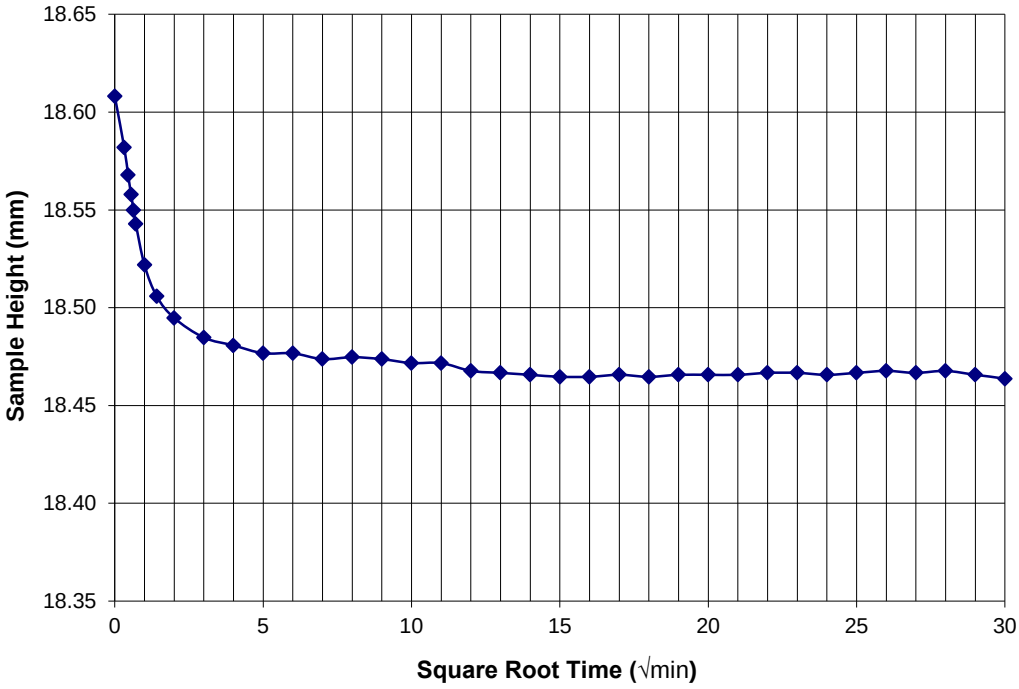
CONSOLIDATION TEST
(ASTM D2435)

Project No.:	1413549
Lab No.:	B508-12
BH No.:	BH15-06
Sample No.:	6223
Depth:	14.4-14.8m

SAMPLE HEIGHT vs. SQUARE ROOT TIME



Total Stress: 25.07 kPa



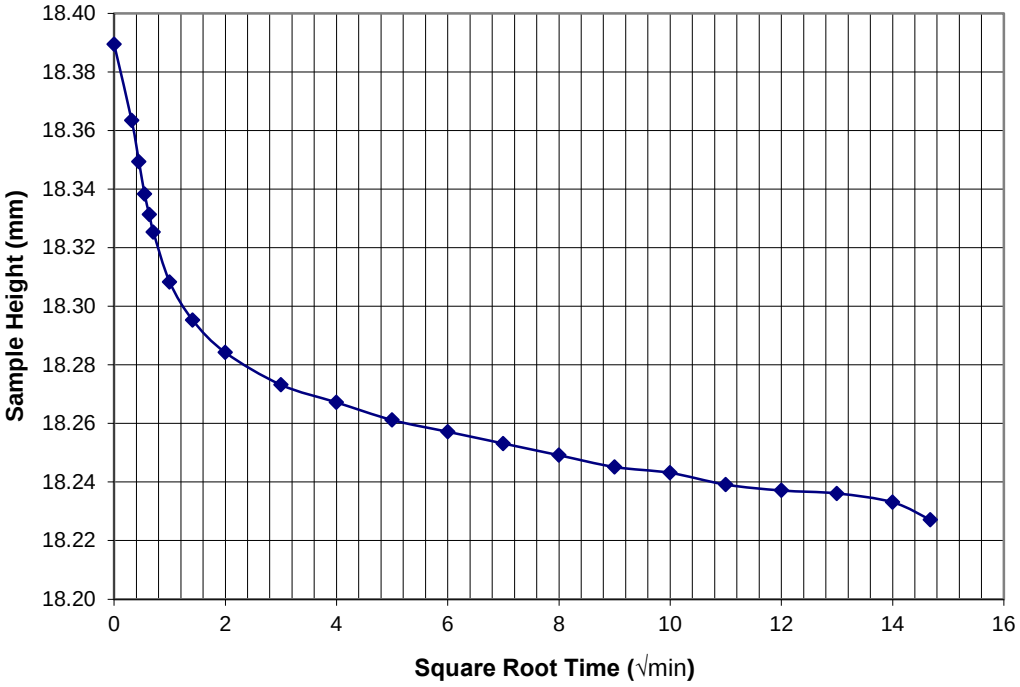
Total Stress: 56.94 kPa

Golder Associates

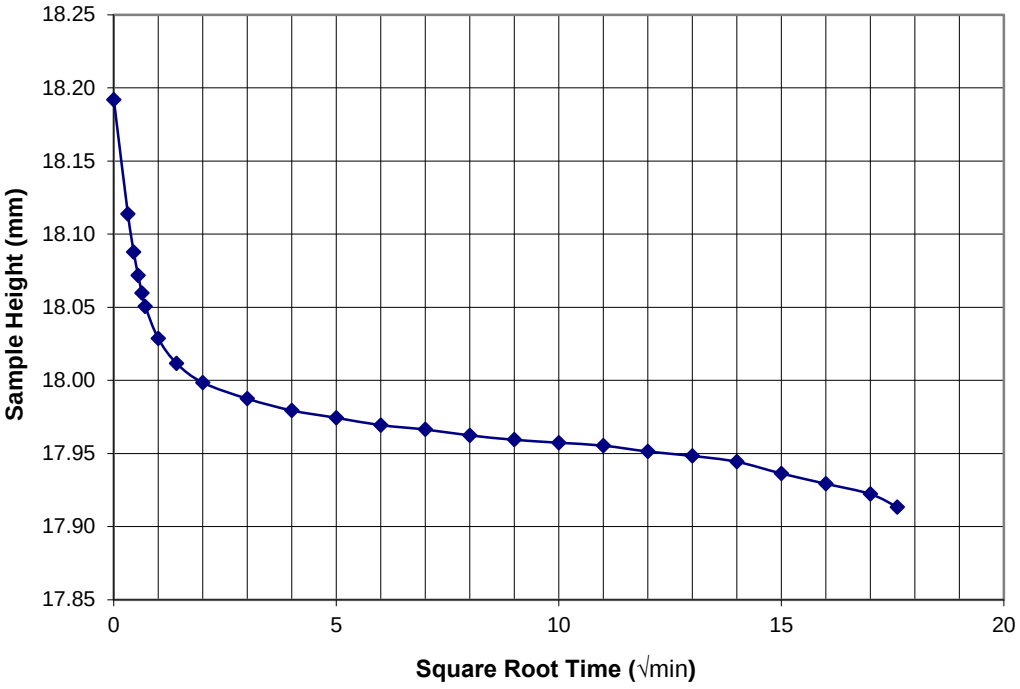
CONSOLIDATION TEST
(ASTM D2435)

Project No.:	1413549
Lab No.:	B508-12
BH No.:	BH15-06
Sample No.:	6223
Depth:	14.4-14.8m

SAMPLE HEIGHT vs. SQUARE ROOT TIME



Total Stress: 120.67 kPa



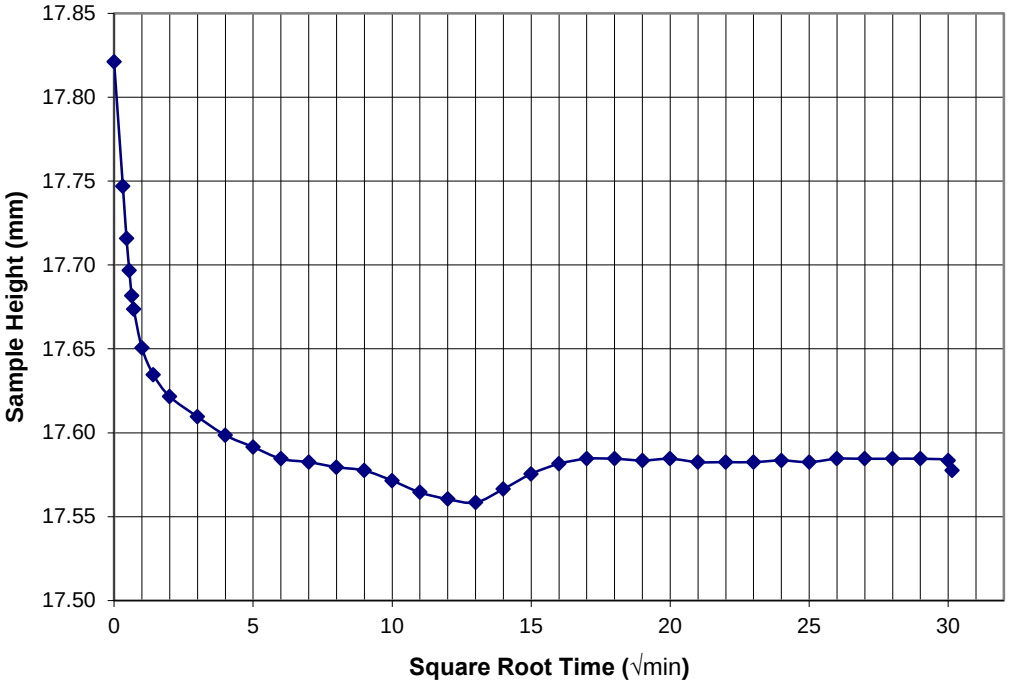
Total Stress: 248.12 kPa

Golder Associates

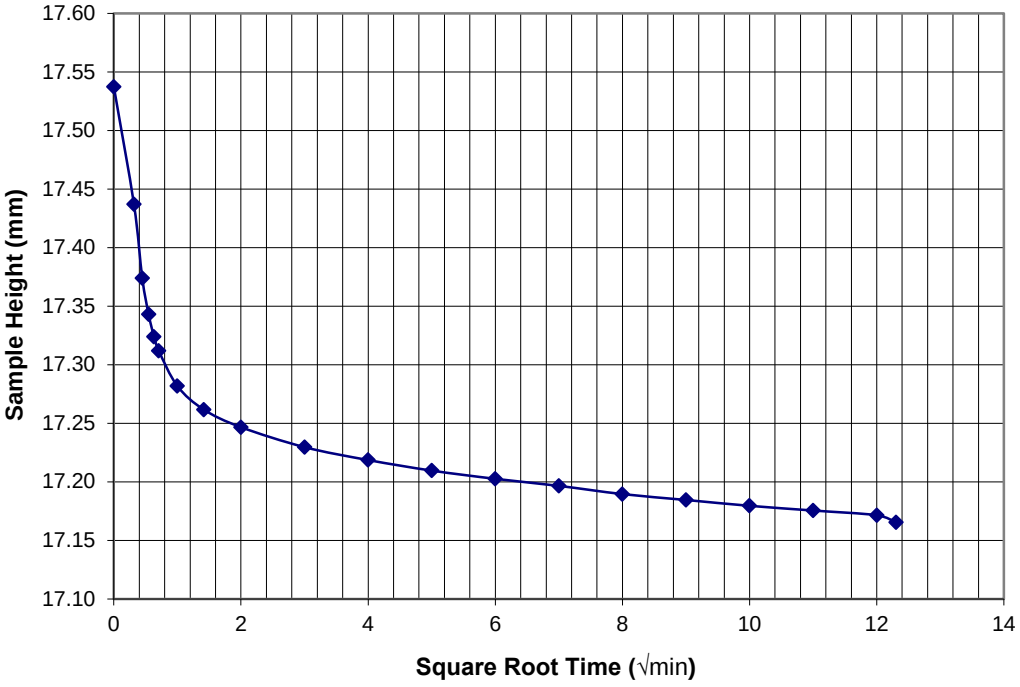
CONSOLIDATION TEST
(ASTM D2435)

Project No.:	1413549
Lab No.:	B508-12
BH No.:	BH15-06
Sample No.:	6223
Depth:	14.4-14.8m

SAMPLE HEIGHT vs. SOUARE ROOT TIME



Total Stress: 503.03 kPa



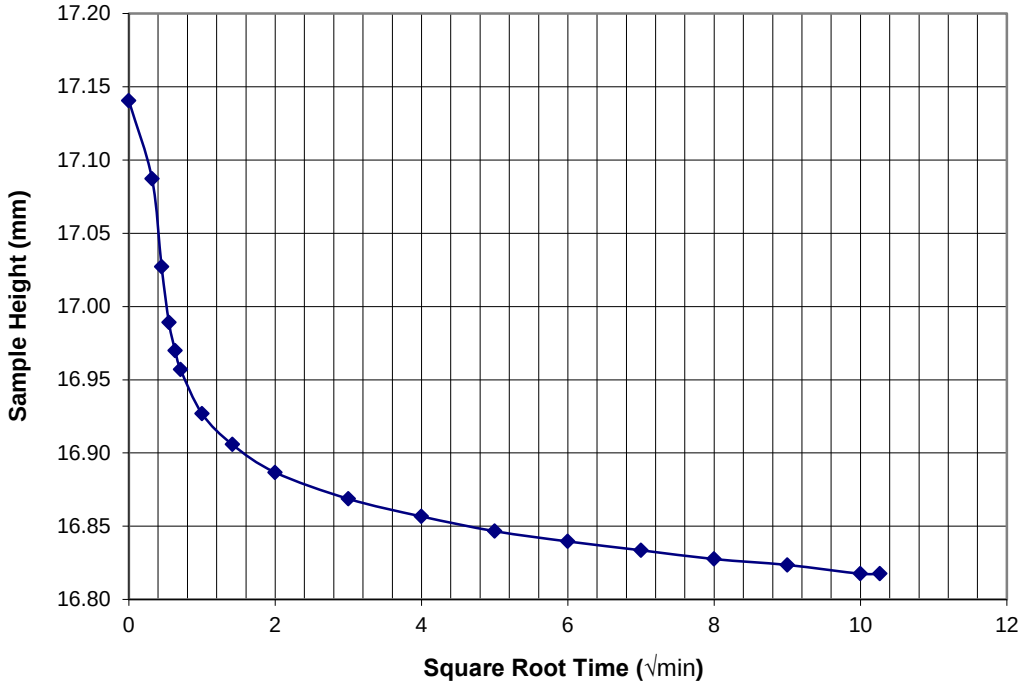
Total Stress: 1012.84 kPa

Golder Associates

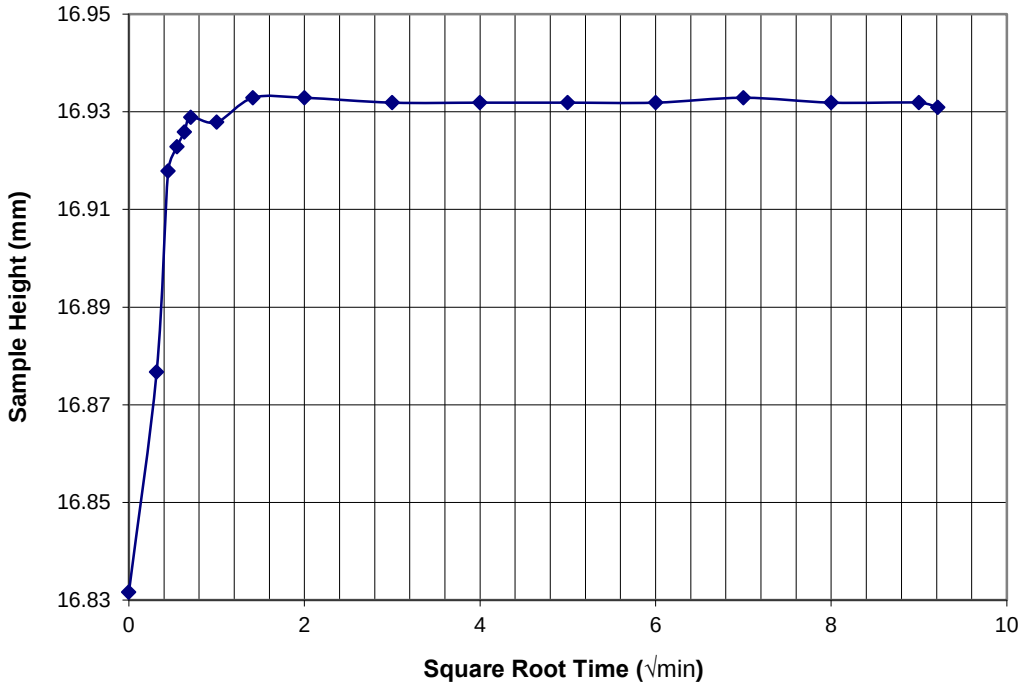
CONSOLIDATION TEST
(ASTM D2435)

Project No.:	1413549
Lab No.:	B508-12
BH No.:	BH15-06
Sample No.:	6223
Depth:	14.4-14.8m

SAMPLE HEIGHT vs. SQUARE ROOT TIME



Total Stress: 1650.11 kPa



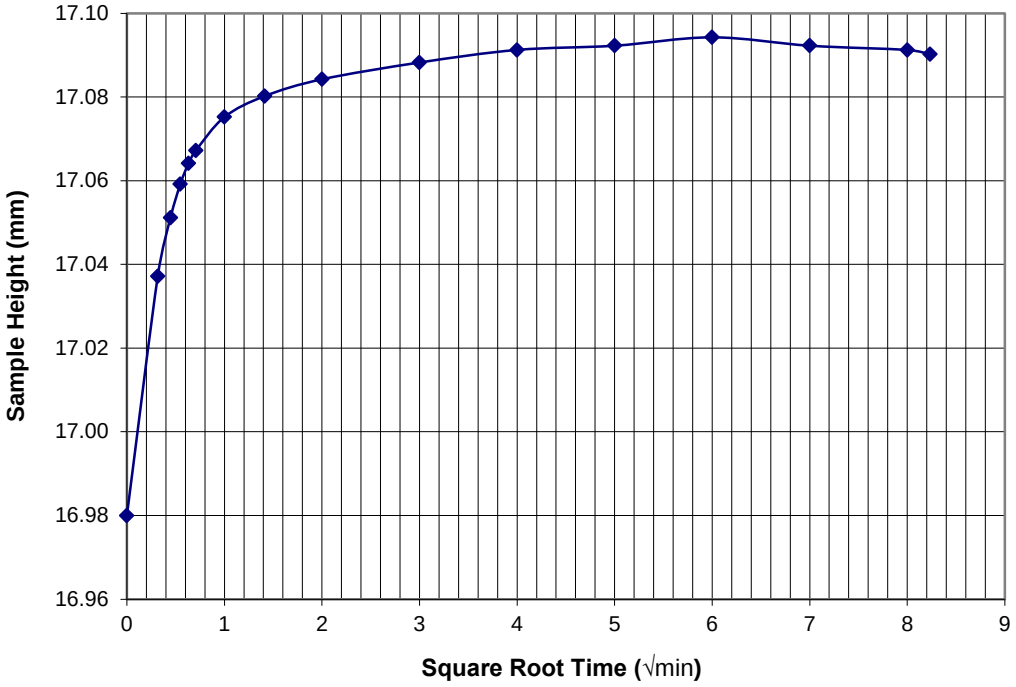
Total Stress: 503.03 kPa

Golder Associates

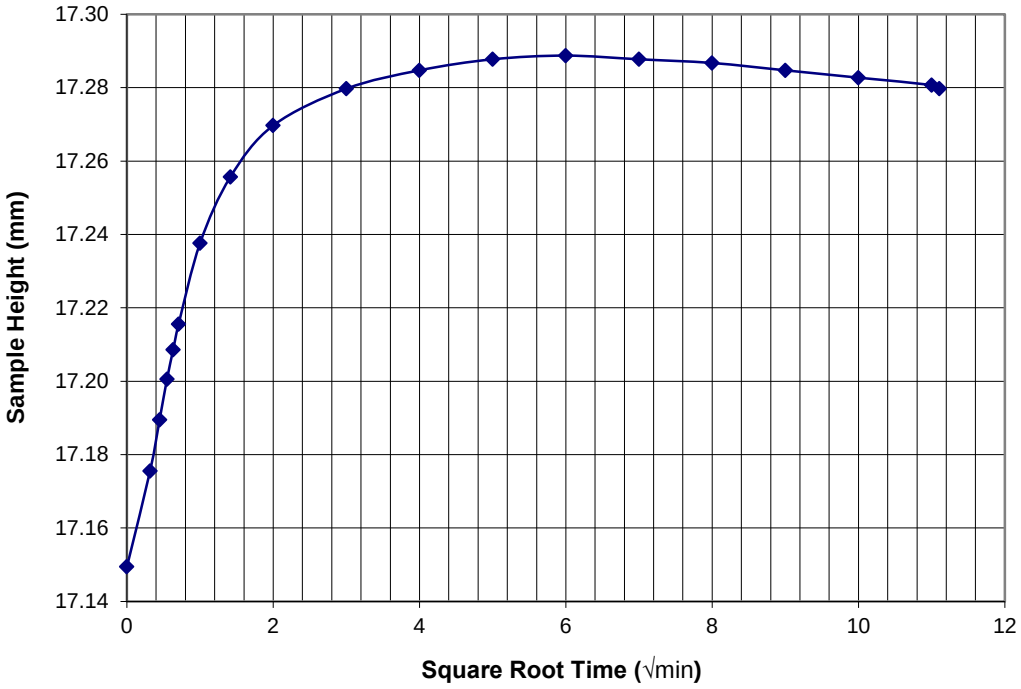
CONSOLIDATION TEST
(ASTM D2435)

Project No.:	1413549
Lab No.:	B508-12
BH No.:	BH15-06
Sample No.:	6223
Depth:	14.4-14.8m

SAMPLE HEIGHT vs. SQUARE ROOT TIME



Total Stress: 120.67 kPa



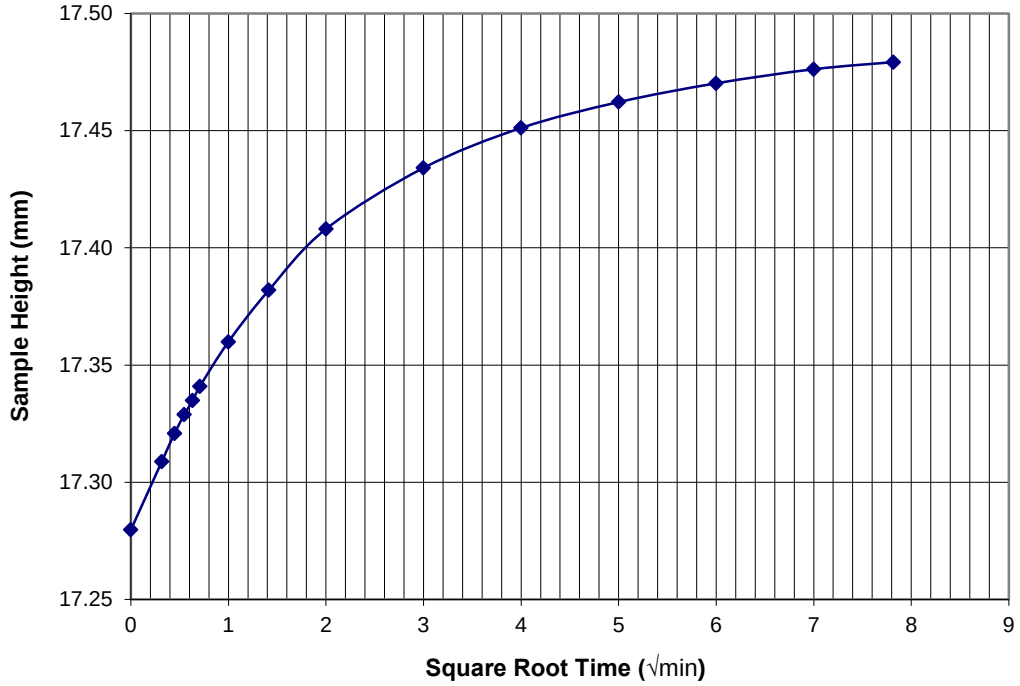
Total Stress: 25.07 kPa

Golder Associates

CONSOLIDATION TEST
(ASTM D2435)

Project No.:	1413549
Lab No.:	B508-12
BH No.:	BH15-06
Sample No.:	6223
Depth:	14.4-14.8m

SAMPLE HEIGHT vs. SQUARE ROOT TIME



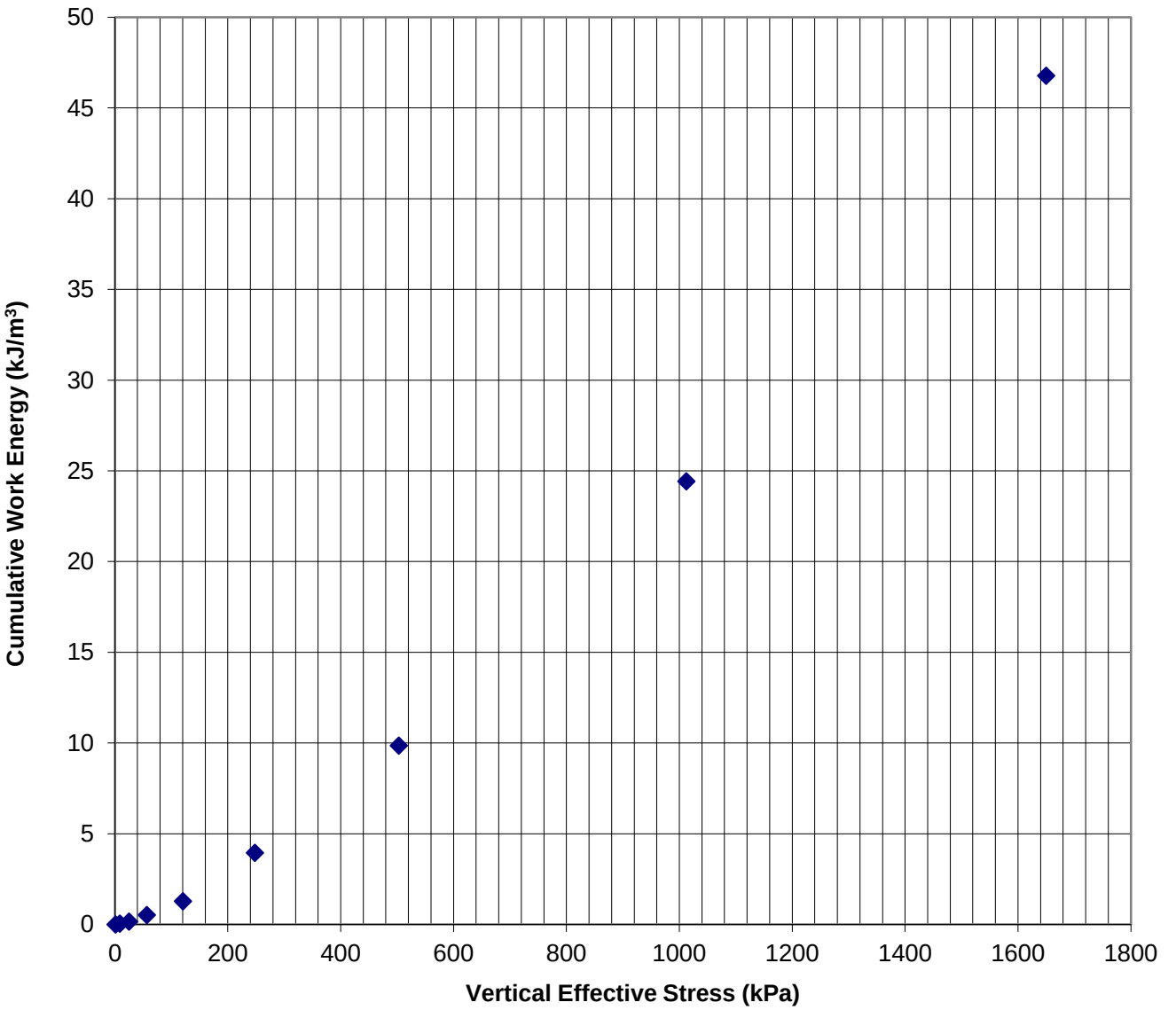
Total Stress: 1.19 kPa

Golder Associates

CONSOLIDATION TEST
(ASTM D2435)

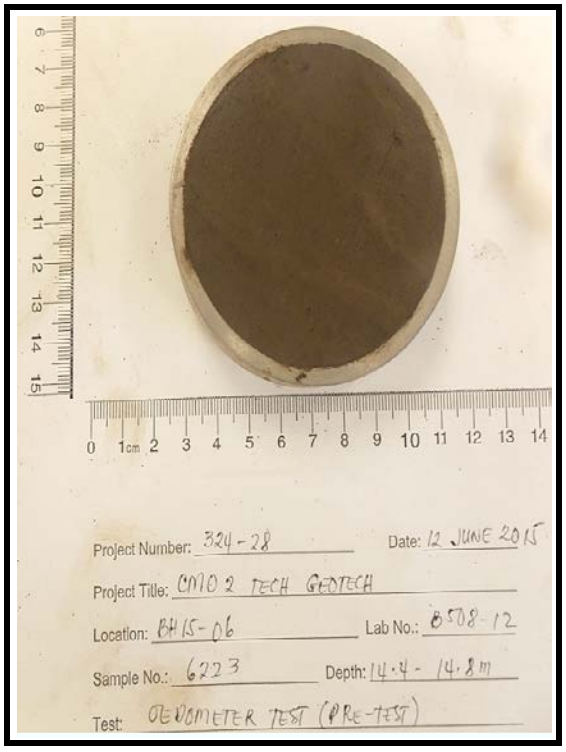
Project No.:	1413549
Lab No.:	B508-12
BH No.:	BH15-06
Sample No.:	6223
Depth:	14.4-14.8m

Work Energy Method

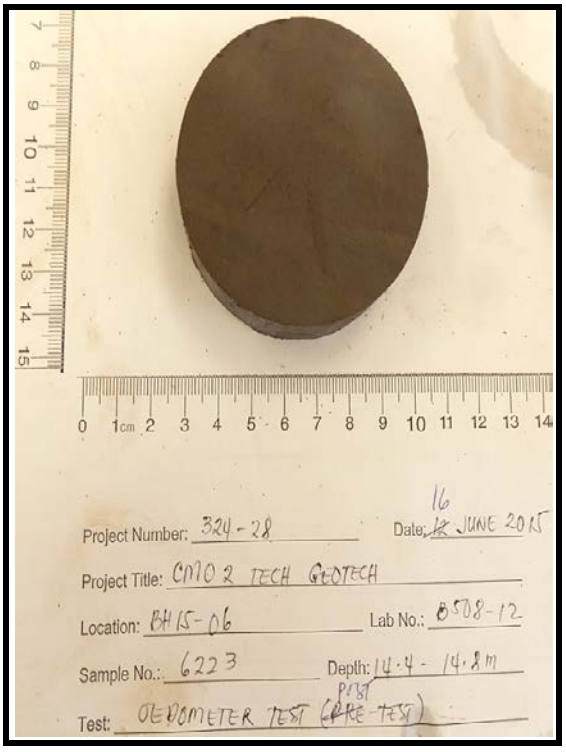


CONSOLIDATION TEST
(ASTM D2435)

Project No.:	1413549
Lab No.:	B508-12
BH No.:	BH15-06
Sample No.:	6223
Depth:	14.4-14.8m



Pre-test



Post-test

Golder Associates Ltd.
ATTN: DEREK HUDSON
8, 820-28th Street NE
Calgary AB T2A 6K1

Date Received: 18-JUN-15
Report Date: 25-JUN-15 11:18 (MT)
Version: FINAL

Client Phone: 403-248-6386

Certificate of Analysis

Lab Work Order #: L1629453

Project P.O. #:	NOT SUBMITTED
Job Reference:	1413549.2000
C of C Numbers:	10-254711
Legal Site Desc:	CMO2 TECK GEOTECH

Jessica Spira, Env. Tech. DIPL
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1629453-1 BH15-03 SA 6279 3-3.45M							
Sampled By: CLIENT							
Matrix: SOIL							
Miscellaneous Parameters							
% Saturation	29.0		1.0	%		24-JUN-15	R3213949
Sulfur (as SO4)	14.1		1.7	mg/kg		25-JUN-15	
Sulfur (as SO4)	48.7		6.0	mg/L		24-JUN-15	R3214005
L1629453-2 BH15-04 SA 6263 1.5-1.95M							
Sampled By: CLIENT							
Matrix: SOIL							
Miscellaneous Parameters							
% Saturation	36.0		1.0	%		24-JUN-15	R3213949
Sulfur (as SO4)	18.0		2.2	mg/kg		25-JUN-15	
Sulfur (as SO4)	50.0		6.0	mg/L		24-JUN-15	R3214005

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
SAL-MG/KG-CALC-CL	Soil	Salinity in mg/kg	Manual Calculation
SAT-PCNT-CL	Soil	% Saturation	CSSS 18.2-Calculation
SO4-PASTE-ICP-CL	Soil	Sulphate (SO4)	CSSS CH15/EPA 6010B

A soil extract produced by the saturated extraction procedure is analyzed for sulfate by ICPOES.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

10-254711

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: Golder Associates Ltd.
8, 820-28th Street NE
Calgary AB T2A 6K1
Contact: DEREK HUDSON

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SAT-PCNT-CL	**Soil**							
Batch R3213949								
WG2115614-3 IRM		**SAL-STD8**						
% Saturation			111.6		%		80-120	24-JUN-15
SO4-PASTE-ICP-CL	**Soil**							
Batch R3214005								
WG2115614-3 IRM		**SAL-STD8**						
Sulfur (as SO4)			84.1		%		70-130	24-JUN-15
WG2115614-1 MB								
Sulfur (as SO4)			<6.0		mg/L		6	24-JUN-15

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

10- 254711

L1629453-COFC

ALS Environment

of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

Page 1 of 1

Report To	Report Format / Distribution	Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
Company: GOLDER ASSOCIATES LTD -	Standard: ✓ Other (specify):	✓ Regular (Standard Turnaround Times - Business Days)
Contact: DEREK HUDSON	Select: PDF ✓ Excel Digital Fax	Priority (2-4 Business Days) - 50% surcharge - Contact ALS to confirm TAT
Address: # 8 - 820 28 4 ST. NE CALGARY, AB	Email 1: dhudson@golder.com	Emergency (1-2 Business Days) - 100% Surcharge - Contact ALS to confirm TAT
	Email 2: Imelda-Suva@golder.com	Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone: Fax:		
Invoice To Same as Report ? (circle) (Yes) or No (if No, provide details)	**Client / Project Information**	**Analysis Request**
Copy of Invoice with Report? (circle) Yes or No	Job #: 1413579.2000	(Indicate Filtered or Preserved, F/P)
Company:	PO / AFE:	
Contact:	LSD: CMO2 TECK GEOTECH	
Address:		
Phone: Fax:	Quote #:	
Lab Work Order # (lab use only)	**ALS Contact:** / **Sampler:**	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	SULPHATES	Number of Containers
	BH15-03 SA 6279 3 - 3.45 m				✓	
	BH15-04 SA 6263 1.5 - 1.95 m				✓	

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
D. Sobredo	17 June '15			6/18	9:17	15 °C				

General Lab Testing Summary

Project No.: 1527423 Phase: -
Short Title: Teck/2015 Gap Analysis/CMO2 Sched: B590
Tested By: CG Date: 25-Aug-15

Sample Identification					Laboratory Test Results	
Tag No.	Sample No.	Depth (m)		Lab No.	Water Content (%)	Dry Density kg/m^3
		from	to			
BH15-03	6292	24.42	24.86	B590-01	15.6	1887
BH15-06	6226	18.40	18.80	B590-02	9.5	2064
BH15-06	6228	21.30	21.80	B590-03	10.2	2003
BH15-07	6259	24.35	24.81	B590-04	11.6	1927
BH15-07	6260	25.85	26.36	B590-05	11.3	1954

Reviewed By:_____

Appendix C
Sewage Investigation Report

CMO2 Sewerage Feasibility Field Investigation Plan

Submitted to:
Teck Coal Limited and Amec Foster Wheeler

Project Number: 324-27

Date:
June 4, 2015

Norwest Corporation
Suite 2700, 411 – 1st Street, S.E.
Calgary, Alberta T2G 4Y5
(403) 237-7763
calgary@norwestcorp.com

Author:
Kyle Schepanow, M.Sc., P.Geo.

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CORPORATION

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1 INTRODUCTION

Teck Coal Limited (Teck) contracted Norwest Corporation (Norwest) to complete a shallow subsurface field investigation as part of a Feasibility Study to determine the suitability of the Coal Mountain Operations Phase 2 (CMO2) project site as a location for an on-site sewerage system.

The field investigation focused on a soils evaluation that was completed near the proposed CMO2 field camp site.

2 FIELD WORK SCOPE

A field investigation was completed at the CMO2 project site on May 6 and May 7, 2015. The goal was to collect the required soil information needed to design a sewerage facility for the proposed field camp. The investigation comprised a test pit program and a soil infiltration testing program, and the following work tasks were completed:

- excavation of test pits;
- detailed soil profile descriptions and collection of soil samples for laboratory analysis;
- depth of the current water table and indication of seasonal high water table (SHWT);
- descriptions of low permeability limiting layers in the subsurface and depth to these layers; and
- soil infiltration testing.

The test pits and soil infiltration testing programs were completed at two of the proposed field camp locations.

3 FIELD METHODS

3.1 Test Pit Program

On May 6 and 7, 2015, Norwest completed the excavation of test pits at two separate locations. Two test pits, spaced approximately 50 m apart, were excavated at each location, as shown on Figure 3-1. Test pits were advanced using a CAT 345C L excavator with a 2.1 m wide flat-blade bucket at the locations shown in Table 3.1. Test pits were excavated to a depth ranging from 2.4 m and 3 m below ground surface (mbgs). Detailed soil profiles were completed and field observations were recorded during the excavation of these test pits. Soil samples were collected during the test pit program and submitted to an accredited geotechnical and materials testing laboratory for analysis of particle size distribution.

Table 3.1
Test Pit Locations

Test Pit ID	Northing (m)	Easting (m)
PT-2015-01	5,495,351	659,247
PT-2015-02	5,495,309	659,245
PT-2015-03	5,495,513	659,483
PT-2015-04	5,495,465	659,472

3.2 Soil Infiltration Testing Program

On May 7, 2015, Norwest completed infiltration tests at five separate locations distributed across the two proposed sewerage system locations. Norwest used a 2800K1 Guelph Permeameter to conduct these tests. Table 3.2 shows the field locations of the five infiltration tests. As shown on Figure 3-1, each of these locations was paired with a test pit location. Due to the relative consistency observed in the test pit profiles, and the similarity between the test results completed adjacent to PT-2015-03 and PT-2015-04, a third, planned soil infiltration test was removed from the program.

The Guelph Permeameter is a constant head apparatus that operates on the Mariotte-siphon principle and provides a relatively quick and simple method to determine a point measurement of the infiltration rate (field-saturated hydraulic conductivity) of water into the soil. Boreholes were hand-augered and excavated to a target depth of 0.6 mbgs, which was the potential top of the infiltrative surface for the proposed sewerage facility. The Guelph Permeameter was used in accordance with the operating instructions outlined in the user manual produced by Soilmoisture Equipment Corp. (2008).

Table 3.2
Soil Infiltration Test Locations

Testing Location ID	Northing (m)	Easting (m)	Relative Location to Test Pit
GP-2015-01	5495359	659226	South side of TP at PT-2015-01
GP-2015-02	5495303	659234	South side of TP at PT-2015-02
GP-2015-03	5495527	659480	North side of TP at PT-2015-03
GP-2015-04	5495460	659475	South side of TP at PT-2015-04
GP-2015-05	5495312	659215	Midway between TPs at PT-2015-01 and PT-2015-02, to the west

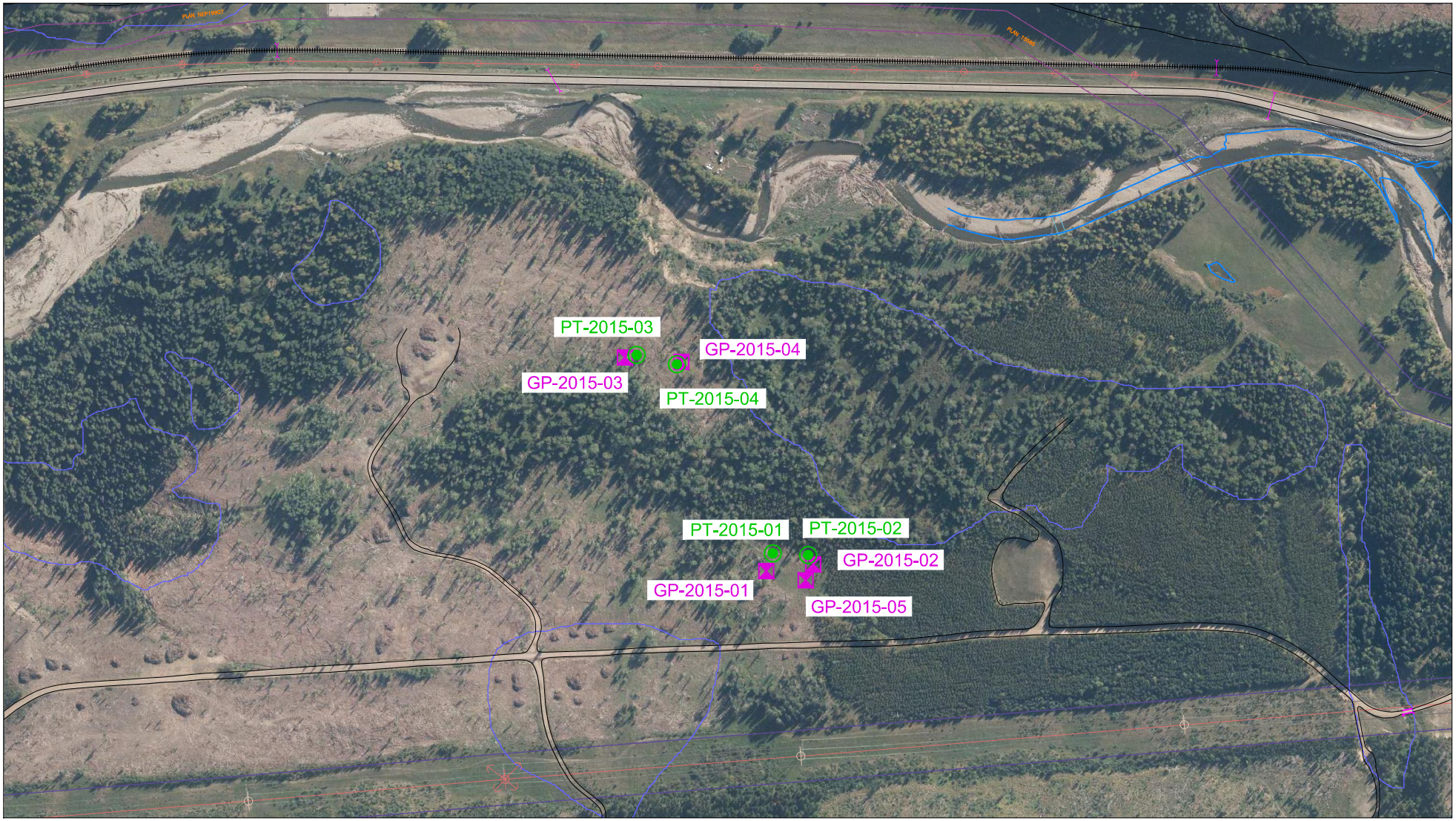
Notes:
Locations not surveyed; UTMs from handheld GPS, ±3 m accuracy.
TP = Test Pit.

A single-head analysis was used to calculate the field-saturated hydraulic conductivity (K_{fs}) using the following equation that was taken from the operating instructions for the Guelph Permeameter (Soilmoisture Equipment Corp., 2008):

$$K_{fs} = \frac{C_1 Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi \frac{H_1}{a^*}}$$

where:

a = well radius;
H_1 = height of water column maintained in the well (5 cm generally used);
Q_1 = steady rate of water fall within the permeameter (cm/s);
C_1 = shape factor based on the height of water column maintained in the well relative to the well radius (H/a); and
a^* = slope of the line [i.e., natural log of K, hydraulic conductivity, relative to Q, the soil water-pressure head (cm^{-1})] (Note: A value of 0.36 was used based on the observed soil type: coarse and gravely sand).



LEGEND

- SOIL INFILTRATION TESTING LOCATION
- TEST PIT LOCATION

N

100 0 100

Metres

GEOTECHNICAL TEST LOCATIONS

LOCATION	NORTHING	EASTING	DESCRIPTION
GP–2015–01	5495359	659226	SOIL INFILTRATION TESTING
GP–2015–02	5495303	659234	SOIL INFILTRATION TESTING
GP–2015–03	5495527	659480	SOIL INFILTRATION TESTING
GP–2015–04	5495460	659475	SOIL INFILTRATION TESTING
GP–2015–05	5495312	659215	SOIL INFILTRATION TESTING
PT–2015–01	5495351	659247	TEST PIT
PT–2015–02	5495309	659245	TEST PIT
PT–2015–03	5495513	659483	TEST PIT
PT–2015–04	5495465	659472	TEST PIT

Teck

TECK CMO2 FEASIBILITY STUDY
FIELD INVESTIGATION

SEWERAGE FEASIBILITY INVESTIGATION SITE PLAN

FIGURE 3-1

DRAWN BY: A.W.
CHK'D BY: K.S.
DATE: 15 05 29

FILE:Fig 1SewerageFeasibility...SitePlan
...\Teck_Coal_C_324\324-27_CMO2 Hydro-Sep\Reports\Draft\Drafting

NORWEST

4 RESULTS

4.1 Test Pit Program

To determine a suitable location for an on-site sewerage system, a total of four test pits were completed. The surface grade at the two selected locations was estimated to be approximately 2% to 4%. The locations were generally flat lying, with a slight very gentle slope to the east (towards the Michel Creek bank) that had a slightly undulating surface. Soil profiles were completed based on field observations collected during the test pit excavation. Field test pit logs are included in Appendix A, and a summary of the field observations is shown in Table 4.1. Soil profiles in the field logs were relatively consistent between the two locations. The subsurface generally consisted of an organic topsoil layer that included finer grained soils and rootlets to a depth ranging from 0.3 mbgs to 0.45 mbgs. That layer was underlain by a poorly sorted, loose, coarse sand and gravel that extended to the base of the test pits. Select samples were submitted to an accredited geotechnical testing laboratory to analyze the particle size distribution (PSD) using sieve and hydrometer analysis. The PSD curves are included in Appendix B.

The test pits remained exposed for a short period of time and were allowed to fill with water to determine the depth of the water table. The observed, ponded depth-to-water in the test pits ranged from 0.8 mbgs to 2.7 mbgs. Field observations to the west of test pit PT-2015-01, located slightly upgradient, indicated the presence of a relatively large body of ponded water; Teck field staff confirmed that water from some of the drainage ditches tended to pond in that area. The test pit profiles provided slight indications of iron oxidation features in the sand and gravel layers, but, in general, there were few indicators of the shallow high water table (SHWT) level in the soil profile. This is probably because the water table was measured in early May which is a seasonal, high-level period, and the effects of the spring melt were still present in the shallow, surface soils. Test pit PT-2015-02 did have some indications of higher water levels, in the form of the presence of iron oxidation, observed at 1 mbgs; this is 0.6 m higher than the ponded water observed in the base of this test pit that, but this was an isolated field observation.

The soil profiles did not indicate the presence of a limiting layer, specifically a low permeability material or bedrock. The soil profile was dominated by the presence of an extremely permeable coarse sand and gravel layer that extended to the base of the excavation.

Table 4.1
Test Pit Observations

Test Pit ID	Total Depth (m)	Observed Ponded-Water Depth (m)	Samples Submitted for PSD Analysis
PT-2015-01	2.4	0.8	Two samples: one from 0.2 mbgs and one from 0.45 mbgs
PT-2015-02	2.4	1.6	One sample from 1.8 mbgs
PT-2015-03	2.5	1.8	One sample from 1.6 mbgs
PT-2015-04	3.0	2.7	One sample from 1.2 mbgs

4.2 Soil Infiltration Testing Investigation Plan

Based on the results of the test pit program, soil infiltration testing was completed at an assumed depth of the planned infiltration surface. Table 4.2 shows the estimated field-saturated hydraulic conductivity results. The estimates were determined using a spreadsheet calculator developed by Soilmoisture Corp. An interpreted *rate of infiltration* was determined using an approximate infiltration rate to field-saturated hydraulic conductivity relationship.

Table 4.2
Infiltration Rate Estimates

Location ID	Testing Depth (mbgs)	Estimated Field-Saturated Hydraulic Conductivity (K_{fs}) (cm/s)	Interpreted Rate of Infiltration [A] (mm/hr)
GP-2015-01	0.55	1.0×10^{-2}	150
GP-2015-02	0.6	1.4×10^{-2}	170
GP-2015-03	0.65	1.0×10^{-2}	150
GP-2015-04	0.7	1.1×10^{-2}	165
GP-2015-05	0.6	3.8×10^{-2}	200

Note: [A] Source is Ontario Ministry of Municipal Affairs and Housing (OMMAH), 1997; Supplemental Guidelines to the Ontario Building Code, 1997; and SG-6 Percolation Time and Soil Descriptions, Toronto, Ontario.

Estimated field-saturated hydraulic conductivity ranged from $1x10^{-2}$ to $4x10^{-2}$ cm/s, with a geometric mean of $1x10^{-2}$ cm/s (infiltration rate of 150 mm/hr). The tabulated field observations and calculations for the estimates of field-saturated hydraulic conductivity are included in Appendix C.

5 CLOSURE

This report presents the results of the shallow subsurface field investigation completed as part of a Feasibility Study to determine the suitability the CMO2 project site as a location for an on-site sewerage system, specifically the results from the field soils infiltration investigation completed by Norwest.

No other warranty, expressed or implied, is made as to the professional services provided to Teck. Any use of this report, other than for its intended purpose, requires the expressed written authorization of Norwest. Any use of this report by a third party, or reliance on or decisions made based upon it, are the responsibility of such third parties

All data contained herein has been reviewed and interpreted by, or generated under the direct supervision of, Sara Wilkins, P.Geol.

"original signed and sealed by author"
June 4, 2015

Prepared by:

_____
Kyle Schepanow, M.Sc., P.Geo.
Hydrogeologist
Norwest Corporation

Reviewed by:

_____
Sara Wilkins, P.Geol.
Manager, Water Resources
Norwest Corporation

Appendix A
Test Pit Logs

FIELD TEST PIT LOG

Job Number:	324-27	Job Name:	CMO2 Hydro and Sewage Investigation	Date:	May 6, 2015
Test Pit Number:	PT-2015-01	Test Pit Size:	2.1m x 3.0m	Elevation:	N/A -
Machine Type:	CAT Excavator 345CL	Contractor:	Teck Resources	Datum:	Ground
Temperature:	12℃	Weather:	Sunny, some clouds		

Depth From (m)	Depth To (m)	Soil Description	Samples No.	Samples Depth (m)	In Situ Density Test No.	In Situ Density Test Depth (m)	Remarks
0	0.35	Loose, Soft, Moist Brown Fine SAND and SILT with sub-rounded gravel 2cm to 5cm diameter, iron oxidation in soil, roots and rootlets extend to 0.35m	1	0.2	1	0.2	0.75 on pen test
0.35	2.4	Loose, Soft, Moist, Light Brown, sub rounded coarse gravelly coarse SAND and GRAVEL, poorly sorted, some cobbles, trace Silt and fine Sand, slightly wet at 0.95 and wet to 2.4	2	0.45	2	0.45	0.5 on pen test
			3	1.35	3	1.35	0.5 on pen test
			4	2	4	2	<0.5 on pen test
		END of TEST PIT					

Comments

UTMs with handheld GPS 11 U
659247 E; 5495351 N

2.1 m wide bucket used on excavator for Test Pit
SHWT not clearly defined in test pit profile
Samples 1 and 2 submitted for particle size distribution analysis

Water Conditions in Test Pit

Water pooled in Test Pit at a depth of 0.8mbgs

☐ Test Pit dry.

JOB No. 324-27
TEST PIT No. PT-2015-01
ENGINEER/FIELD TECHNICIAN Kyle Schepanow

FIELD TEST PIT LOG

Job Number:	324-27	Job Name:	CMO2 Hydro and Sewage Investigation	Date:	May 6, 2015
Test Pit Number:	PT-2015-02	Test Pit Size:	2.1m x 3.0m	Elevation:	N/A -
Machine Type:	CAT Excavator 345CL	Contractor:	Teck Resources	Datum:	Ground
Temperature:	12℃	Weather:	Sunny, some clouds		

Depth From (m)	Depth To (m)	Soil Description	Samples No.	Samples Depth (m)	In Situ Density Test No.	In Situ Density Test Depth (m)	Remarks
0	0.45	Loose, Soft, Moist Brown Medium SAND some coarse Sand, trace sub-rounded gravel 2cm to 5cm diameter, iron oxidation in soil, roots and rootlets extend to 0.45m	1	0.3	1	032	1.0 on pen test
0.45	2.4	Loose, Soft, Moist, Light Brown, sub rounded coarse gravelly coarse SAND and GRAVEL, poorly sorted, some cobbles, trace silt and fine sand, poorly sorted, slight iron oxidation at shallow depths, wet at 1.6mbgs	2	0.7-0.8	2	0.75	<0.5 on pen test
			3	1.3	3	1.3	<0.5 on pen test
			4	1.8	4	1.8	<0.5 on pen test Water entering pit quickly from 1.8m and lower
		END of TEST PIT					

Comments

UTMs with handheld GPS 11 U
659245 E; 5495309 N

2.1 m wide bucket used on excavator for Test Pit

Possible SHWT at 1mbgs, no restrictive layers found slight
Sample 4 submitted for particle size distribution analysis

Water Conditions in Test Pit

Water entering test pit and pooled at 1.6mbgs.

☐ Test Pit dry.

JOB No. 324-27
TEST PIT No. PT-2015-01
ENGINEER/FIELD TECHNICIAN Kyle Schepanow

FIELD TEST PIT LOG

Job Number:	324-27	Job Name:	CMO2 Hydro and Sewage Investigation	Date:	May 7, 2015
Test Pit Number:	PT-2015-03	Test Pit Size:	2.1m x 3.0m	Elevation:	N/A -
Machine Type:	CAT Excavator 345CL	Contractor:	Teck Resources	Datum:	Ground
Temperature:	10℃	Weather:	Sunny, clear skies		

Depth From (m)	Depth To (m)	Soil Description	Samples No.	Samples Depth (m)	In Situ Density Test No.	In Situ Density Test Depth (m)	Remarks
0	0.4	Loose, Soft, Moist Brown Fine Sandy SILT some coarse Sand, trace sub-rounded gravel 2cm to 5cm diameter, iron oxidation in soil, roots and rootlets extend to 0.3m	1	0.2	1	0.2	0.5 on pen test
0.4	2.5	Loose, Soft, Moist, Light Brown, sub rounded coarse gravelly coarse SAND and GRAVEL, poorly sorted, some cobbles, trace silt and fine sand, poorly sorted, wet at 1.8mbgs and begins to pool	2	0.8	2	0.8	<0.5 on pen test
		A discontinuous sand lens, 30cm thick, along north side of Test Pit at 1.4-1.7mbgs	3	1.6	3	1.6	<0.5 on pen test
			4	1.4 – 1.7	n/a	n/a	<0.5 on pen test
			5	2.0-2.1	4	2.1	
		END of TEST PIT					

Comments

UTMs with handheld GPS 11 U
659483 E; 5495513 N

2.1 m wide bucket used on excavator for Test Pit

SHWT not clear, no restrictive layers found or other indicators of reduced soil conditions
Sample 3 submitted for particle size distribution analysis

Water Conditions in Test Pit

Water entering test pit and pooled at 1.8mbgs.

☐ Test Pit dry.

JOB No. 324-27
TEST PIT No. PT-2015-03
ENGINEER/FIELD TECHNICIAN Kyle Schepanow

FIELD TEST PIT LOG

Job Number:	324-27	Job Name:	CMO2 Hydro and Sewage Investigation	Date:	May 6, 2015
Test Pit Number:	PT-2015-04	Test Pit Size:	2.2m x 3.4m	Elevation:	N/A -
Machine Type:	CAT Excavator 345CL	Contractor:	Teck Resources	Datum:	Ground
Temperature:	12℃	Weather:	Sunny, some clouds		

Depth From (m)	Depth To (m)	Soil Description	Samples No.	Samples Depth (m)	In Situ Density Test No.	In Situ Density Test Depth (m)	Remarks
0	0.3	Loose, Soft, Moist Brown Silty Fine SAND with sub-rounded gravel 2cm to 10cm diameter, iron oxidation in soil, roots and rootlets extend to 0.3m	1	0.2	1	0.2	0.75 on pen test
0.3	3.0	Loose, Soft, Moist, Light Brown, sub rounded coarse gravelly coarse SAND and GRAVEL, some cobbles, wet at 2.2mbgs	2	0.45	2	0.45	<0.5 on pen test
			3	1.2	3	1.2	<0.5 on pen test
			4	2.3	4	2.3	<0.5 on pen test
			5	2.7	5	2.7	<0.5 on pen test
		END of TEST PIT					

Comments

UTMs with handheld GPS 11 U
659472 E; 5495465 N

2.1 m wide bucket used on excavator for Test Pit
SHWT not clear, no restrictive layers found or other indicators of reduced soil conditions

Sample 3 submitted for particle size distribution analysis

Water Conditions in Test Pit

Water entering test pit from side walls at 2.7 mbgs. Flow is very slow, <5L/min

☐ Test Pit dry.

JOB No. 324-27

TEST PIT No. PT-2015-04

ENGINEER/FIELD TECHNICIAN _____

Appendix B
PSD Curves

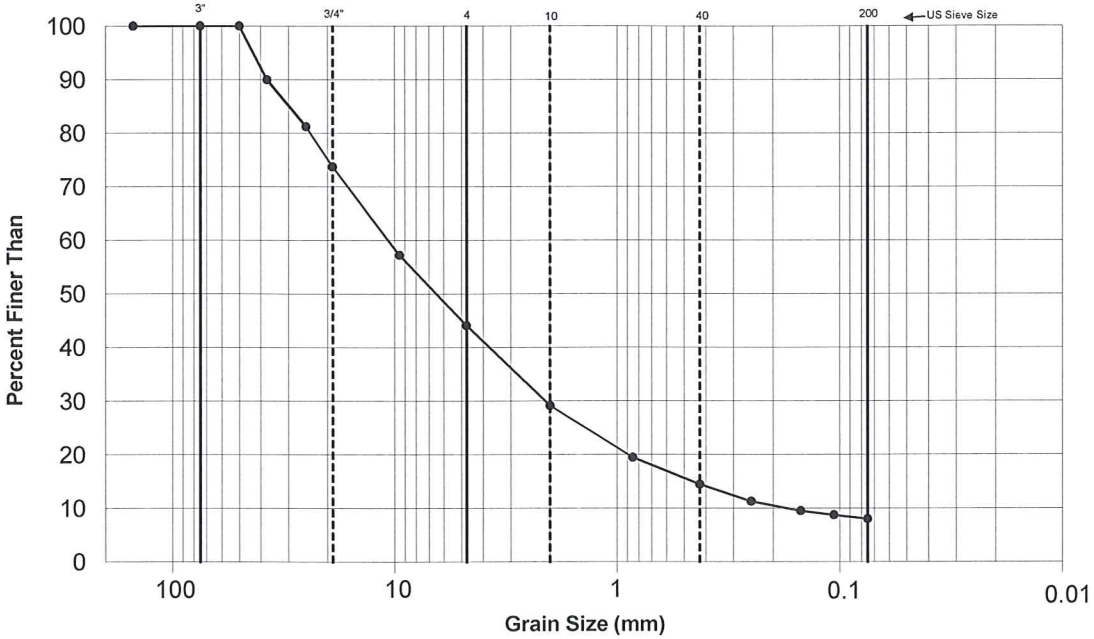
Golder Associates

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1413549	Phase:	-		Date:	26-May-15
Short Title:	NORWEST/LAB TESTING/CGY					
Sub Sampled By:	KP	Washed By:	-		Sieved By:	-
Field Tag No.:	-	Location:	-		BH or TP No.:	PT-2015-01
Lab No.:	B494-01	Northing:	-	m	Sample No.:	-
Sampled By:	Client	Easting:	-	m	Depth From:	0.45 m
Sample Date:	-	Elevation:	-	m	Depth To:	- m

Test Method:	A	Drying Method:	Oven	
Composite Sieve:	Yes	if Yes, Split on:	4.75	mm
Material Exluded from Sieve:	No	Describe:		
Prior Testing on Sample:	No	Describe:		



Sieve Size (mm)	Passing %
150	100
75	100
50	100
37.5	90
25	81
19	74
9.5	57
4.75	44
2	29
0.85	19
0.425	14
0.25	11
0.15	10
0.106	9
0.075	8

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
10.6	0	56	36	8	11.1	2.2	0.2	62.4	2.4

Sample Description: (GW-GM) GRAVEL and SAND, fine to coarse sub-rounded gravel, medium to coarse sand, trace fine sand; brown; non-cohesive, moist

USCS Classification: GW-GM

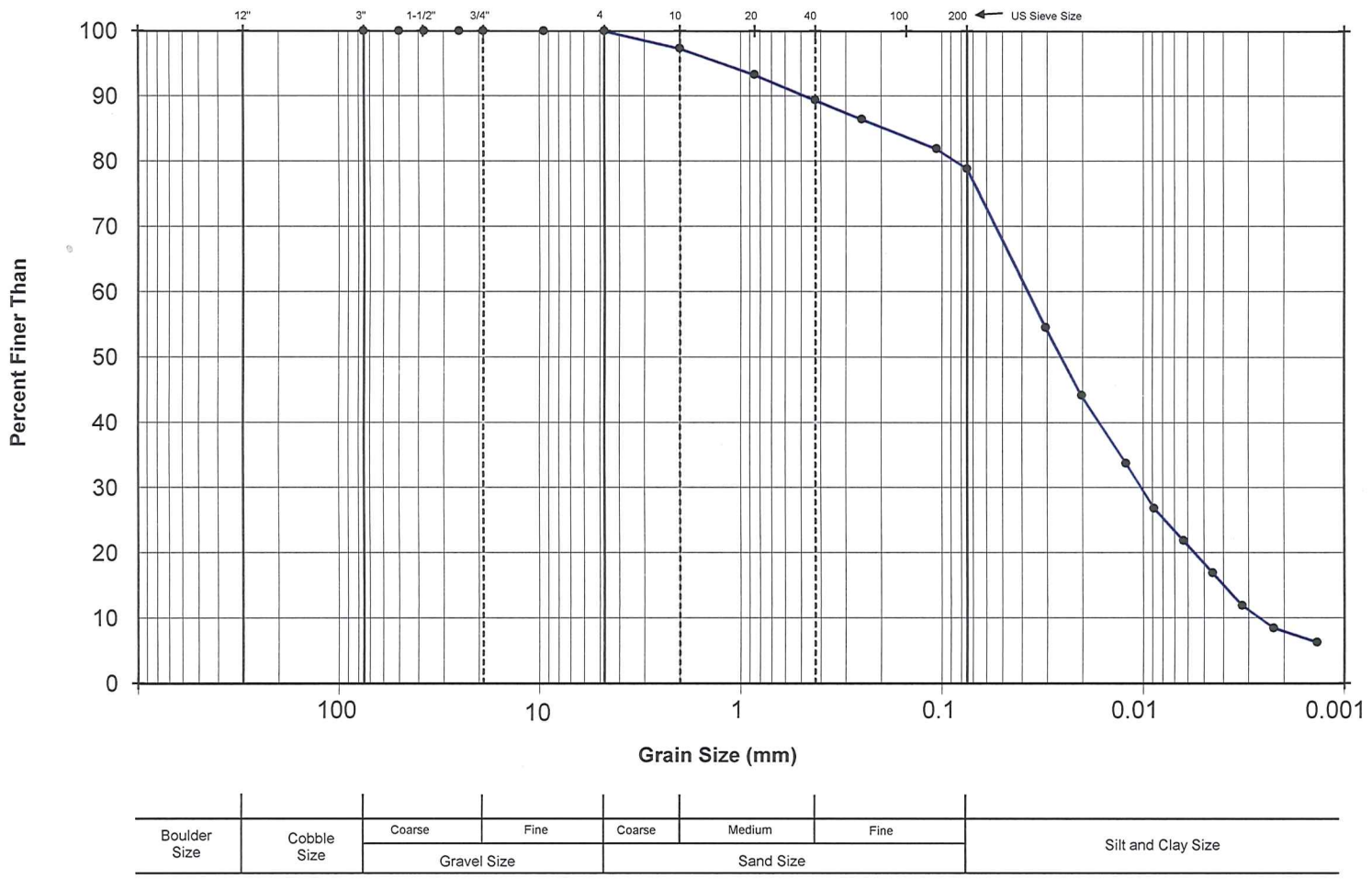
Remarks:

Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

Reviewed by: _____

Project No.:	1413549	Lab No.:	B494-02
Project Title:	NORWEST/LAB TESTING/CGY		
Borehole:	PT-2015-01	Sample No.:	-
Depth:	0.2 m		
Date Tested:	26-May-15	By:	KP

Particle Size Analysis of Soil
(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	97.3
0.850	93.3
0.425	89.4
0.250	86.4
0.106	81.9
0.075	78.9
0.031	54.6
0.020	44.2
0.012	33.8
0.009	26.9
0.006	21.9
0.005	16.9
0.003	11.9
0.002	8.5
0.001	6.3

Comments:

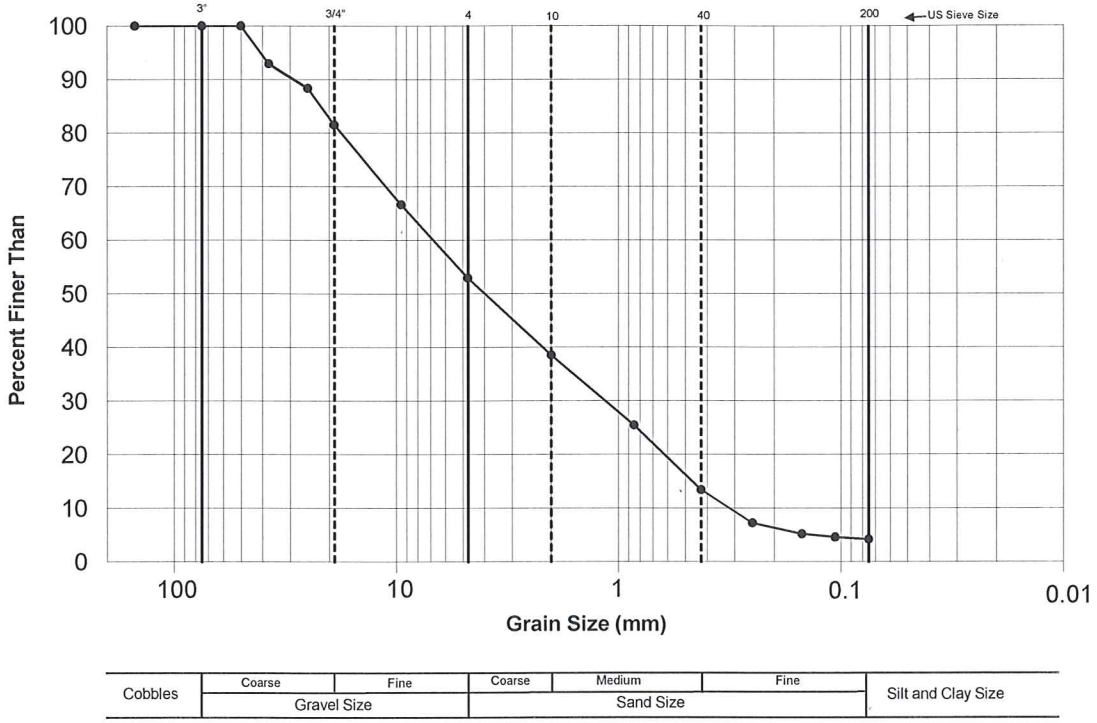
Reviewed:

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1413549	Phase:	-			Date:	26-May-15
Short Title:	NORWEST/LAB TESTING/CGY						
Sub Sampled By:	KP	Washed By:	-			Sieved By:	-
Field Tag No.:	-	Location:	-			BH or TP No.:	PT-2015-02
Lab No.:	B494-03	Northing:	-	m		Sample No.:	-
Sampled By:	Client	Easting:	-	m		Depth From:	1.7 m
Sample Date:	-	Elevation:	-	m		Depth To:	1.9 m

Test Method:	A	Drying Method:	Oven	
Composite Sieve:	Yes	if Yes, Split on:	4.75	mm
Material Exluded from Sieve:	No	Describe:		
Prior Testing on Sample:	No	Describe:		



Sieve Size (mm)	Passing %
150	100
75	100
50	100
37.5	93
25	88
19	82
9.5	67
4.75	53
2	39
0.85	26
0.425	13
0.25	7
0.15	5
0.106	5
0.075	4

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
12.2	0	47	49	4	7.2	1.2	0.3	21.9	0.7

Sample Description: (SP) medium to coarse SAND, some fine to coarse sub-rounded gravel; brown; non-cohesive, moist

USCS Classification: SP

Remarks:

Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

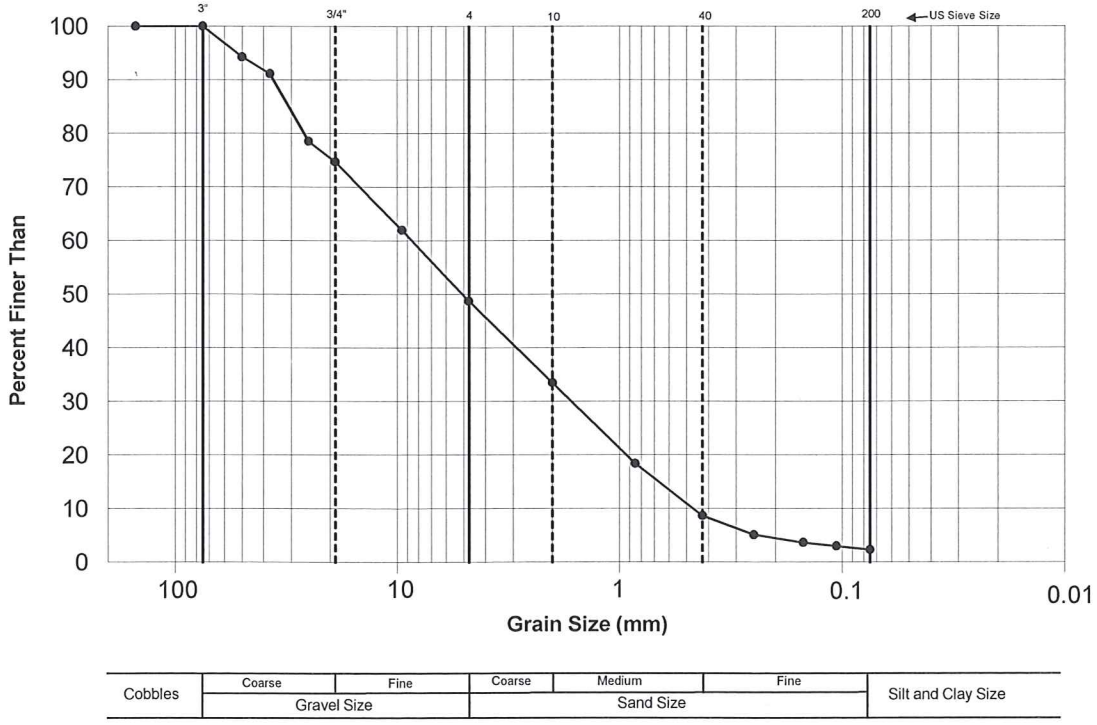
Reviewed by: _____

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1413549	Phase:	-		Date:	26-May-15
Short Title:	NORWEST/LAB TESTING/CGY					
Sub Sampled By:	KP	Washed By:	-		Sieved By:	-
Field Tag No.:	-	Location:	-		BH or TP No.:	PT-2015-03
Lab No.:	B494-05	Northing:	-	m	Sample No.:	-
Sampled By:	Client	Easting:	-	m	Depth From:	1.6 m
Sample Date:	-	Elevation:	-	m	Depth To:	- m

Test Method:	A	Drying Method:	Air Dry	
Composite Sieve:	Yes	if Yes, Split on:	4.75	mm
Material Exluded from Sieve:	No	Describe:		
Prior Testing on Sample:	No	Describe:		



Sieve Size (mm)	Passing %
150	100
75	100
50	94
37.5	91
25	79
19	75
9.5	62
4.75	49
2	33
0.85	18
0.425	9
0.25	5
0.15	4
0.106	3
0.075	2

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
7.7	0	51	46	2	8.8	1.7	0.5	18.2	0.7

Sample Description: (GP) GRAVEL and SAND, fine to coarse sub-rounded gravel, medium to coarse sand, trace fine sand; brown; non-cohesive, moist

USCS Classification: GP

Remarks:

Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

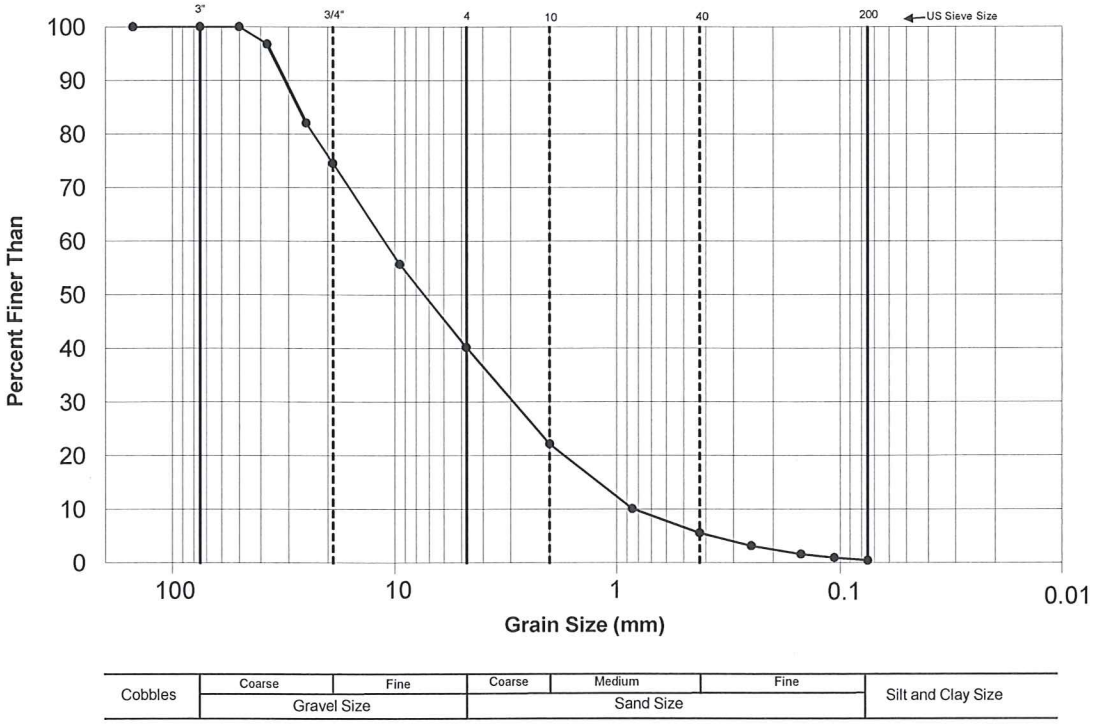
Reviewed by: _____

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1413549	Phase:	-	Date:	26-May-15
Short Title:	NORWEST/LAB TESTING/CGY				
Sub Sampled By:	KP	Washed By:	-	Sieved By:	-
Field Tag No.:	-	Location:	-	BH or TP No.:	PT-2015-04
Lab No.:	B494-06	Northing:	- m	Sample No.:	-
Sampled By:	Client	Easting:	- m	Depth From:	1.2 m
Sample Date:	-	Elevation:	- m	Depth To:	- m

Test Method:	A	Drying Method:	Air Dry	
Composite Sieve:	Yes	if Yes, Split on:	4.75	mm
Material Exluded from Sieve:	No	Describe:		
Prior Testing on Sample:	No	Describe:		



Sieve Size (mm)	Passing %
150	100
75	100
50	100
37.5	97
25	82
19	75
9.5	56
4.75	40
2	22
0.85	10
0.425	6
0.25	3
0.15	2
0.106	1
0.075	0

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
7.5	0	60	40	0	11.6	3.2	0.8	13.8	1.0

Sample Description: (GW) GRAVEL, fine to coarse sub-rounded gravel, medium to coarse sand; brown; non-cohesive, moist

USCS Classification: GW

Remarks:

Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

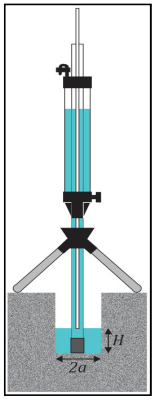
Reviewed by: _____

Appendix C
Soil Infiltration Test Results

GP-2015-01 - Guelph Permeameter Calculations (Single Head Method)

Inputs

Results



Res Type 35
H 5
a 5
H/a 1
a* 0
C0.01 1
C0.04 1
C0.12 1
C0.36 1
C 1
R ##
Q ##
pi 3

Parameters

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir):	1
Enter water Head Height ("H" in cm):	5
Enter the Borehole Radius ("a" in cm):	5
Enter the soil texture-structure category (enter one of the below numbers):	4

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

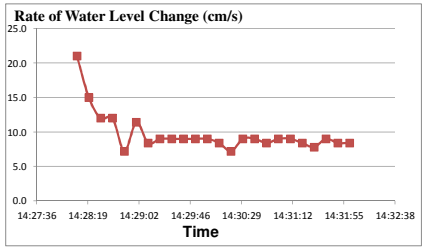
Error Messages

Data

Steady State* Rate of Water Level Change ("R" in cm/min): 9.000

* In order to determine "R", there sould be at least three identical consequtive readings in the blue column.

Time	Time interval (sec)	Reservoir Water Level (cm)	Water Level Change (cm)	Rate of Water Level Change (cm/min)
14:28:00		1.5		
14:28:10	10.00	5.0	3.5	21.0
14:28:20	10.00	7.5	2.5	15.0
14:28:30	10.00	9.5	2.0	12.0
14:28:40	10.00	11.5	2.0	12.0
14:28:50	10.00	12.7	1.2	7.2
14:29:00	10.00	14.6	1.9	11.4
14:29:10	10.00	16.0	1.4	8.4
14:29:20	10.00	17.5	1.5	9.0
14:29:30	10.00	19.0	1.5	9.0
14:29:40	10.00	20.5	1.5	9.0
14:29:50	10.00	22.0	1.5	9.0
14:30:00	10.00	23.5	1.5	9.0
14:30:10	10.00	24.9	1.4	8.4
14:30:20	10.00	26.1	1.2	7.2
14:30:30	10.00	27.6	1.5	9.0
14:30:40	10.00	29.1	1.5	9.0
14:30:50	10.00	30.5	1.4	8.4
14:31:00	10.00	32	1.5	9.0
14:31:10	10.00	33.5	1.5	9.0
14:31:20	10.00	34.9	1.4	8.4
14:31:30	10.00	36.2	1.3	7.8
14:31:40	10.00	37.7	1.5	9.0
14:31:50	10.00	39.1	1.4	8.4
14:32:00	10.00	40.5	1.4	8.4



Results

Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), a is borehole radius (cm) and α^* is microscopic capillary length factor which is decided according to the soil texture-structure category (modified from Zang et al., 1998).

$\alpha^*(cm^{-1})$	Shape Factor
0.01	$C_1 = \left(\frac{H_1/a}{2.081 + 0.121(H_1/a)}\right)^{0.672}$
0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.91(H_1/a)}\right)^{0.683}$
0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.93(H_1/a)}\right)^{0.754}$
0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.93(H_1/a)}\right)^{0.754}$

$\alpha^*(cm^{-1}) =$ 0.36

$C_1 =$ 0.558164718

Calculation formulas related to one-head. Where R_1 is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), x is Combined reservoir constant (35.22 cm^2), y is Inner reservoir constant (2.16 cm^2), α^* is Macroscopic capillary length parameter, a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm) and C_1 is Shape factor.

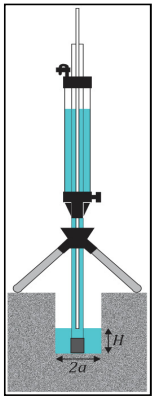
Combined Reservoir	$Q_1 = R_1 \times y$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ =	6.14E-01 (cm/min)
Inner Reservoir	$Q_1 = R_1 \times x$	$\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$ =	1.71E+00 (cm^2/min)

$Q_1 =$ 317

GP-2015-02 - Guelph Permeameter Calculations (Single Head Method)

Inputs

Results



Res Type 35
H 5
a 5
H/a 1
a* 0
C0.01 1
C0.04 1
C0.12 1
C0.36 1
C 1
R ##
Q ##
pi 3

Parameters

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir):	1
Enter water Head Height ("H" in cm):	5
Enter the Borehole Radius ("a" in cm):	5
Enter the soil texture-structure category (enter one of the below numbers):	4

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

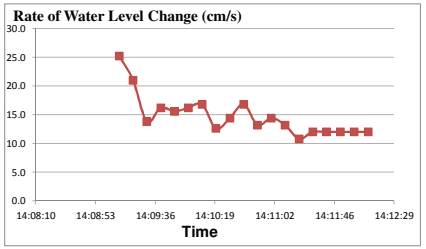
Error Messages

Data

Steady State* Rate of Water Level Change ("R" in cm/min): 12.000

* In order to determine "R", there sould be at least three identical consequtive readings in the blue column.

Time	Time interval (sec)	Reservoir Water Level (cm)	Water Level Change (cm)	Rate of Water Level Change (cm/min)
14:09:00		5.3		
14:09:10	10.00	9.5	4.2	25.2
14:09:20	10.00	13.0	3.5	21.0
14:09:30	10.00	15.3	2.3	13.8
14:09:40	10.00	18.0	2.7	16.2
14:09:50	10.00	20.6	2.6	15.6
14:10:00	10.00	23.3	2.7	16.2
14:10:10	10.00	26.1	2.8	16.8
14:10:20	10.00	28.2	2.1	12.6
14:10:30	10.00	30.6	2.4	14.4
14:10:40	10.00	33.4	2.8	16.8
14:10:50	10.00	35.6	2.2	13.2
14:11:00	10.00	38.0	2.4	14.4
14:11:10	10.00	40.2	2.2	13.2
14:11:20	10.00	42.0	1.8	10.8
14:11:30	10.00	44.0	2.0	12.0
14:11:40	10.00	46.0	2.0	12.0
14:11:50	10.00	48	2.0	12.0
14:12:00	10.00	50	2.0	12.0
14:12:10	10.00	52	2.0	12.0



Results

Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), a is borehole radius (cm) and α^* is microscopic capillary length factor which is decided according to the soil texture-structure category (modified from Zang et al., 1998).

$\alpha^*(cm^{-1})$	Shape Factor
0.01	$C_1 = \left(\frac{H_1/a}{2.081 + 0.121(H_1/a)}\right)^{0.672}$
0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.91(H_1/a)}\right)^{0.683}$
0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.93(H_1/a)}\right)^{0.754}$
0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.93(H_1/a)}\right)^{0.754}$

$\alpha^*(cm^{-1}) =$ 0.36

$C_1 =$ 0.558164718

Calculation formulas related to one-head. Where R_1 is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), x is Combined reservoir constant (35.22 cm^2), y is Inner reservoir constant (2.16 cm^2), α^* is Macroscopic capillary length parameter, a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm) and C_1 is Shape factor.

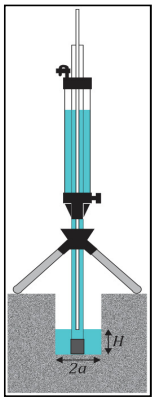
Combined Reservoir	$Q_1 = R_1 \times y$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ =	8.19E-01 (cm/min)
Inner Reservoir	$Q_1 = R_1 \times x$	$\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$ =	2.27E+00 (cm^2/min)

$Q_1 =$ 422.6

GP-2015-03 - Guelph Permeameter Calculations (Single Head Method)

Inputs

Results



Res Type	35.22
H	5
a	5
H/a	1
a*	0.36
C0.01	0.58833782
C0.04	0.60580831
C0.12	0.55816472
C0.36	0.55816472
C	0.55816472
R	9.000
Q	316.97929
pi	3.1415

Parameters

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir):	1
Enter water Head Height ("H" in cm):	5
Enter the Borehole Radius ("a" in cm):	5
Enter the soil texture-structure category (enter one of the below numbers):	4

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

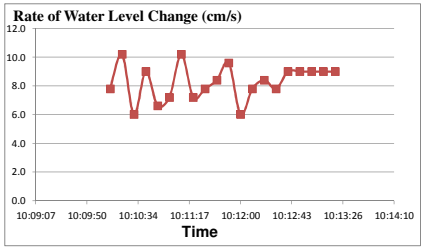
Error Messages

Data

Steady State* Rate of Water Level Change ("R" in cm/min): 9.000

* In order to determine "R", there sould be at least three identical consequtive readings in the blue column.

Time	Time interval (sec)	Reservoir Water Level (cm)	Water Level Change (cm)	Rate of Water Level Change (cm/min)
10:10:00		25.5		
10:10:10	10.00	26.8	1.3	7.8
10:10:20	10.00	28.5	1.7	10.2
10:10:30	10.00	29.5	1.0	6.0
10:10:40	10.00	31.0	1.5	9.0
10:10:50	10.00	32.1	1.1	6.6
10:11:00	10.00	33.3	1.2	7.2
10:11:10	10.00	35	1.7	10.2
10:11:20	10.00	36.2	1.2	7.2
10:11:30	10.00	37.5	1.3	7.8
10:11:40	10.00	38.9	1.4	8.4
10:11:50	10.00	40.5	1.6	9.6
10:12:00	10.00	41.5	1.0	6.0
10:12:10	10.00	42.8	1.3	7.8
10:12:20	10.00	44.2	1.4	8.4
10:12:30	10.00	45.5	1.3	7.8
10:12:40	10.00	47	1.5	9.0
10:12:50	10.00	48.5	1.5	9.0
10:13:00	10.00	50	1.5	9.0
10:13:10	10.00	51.5	1.5	9.0
10:13:20	10.00	53	1.5	9.0



Results

Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), a is borehole radius (cm) and α^* is microscopic capillary length factor which is decided according to the soil texture-structure category (modified from Zang et al., 1998).

$\alpha^*(cm^{-1})$	Shape Factor
0.01	$C_1 = \left(\frac{H_1/a}{2.081 + 0.121(H_1/a)}\right)^{0.672}$
0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.91(H_1/a)}\right)^{0.683}$
0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.93(H_1/a)}\right)^{0.754}$
0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.93(H_1/a)}\right)^{0.754}$

$\alpha^*(cm^{-1}) =$ 0.36

$C_1 =$ 0.558164718

Calculation formulas related to one-head. Where R_1 is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), x is Combined reservoir constant (35.22 cm^2), y is Inner reservoir constant (2.16 cm^2), α^* is Macroscopic capillary length parameter, a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm) and C_1 is Shape factor.

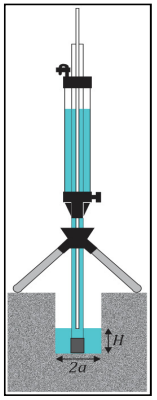
Combined Reservoir	$Q_1 = R_1 \times y$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)} =$	6.14E-01 (cm/min)
Inner Reservoir	$Q_1 = R_1 \times x$	$\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1} =$	1.71E+00 (cm^2/min)

$Q_1 =$ 317

GP-2015-04 - Guelph Permeameter Calculations (Single Head Method)

Inputs

Results



Res Type 35
H 10
a 5
H/a 2
a* 0
C0.01 1
C0.04 1
C0.12 1
C0.36 1
C 1
R ##
Q ##
pi 3

Parameters

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir):	1
Enter water Head Height ("H" in cm):	10
Enter the Borehole Radius ("a" in cm):	5
Enter the soil texture-structure category (enter one of the below numbers):	4

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

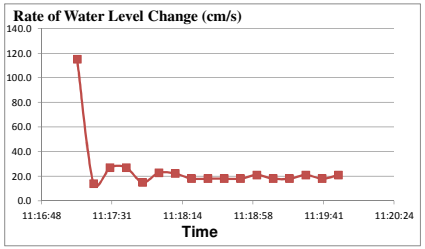
Error Messages

Data

Steady State* Rate of Water Level Change ("R" in cm/min): 18.000

* In order to determine "R", there sould be at least three identical consequtive readings in the blue column.

Time	Time interval (sec)	Reservoir Water Level (cm)	Water Level Change (cm)	Rate of Water Level Change (cm/min)
11:17:00		3.0		
11:17:10	10.00	22.2	19.2	115.2
11:17:20	10.00	24.5	2.3	13.8
11:17:30	10.00	29.0	4.5	27.0
11:17:40	10.00	33.5	4.5	27.0
11:17:50	10.00	36.0	2.5	15.0
11:18:00	10.00	39.8	3.8	22.8
11:18:10	10.00	43.5	3.7	22.2
11:18:20	10.00	46.5	3.0	18.0
11:18:30	10.00	49.5	3.0	18.0
11:18:40	10.00	52.5	3.0	18.0
11:18:50	10.00	55.5	3.0	18.0
11:19:00	10.00	59.0	3.5	21.0
11:19:10	10.00	62.0	3.0	18.0
11:19:20	10.00	65.0	3.0	18.0
11:19:30	10.00	68.5	3.5	21.0
11:19:40	10.00	71.5	3.0	18.0
11:19:50	10.00	75	3.5	21.0



Results

Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), a is borehole radius (cm) and α^* is microscopic capillary length factor which is decided according to the soil texture-structure category (modified from Zang et al., 1998).

$\alpha^*(cm^{-1})$	Shape Factor
0.01	$C_1 = \left(\frac{H_1/a}{2.081 + 0.121(H_1/a)}\right)^{0.672}$
0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.91(H_1/a)}\right)^{0.683}$
0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.93(H_1/a)}\right)^{0.754}$
0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.93(H_1/a)}\right)^{0.754}$

$\alpha^*(cm^{-1}) =$ 0.36

$C_1 =$ 0.911966433

Calculation formulas related to one-head. Where R_1 is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), x is Combined reservoir constant (35.22 cm^2), y is Inner reservoir constant (2.16 cm^2), α^* is Macroscopic capillary length parameter, a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm) and C_1 is Shape factor.

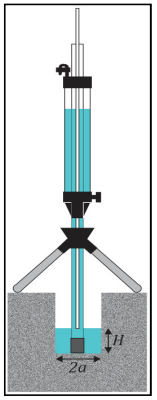
Combined Reservoir	$Q_1 = R_1 \times y$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ =	6.61E-01 (cm/min)
Inner Reservoir	$Q_1 = R_1 \times x$	$\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$ =	1.84E+00 (cm^2/min)

$Q_1 =$ 634

GP-2015-05 - Guelph Permeameter Calculations (Single Head Method)

Inputs

Results



Res Type 35
H 5
a 5
H/a 1
a* 0
C0.01 1
C0.04 1
C0.12 1
C0.36 1
C 1
R ##
Q ##
pi 3

Parameters

Reservoir Type (enter "1" for Combined and "2" for Inner reservoir):	1
Enter water Head Height ("H" in cm):	5
Enter the Borehole Radius ("a" in cm):	5
Enter the soil texture-structure category (enter one of the below numbers):	4

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

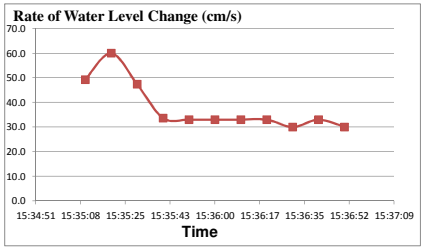
Error Messages

Data

Steady State* Rate of Water Level Change ("R" in cm/min): 33.000

* In order to determine "R", there sould be at least three identical consequtive readings in the blue column.

Time	Time interval (sec)	Reservoir Water Level (cm)	Water Level Change (cm)	Rate of Water Level Change (cm/min)
15:35:00		7.3		
15:35:10	10.00	15.5	8.2	49.2
15:35:20	10.00	25.5	10.0	60.0
15:35:30	10.00	33.4	7.9	47.4
15:35:40	10.00	39.0	5.6	33.6
15:35:50	10.00	44.5	5.5	33.0
15:36:00	10.00	50.0	5.5	33.0
15:36:10	10.00	55.5	5.5	33.0
15:36:20	10.00	61.0	5.5	33.0
15:36:30	10.00	66.0	5.0	30.0
15:36:40	10.00	71.5	5.5	33.0
15:36:50	10.00	76.5	5.0	30.0



Results

Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), a is borehole radius (cm) and α^* is microscopic capillary length factor which is decided according to the soil texture-structure category (modified from Zang et al., 1998).

$\alpha^*(cm^{-1})$	Shape Factor
0.01	$C_1 = \left(\frac{H_1/a}{2.081 + 0.121(H_1/a)}\right)^{0.672}$
0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.91(H_1/a)}\right)^{0.683}$
0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.93(H_1/a)}\right)^{0.754}$
0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.93(H_1/a)}\right)^{0.754}$

$\alpha^*(cm^{-1}) =$ 0.36

$C_1 =$ 0.558164718

Calculation formulas related to one-head. Where R_1 is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm^2/s), x is Combined reservoir constant (35.22 cm^2), y is Inner reservoir constant (2.16 cm^2), α^* is Macroscopic capillary length parameter, a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm) and C_1 is Shape factor.

Combined Reservoir	$Q_1 = R_1 \times y$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ =	2.25E+00 (cm/min)
Inner Reservoir	$Q_1 = R_1 \times x$	$\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$ =	6.25E+00 (cm^2/min)

$Q_1 =$ 1162

Appendix D
Hydrogeological Investigation Report

CMO2 Hydrogeological Investigation Plan

Submitted to:
Teck Coal Limited and Amec Foster Wheeler

Project Number: 324-27

Date:
June 4, 2015

Norwest Corporation
Suite 2700, 411 – 1st Street, S.E.
Calgary, Alberta T2G 4Y5
(403) 237-7763
calgary@norwestcorp.com

Authors:
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Kyle Schepanow, M.Sc., P.Geo.

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1 INTRODUCTION

Teck Coal Limited (Teck) contracted Norwest Corporation (Norwest) to complete a focused hydrogeological field testing investigation at Coal Mountain Operations Phase 2 (CMO2) project site.

The field investigation was completed from May 4, 2015 to May 20, 2015.

The field investigation was designed to complete a hydrogeological assessment of the groundwater conditions to address specific uncertainties regarding the availability of water for the required water-supply system at the proposed CMO2 project site. Based on the Prefeasibility Study and previous updates, it was anticipated that the water-supply system would be used to support the needs of the following facilities:

- Lower Facility Maintenance/Warehouse/Dry/First Aid:
  - washwater for maintenance bays, truck wash and light vehicle wash;
  - potable water for mine dry, warehouse and first aid toilet facilities; and
  - fire suppression during winter months.
- Guard House and Drug Testing Building:
  - potable water for toilet facilities.
- Upper Facility Mine Dry/Office:
  - potable water for shower and toilet facilities;
  - potable water for office and lunch area; and
  - fire suppression during winter months.
- Site Dust Control.

Norwest's hydrogeological field investigation was limited to the assessment of the proposed lower facility area only. At the start of the investigation, very little was known about the site's current hydrogeological conditions.

This document summarizes the field investigation methods, and the results from the focused hydrogeological field investigation completed by Norwest at the CMO2 project site.

2 SITE INVESTIGATION PLANNING

The geology of the lower facility area was estimated using the Alberta and British Columbia Coal Resource Map 82G/07 10 (Lawrence Consulting Ltd., 2006), and based on a desktop review of the geology, two locations were selected to drill and install water test wells. The two areas that are part of the investigation are shown on Figure 2-1.

LEGEND

W WATER TEST PIT LOCATION

N

100 0 100

Metres

GEOTECHNICAL TEST LOCATIONS			
LOCATION	NORTHING	EASTING	DESCRIPTION
TW-2015-01	5495627	658906	WATER TEST WELL
TW-2015-02	5495594	658919	WATER TEST WELL
TW-2015-04	5494917	658894	WATER TEST WELL

Teck

TECK CMO2 FEASIBILITY STUDY
FIELD INVESTIGATION

HYDROGEOLOGICAL INVESTIGATION SITE PLAN

FIGURE 2-1

DRAWN BY: A.W.
CHK'D BY: K.S.
DATE: 15 05 29

FILE: Fig 1 Hydrogeological ... Site Plan ... \Teck_Coal_C_324\324-27_CMO2 Hydro-Sep\Reports\Draft\Drafting

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3 DRILLING AND WELL INSTALLATIONS

Good Earth Drilling Services Ltd. (GED) was contracted by Teck to drill and complete the water test well installations. GED used a GEFCO 30K air rotary rig to drill the water test holes; locations are listed in Table 3.1. GED drilled a pilot hole at location TW-2015-04 from May 4, 2015 to May 8, 2015. GED logged and collected drill cuttings (rock chips), and then gave them to the Teck geologist. During the drilling process, GED recorded all water-return observations, which were used to provide estimates regarding the available water in the borehole. The borehole was advanced to a depth of 175 m, and then geophysically logged; a typical suite was completed, including natural gamma, normal resistivity and borehole deviation. Century Wireline Services (Century) completed the borehole geophysics. Norwest did not observe or log the results of the drilling at TW-2015-04. Norwest was, however, involved in the field determination of the well's ability to provide a portion of the required water supply demands of the proposed facility. Based on a review of the drill cuttings, drill and geophysical logs, and water-production observations, it was decided that the water available at this location would be insufficient and unable to meet the requirements of the proposed facility. Therefore, the borehole was not completed as a monitoring well and not twinned with the installation of a pumping well at proposed location TW-2015-03. The borehole at TW-2015-04 was backfilled with available cuttings.

The original locations for water test wells at TW-2015-01 and TW-2015-02 were field-fitted based on available site access and the ability to disturb the least amount of natural area. To reduce potential issues during the water-well permitting process, the location of TW-2015-01 was further adjusted and repositioned at a distance of more than 100 m from a discovered watercourse to the south. GED drilled a pilot hole at TW-2015-02 using a 5.25-in. (133.35 mm) PDC drill bit to a depth of 146 mbgs. GED collected rock chips every 2 m of drill advance, and recorded the drill log. GED also recorded field observations regarding water production. Century geophysically logged the borehole and the results indicated a zone of relatively low-clay composition, or a slightly higher concentration of sandy deposits from 132 mbgs to 116 mbgs. In addition, water production observations during drilling estimated a potential flow rate of 45 g/m (170 L/min) for the same zone as the sandy interval. Based on these observations, it was determined that further testing would be completed at this location, and that TW-2015-01 could be a potential water supply. The decision was made to install a monitoring well at location TW-2015-02, twin that location with the installation of a pumping well atTW-2015-01. A 2-in. (51 mm) Schedule 80 PVC monitoring well with 20-slot screen was installed into a relatively permeable section of a sandstone and minor interbedded shale mix of bedrock at TW-2015-02. The well completion diagram for TW-2015-02 is included in Appendix A.

GED drilled TW-2015-01 using a 9⅞-in. (250.83-mm) PDC bit to a depth similar to TW-2015-02. Borehole geophysics results from TW-2015-02 were used to determine target depths for TW-2015-01, and, as a result, a borehole geophysical investigation was not completed on the TW-2015-01 borehole. Well screen and installation details for TW-2015-01 were based on rock chip cuttings, drill logs and water production observations. Norwest field hydrogeologist did not log the hole during drilling operations, but they did review the drill cuttings and driller notes on water production. The well was developed using a jetting tool, provided by GED, with air and water being injected into the well within the well screen area. Additional airlifting development was completed by positioning the jetting tool slightly above the well screen. Field water quality parameters, including pH, electrical conductivity, turbidity and temperature, were recorded until stabilization was reached. The well completion diagram for TW-2015-01 is included in Appendix A.

Based on instructions received from Teck, a Teck-owned Grundfos 230-S200-6 pump was installed by Sierra Drilling & Blasting Ltd. (Sierra). The pump was installed with a galvanized steel 3-in. discharge pipe, placing the pump intake 111.28 m below top of casing (mbTOC), approximately 8 m above the well screen. A flow meter was attached to the extended surface discharge line. A gate valve was installed at the well head with a pressure valve and both were used to control the flow rate from the pump. A non-vented pressure transducer was installed at a depth of 104 mbTOC to record the changes in water level during the pumping test.

Both wells were under artesian conditions and began flowing at surface within a day of the completed installation. An attempt was made to determine static conditions at TW-2015-02 by adding a 3.02 m riser to the well. However, the well continued to flow. A vented pressure transducer was installed in TW-2015-02 at a depth of 69.44 mbTOC to monitor the water level response to pumping at TW-2015-01.

Table 3.1
Water Well Testing Locations

Well ID	Northing	Easting
TW-2015-04	5494917	658894
TW-2015-02 (Monitoring Well)	5495594	658919
TW-2015-01 (Pumping Well)	5495627	658906

Note: UTMs collected using handheld GPS.

4 PUMPING TEST

Initially, a 72-hour pumping test was proposed, but it was observed during well development with the pump that flow rates were insufficient to meet the originally required water supply estimates. Based on these lower-than-expected results, the pumping test was reduced to a 24-hour pumping test. In addition, given the low flow rates and lack of equipment to properly control the pump rate at lower flow rates, a step-rate test was not completed on TW-2015-01.

The pumping test began on May 18, 2015 at 14:01 and a stable rate of 16 g/m (60 L/min) was maintained for the duration of the test. After 22.3 hours, for no observable reason, back pressure began to increase and the flow decreased drastically; therefore, a decision was made to terminate the pumping test. Observations of the pumping water level indicated that the water level had flat-lined 4.5 hours earlier. Field observations of the pumping test are shown in Table 4.1.

TW-2015-01 produced an estimated total of 79.3 m^3 during the 1,340 minutes of pumping activities. Maximum drawdowns were measured at 102.759 m and 25.523 m in the pumping and monitoring wells, respectively. The pumping well and monitoring wells reached a recovery of 95% of the total drawdown in 8.78 hours and 21 hours, respectively.

Table 4.1
Pumping Test Field Observations

Well	Date & Time (mm/dd/yy hr:min)	Elapsed Time (min)	Water Level (mbTOC)	Water Level Transducer (m)	Flow Rate (L/min)	Total Volume (m^3)	Well Head Back Pressure (psi)	pH	EC (µS/cm)	Turbidity (NTU)	Comments
TW-2015-01	5/18/15 14:01	0	0	-	-	0	0	-	-	-	-
TW-2015-01	5/18/15 14:02	1	-	-	800-200	-	-	-	-	-	Start pump.
TW-2015-01	5/18/15 14:02	12	4.53	106.75	~100	-	50	-	-	-	Flow meter failed. Use of bucket test for flow.
TW-2015-01	5/18/15 14:28	0	-	-	70	2.3	40	-	-	-	Water level tape stuck down hole.
TW-2015-01	5/18/15 14:46	45	-	25.206	62	-	-	7.14	477	2.99	-
TW-2015-01	5/18/15 15:49	108	-	24.306	60	4.8	40	7.4	477	4.97	Clear water; no colour.
TW-2015-01	5/18/15 16:40	159	-	23.828	58	7.6	38	7.46	478	3.79	-
TW-2015-01	5/18/15 17:30	209	-	23.43	60	10.8	37	-	-	-	Clear.
TW-2015-01	5/18/15 18:24	263	-	22.995	60	14.4	35	7.5	475	1.84	-
TW-2015-01	5/19/15 7:30	1,049	-	20.552	59	60.4	38	7.46	468	1.69	-
TW-2015-01	5/19/15 8:53	1,132	-	20.417	60	65.4	35	-	-	-	-
TW-2015-01	5/19/15 9:55	1,194	-	20.414	61	69.2	37	-	-	-	-
TW-2015-01	5/19/15 10:54	1,253	-	20.406	60	72.8	35	7.32	472	1.99	-
TW-2015-01	5/19/15 11:58	1,317	-	20.381	60	76.6	38	-	-	-	-
TW-2015-01	5/19/15 12:22	1,341	-	-	0	-	0	-	-	-	Pump issue: flow ~ 20 L/min. Water level starts to rise. Back pressure 100 psi prior to shutdown. Switch @ 15A/586V.
TW-2015-01	5/19/15 13:13	1,392	-	-	0	79.3	0	-	-	-	Stop pump.
-	-	-	-	-	-	-	-	-	-	-	Rate assumed 60 L/min for constant rate test.
-	-	-	-	-	-	-	-	-	-	-	Drawdown = 11.75-20.346 = 91.404 m.
-	-	-	-	-	-	-	-	-	-	-	Discharge volume is rough estimate based on bucket tests.

5 DATA ANALYSIS

The observed changes in water level during the constant rate pumping test and recovery were analyzed for hydraulic parameters using the commercially available software AQTESOLV. The Dougherty and Babu (1984) solution provided the best fit for the solution-type curves for analyzing the observed pumping and recovery data from the pumping and monitoring well. A detailed report on the analytical solution is included in Appendix B. The results of the solution estimated the transmissivity and storativity at 2 m^2/day and $3x10^{-5}$, respectively.

6 WATER QUALITY RESULTS

Water quality parameters (including pH, electrical conductivity, turbidity, and temperature) were monitored throughout the pumping test, and are shown in Table 4.1. Following the pumping test, a water sample was collected from the free-flowing monitoring well (TW-2015-02) and sent to Maxxam Analytics in Calgary, Alberta. The requested analyses included the following parameters:

- routine groundwater analysis;
- total organic carbon (TOC);
- total coliforms;
- nitrate-nitrite;
- ammonia nitrogen;
- turbidity;
- dissolved metals;
- E. coli; and
- total Kjeldahl nitrogen (TKN).

Lab water quality results are shown in Table 6.1, and the analytical reports are included in Appendix C.

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Table 6.1
Water Quality Results

Sample Identification	Sampling Date (dd/mm/yyyy)	Lab Results																												
		Calculated Parameters								Misc. Inorganics					Low Level Elements	Anions								Nutrients		Microbiological Parameters		Nutrients		Physical Properties
		Anion Sum	Cation Sum	Hardness (CaCO3)	Ion Balance	Dissolved Nitrate (NO3)	Nitrate plus Nitrite (N)	Dissolved Nitrite (NO2)	Total Dissolved Solids	Conductivity	pH	Total Organic Carbon (C)	Total Dissolved Solids	Total Suspended Solids	Dissolved Cadmium (Cd)	Alkalinity (PP as CaCO3)	Alkalinity (Total as CaCO3)	Bicarbonate (HCO3)	Carbonate (CO3)	Hydroxide (OH)	Dissolved Sulphate (SO4)	Dissolved Chloride (Cl)	Dissolved Nitrite (N)	Dissolved Nitrate (N)	E. Coli DST	Total Coliforms DST	Total Ammonia (N)	Total Kjeldahl Nitrogen	Turbidity
		meq/L	meq/L	mg/L		mg/L	mg/L	mg/L	mg/L	µS/cm					µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mpn/100 ml	mpn/100 ml	mg/L	mg/L	NTU
TW-2015-02	20/05/2015	5.5	5.6	270	1	<0.044	<0.01	<0.033	260	520	7.9	<0.5	250	1.5	<0.02	<0.5	260	320	<0.5	<0.5	12	<1	<0.01	<0.01	<1	**30**	0.63 (1)	0.57 (1)	2.4
TW-2015-02 Lab-Dup	20/05/2015	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<0.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	<0.01	<0.01	<1	**34**	N/A	N/A	N/A
GCDWQ MAC		NG	NG	NG	NG	45	10 [1.3]	3	NG	NG	NG	NG	NG	NG	5	NG	NG	NG	NG	NG	NG	NG	1	10	0	0	NG	NG	N [1.1]
CCME AL		NG	NG	NG	NG	13 [2.7]	3 [2.9]	0.197	NG	NG	6.5 - 9	NG	NG	N 2.1	Calc [2.4]	NG	NG	NG	NG	NG	NG	120 [2.4]	0.06	3 [2.6]	NG	NG	Calc [2.3]	NG	N [2.2]
Tier 1 CL/IL CS		NG	NG	NG	NG	13.5	N [3.3]	Calc [3.5]	500	NG	6.5 - 8.5	NG	500	NG	Calc [3.2]	NG	NG	NG	NG	NG	Calc [3.6]	120	Calc [3.4]	3	NG	NG	Calc [3.1]	NG	NG

Sample Identification	Sampling Date (dd/mm/yyyy)	Lab Results																													
		Elements																													
		Dissolved Aluminum (Al)	Dissolved Antimony (Sb)	Dissolved Arsenic (As)	Dissolved Barium (Ba)	Dissolved Beryllium (Be)	Dissolved Boron (B)	Dissolved Calcium (Ca)	Dissolved Chromium (Cr)	Dissolved Cobalt (Co)	Dissolved Copper (Cu)	Dissolved Iron (Fe)	Dissolved Lead (Pb)	Dissolved Lithium (Li)	Dissolved Magnesium (Mg)	Dissolved Manganese (Mn)	Dissolved Molybdenum (Mo)	Dissolved Nickel (Ni)	Dissolved Phosphorus (P)	Dissolved Potassium (K)	Dissolved Selenium (Se)	Dissolved Silicon (Si)	Dissolved Silver (Ag)	Dissolved Sodium (Na)	Dissolved Strontium (Sr)	Dissolved Sulphur (S)	Dissolved Thallium (Tl)	Dissolved Tin (Sn)	Dissolved Titanium (Ti)	Dissolved Uranium (U)	Dissolved Vanadium (V)	Dissolved Zinc (Zn)
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
TW-2015-02	20/05/2015	0.0067	0.003	0.00062	0.12	<0.001	0.024	55	<0.001	0.00045	<0.0002	0.22	<0.0002	0.062	33	0.051	0.0032	0.0013	<0.1	2.7	<0.0002	2.9	<0.0001	<0.5	0.33	3.4	<0.0002	<0.001	<0.001	0.0036	<0.001	0.02
TW-2015-02 Lab-Dup	20/05/2015	N/A	N/A	N/A	0.12	N/A	0.024	55	N/A	N/A	N/A	0.22	N/A	0.06	32	0.052	N/A	N/A	<0.1	2.6	N/A	2.8	N/A	<0.5	0.33	3.3	N/A	N/A	N/A	N/A	N/A	N/A
GCDWQ MAC		NG	0.006	0.010 [1.1]	1	NG	5	NG	0.05	NG	NG	NG	0.01	NG	NG	NG	NG	NG	NG	NG	0.05	NG	NG	NG	NG	NG	NG	NG	NG	0.02	NG	NG
CCME AL		Calc [2.1]	NG	0.005 [2.2]	NG	NG	1.5 [2.3]	NG	0.001 [2.5]	NG	Calc [2.6]	0.3	Calc [2.7]	NG	NG	NG	0.073	Calc [2.9]	N [2.10]	NG	0.001	NG	0.0001	NG	NG	NG	0.0008	NG	NG	0.015 [2.11]	NG	0.03
Tier 1 CL/IL CS		Calc [3.1]	0.006	0.005	1	NG	1.5	NG	0.001 [3.3]	NG	0.007	0.3	Calc [3.4]	NG	NG	0.05	NG	Calc [3.5]	NG	NG	0.001	NG	0.0001	200	NG	NG	NG	NG	NG	0.015	NG	0.03

Notes:

1. Notes for Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations (GCDWQ MAC)

Note 1.1 for Turbidity: "Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters should meet the requirements described in GCDWQ. For systems that use groundwater that is not under the direct influence of surface water, which are considered less vulnerable to faecal contamination, turbidity should generally be below 1.0 NTU. For effective operation of the distribution system, it is good practice to ensure that water entering the distribution system has turbidity levels below 1.0 NTU."

Note 1.2 for Nitrate + Nitrite (as N): The MAC for Nitrate (as N) is 10 mg/L

Note 1.3 for Nitrate + Nitrite (as N) (calculated): The MAC for Nitrate (as N) is 10 mg/L

2. Notes for CCME. Canadian water quality guidelines for the protection of freshwater aquatic life. (CCME AL)

General Notes: The CCME Canadian water quality guidelines for the protection of freshwater aquatic life provide both a Long-Term Exposure guideline, and Short-Term Exposure guideline for some analytes. The Long-Term Exposure guidelines were used in this report.

Note 2.1 for Temperature: "Thermal Stratification: Thermal additions to receiving waters should be such that thermal stratification and subsequent turnover dates are not altered from those existing prior to the addition of heat from artificial origins. Maximum Weekly Average Temperature: Thermal additions to receiving waters should be such that the maximum weekly average temperature is not exceeded. Short-term Exposure to Extreme Temperature: Thermal additions to receiving waters should be such that the short-term exposures to maximum temperatures are not exceeded. Exposures should not be so lengthy or frequent as to adversely affect the important species."

Note 2.2 for Turbidity: "Water quality guideline for turbidity is as follows. Clear flow: Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g., 24-h period). Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g., 30-d period). High flow or turbid waters: Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs. Should not increase more than 10% of background levels when background is >80 NTUs."

Note 2.3 for Ammonia (total, as N): The guideline for ammonia varies as a function of pH and temperature.

Note 2.4 for Chloride: The Short-Term Exposure Guideline is 640 mg/L. The Long-Term Exposure Guideline is 120 mg/L.

Note 2.5 for Fluoride: The interim guideline for the protection of freshwater aquatic life for total inorganic fluorides is 0.12 mg/L

Note 2.6 for Nitrate (as N): "The Short-Term Exposure Guideline is 124 mg/L. The Long-Term Exposure Guideline is 3.0 mg/L. The guidelines for nitrate are for protection from direct toxic effects; the guidelines do not consider indirect effects due to eutrophication. The Long Term guideline is derived from toxicity tests utilizing $NaNO_3$. The Long Term guideline is derived with mostly no- and some low-effect data and are intended to protect against negative effects to aquatic ecosystem structure and function during indefinite exposures (e.g. abide by the guiding principle as per CCME 2007)."

Note 2.7 for Nitrate (as NO_3): "The Short-Term Exposure Guideline is 550 mg/L. The Long-Term Exposure Guideline is 13 mg/L. The guidelines for nitrate are for protection from direct toxic effects; the guidelines do not consider indirect effects due to eutrophication. The Long Term guideline is derived from toxicity tests utilizing $NaNO_3$. The Long Term guideline is derived with mostly no- and some low-effect data and are intended to protect against negative effects to aquatic ecosystem structure and function during indefinite exposures (e.g. abide by the guiding principle as per CCME 2007)."

Note 2.8 for Nitrate + Nitrite (as N): Long-Term Exposure Guideline for Nitrate (as N) is 3.0 mg/L

Note 2.9 for Nitrate + Nitrite (as N) (calculated): Long-Term Exposure Guideline for Nitrate (as N) is 3.0 mg/L

Note 2.10 for Total Suspended Solids: "Clear Flow: Maximum increase of 25 mg/L from background levels for any short-term exposure (e.g., 24-h period). Maximum average increase of 5 mg/L from background levels for longer term exposures (e.g., inputs lasting between 24 h and 30 d). High flow: Maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L. Should not increase more than 10% of background levels when background is ≥ 250 mg/L."

3. Notes for Alberta Tier 1 Groundwater Remediation Guidelines for Commercial/Industrial Land Use and Coarse-grained Soil (2014 and updates) (Tier 1 CL/IL CS)

Note 3.1 for Ammonia (total, as N): The CCME guideline for protection of freshwater aquatic life was used. The guideline for ammonia varies as a function of pH and temperature.

Note 3.2 for Nitrate + Nitrite (as N): Guideline for Nitrate (as N) is 3 mg/L

Note 3.3 for Nitrate + Nitrite (as N) (calculated): Guideline for Nitrate (as N) is 3 mg/L

Note 3.4 for Nitrite (as N): "The long term guideline for nitrite as N is:0.02 mg/L if chloride less than 2 mg/L; 0.04 mg/L if chloride is 2 to 4 mg/L; 0.06 mg/L if chloride is 4 to 6 mg/L; 0.08 mg/L if chloride is 6 to 8 mg/L; 0.10 mg/L if chloride is 8 to 10 mg/L; 0.20 mg/L if chloride is greater than 10 mg/L. (Based on BC 2001, 30-day average)"

Note 3.5 for Nitrite (as NO_2): "The long term guideline for nitrite as NO_2 is: 0.064 mg/L if chloride less than 2 mg/L; 0.128 mg/L if chloride is 2 to 4 mg/L; 0.192 mg/L if chloride is 4 to 6 mg/L; 0.256 mg/L if chloride is 6 to 8 mg/L; 0.32 mg/L if chloride is 8 to 10 mg/L; 0.64 mg/L if chloride is greater than 10 mg/L. (Based on BC 2001, 30-day average)"

Note 3.6 for Sulphate: "The guideline for sulphate is: 128 mg/L at hardness of 0 to 30 mg/L as $CaCO_3$; 218 mg/L at hardness of 31 to 75 mg/L as $CaCO_3$; 309 mg/L at hardness of 76 to 180mg/L as $CaCO_3$; 429 mg/L at hardness 181 to 250 mg/L as $CaCO_3$; Need to determine guideline based on site water for hardness greater than 250 mg/L as $CaCO_3$ (Based on BC 2013, 30-day average). For screening purposes in this report, exceedances were flagged for sulphate greater than 429 mg/L at hardness greater than 250 mg/L as $CaCO_3$."

Note 3.7 for Sulphide (dissolved, as H_2S): The guideline for sulphide (total, as S) is 0.0019 mg/L. This is equivalent to 0.002 mg/L sulphide (total, as H_2S).

Legend for Reports for 2014/2015 AFP testing Water Quality Results:

<	Less than reported detection limit
>	Greater than reported upper detection limit
A	Absent
Calc	Calculated guideline or standard. The guideline or standard is dependent on the value of one or more other analytes, and is calculated from a formula or table.
CCME AL	CCME. Canadian water quality guidelines for the protection of freshwater aquatic life
GCDWQ MAC	Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations
L	Laboratory reading type (Lab result)
masl	metres above sea level
N	Narrative type of guideline or standard, or Result Note
ND	Non-detect; result is less than lower detection limit
NG	No Guideline
NR	No Result
NS	No Standard
NT	Not Tested
OG	Overgrown
P	Present
PR	Presumptive
Tier 1 CL/IL CS	Alberta Tier 1 Groundwater Remediation Guidelines for Commercial/Industrial Land Use and Coarse-grained Soil (2014 and updates)
TK	Test kit reading type (field result)
TNTC	Too numerous to count
	Highlighted value has a lower detection limit that is greater than the guideline/standard maximum and/or the guideline/standard minimum, or has an upper detection limit that is less than the guideline/standard maximum and/or the guideline/standard minimum
CCME AL	Highlighted value exceeds CCME AL
GCDWQ MAC	Highlighted value exceeds GCDWQ MAC
SL Criteria Override	Highlighted value exceeds sampling location criteria override
Tier 1 CL/IL CS	Highlighted value exceeds Tier 1 CL/IL CS

7 CLOSURE

This report presents the results of the focused hydrogeological field investigation at Coal Mountain Operations Phase 2 (CMO2) project site.

No other warranty, expressed or implied, is made as to the professional services provided to Teck. Any use of this report, other than for its intended purpose, requires the expressed written authorization of Norwest. Any use of this report by a third party, or reliance on or decisions made based upon it, are the responsibility of such third parties

All data contained herein has been reviewed and interpreted by, or generated under the direct supervision of Sara Wilkins, P.Geol.

"original signed and sealed by author"
June 4, 2015

Prepared by:

_____
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_____
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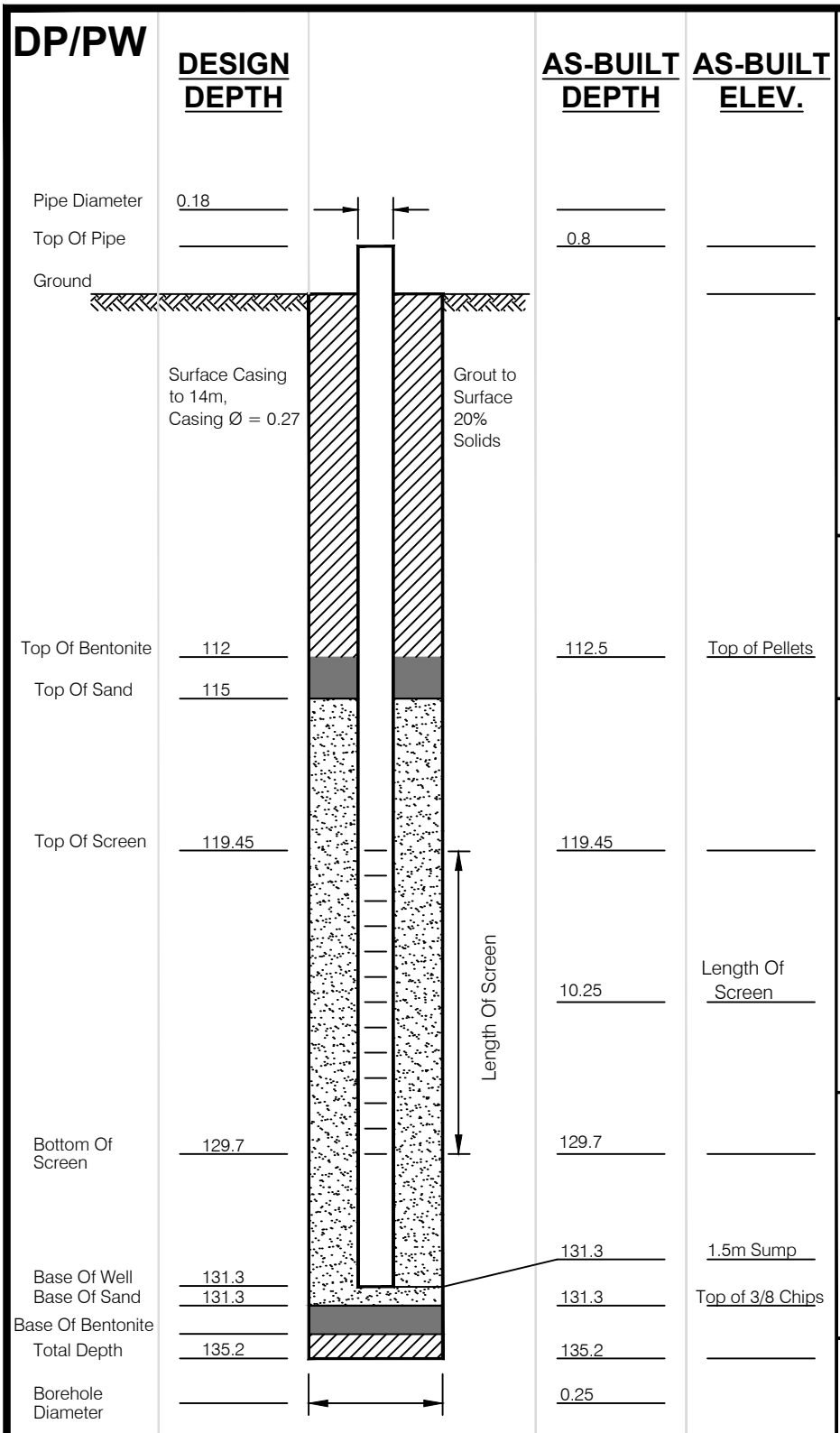
Manager, Water Resources
Norwest Corporation

Appendix A
Well Installation Diagrams

DP/PW



WELL INFO

Well Name: TW-2015-01
Project Name: CM02
Project No.: 324-27
Date Installed: May 15-16, 2015
Weather: Cloudy, Slight Rain 12°C
Drilling Co./Rig: Good Earth Drilling
Geological Unit:
Geologist: Kyle Schepanow

LOCATION INFO

Location:
Easting: 5 495 594
Northing: 658 906
Pipe Elev.:
Grid:

GROUT MIX

Water: l
Cement: kg
Bentonite: kg

WATER LEVELS

1. Design: Flowing at Surface 1-2 gpm (4-8 l/min) mbg
2. End Of Drilling: Date: May 15/15 Time: 14:00 mbg
3. End Of Installation: Date: May 16/15 Time: 17:00 mbg
4. End Of Development: Date: May 17/15 Time: 09:00 mbg

MATERIALS USED

1. Bags of Sand: 30 Bags 10-20 Filter
2. Bags of Pellets: 3 Buckets
3. Screen Slot Size: 20 Slot 0.18 SS Wire Wrap
4. Grout: 34 Bags

LEGEND

Frac. Sand | Grout | Bentonite

COMMENTS

Slough Material 135.2 to 131.1
Use of PDC Bit
Sand Added to Borehole over two days
0.18 SS Wire Wrap, Flush Thread 20 Slot Screen
0.18 Black Steel Casing

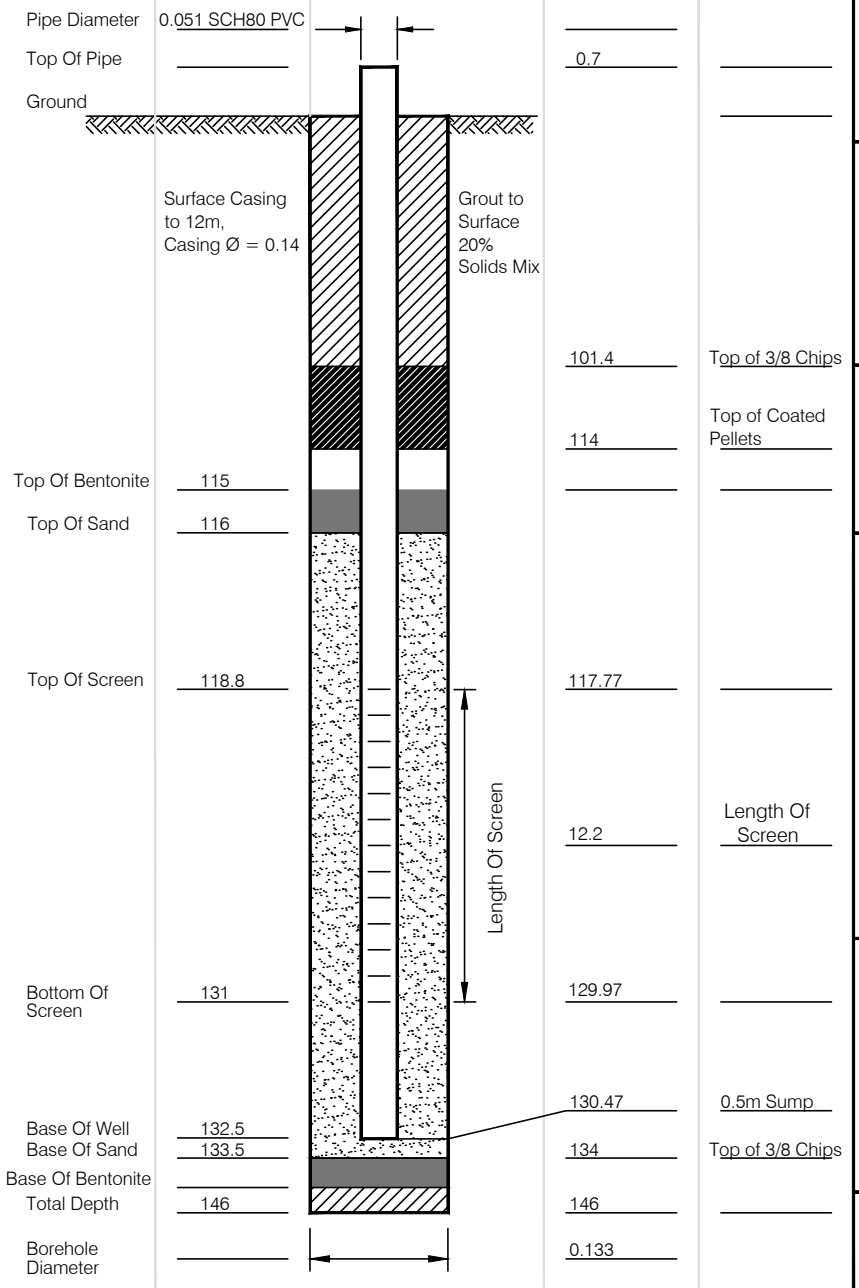
All Units in m.

NORWEST

WELL INSTALLATION RECORD TW-2015-01

DRAWN BY: A.W. DATE: 2015-05-27 REV: 01	FIG. 2 FILE:	SCALE N.T.S.

DP/PW



WELL INFO

Well Name: TW-2015-02
Project Name: CM02
Project No.: 324-27
Date Installed: May 10, 2015
Weather: Slight Rain 10°C
Drilling Co./Rig: Good Earth Drilling
Geological Unit:
Geologist: Kyle Schepanow

LOCATION INFO

Location:
Easting: 5 495 594
Northing: 658 919
Pipe Elev.:
Grid:

GROUT MIX

Water: l
Cement: kg
Bentonite: kg

WATER LEVELS

1. Design: Flowing at Surface 3-5 gpm (11-19 l/min) mbg
2. End Of Drilling: Date: May 10/15 Time: 10-30 mbg
3. End Of Installation: Date: Time: mbg
4. End Of Development: Date: Time: mbg

MATERIALS USED

1. Bags of Sand: 15 Bags 10-20 Filter
2. Bags of Bentonite: 16 Bags 3/8 Chips
3. Screen Slot Size: 20 Slot, Machine
4. Coated Pellets: 1 Bucket
5. Grout: 15 Bags

LEGEND

Frac. Sand | Grout | Bentonite

COMMENTS

0.5m Sump, 2" Slip Cap Glued
Screen 20 Slot Sch80 PVC (4x3.05m=12.2m)
Solid Riser 2" Sch80 PVC (39x3.05=118.95m)
UTM - Handheld GPS
Sand 10/20 Filter
3/8 Bentonite Chips

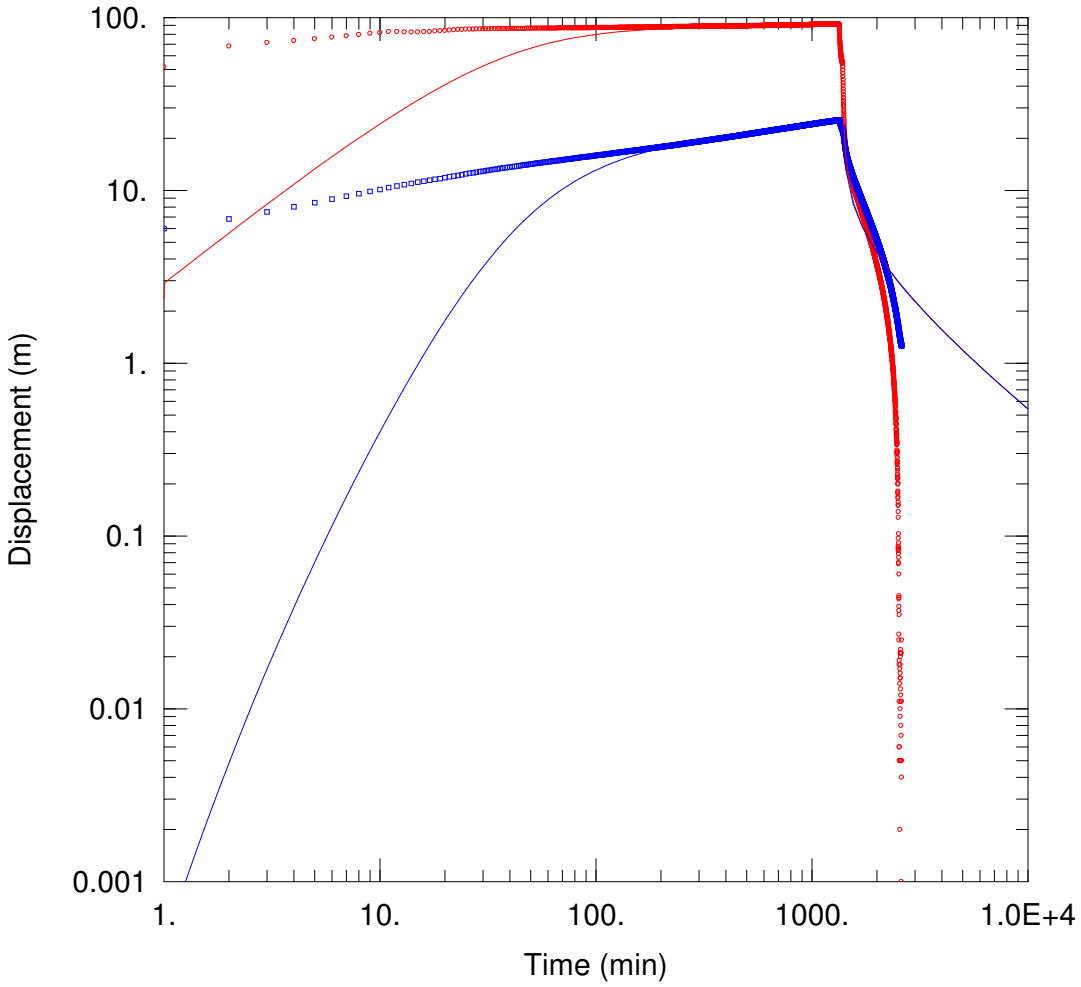
All Units in m.

NORWEST

WELL INSTALLATION RECORD
TW-2015-02

DRAWN BY: A.W. DATE: 2015-05-27 REV: 01	FIG. 1 FILE:	SCALE N.T.S.

Appendix B
Pumping Test Analysis



WELL TEST ANALYSIS

Data Set: G:\...\DB 20150525 TW-2015-01 Constant Rate Test - D-B.aqt
Date: 05/27/15 Time: 15:04:24

PROJECT INFORMATION

Company: Norwest Corporation
Client: Teck
Project: 324-27
Location: CMO2
Test Well: TW-2015-01
Test Date: 05-18-2015

AQUIFER DATA

Saturated Thickness: 16.3 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW-2015-01	5495594	658906

Observation Wells

Well Name	X (m)	Y (m)
◦ TW-2015-01	5495594	658906
▫ TW-2015-02	5495594	658919

SOLUTION

Aquifer Model: Confined
Solution Method: Dougherty-Babu

T = 1.831 m^2/day
Kz/Kr = 1.
r(w) = 0.1254 m

S = 2.301E-5
Sw = 4.522
r(c) = 0.0889 m

Appendix C
Water Quality Lab Reports

Maxxam
A Bureau Veritas Group Company

Success Through Science®

Your Project #: 324-27
Your C.O.C. #: A099231

Attention:Kyle Schepanow

NORWEST CORPORATION
2700, 411 - 1ST STREET SE
CALGARY, AB
CANADA T2G 4Y5

Report Date: 2015/05/29
Report #: R1966632
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B541547
Received: 2015/05/20, 17:50

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity @25C (pp, total), CO3,HCO3,OH	1	N/A	2015/05/23	AB SOP-00005	SM 22 2320 B m
Cadmium - low level CCME - Dissolved	1	N/A	2015/05/27	AB SOP-00043	Auto Calc
Chloride by Automated Colourimetry	1	N/A	2015/05/25	AB SOP-00020	SM 22-4500-Cl G m
Total Coliforms and E.Coli	1	2015/05/21	2015/05/22	CAL SOP-00013	SM 22 9223 A,B m
Conductivity @25C	1	N/A	2015/05/23	AB SOP-00005	SM 22 2510 B m
Hardness	1	N/A	2015/05/26	AB WI-00065	Auto Calc
Elements by ICP - Dissolved	1	N/A	2015/05/25	AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Dissolved	1	N/A	2015/05/26	AB SOP-00043	EPA 200.8 R5.4 m
Ion Balance	1	N/A	2015/05/22	AB WI-00065	SM 1030E
Sum of cations, anions	1	N/A	2015/05/26	AB WI-00065	SM 1030E
Ammonia-N (Total)	1	N/A	2015/05/25	AB SOP-00007	EPA 350.1 R2.0 m
Nitrate and Nitrite	1	N/A	2015/05/26	AB SOP-00023	Auto Calc
Nitrate + Nitrite-N (calculated)	1	N/A	2015/05/26	AB SOP-00023	Auto Calc
Nitrogen, (Nitrite, Nitrate) by IC	1	N/A	2015/05/25	AB SOP-00023	SM 22 4110 B m
pH @25°C (Alkalinity titrator)	1	N/A	2015/05/23	AB SOP-00005	SM 22 4500-H+B m
Sulphate by Automated Colourimetry	1	N/A	2015/05/25	AB SOP-00018	SM 22 4500-SO4 E m
Total Dissolved Solids (Filt. Residue)	1	2015/05/26	2015/05/26	AB SOP-00065	SM 22 2540 C m
Total Dissolved Solids (Calculated)	1	N/A	2015/05/26	AB WI-00065	SM 1030E
Total Kjeldahl Nitrogen	1	2015/05/27	2015/05/27	AB SOP-00008	EPA 351.1 R1978 m
Carbon (Total Organic) (1)	1	N/A	2015/05/27	CAL SOP-00077	MMCW 119 1996 m
Total Suspended Solids (NFR)	1	2015/05/27	2015/05/27	AB SOP-00061	SM 22 2540 D m
Turbidity	1	N/A	2015/05/25	CAL SOP-00081	SM 22 2130 B m

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) TOC present in the sample should be considered as non-purgeable TOC.

Maxxam Analytics International Corporation o/a Maxxam Analytics Calgary: 2021 - 41st Avenue N.E. T2E 6P2 Telephone (403) 291-3077 Fax (403) 291-9468

Your Project #: 324-27
Your C.O.C. #: A099231

Attention:Kyle Schepanow

NORWEST CORPORATION
2700, 411 - 1ST STREET SE
CALGARY, AB
CANADA T2G 4Y5

Report Date: 2015/05/29
Report #: R1966632
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B541547
Received: 2015/05/20, 17:50

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Jenelle Feller, Project Manager
Email: JFeller@maxxam.ca
Phone# (403)735-2264

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Calgary: 2021 - 41st Avenue N.E. T2E 6P2 Telephone (403) 291-3077 Fax (403) 291-9468

Maxxam Job #: B541547
Report Date: 2015/05/29

NORWEST CORPORATION
Client Project #: 324-27
Sampler Initials: KS

ROUTINE WATER & DISS. REGULATED METALS (WATER)

Maxxam ID		MG8787	MG8787		
Sampling Date		2015/05/20 12:15	2015/05/20 12:15		
COC Number		A099231	A099231		
	Units	TW-2015-02	TW-2015-02 Lab-Dup	RDL	QC Batch
Calculated Parameters					
Anion Sum	meq/L	5.5	N/A	N/A	7908016
Cation Sum	meq/L	5.6	N/A	N/A	7908016
Hardness (CaCO3)	mg/L	270	N/A	0.50	7908014
Ion Balance	N/A	1.0	N/A	0.010	7908015
Dissolved Nitrate (NO3)	mg/L	<0.044	N/A	0.044	7908017
Nitrate plus Nitrite (N)	mg/L	<0.010	N/A	0.010	7908018
Dissolved Nitrite (NO2)	mg/L	<0.033	N/A	0.033	7908017
Total Dissolved Solids	mg/L	260	N/A	10	7908020
Misc. Inorganics					
Conductivity	uS/cm	520	N/A	1.0	7910574
pH	pH	7.90	N/A	N/A	7910573
Low Level Elements					
Dissolved Cadmium (Cd)	ug/L	<0.020	N/A	0.020	7908012
Anions					
Alkalinity (PP as CaCO3)	mg/L	<0.50	N/A	0.50	7910572
Alkalinity (Total as CaCO3)	mg/L	260	N/A	0.50	7910572
Bicarbonate (HCO3)	mg/L	320	N/A	0.50	7910572
Carbonate (CO3)	mg/L	<0.50	N/A	0.50	7910572
Hydroxide (OH)	mg/L	<0.50	N/A	0.50	7910572
Dissolved Sulphate (SO4)	mg/L	12	N/A	1.0	7912261
Dissolved Chloride (Cl)	mg/L	<1.0	N/A	1.0	7912258
Nutrients					
Dissolved Nitrite (N)	mg/L	<0.010	<0.010	0.010	7911337
Dissolved Nitrate (N)	mg/L	<0.010	<0.010	0.010	7911337
Elements					
Dissolved Aluminum (Al)	mg/L	0.0067	N/A	0.0030	7911641
Dissolved Antimony (Sb)	mg/L	0.0030	N/A	0.00060	7911641
Dissolved Arsenic (As)	mg/L	0.00062	N/A	0.00020	7911641
Dissolved Barium (Ba)	mg/L	0.12	0.12	0.010	7911809
Dissolved Beryllium (Be)	mg/L	<0.0010	N/A	0.0010	7911641
Dissolved Boron (B)	mg/L	0.024	0.024	0.020	7911809
Dissolved Calcium (Ca)	mg/L	55	55	0.30	7911809
Dissolved Chromium (Cr)	mg/L	<0.0010	N/A	0.0010	7911641
Dissolved Cobalt (Co)	mg/L	0.00045	N/A	0.00030	7911641

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

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NORWEST CORPORATION
Client Project #: 324-27
Sampler Initials: KS

ROUTINE WATER & DISS. REGULATED METALS (WATER)

Maxxam ID		MG8787	MG8787		
Sampling Date		2015/05/20 12:15	2015/05/20 12:15		
COC Number		A099231	A099231		
	Units	TW-2015-02	TW-2015-02 Lab-Dup	RDL	QC Batch
Dissolved Copper (Cu)	mg/L	<0.00020	N/A	0.00020	7911641
Dissolved Iron (Fe)	mg/L	0.22	0.22	0.060	7911809
Dissolved Lead (Pb)	mg/L	<0.00020	N/A	0.00020	7911641
Dissolved Lithium (Li)	mg/L	0.062	0.060	0.020	7911809
Dissolved Magnesium (Mg)	mg/L	33	32	0.20	7911809
Dissolved Manganese (Mn)	mg/L	0.051	0.052	0.0040	7911809
Dissolved Molybdenum (Mo)	mg/L	0.0032	N/A	0.00020	7911641
Dissolved Nickel (Ni)	mg/L	0.0013	N/A	0.00050	7911641
Dissolved Phosphorus (P)	mg/L	<0.10	<0.10	0.10	7911809
Dissolved Potassium (K)	mg/L	2.7	2.6	0.30	7911809
Dissolved Selenium (Se)	mg/L	<0.00020	N/A	0.00020	7911641
Dissolved Silicon (Si)	mg/L	2.9	2.8	0.10	7911809
Dissolved Silver (Ag)	mg/L	<0.00010	N/A	0.00010	7911641
Dissolved Sodium (Na)	mg/L	<0.50	<0.50	0.50	7911809
Dissolved Strontium (Sr)	mg/L	0.33	0.33	0.020	7911809
Dissolved Sulphur (S)	mg/L	3.4	3.3	0.20	7911809
Dissolved Thallium (Tl)	mg/L	<0.00020	N/A	0.00020	7911641
Dissolved Tin (Sn)	mg/L	<0.0010	N/A	0.0010	7911641
Dissolved Titanium (Ti)	mg/L	<0.0010	N/A	0.0010	7911641
Dissolved Uranium (U)	mg/L	0.0036	N/A	0.00010	7911641
Dissolved Vanadium (V)	mg/L	<0.0010	N/A	0.0010	7911641
Dissolved Zinc (Zn)	mg/L	0.020	N/A	0.0030	7911641

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RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		MG8787	MG8787		
Sampling Date		2015/05/20 12:15	2015/05/20 12:15		
COC Number		A099231	A099231		
	Units	TW-2015-02	TW-2015-02 Lab-Dup	RDL	QC Batch
Misc. Inorganics					
Total Organic Carbon (C)	mg/L	<0.50	<0.50	0.50	7913899
Total Dissolved Solids	mg/L	250	N/A	10	7912546
Total Suspended Solids	mg/L	1.5	N/A	1.0	7914099
Microbiological Param.					
E.Coli DST	mpn/100mL	<1.0	<1.0	1.0	7907964
Total Coliforms DST	mpn/100mL	30	34	1.0	7907964
Nutrients					
Total Ammonia (N)	mg/L	0.63 (1)	N/A	0.050	7911756
Total Kjeldahl Nitrogen	mg/L	0.57 (1)	N/A	0.050	7913841
Physical Properties					
Turbidity	NTU	2.4	N/A	0.10	7911580

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable
(1) Ammonia greater than TKN. Results are within acceptable limits of precision.

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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	10.3°C

Results relate only to the items tested.

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QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7907964	LLF	RPD [MG8787-04]	E.Coli DST	2015/05/22	NC		%	100
			Total Coliforms DST	2015/05/22	13		%	100
7910572	CPI	Spiked Blank	Alkalinity (Total as CaCO3)	2015/05/23		96	%	80 - 120
7910572	CPI	Method Blank	Alkalinity (PP as CaCO3)	2015/05/23	<0.50		mg/L	
			Alkalinity (Total as CaCO3)	2015/05/23	<0.50		mg/L	
			Bicarbonate (HCO3)	2015/05/23	<0.50		mg/L	
			Carbonate (CO3)	2015/05/23	<0.50		mg/L	
			Hydroxide (OH)	2015/05/23	<0.50		mg/L	
7910572	CPI	RPD	Alkalinity (PP as CaCO3)	2015/05/25	6.1		%	20
			Alkalinity (Total as CaCO3)	2015/05/25	0.69		%	20
			Bicarbonate (HCO3)	2015/05/25	0.36		%	20
			Carbonate (CO3)	2015/05/25	6.1		%	20
			Hydroxide (OH)	2015/05/25	NC		%	20
7910573	CPI	Spiked Blank	pH	2015/05/23		100	%	97 - 103
7910573	CPI	RPD	pH	2015/05/25	0.23		%	N/A
7910574	CPI	Spiked Blank	Conductivity	2015/05/23		101	%	90 - 110
7910574	CPI	Method Blank	Conductivity	2015/05/23	<1.0		uS/cm	
7910574	CPI	RPD	Conductivity	2015/05/23	0.30		%	20
7911337	JLD	Matrix Spike [MG8787-01]	Dissolved Nitrite (N)	2015/05/25		100	%	80 - 120
			Dissolved Nitrate (N)	2015/05/25		102	%	80 - 120
7911337	JLD	Spiked Blank	Dissolved Nitrite (N)	2015/05/25		100	%	80 - 120
			Dissolved Nitrate (N)	2015/05/25		102	%	80 - 120
7911337	JLD	Method Blank	Dissolved Nitrite (N)	2015/05/25	<0.010		mg/L	
			Dissolved Nitrate (N)	2015/05/25	<0.010		mg/L	
7911337	JLD	RPD [MG8787-01]	Dissolved Nitrite (N)	2015/05/25	NC		%	20
			Dissolved Nitrate (N)	2015/05/25	NC		%	20
7911580	HE1	Spiked Blank	Turbidity	2015/05/25		98	%	80 - 120
7911580	HE1	Method Blank	Turbidity	2015/05/25	<0.10		NTU	
7911580	HE1	RPD	Turbidity	2015/05/25	2.1		%	20
7911641	PC5	Matrix Spike	Dissolved Aluminum (Al)	2015/05/26		111	%	80 - 120
			Dissolved Antimony (Sb)	2015/05/26		48 (1)	%	80 - 120
			Dissolved Arsenic (As)	2015/05/26		97	%	80 - 120
			Dissolved Beryllium (Be)	2015/05/26		108	%	80 - 120
			Dissolved Chromium (Cr)	2015/05/26		94	%	80 - 120
			Dissolved Cobalt (Co)	2015/05/26		91	%	80 - 120
			Dissolved Copper (Cu)	2015/05/26		91	%	80 - 120
			Dissolved Lead (Pb)	2015/05/26		92	%	80 - 120
			Dissolved Molybdenum (Mo)	2015/05/26		97	%	80 - 120
			Dissolved Nickel (Ni)	2015/05/26		89	%	80 - 120
			Dissolved Selenium (Se)	2015/05/26		92	%	80 - 120
			Dissolved Silver (Ag)	2015/05/26		84	%	80 - 120
			Dissolved Thallium (Tl)	2015/05/26		93	%	80 - 120
			Dissolved Tin (Sn)	2015/05/26		92	%	80 - 120
			Dissolved Titanium (Ti)	2015/05/26		99	%	80 - 120
			Dissolved Uranium (U)	2015/05/26		98	%	80 - 120
			Dissolved Vanadium (V)	2015/05/26		98	%	80 - 120
			Dissolved Zinc (Zn)	2015/05/26		94	%	80 - 120
7911641	PC5	Spiked Blank	Dissolved Aluminum (Al)	2015/05/26		105	%	80 - 120
			Dissolved Antimony (Sb)	2015/05/26		99	%	80 - 120
			Dissolved Arsenic (As)	2015/05/26		96	%	80 - 120
			Dissolved Beryllium (Be)	2015/05/26		95	%	80 - 120
			Dissolved Chromium (Cr)	2015/05/26		93	%	80 - 120

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Dissolved Cobalt (Co)	2015/05/26		92	%	80 - 120
			Dissolved Copper (Cu)	2015/05/26		91	%	80 - 120
			Dissolved Lead (Pb)	2015/05/26		92	%	80 - 120
			Dissolved Molybdenum (Mo)	2015/05/26		95	%	80 - 120
			Dissolved Nickel (Ni)	2015/05/26		90	%	80 - 120
			Dissolved Selenium (Se)	2015/05/26		91	%	80 - 120
			Dissolved Silver (Ag)	2015/05/26		87	%	80 - 120
			Dissolved Thallium (Tl)	2015/05/26		90	%	80 - 120
			Dissolved Tin (Sn)	2015/05/26		99	%	80 - 120
			Dissolved Titanium (Ti)	2015/05/26		101	%	80 - 120
			Dissolved Uranium (U)	2015/05/26		94	%	80 - 120
			Dissolved Vanadium (V)	2015/05/26		96	%	80 - 120
			Dissolved Zinc (Zn)	2015/05/26		93	%	80 - 120
7911641	PC5	Method Blank	Dissolved Aluminum (Al)	2015/05/26	<0.0030		mg/L	
			Dissolved Antimony (Sb)	2015/05/26	0.00091, RDL=0.00060		mg/L	
			Dissolved Arsenic (As)	2015/05/26	<0.00020		mg/L	
			Dissolved Beryllium (Be)	2015/05/26	<0.0010		mg/L	
			Dissolved Chromium (Cr)	2015/05/26	<0.0010		mg/L	
			Dissolved Cobalt (Co)	2015/05/26	<0.00030		mg/L	
			Dissolved Copper (Cu)	2015/05/26	<0.00020		mg/L	
			Dissolved Lead (Pb)	2015/05/26	<0.00020		mg/L	
			Dissolved Molybdenum (Mo)	2015/05/26	0.00031, RDL=0.00020		mg/L	
			Dissolved Nickel (Ni)	2015/05/26	<0.00050		mg/L	
			Dissolved Selenium (Se)	2015/05/26	0.00029, RDL=0.00020		mg/L	
			Dissolved Silver (Ag)	2015/05/26	<0.00010		mg/L	
			Dissolved Thallium (Tl)	2015/05/26	<0.00020		mg/L	
			Dissolved Tin (Sn)	2015/05/26	<0.0010		mg/L	
			Dissolved Titanium (Ti)	2015/05/26	<0.0010		mg/L	
			Dissolved Uranium (U)	2015/05/26	0.00011, RDL=0.00010		mg/L	
			Dissolved Vanadium (V)	2015/05/26	<0.0010		mg/L	
			Dissolved Zinc (Zn)	2015/05/26	<0.0030		mg/L	
7911641	PC5	RPD	Dissolved Aluminum (Al)	2015/05/26	NC		%	20
			Dissolved Antimony (Sb)	2015/05/26	NC		%	20
			Dissolved Arsenic (As)	2015/05/26	NC		%	20
			Dissolved Beryllium (Be)	2015/05/26	NC		%	20
			Dissolved Chromium (Cr)	2015/05/26	NC		%	20
			Dissolved Cobalt (Co)	2015/05/26	NC		%	20
			Dissolved Copper (Cu)	2015/05/26	NC		%	20
			Dissolved Lead (Pb)	2015/05/26	NC		%	20
			Dissolved Molybdenum (Mo)	2015/05/26	NC		%	20
			Dissolved Nickel (Ni)	2015/05/26	NC		%	20
			Dissolved Selenium (Se)	2015/05/26	NC		%	20
			Dissolved Silver (Ag)	2015/05/26	NC		%	20
			Dissolved Thallium (Tl)	2015/05/26	NC		%	20
			Dissolved Tin (Sn)	2015/05/26	NC		%	20
			Dissolved Titanium (Ti)	2015/05/26	NC		%	20
			Dissolved Uranium (U)	2015/05/26	NC		%	20
			Dissolved Vanadium (V)	2015/05/26	NC		%	20
			Dissolved Zinc (Zn)	2015/05/26	NC		%	20

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
7911756	BL5	Matrix Spike	Total Ammonia (N)	2015/05/25		93	%	80 - 120
7911756	BL5	Spiked Blank	Total Ammonia (N)	2015/05/25		94	%	80 - 120
7911756	BL5	Method Blank	Total Ammonia (N)	2015/05/25	<0.050		mg/L	
7911756	BL5	RPD	Total Ammonia (N)	2015/05/25	NC		%	20
7911809	MAP	Matrix Spike [MG8787-03]	Dissolved Barium (Ba)	2015/05/25		87	%	80 - 120
			Dissolved Boron (B)	2015/05/25		90	%	80 - 120
			Dissolved Calcium (Ca)	2015/05/25		NC	%	80 - 120
			Dissolved Iron (Fe)	2015/05/25		91	%	80 - 120
			Dissolved Lithium (Li)	2015/05/25		88	%	80 - 120
			Dissolved Magnesium (Mg)	2015/05/25		90	%	80 - 120
			Dissolved Manganese (Mn)	2015/05/25		93	%	80 - 120
			Dissolved Phosphorus (P)	2015/05/25		91	%	80 - 120
			Dissolved Potassium (K)	2015/05/25		89	%	80 - 120
			Dissolved Silicon (Si)	2015/05/25		93	%	80 - 120
			Dissolved Sodium (Na)	2015/05/25		91	%	80 - 120
			Dissolved Strontium (Sr)	2015/05/25		89	%	80 - 120
7911809	MAP	Spiked Blank	Dissolved Barium (Ba)	2015/05/25		95	%	80 - 120
			Dissolved Boron (B)	2015/05/25		99	%	80 - 120
			Dissolved Calcium (Ca)	2015/05/25		107	%	80 - 120
			Dissolved Iron (Fe)	2015/05/25		100	%	80 - 120
			Dissolved Lithium (Li)	2015/05/25		96	%	80 - 120
			Dissolved Magnesium (Mg)	2015/05/25		100	%	80 - 120
			Dissolved Manganese (Mn)	2015/05/25		103	%	80 - 120
			Dissolved Phosphorus (P)	2015/05/25		99	%	80 - 120
			Dissolved Potassium (K)	2015/05/25		99	%	80 - 120
			Dissolved Silicon (Si)	2015/05/25		104	%	80 - 120
			Dissolved Sodium (Na)	2015/05/25		99	%	80 - 120
			Dissolved Strontium (Sr)	2015/05/25		98	%	80 - 120
7911809	MAP	Method Blank	Dissolved Barium (Ba)	2015/05/25	<0.010		mg/L	
			Dissolved Boron (B)	2015/05/25	<0.020		mg/L	
			Dissolved Calcium (Ca)	2015/05/25	<0.30		mg/L	
			Dissolved Iron (Fe)	2015/05/25	<0.060		mg/L	
			Dissolved Lithium (Li)	2015/05/25	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2015/05/25	<0.20		mg/L	
			Dissolved Manganese (Mn)	2015/05/25	<0.0040		mg/L	
			Dissolved Phosphorus (P)	2015/05/25	<0.10		mg/L	
			Dissolved Potassium (K)	2015/05/25	<0.30		mg/L	
			Dissolved Silicon (Si)	2015/05/25	<0.10		mg/L	
			Dissolved Sodium (Na)	2015/05/25	<0.50		mg/L	
			Dissolved Strontium (Sr)	2015/05/25	<0.020		mg/L	
			Dissolved Sulphur (S)	2015/05/25	<0.20		mg/L	
7911809	MAP	RPD [MG8787-03]	Dissolved Barium (Ba)	2015/05/25	0.72		%	20
			Dissolved Boron (B)	2015/05/25	NC		%	20
			Dissolved Calcium (Ca)	2015/05/25	0.28		%	20
			Dissolved Iron (Fe)	2015/05/25	NC		%	20
			Dissolved Lithium (Li)	2015/05/25	NC		%	20
			Dissolved Magnesium (Mg)	2015/05/25	0.45		%	20
			Dissolved Manganese (Mn)	2015/05/25	0.058		%	20
			Dissolved Phosphorus (P)	2015/05/25	NC		%	20
			Dissolved Potassium (K)	2015/05/25	0.95		%	20
			Dissolved Silicon (Si)	2015/05/25	0.70		%	20
			Dissolved Sodium (Na)	2015/05/25	NC		%	20

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	Units	QC Limits
			Dissolved Strontium (Sr)	2015/05/25	0.68		%	20
			Dissolved Sulphur (S)	2015/05/25	0.54		%	20
7912258	KP9	Matrix Spike	Dissolved Chloride (Cl)	2015/05/25		NC	%	80 - 120
7912258	KP9	Spiked Blank	Dissolved Chloride (Cl)	2015/05/25		102	%	80 - 120
7912258	KP9	Method Blank	Dissolved Chloride (Cl)	2015/05/25	<1.0		mg/L	
7912258	KP9	RPD	Dissolved Chloride (Cl)	2015/05/25	3.4		%	20
7912261	KP9	Matrix Spike	Dissolved Sulphate (SO4)	2015/05/25		NC	%	80 - 120
7912261	KP9	Spiked Blank	Dissolved Sulphate (SO4)	2015/05/25		105	%	80 - 120
7912261	KP9	Method Blank	Dissolved Sulphate (SO4)	2015/05/25	<1.0		mg/L	
7912261	KP9	RPD	Dissolved Sulphate (SO4)	2015/05/25	1.8		%	20
7912546	HE1	Matrix Spike	Total Dissolved Solids	2015/05/26		97	%	80 - 120
7912546	HE1	Spiked Blank	Total Dissolved Solids	2015/05/26		83	%	80 - 120
7912546	HE1	Method Blank	Total Dissolved Solids	2015/05/26	<10		mg/L	
7912546	HE1	RPD	Total Dissolved Solids	2015/05/26	3.5		%	20
7913841	BL5	Matrix Spike	Total Kjeldahl Nitrogen	2015/05/27		NC	%	80 - 120
7913841	BL5	QC Standard	Total Kjeldahl Nitrogen	2015/05/27		95	%	80 - 120
7913841	BL5	Spiked Blank	Total Kjeldahl Nitrogen	2015/05/27		92	%	80 - 120
7913841	BL5	Method Blank	Total Kjeldahl Nitrogen	2015/05/27	<0.050		mg/L	
7913841	BL5	RPD	Total Kjeldahl Nitrogen	2015/05/27	15		%	20
7913899	KSF	Matrix Spike [MG8787-05]	Total Organic Carbon (C)	2015/05/27		101	%	80 - 120
7913899	KSF	Spiked Blank	Total Organic Carbon (C)	2015/05/27		98	%	80 - 120
7913899	KSF	Method Blank	Total Organic Carbon (C)	2015/05/27	<0.50		mg/L	
7913899	KSF	RPD [MG8787-05]	Total Organic Carbon (C)	2015/05/27	NC		%	20
7914099	HE1	Matrix Spike	Total Suspended Solids	2015/05/27		NC	%	80 - 120
7914099	HE1	Spiked Blank	Total Suspended Solids	2015/05/27		98	%	80 - 120
7914099	HE1	Method Blank	Total Suspended Solids	2015/05/27	<1.0		mg/L	
7914099	HE1	RPD	Total Suspended Solids	2015/05/27	9.5		%	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

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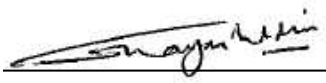
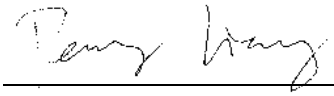
VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Ghayasuddin Khan, M.Sc., B.Ed., P.Chem, Scientific Specialist



Harry (Peng) Liang, Senior Analyst

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Calgary: 2021 - 41st Avenue N.E. T2E 6P2 Telephone (403) 291-3077 Fax (403) 291-9468

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www.maxxamanalytics.com

603

Chain of Custody A099231

Page: 1 of 1

	Invoice To:	C/O Report Address ☐	Report To:	Same as Invoice ☑
Company:	NORWEST CORPORATION			
Contact:	KYLE SCHEPANOW			
Address:	2700 411 1ST STREET SE.			
	Prov: ALBERTA	PC: T2G 4Y5	Prov:	PC:
Contact #s:	Ph: 403 817 7200	Cell: 403 701 9874	Ph:	Cell:

Report Distribution (E-Mail):

REGULATORY GUIDELINES:
- ☐ AT1
- ☐ CCME
- ☐ Regulated Drinking Water
- ☑ Other:

All samples are held for 60 calendar days after sample receipt, unless specified otherwise.

PO #:	
Project # / Name:	324-27
Site Location:	
Quote #:	
Sampled By:	KYLE SCHEPANOW

SERVICE REQUESTED: ☐ RUSH (Contact lab to reserve) Date Required: _____ ☑ REGULAR (5 to 7 Days)

See reverse for package specifics

	Sample ID	Depth (unit)	Matrix GW / SW Soil	Date/Time Sampled YY/MM/DD 24:00	SOIL: BTEX F1-F4	Sieve (75 micron)	Regulated Metals (CCME / AT1)	Salinity 4	Assessment ICP Metals	Basic Class II Landfill	WATER: ☐VOCs ☐BTEX F1 ☐BTEX F1-F2 ☐BTEX F1-F4	☑Routine Water ☐Turb ☐F	☑TOC ☐DOC	Regulated Metals (CCME / AT1) Total	Dissolved	Mercury	☐Total ☐Dissolved	Other Analysis: Total Coliforms	E. coli	TDS; TSS										HOLD - Do not Analyze	# of Containers Submitted
1	TW-2015-01	N/A	GW	15/05/20 11:25								X			X			X	X	X	10								X	3
2	TW-2015-02	N/A	GW	15/05/20 12:15								X			X			X	X	X	11								X	3
3	DUP 1	N/A	GW	15/05/20 11:30								X			X					X	10								X	3
4																														
5																														
6																														
7																														
8																														
9																														
10																														
11																														
12																														

20-May-15 17:50
Jenelle Feller
B541547
FL5 INS-0053

Please indicate Filtered, Preserved or Both (F, P, F/P) → F/P

Relinquished By (Signature/Print): KYLE SCHEPANOW	Date (YY/MM/DD): 15/05/20	Time (24:00): 17:45
Relinquished By (Signature/Print):	Date (YY/MM/DD):	Time (24:00):

Special Instructions: HOLD SAMPLES - WILL CALL TO CONFIRM ANALYSIS

# of Jars Used & Not Submitted

LAB USE ONLY

Received By:	Date:	Time:	Maxxam Job #:		
Muhammad Akhter	2015/05/20	17:50	Custody Seal	Temperature	Ice
Lab Comments:			NO	10, 1, 10	YES

Appendix E
East Wheeler Creek Sedimentation Pond Investigation Results

NORWEST CORPORATION

Suite 2700, 411 1st Street SE
Calgary, AB T2G 4Y5
(403) 237-7763
www.norwestcorp.com

Memorandum

To	Don Hufsmith	**Project #**	324-27
CC	Sara Wilkins	**Date**	July 21, 2015
From	Lacy Gielen, Steven Bundrock		
Subject	East Wheeler Lower Sediment Pond Dam Foundation Test Pit Data Report: Borehole Logs and Laboratory Results		

INTRODUCTION

Norwest Corporation (Norwest) was retained by Teck Coal (Teck) to collect and report a test pit program to support the feasibility level evaluation and design of Teck's Coal Mountain Operations Area 2 (CMO2) sedimentation ponds. This Data Report presents the results from field logs and laboratory results from the test pits that were excavated on May 29, 2015. Test pit samples were tested at Golder Associates soils lab in Calgary, Alberta and completed June 23, 2015.

TEST PIT LOGGING

Field logs and test pit sampling was completed by Teck's Ray Yost and E. Gerard and results appear in Appendix A. A 345 CAT Backhoe was utilized to extract surficial samples from 0 m to approximately 6 m in depth. Test pit locations can be found in Figure 1-1.

The test pit logs present data as follows:

- Test Pit logs provided by Teck;
- Laboratory results provided by Golder Associates; and
- As-built coordinates and elevations provided by Teck.

SAMPLING AND LABORATORY TESTING

Grab samples were collected at each new lithological interval in each of the three test pits. A total of 15 grab samples were collected and tested at Golder Labs.

The following laboratory tests were conducted in each test pit:

- ASTM Method D2216 – Natural Water content (**15** tested);
- ASTM Method D4318 – Liquid and Plastic Limits (**12** tested); and
- ASTM Method D422/D6913 – Sieve and Hydrometer Analysis (**3** tested).

Memorandum

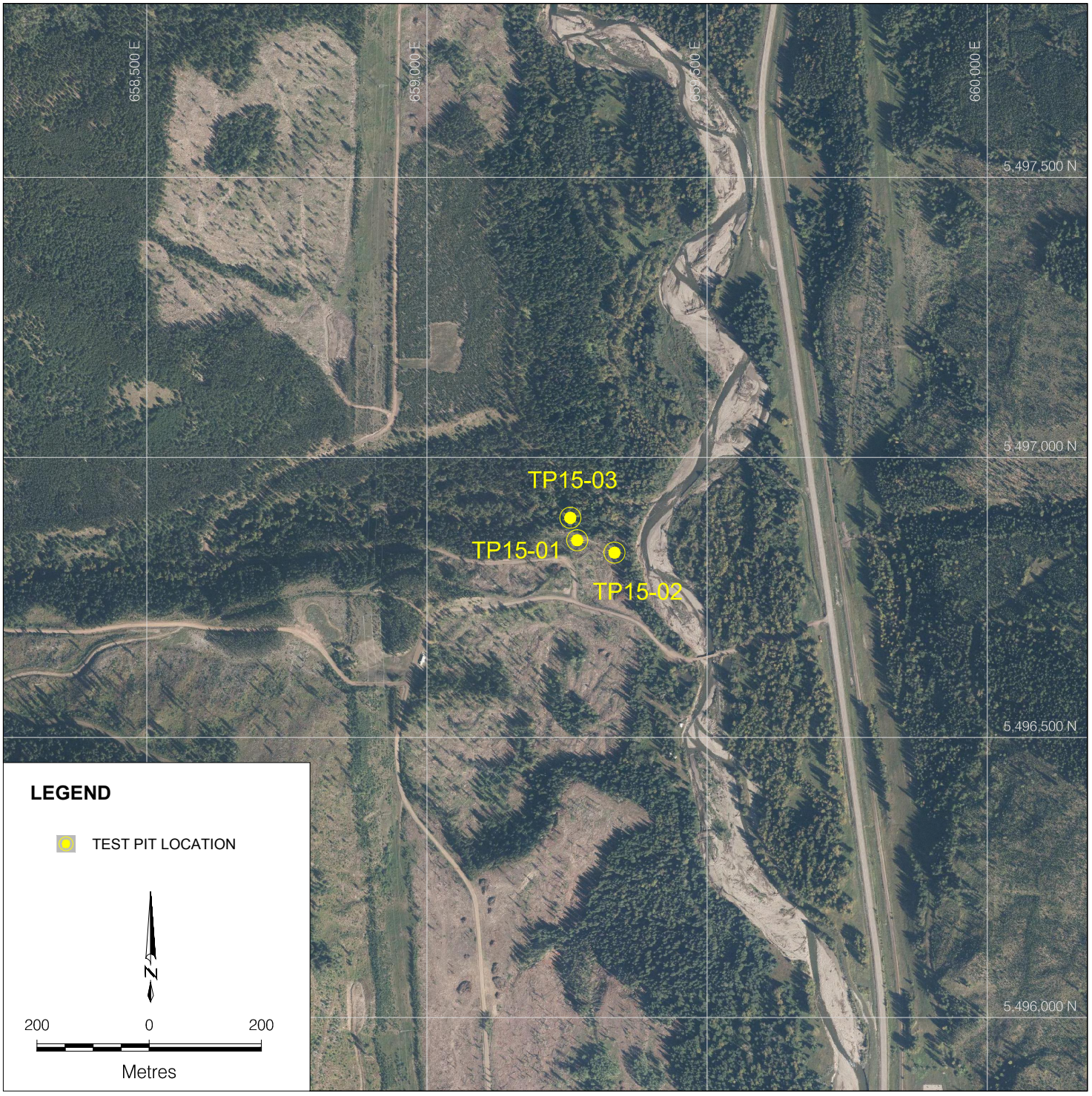
Refer to Appendix B for complete laboratory results.

CLOSING

All information contained herein has been compiled by Lacy Gielen and reviewed by Steven Bundrock, P.Eng.

Please contact the authors if there are questions regarding this report or if any additional information is required.

Norwest Corporation APEGGA Permit Number P – 5015.



Geotechnical Test Pit Locations			
Location	Northing	Easting	Elevation
TP15-01	659268	5496852	1318
TP15-02	659335	5496830	1319
TP15-03	659303	5496842	1317

Teck

CMO2 GEOTECHNICAL FIELD INVESTIGATION

Test Pit Locations

FIGURE 1-1

DRAWN BY:A.W. CHK'D BY: S.B DATE: 15 07 14	FILE:Fig 1-1 Geotech BH Locations ...\Teck_Coal_C_324\324-28_CMO2 Geotech\Disc\Drafting	NORWEST

Appendix A
Test Pit Logs and Photos

NORWEST CORPORATION

Project #/Description	Test Pit ID #	
CMO2 Test Pits	TP-1	

Location (m) E 659268.1	N 5496851.8	Excavation Date: May 29, 2015
Ground Elev (m) 1318.4	Contractor: Teck	Equipment Type: 345 CAT Backhoe
Pit Length & Width (m): 1.5 x 4.0	Sample Type: BS=Block Sample GS=Grab Sample	
Pit Depth (m): 5.9	Logged By: R Yost / E Gerard	

Test Pit/Trench interval (m)		Sample/log interval (m)		Sample type		Root depth (m)	Insitu Strength: (pp)-pkt pen, (tv)-torvane, (sv)-shear vane		Depth to Water (m)	Sand Size + (%)	Sample number	Stratigraphy	Description
0.0	0.2	0.1	0.2	GS		0.2					GS-1		Silty SAND, fine to coarse, well graded, sub-angular, dusky brown 5YR2/2, damp, loose, non-plastic, structureless, SM, loamy odour.
0.2	1.1	0.4	0.6	GS			seep at 1.1m				GS-2		Well-graded SAND, fine to coarse sand & fine to coarse gravel, well graded, sub-round gravel, sub-angular sand, olive grey 5Y4/1, wet, loose, non-plastic, structureless, SW.
1.1	4.1	3.0	3.1	GS							GS-3/ GS-4		Fat CLAY, dark yellow brown 10YR4/2, wet, very soft, high plasticity, varved, CH. Contains thin layers of sandy carbonacious material.
4.1	5.6	4.2	4.3	GS			seep at 4.1m				GS-5		Fat CLAY with sand, olive grey 5Y4/1, wet, soft, high plasticity, varved, CH.
5.6	5.9	5.8	5.9	GS							GS-6		Silty SAND, very fine to fine, poorly graded, sub-angular, olive black 5Y2/1, wet, loose, non-plastic to low plasticity, varved, SM.

Notes: 1) varved refers to alternating layers of finer versus coarser grained materials, typically on the order of several cm of fine materials and several mm of coarser materials

NORWEST CORPORATION

Project #/Description	Test Pit ID #	Page 1 of 1
CMO2 Test Pits	TP-2	

Location (m) E 659302.5	N 5496842.3	Excavation Date: May 29, 2015
Ground Elev (m) 1317.4	Contractor: Teck	Equipment Type: 345 CAT Backhoe
Pit Length & Width (m): 1.5 x 5.0	Sample Type: BS=Block Sample GS=Grab Sample	
Pit Depth (m): 4.5	Logged By: R Yost / E Gerard	

Test Pit/Trench interval (m)		Sample/log interval (m)		Sample type		Root depth (m)	Insitu Strength: (pp)-pkt pen, (tv)-torvane, (sv)-shear vane		Depth to Water (m)	Sand Size + (%)	Sample number	Stratigraphy	Description: Group name, grain size, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other
0.0	0.3	0.0	0.1	GS		0.05					GS-1		Well graded GRAVEL with silt and sand / well graded SAND with gravel and silt, fine to coarse sand & fine to coarse gravel, sub-rounded gravel, sub-angular sand, gray brown 5YR3/2, damp, loose, non-plastic, unstructured, GW-GM/SW-SM.
0.3	1.0	0.5	0.6	GS							GS-2		
1.0	1.7	1.2	1.4	GS							GS-3		Fat CLAY, fine, olive gray 5Y3/2, damp, firm, high plasticity, varved, CH. Note: 10-15% silt.
1.7	3.5	2.1	2.3	GS							GS-5		Well graded SAND, fine to coarse sand & fine to coarse gravel with some cobbles, sub-angular to sub-round, olive gray 5Y3/2, damp, loose, non-plastic, unstructured, SW.
3.5	4.5	3.6	3.8	GS				Seep ~ 4.4m			GS-6		Silty SAND with gravel and cobbles, fine to coarse sand & gravel, well graded, sub-angular to sub-round, round cobbles, olive black 5Y2/1, damp, loose, non-plastic, unstrutured, SM.

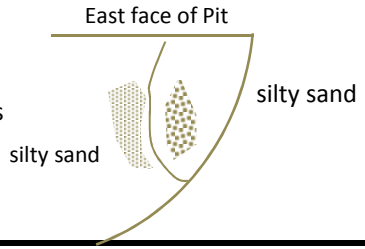
Notes: 1) Large cobbles were encountered at ~4.5 m - stopped digging. 2) Ground surface was disturbed prior to excavation 3) varved refers to alternating layers of finer versus coarser grained materials, typically on the order of several cm of fine materials and several mm of coarser materials

NORWEST CORPORATION

Project #/Description: CMO2 Test Pits	Test Pit ID #: TP-3	Page 1 of 1
Location (m): E 659334.8	N 5496829.8	Excavation Date: May 29, 2015
Ground Elev (m): 1319.2	Contractor: Teck	Equipment Type: 345 CAT Backhoe
Pit Length & Width (m): 1.5 x 5.0	Sample Type: BS=Block Sample GS=Grab Sample	
Pit Depth (m): 5.4	Logged By: R Yost / E Gerard	

Test Pit/Trench interval (m)		Sample/log interval (m)		Sample type		Root depth (m)	Insitu Strength: (pp)-pkt pen, (tv)-torvane, (sv)-shear vane		Depth to Water (m)	Sand Size + (%)	Sample number	Stratigraphy	Description (Group name, grain size, gradation, particle shape, colour, moisture, consistency or compactness, plasticity, structure, USCS, local name, other)
0.0	1.7	0.2	0.3	GS							GS-1		Silty SAND with gravel, very fine to coarse sand & fine to coarse gravel, well graded, round to sub-angular, dark yellow brown 10YR4/2, damp, loose, non-plastic, unstructured, SM.
1.7	3.7	2.3	2.4	GS							GS-2		Well graded SAND, very fine and coarse, gap graded, sub-angular, dusky yellowish brown 10YR2/2, damp, compact, non-plastic, unstructured, SW.
3.7	5.2	5.0	5.2	GS							GS-3		Poorly graded SAND with silt, very fine to fine, sub-angular, dark-yellowish brown 10YR4/2, damp, compact, non-plastic, unstructured, SP-SM.
5.2	5.4	5.2	5.4	GS							GS-4		Elastic SILT, moderate yellowish brown 10YR5/4, damp, firm, medium plasticity, laminated, MH.

Note:
1) Descriptions may be influenced by mixing of samples from possible paleo-stream channel and bank



Notes: 2) Ground surface had been cleared to bare soil prior to TP excavation 3) laminated refers to alternating layers of finer versus coarser grained materials, typically on the order of several cm of fine materials and several mm to cm of coarser materials

Field log v2014.2

TP-1 North view

TP-1 West view

TP-1 East View

TP-1 GS-1

TP-1 GS-2

TP-1 GS-3

TP-1 GS-4

TP-1 GS-5

TP-1 GS-6

TP-2 North View

TP-2 East View

TP-3 North-West View

TP-2 GS-1

TP-2 GS-2

TP-2 GS-3

TP-2 GS-4

TP-2 GS-5

TP-3 South View

TP-3 South-East View

TP-3 South-West View

TP-3 GS-1

TP-3 GS-2

TP-3 GS-3

TP-3 GS-4

Appendix B
Test Pit Sample Results

Note:

Borehole sample data from the Teck CMO2 Geotechnical Investigation is included on the General Lab Testing Summary (page 15). Test Pit Samples are listed below the borehole samples.

General Lab Testing Summary

Project No.: 1413549 | Phase: 2000
Short Title: NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing | Sched: B508
Tested By: CG | Date: 12-Jun-15

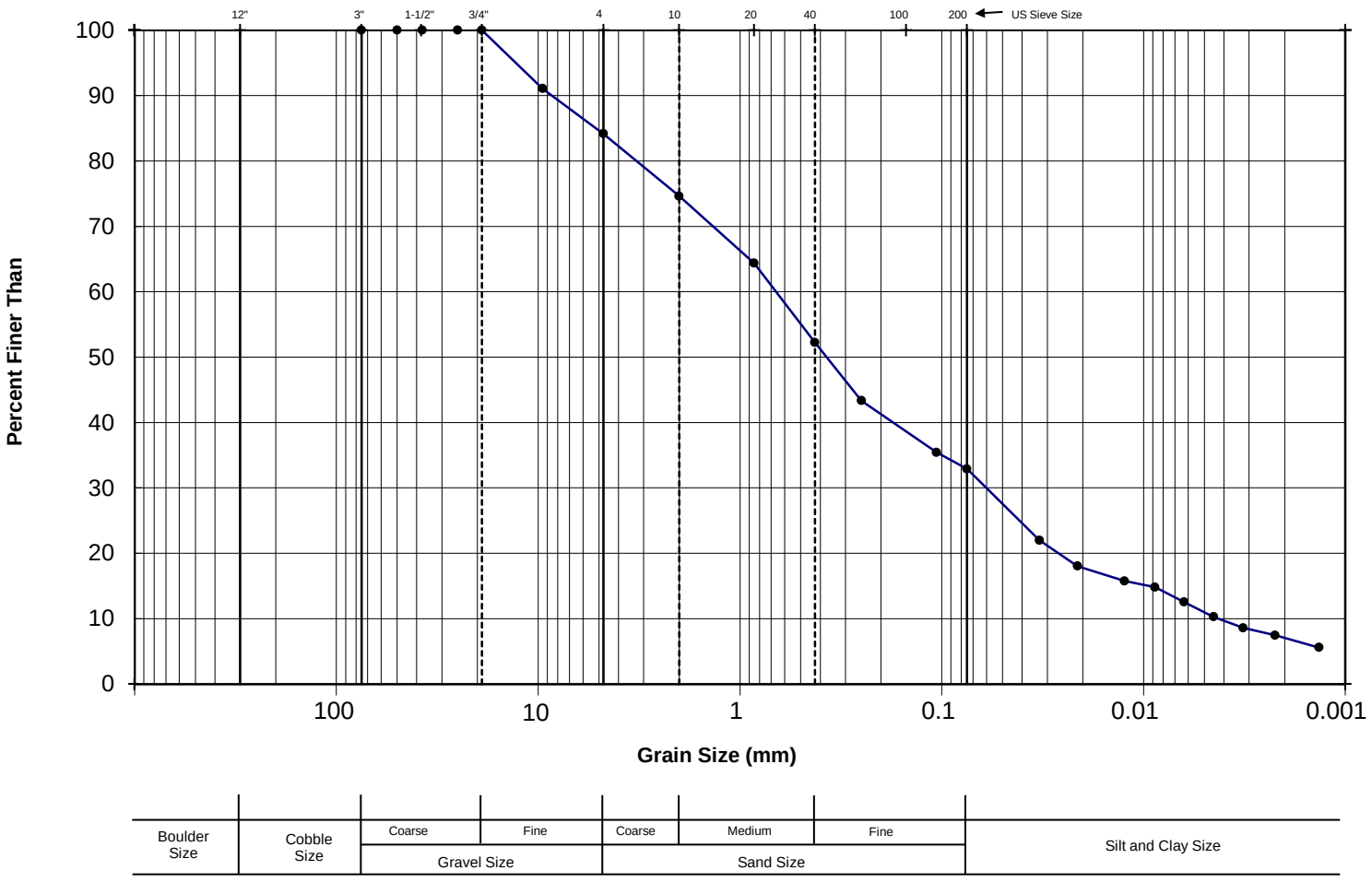
Sample Identification					Laboratory Test Results					
Borehole No.	Sample No.	Depth (m)		Lab No.	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	SPMDD (kg/m^3)	Optimum w (%)
		from	to							
BH15-01	6210	18.92	19.39	B50-01	27.9	NP	NP	NP		
BH15-03	6279	3.00	3.45	B50-02	11.7					
	6282	7.63	8.07	B50-03	31.0	NP	NP	NP		
	6286	13.74	14.20	B50-04	27.6	NP	NP	NP		
	6288	16.79	17.24	B50-05	25.9	33	18	15		
	6291	23.36	23.82	B50-06	17.2	40	20	20		
BH15-04	6263	1.50	1.95	B50-07	14.2					
	6270	13.74	14.19	B50-08	30.7	26	17	9		
BH15-06	6217	5.99	6.45	B50-09	28.5	NP	NP	NP		
	6219	9.06	9.83	B50-10	32.0	NP	NP	NP		
	6221	11.98	12.44	B50-11	30.3	26	18	8		
	6223	14.40	14.80	B50-12	24.2	27	17	10		
BH15-07	6250	12.10	12.59	B50-13						
	6252	14.50	14.90	B50-14	17.5	30	17	13		
	6253	15.18	15.64	B50-15						
	6251	13.68	14.13	B50-16	29.7	31	18	13		
CM02 TP-1	GS-1	0.10	0.50	B50-17	55.5					
	GS-2	0.40	0.60	B50-18	17.6					
	GS-3	2.50	2.60	B50-32	29.8	29	19	10		
	GS-4	3.00	3.10	B50-19	28.7	27	18	9		
	GS-5	4.20	4.30	B50-20	26.2	29	19	10		
	GS-6	5.80	5.90	B50-21	24.6	23	16	7		
CM02 TP-2	GS-1	0.00	0.10	B50-22	37.6					
	GS-2	0.50	0.60	B50-23	11.9					
	GS-3	1.20	1.40	B50-24	28.2	32	18	14		
	GS-5	2.10	2.30	B50-25	8.5					
	GS-6	3.60	3.80	B50-26	9.3					
CM02 TP-3	GS-1	0.20	0.30	B50-28	16.8					
	GS-2	2.30	2.40	B50-29	15.9					
	GS-3	5.00	5.20	B50-30	15.4					
	GS-4	5.20	5.40	B50-31	25.3	NP	NP	NP		

Reviewed By:_____

Project No.:	1413549.2000	Lab No.:	B508-17
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	CM02 TP-1	Sample No.:	GS-1
Depth:	0.10-0.20 m		
Date Tested:	15-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	91.1
4.75	84.1
2.0	74.6
0.850	64.4
0.425	52.2
0.250	43.3
0.106	35.4
0.075	32.9
0.033	22.0
0.021	18.0
0.012	15.8
0.009	14.8
0.006	12.5
0.004	10.3
0.003	8.6
0.002	7.5
0.001	5.6

Comments:

Sample contained trace to little wood and root fibers(organics)

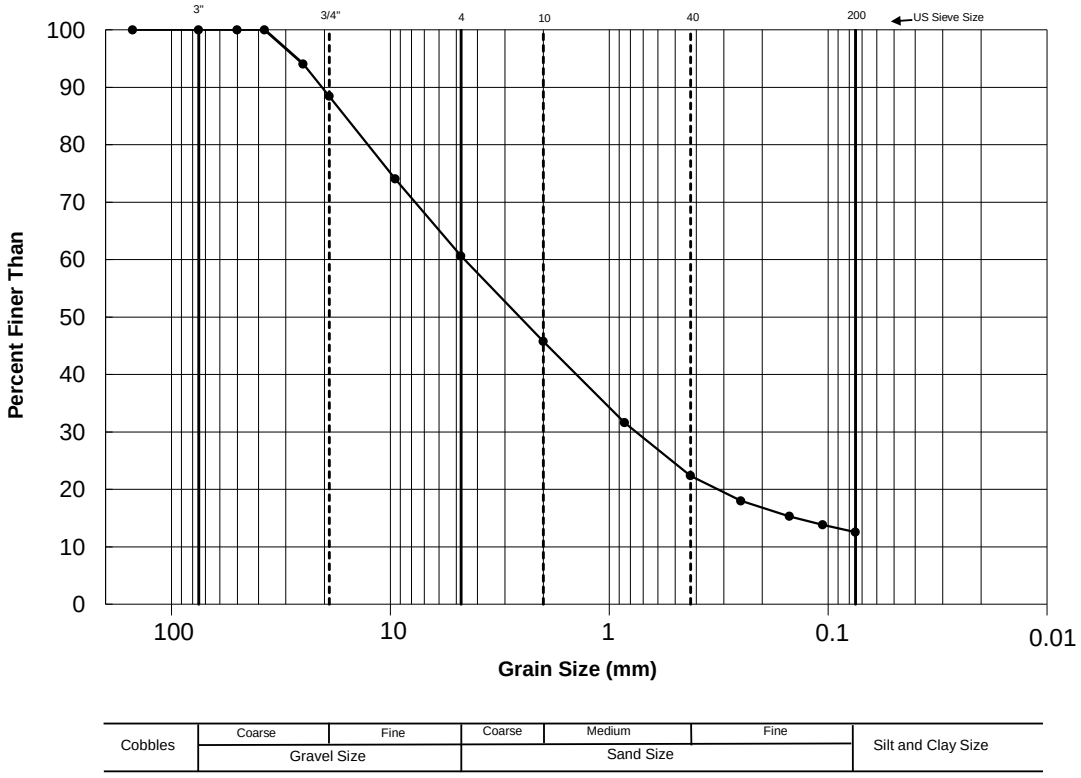
Reviewed: _____

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1413549	Phase:	2000		Date:	12-Jun-15
Short Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech T					
Sub Sampled By:	CG	Washed By:	DS		Sieved By:	CL
Field Tag No.:	-	Location:	-		BH or TP No.:	CM02 TP-1
Lab No.:	B508-18	Northing:	-	m	Sample No.:	GS-2
Sampled By:	L. Gielen / R. Host	Easting:	-	m	Depth From:	0.40 m
Sample Date:	19-May-15	Elevation:	-	m	Depth To:	0.60 m

Test Method:	A	Drying Method:	Oven	
Composite Sieve:	Yes	if Yes, Split on:	4.75	mm
Material Exluded from Sieve:	No	Describe:		
Prior Testing on Sample:	No	Describe:		



Sieve Size (mm)	Passing %
150	100
75	100
50	100
37.5	100
25	94
19	88
9.5	74
4.75	61
2	46
0.85	32
0.425	22
0.25	18
0.15	15
0.106	14
0.075	13

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
17.6	0	39	48	13	4.6	0.8	N/A	N/A	N/A

Sample Description: (SM) SILTY SAND and fine to coarse sub-angular GRAVEL, fine to coarse sand; dark brown; presence of roots, non-cohesive, moist

USCS Classification: SM

Remarks:

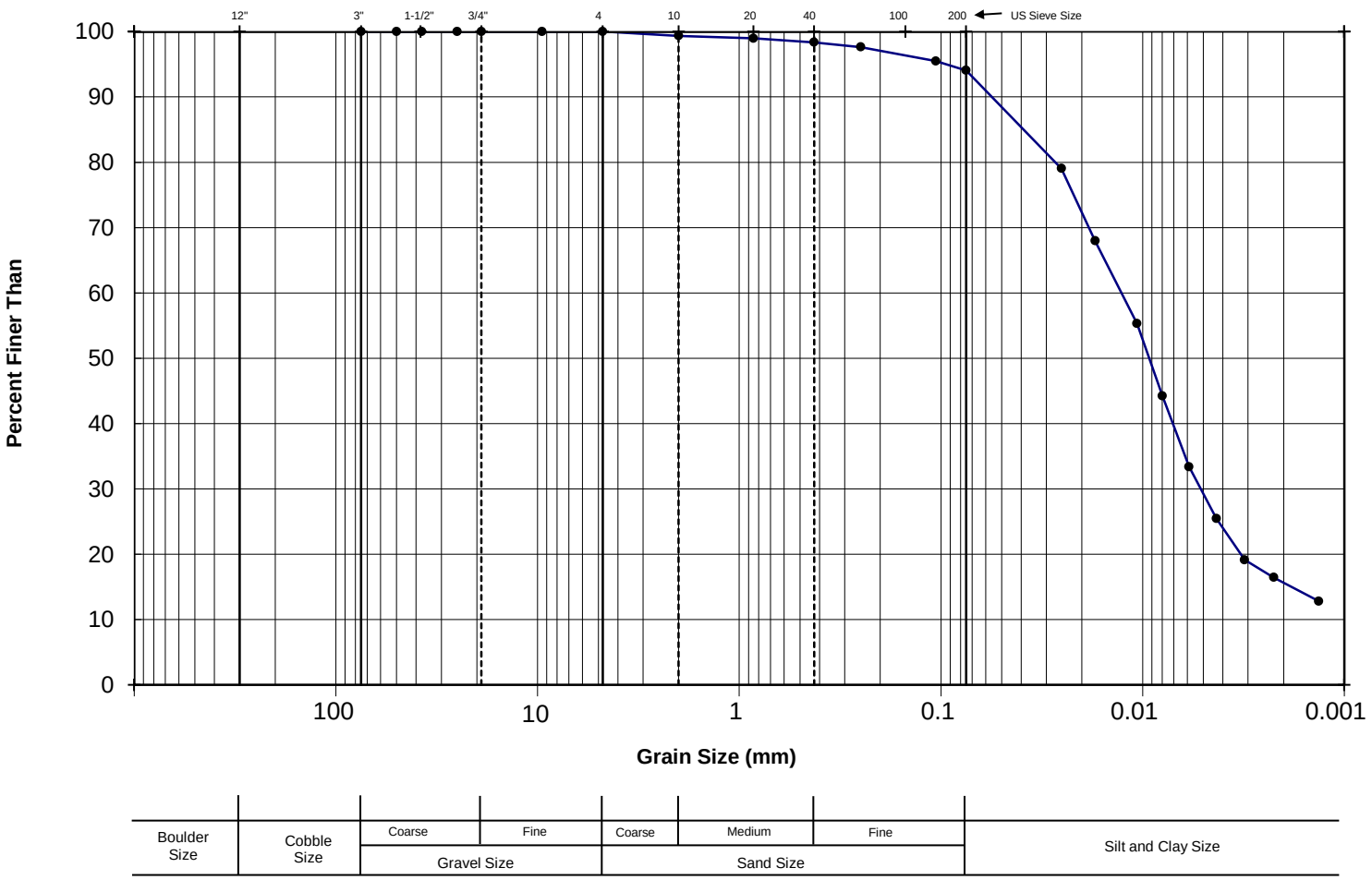
Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

Reviewed by: _____

Project No.:	1413549.2000	Lab No.:	B508-32
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	CM02 TP-1	Sample No.:	GS-3
Depth:	2.50-2.60 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.4
0.850	99.0
0.425	98.4
0.250	97.6
0.106	95.5
0.075	94.0
0.025	79.0
0.017	68.0
0.011	55.3
0.008	44.2
0.006	33.4
0.004	25.5
0.003	19.1
0.002	16.4
0.001	12.8

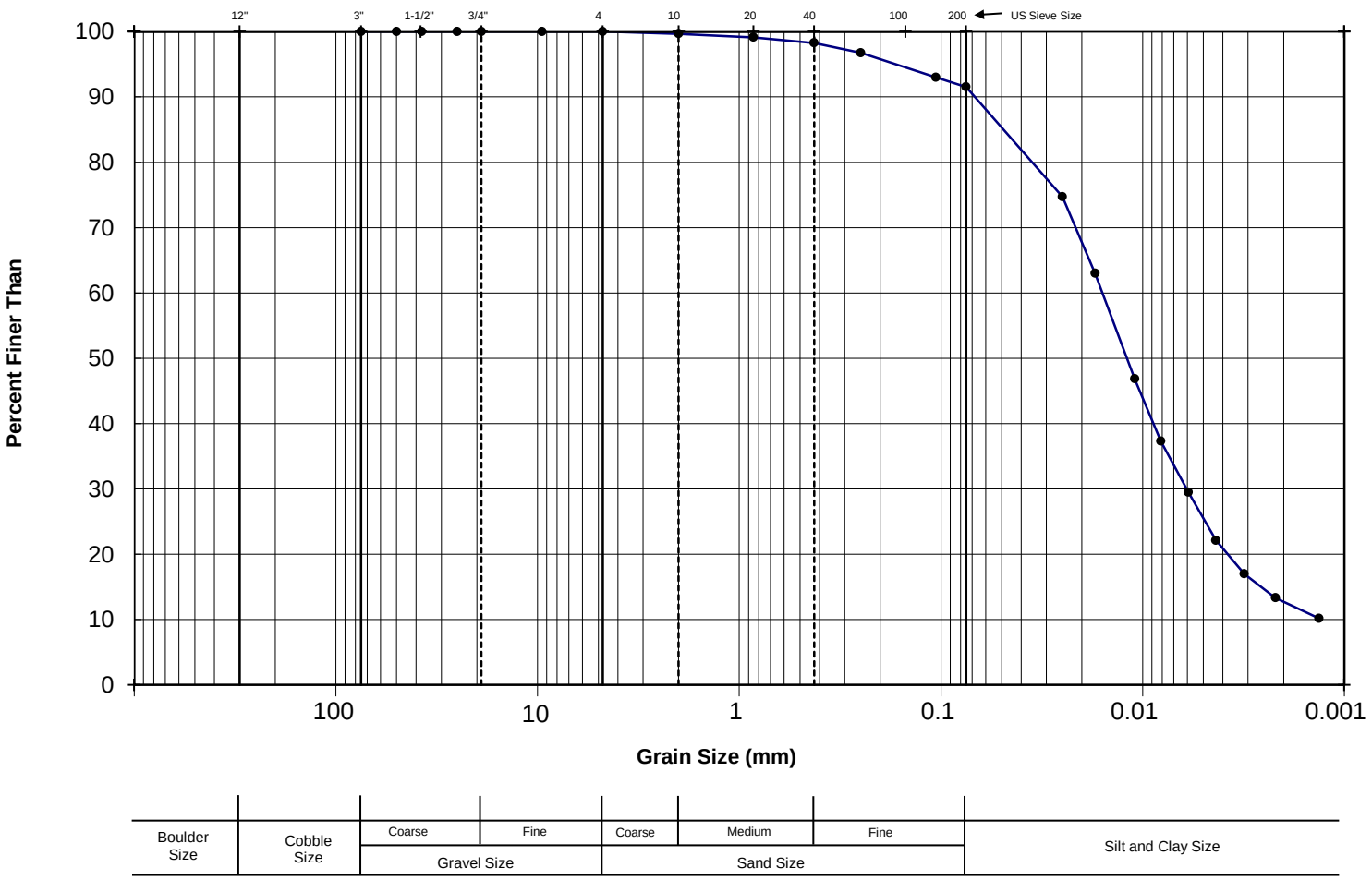
Comments:

Reviewed: _____

Project No.:	1413549.2000	Lab No.:	B508-19
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	CM02 TP-1	Sample No.:	GS-4
Depth:	3.00-3.10 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.7
0.850	99.1
0.425	98.3
0.250	96.8
0.106	93.0
0.075	91.5
0.025	74.7
0.017	63.0
0.011	46.8
0.008	37.3
0.006	29.5
0.004	22.1
0.003	17.0
0.002	13.3
0.001	10.2

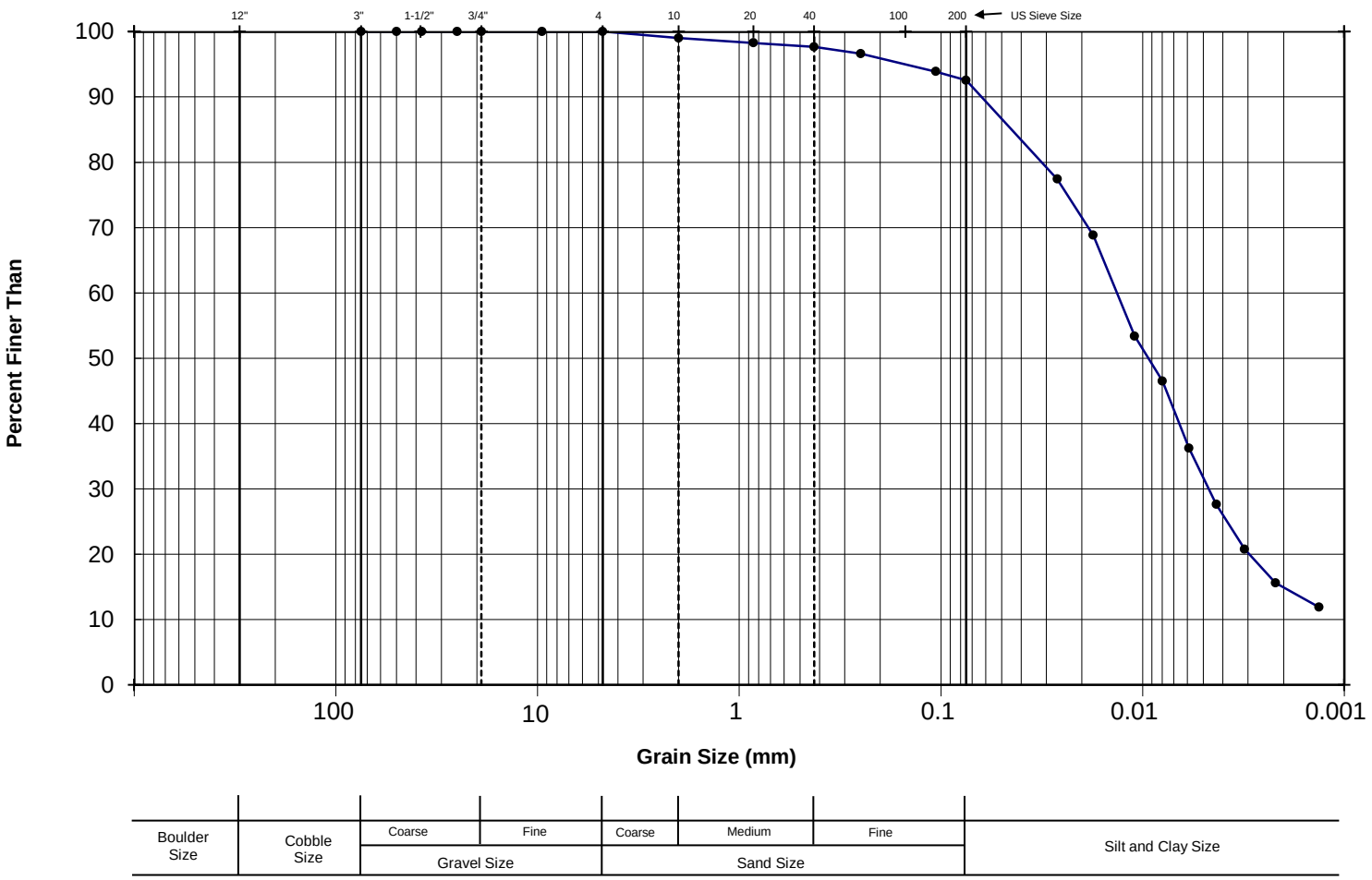
Comments:

Reviewed: _____

Project No.:	1413549.2000	Lab No.:	B508-20
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	CM02 TP-1	Sample No.:	GS-5
Depth:	4.20-4.30 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.0
0.850	98.3
0.425	97.6
0.250	96.6
0.106	93.9
0.075	92.5
0.026	77.4
0.018	68.8
0.011	53.4
0.008	46.5
0.006	36.2
0.004	27.6
0.003	20.8
0.002	15.6
0.001	11.9

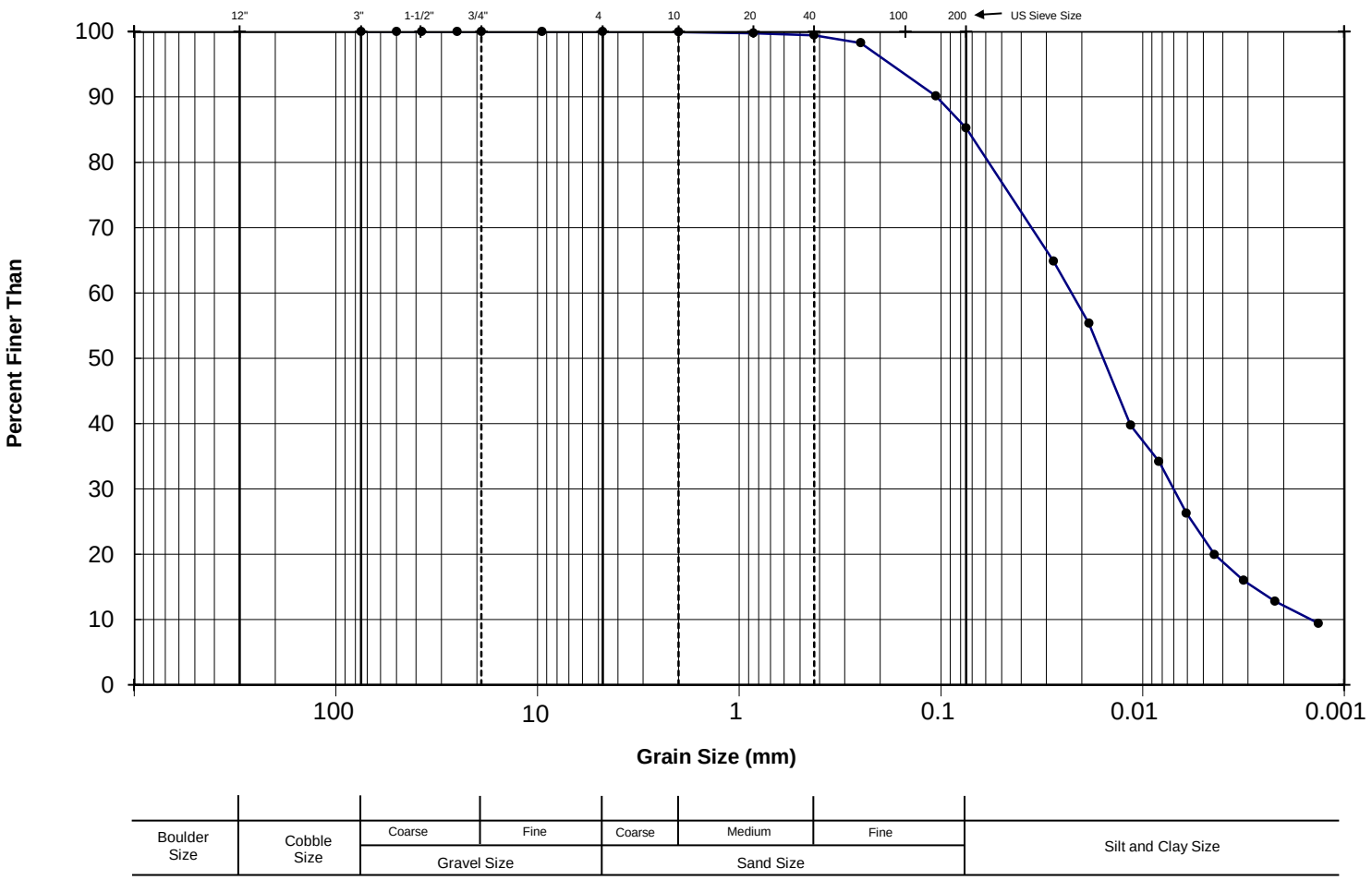
Comments:

Reviewed: _____

Project No.:	1413549.2000	Lab No.:	B508-21
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	CM02 TP-1	Sample No.:	GS-6
Depth:	5.80-5.90 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.9
0.850	99.7
0.425	99.4
0.250	98.3
0.106	90.1
0.075	85.2
0.028	64.9
0.018	55.3
0.011	39.7
0.008	34.2
0.006	26.3
0.004	19.9
0.003	16.0
0.002	12.8
0.001	9.4

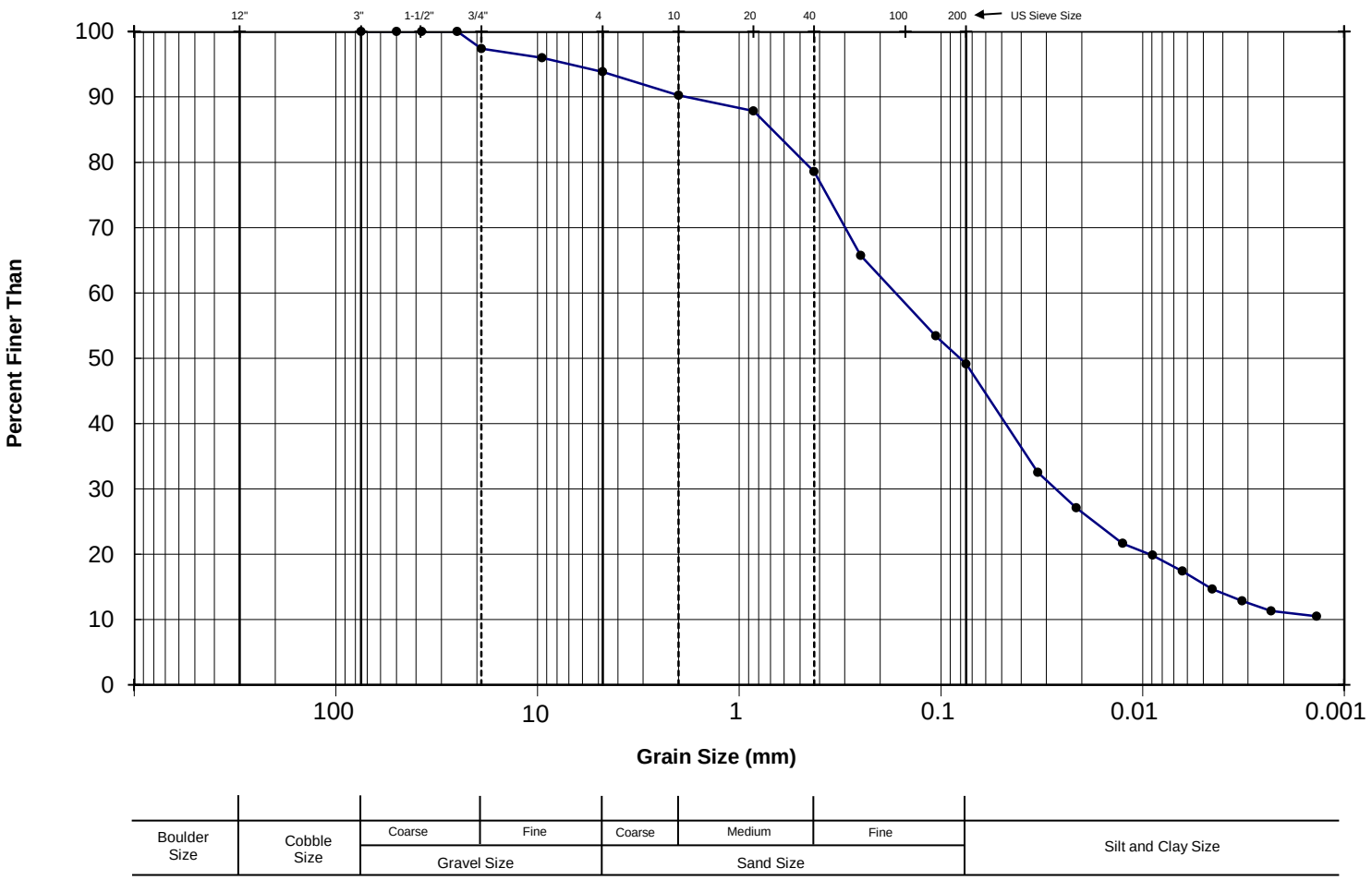
Comments:

Reviewed: _____

Project No.:	1413549.2000	Lab No.:	B508-22
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	CM02 TP-2	Sample No.:	GS-1
Depth:	0.00-0.10 m		
Date Tested:	12-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	97.4
9.5	96.0
4.75	93.8
2.0	90.2
0.850	87.8
0.425	78.5
0.250	65.7
0.106	53.4
0.075	49.1
0.033	32.5
0.021	27.1
0.013	21.6
0.009	19.8
0.006	17.4
0.005	14.7
0.003	12.9
0.002	11.3
0.001	10.5

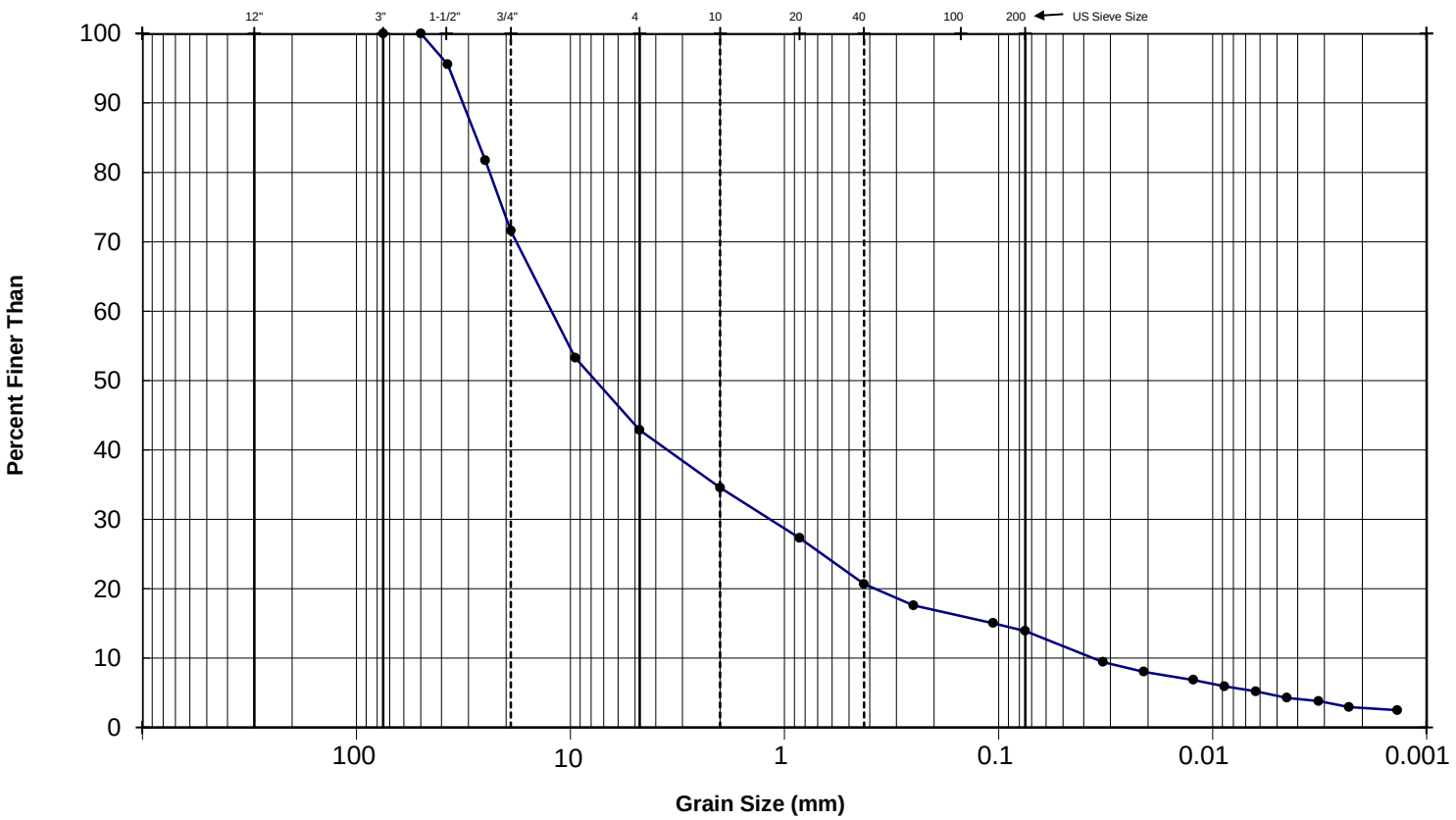
Comments:

Reviewed:

Project No.:	1413549.2000	Lab No.:	B508-23
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	CM02 TP-2	Sample No.:	GS-2
Depth:	0.50-0.60 m		
Date Tested:	17-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	95.6
25.0	81.7
19.0	71.6
9.5	53.3
4.75	42.9
2.0	34.6
0.850	27.3
0.425	20.7
0.250	17.6
0.106	15.0
0.075	13.9
0.032	9.4
0.021	8.0
0.012	6.9
0.009	5.9
0.006	5.2
0.004	4.3
0.003	3.8
0.002	2.9
0.001	2.5

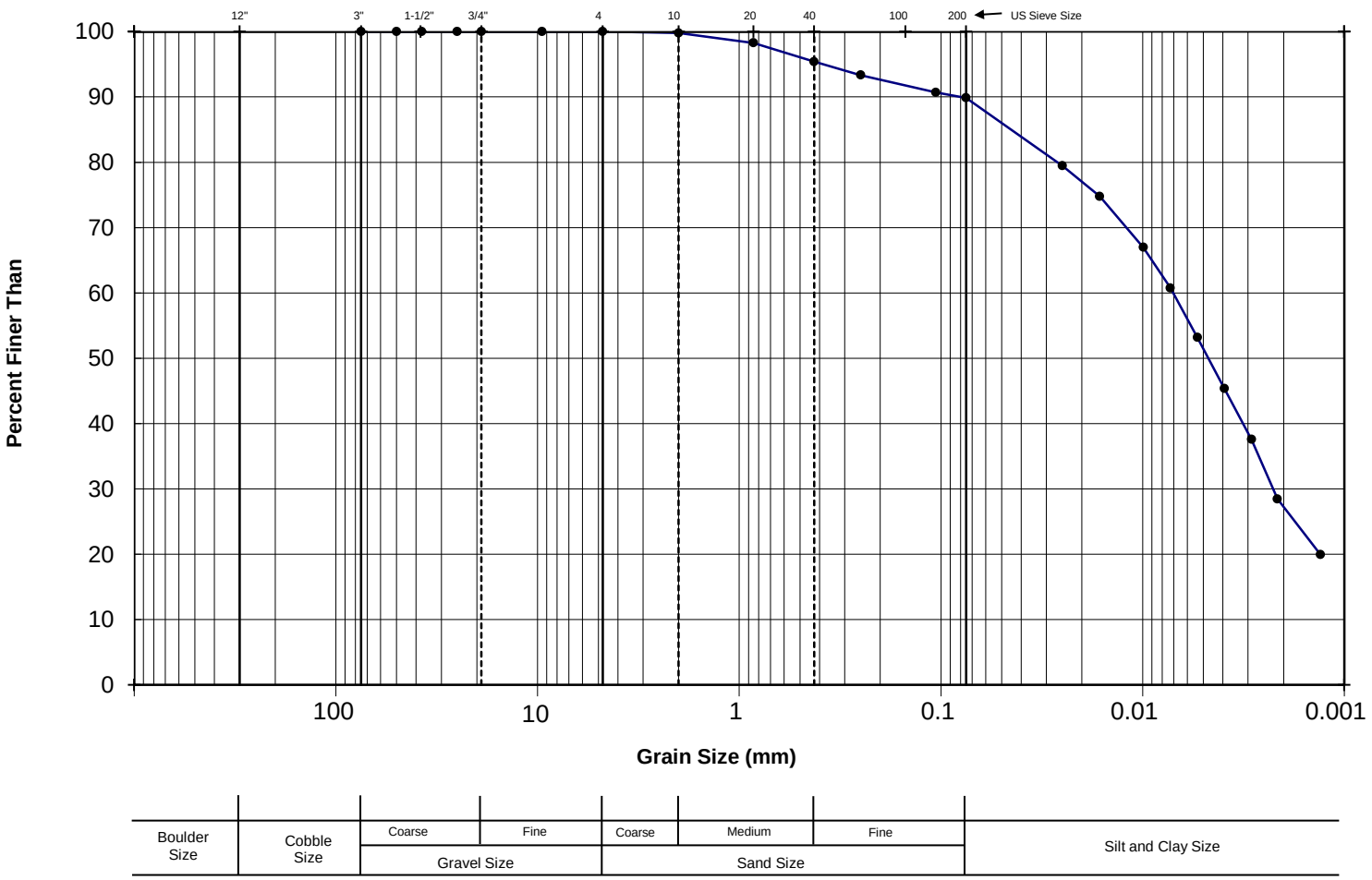
Comments:

Reviewed:

Project No.:	1413549.2000	Lab No.:	B508-24
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	CM02 TP-2	Sample No.:	GS-3
Depth:	1.20-1.40 m		
Date Tested:	17-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.8
0.850	98.3
0.425	95.4
0.250	93.3
0.106	90.7
0.075	89.9
0.025	79.5
0.016	74.8
0.010	67.0
0.007	60.7
0.005	53.2
0.004	45.4
0.003	37.6
0.002	28.5
0.001	19.9

Comments:

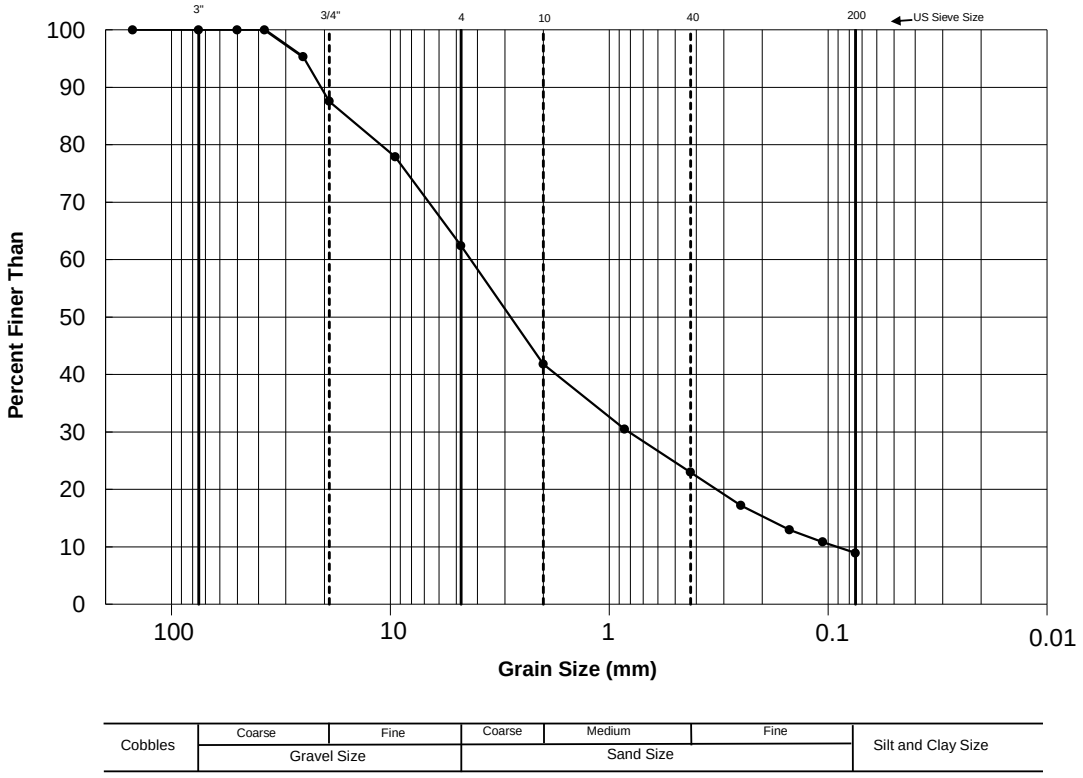
Reviewed:

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1413549	Phase:	2000		Date:	17-Jun-15
Short Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech T					
Sub Sampled By:	CG	Washed By:	DS		Sieved By:	CL
Field Tag No.:	-	Location:	-		BH or TP No.:	CM02 TP-2
Lab No.:	B508-25	Northing:	-	m	Sample No.:	GS-5
Sampled By:	-	Easting:	-	m	Depth From:	2.10 m
Sample Date:	-	Elevation:	-	m	Depth To:	2.30 m

Test Method:	A	Drying Method:	Oven	
Composite Sieve:	Yes	if Yes, Split on:	4.75	mm
Material Exluded from Sieve:	Yes	Describe:	1 pc retaining 50 mm sieve (432.50 g)	
Prior Testing on Sample:	No	Describe:		



Sieve Size (mm)	Passing %
150	100
75	100
50	100
37.5	100
25	95
19	88
9.5	78
4.75	62
2	42
0.85	30
0.425	23
0.25	17
0.15	13
0.106	11
0.075	9

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
8.5	0	38	54	9	4.4	0.8	0.1	47.7	1.6

Sample Description:

(SW-SM) fine to coarse SAND and fine to coarse sub-angular GRAVEL; brown; non-cohesive, moist

USCS Classification: SW-SM

Remarks:

Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

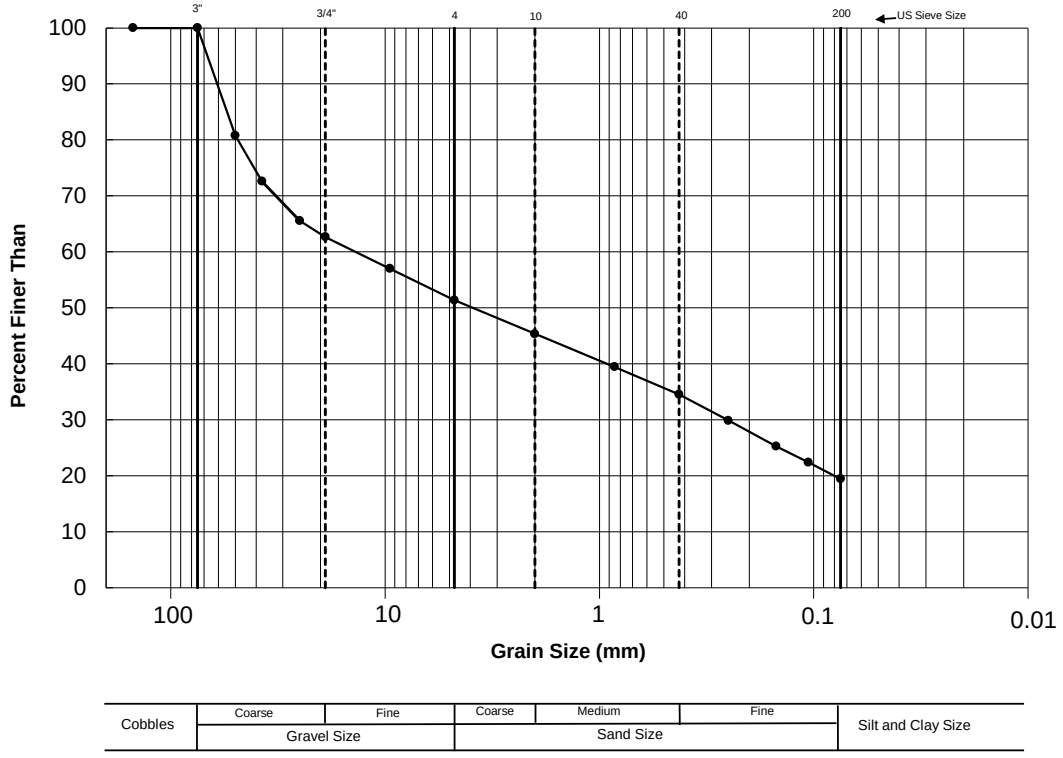
Reviewed by: _____

Particle Size Distribution of Soils using Sieve Analysis

(ASTM D6913-04)

Project No.:	1413549	Phase:	2000		Date:	17-Jun-15
Short Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech T					
Sub Sampled By:	CG	Washed By:	CG		Sieved By:	CL
Field Tag No.:	-	Location:	-		BH or TP No.:	CM02 TP-2
Lab No.:	B508-26	Northing:	-	m	Sample No.:	GS-6
Sampled By:	-	Easting:	-	m	Depth From:	3.60 m
Sample Date:	-	Elevation:	-	m	Depth To:	3.80 m

Test Method:	A	Drying Method:	Oven	
Composite Sieve:	Yes	if Yes, Split on:	4.75	mm
Material Exluded from Sieve:	No	Describe:		
Prior Testing on Sample:	No	Describe:		



Sieve Size (mm)	Passing %
150	100
75	100
50	81
37.5	73
25	66
19	63
9.5	57
4.75	51
2	45
0.85	39
0.425	35
0.25	30
0.15	25
0.106	22
0.075	19

Received Water Content (%)	Cobbles (%)	Gravel (%)	Sand (%)	Fines (%)	D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc
9.3	0	49	32	19	14.6	0.3	N/A	N/A	N/A

Sample Description: (SM) SILTY SAND, fine to coarse sand, fine to coarse gravel; brown; cohesive, w > PL

USCS Classification: SM

Remarks:

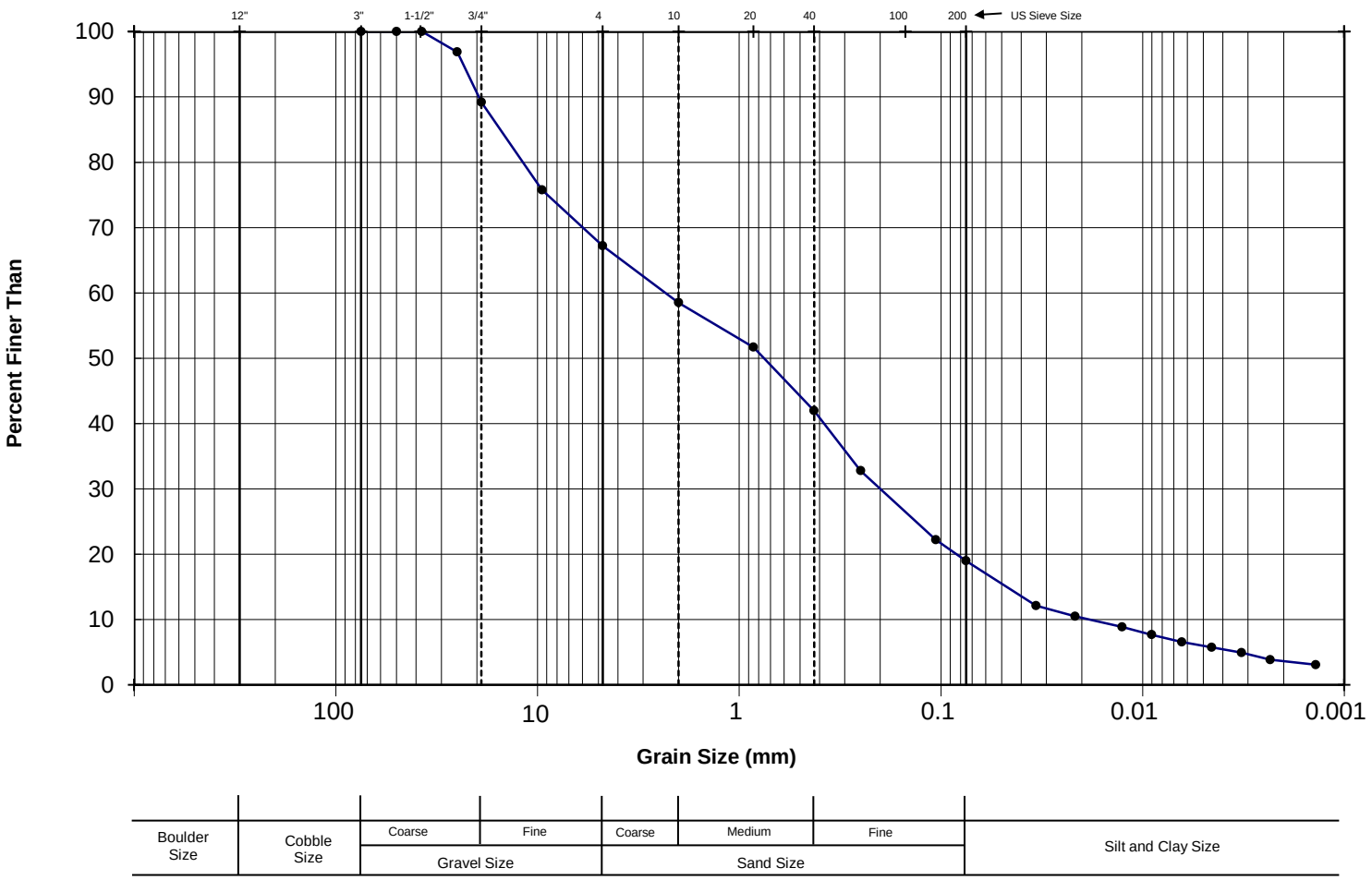
Bay 8, 820 - 28 St. NE
Calgary, AB T2A 6K1

Reviewed by: _____

Project No.:	1413549.2000	Lab No.:	B508-28
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	CM02 TP-3	Sample No.:	GS-1
Depth:	0.20-0.30 m		
Date Tested:	17-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	96.9
19.0	89.2
9.5	75.8
4.75	67.2
2.0	58.5
0.850	51.7
0.425	41.9
0.250	32.8
0.106	22.2
0.075	19.0
0.034	12.1
0.022	10.5
0.013	8.9
0.009	7.7
0.006	6.6
0.005	5.8
0.003	4.9
0.002	3.8
0.001	3.1

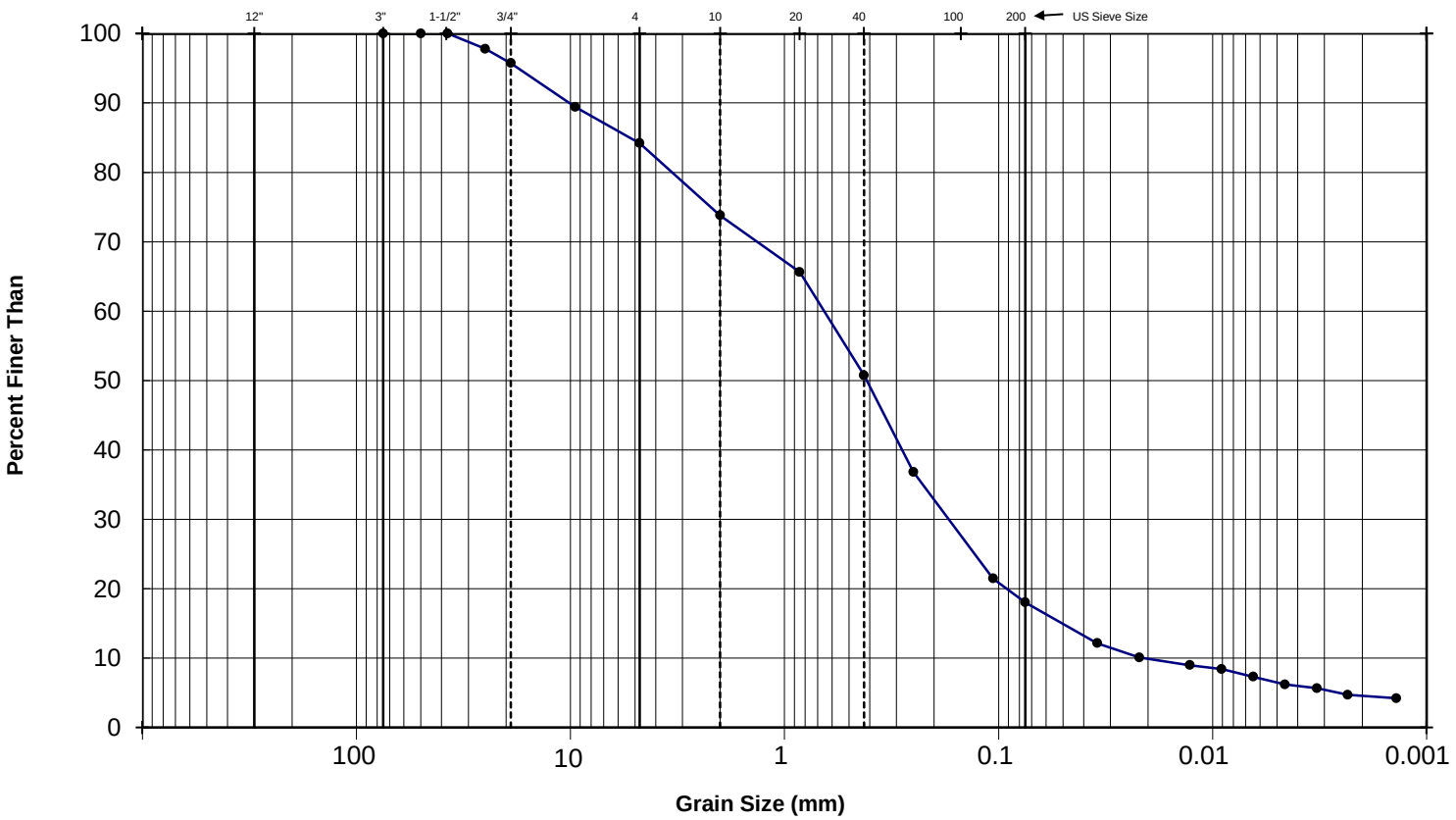
Comments:

Reviewed: _____

Project No.:	1413549.2000	Lab No.:	B508-29
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	CM02 TP-3	Sample No.:	GS-2
Depth:	2.30-2.40 m		
Date Tested:	17-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	97.8
19.0	95.7
9.5	89.4
4.75	84.2
2.0	73.8
0.850	65.6
0.425	50.7
0.250	36.8
0.106	21.5
0.075	18.0
0.035	12.1
0.022	10.1
0.013	9.0
0.009	8.4
0.006	7.3
0.005	6.2
0.003	5.6
0.002	4.7
0.001	4.2

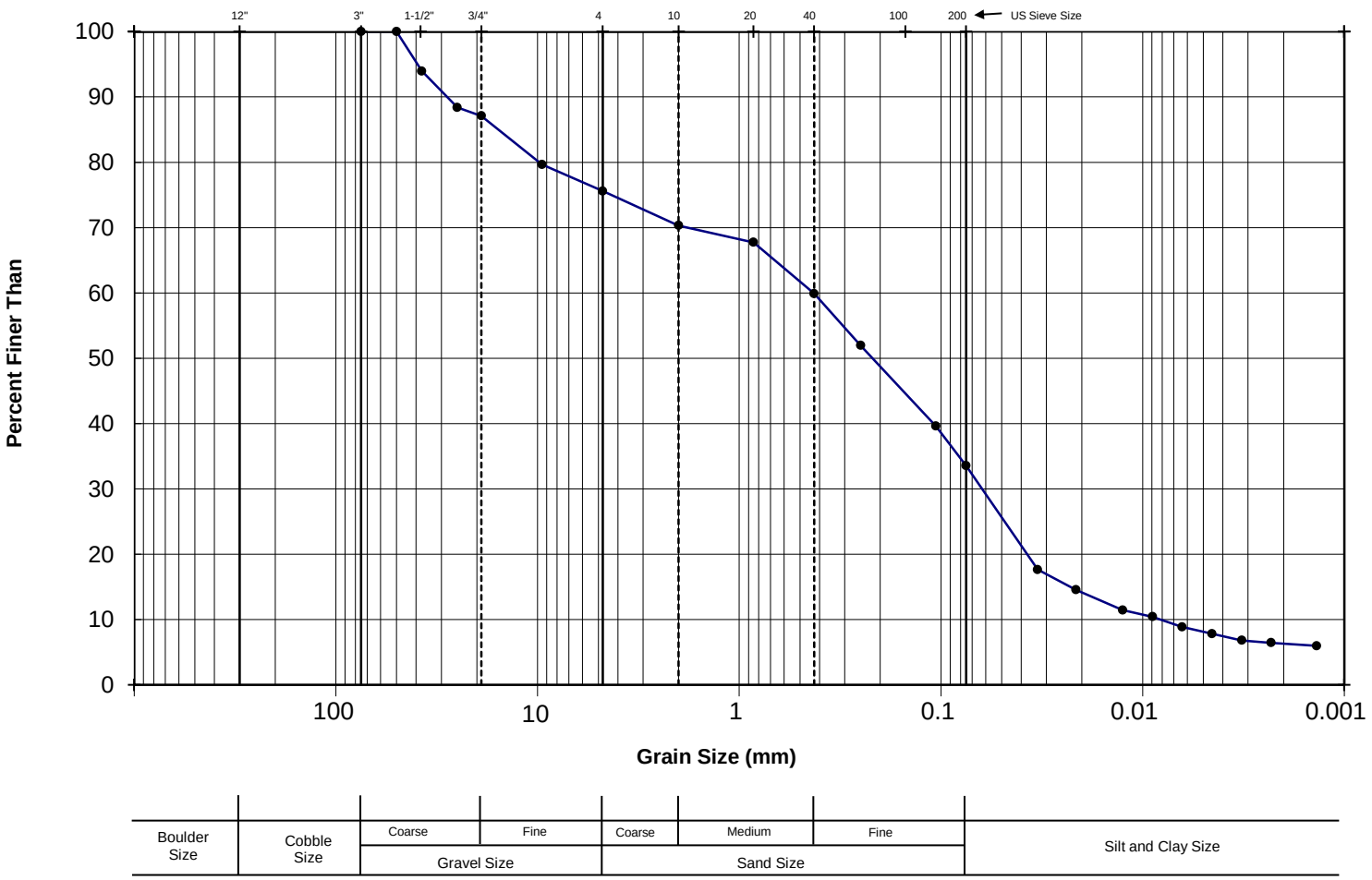
Comments:

Reviewed: _____

Project No.:	1413549.2000	Lab No.:	B508-30
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	CM02 TP-3	Sample No.:	GS-3
Depth:	5.00-5.20 m		
Date Tested:	17-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	93.9
25.0	88.4
19.0	87.1
9.5	79.7
4.75	75.6
2.0	70.3
0.850	67.7
0.425	59.9
0.250	51.9
0.106	39.6
0.075	33.5
0.033	17.7
0.021	14.6
0.013	11.5
0.009	10.4
0.006	8.9
0.005	7.8
0.003	6.8
0.002	6.4
0.001	6.0

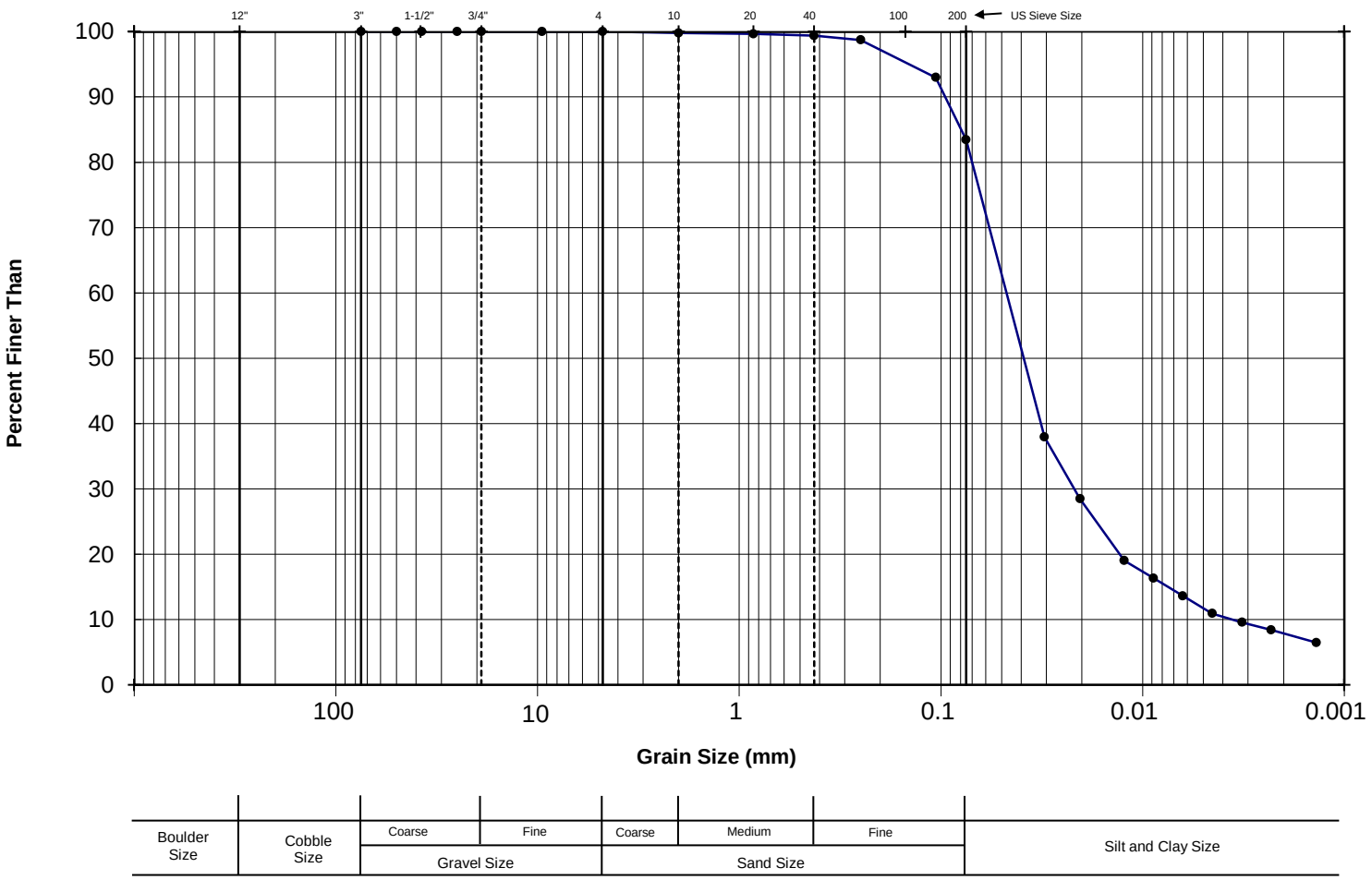
Comments:

Reviewed: _____

Project No.:	1413549.2000	Lab No.:	B508-31
Project Title:	NORWEST/LAB TESTING/CGY-CM02 Teck Geotech Testing		
Borehole:	CM02 TP-3	Sample No.:	GS-4
Depth:	5.20-5.40 m		
Date Tested:	17-Jun-15	By:	CG

Particle Size Analysis of Soil

(ASTM D422)



Diameter of Sieve (mm)	Percent Passing (%)
75.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
9.5	100.0
4.75	100.0
2.0	99.8
0.850	99.6
0.425	99.4
0.250	98.7
0.106	93.0
0.075	83.4
0.031	37.9
0.020	28.5
0.012	19.0
0.009	16.3
0.006	13.6
0.005	10.9
0.003	9.6
0.002	8.4
0.001	6.5

Comments:

Reviewed: _____

September 17, 2015

TECK COAL LIMITED
COAL MOUNTAIN OPERATIONS PHASE 2

Waste Rock Dumps Additional Geotechnical Field Investigations

Submitted to:
Teck Coal Limited
Sparwood Operations
PO Box 3000
Sparwood, BC
V0B 2G0

Attention:
Dr. Ray Yost, P.Eng. and Mr. Jeff Colden, M.Eng., P.Eng.

REPORT

Reference Number: 1527423-2015-122-R-Rev0-4000

Distribution:

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1.0 INTRODUCTION

This report presents the results of an additional geotechnical field investigation carried out by Golder Associates Ltd. (Golder) at the Teck Coal Limited (Teck Coal) Coal Mountain Operations Phase 2 (CMO2) site from July 13 to 16, 2015. The purpose of the field investigation was to collect geotechnical data for two additional major waste rock dump areas proposed in the updated mine plan by Teck Coal, namely the Snowslide Valley Dump and the East Wheeler Dump. This report should be read as an addendum to the Golder report titled *Teck Coal Marten Wheeler Project Spoils Stability Assessment* (Golder 2013).

This report presents and summarizes the data collected during the 2015 test pit investigation and site reconnaissance in the CMO2 project area, and includes:

- a brief description of the CMO2 project;
- a summary of methods used in the 2015 field investigation;
- a summary of samples collected for laboratory testing;
- results of the field investigation and laboratory testing program; and
- a summary of subsurface conditions encountered.

This report should be read in conjunction with the "***Study Limitations***" which is included at the beginning of the report. The reader's attention is specifically drawn to this information, as it is essential that it be followed for the proper use and interpretation of this report.

2.0 BACKGROUND

2.1 Location

The location of the CMO2 site is shown in Figure 1. The CMO2 site is located approximately 20 km south of Sparwood, BC, in the Regional District of East Kootenay and the project area comprises portions of Little Wheeler Creek, Wheeler Creek, Snowslide Creek, and Carbon Creek. The CMO2 project area encompasses an area of approximately 3,800 hectares. The project area has been the subject of coal exploration since the 1960s. The property includes approximately 35 km of access roads, some of which were used during the 2015 geotechnical investigations.

2.2 Coal Mountain Operations Phase 2 Project Description

CMO2 would include the creation of a new mining area located west of the Corbin Road (Teck Coal 2014). Mining is planned to take place along the Wheeler and Marten ridges and on the east side of Hosmer Ridge, resulting in three open pits, namely the Wheeler, Marten, and Marten Ridge Pits.

The waste rock is planned to be placed in waste rock dumps located within the CMO2 project area. These include the dumps located in the Wheeler, Little Wheeler, and Snowslide drainages, as well as in-pit waste dumps. The Little Wheeler Creek Valley and Wheeler Creek Valley waste dumps were assessed in Golder's 2013 pre-feasibility spoil assessment (Golder 2013). The updated mine plan includes a larger Wheeler Creek Valley waste dump and two additional major waste rock dump areas, the Snowslide Valley and the East Wheeler waste dumps.

Test pit locations, along with the CMO2 site topography, are presented in Figure 2.

3.0 GEOTECHNICAL SITE INVESTIGATION

Golder personnel were on site between July 13 and July 16, 2015, to collect data to support geotechnical assessments for the proposed CMO2 Snowslide Valley and East Wheeler waste rock dumps. The geotechnical test pit investigation program was carried out to identify foundation soil types, depth to bedrock, bedrock characteristics, and groundwater conditions to support the waste rock dump geotechnical assessment recommended in Golder's geotechnical gap analysis (Golder 2015a).

Due to limited physical site access during the July field program, proposed pits G, H, and I (Golder 2015b) could not be excavated during the July 2015 field program. Hand dug test pits with sample collection at these locations were carried out by Teck Coal's Andrew Bidwell, P.Eng., on August 17, 2015.

An overview of the CMO2 project area showing the locations of test pits, surface site reconnaissance, and hand test pits are shown in Figure 3 along with the CMO2 mine plan at year 2054.

3.1 Test Pit Investigation

Twenty-one test pits were excavated during the geotechnical site investigation. The test pit locations were selected to expose shallow foundation materials, collect representative bulk samples for laboratory testing, and observe shallow groundwater conditions.

Test pits were excavated using a CAT 345C equipped with a saw toothed bucket supplied by Teck Coal. The excavated depths of the pits ranged from 1.1 to 5.7 m depending on the reach of the excavator and depth to bedrock within each pit.

Golder personnel prepared a field record of the subsurface conditions and collected representative samples for further examination and laboratory testing. Table 1 presents a summary of the test pit locations, depths of the test pits below ground surface, and the approximate depths to bedrock from ground surface.

Table 1: Summary of Test Pit Locations

Area Investigated	Test Pit ID	UTM[a]		Ground Elevation[a] (Z, in m)	Total Depth Excavated (m)	Approximate Depth to Bedrock[b] from Ground Surface (m)
		Easting (X, in m)	Northing (Y, in m)			
Wheeler Valley	TP15-01	656,348.0	5,497,910.0	1,454.0	2.5	bedrock not encountered
	TP15-02	656,616.0	5,497,703.0	1,461.0	5.5	bedrock not encountered
	TP15-03	656,851.0	5,497,382.0	1,449.0	5.5	bedrock not encountered
	TP15-04	657,084.0	5,497,027.0	1,449.0	5.5	bedrock not encountered
	TP15-05	657,420.0	5,496,843.0	1,449.0	3.0	2.8
	TP15-05A	657,419.0	5,496,846.0	1,444.0	5.5	bedrock not encountered
	TP15-06	657,859.0	5,496,674.0	1,401.0	5.5	bedrock not encountered
	TP15-07	658,186.0	5,496,684.0	1,396.0	4.8	bedrock not encountered

Area Investigated	Test Pit ID	UTM[a]		Ground Elevation[a] (Z, in m)	Total Depth Excavated (m)	Approximate Depth to Bedrock[b] from Ground Surface (m)
		Easting (X, in m)	Northing (Y, in m)			
Snowslide Creek	TP15-08	656,387.0	5,494,923.0	1,885.0	3.2	0.0
	TP15-09	656,105.0	5,494,754.0	1,864.0	1.1	0.0
	TP15-10	655,661.0	5,494,639.0	1,832.0	5.5	bedrock not encountered
	TP15-11	655,803.0	5,494,227.0	1,764.0	4.1	bedrock not encountered
	TP15-12	656,189.0	5,494,202.0	1,726.0	5.7	bedrock not encountered
	TP15-13	656,482.0	5,494,223.0	1,709.0	5.2	3.5
	TP15-14	656,828.0	5,494,229.0	1,674.0	5.5	bedrock not encountered
	TP15-15	657,053.0	5,494,230.0	1,674.0	5.6	bedrock not encountered
	TP15-16	657,270.0	5,494,344.0	1,651.0	1.8	0.0
Access Road	TP15-B	655,642.0	5,496,432.0	1,842.0	5.2	0.0
	TP15-C	655,758.0	5,497,877.0	1,529.0	2.2	0.7
	TP15-D	655,024.0	5,494,961.0	1,811.0	3.1	0.0
	TP15-E	658,460.0	5,496,497.0	1,440.0	4.5	bedrock not encountered

a) Test pit locations and elevations were recorded from a GPS unit in the field by Golder personnel.

b) Approximate depth to weathered or fractured bedrock.

The Records of Test Pit are presented in Appendix A.

3.2 Surface Site Reconnaissance

Surface site reconnaissance was carried out between July 14 and July 16, 2015, during the test pit program. Three sites along Wheeler Valley, three sites along Snowslide Creek, and one site along the proposed access road were inspected.

The surface site reconnaissance involved the observation of exposed road cuts and rock outcrops. The approximate locations of the site reconnaissance data collection are presented in Figure 2.

A summary of the site reconnaissance locations and the observed ground conditions is presented in Table 2.

Table 2: Summary of Site Reconnaissance Locations and Observed Ground Conditions

Area Investigated	Site Reconnaissance Location	UTM[a]		Ground Elevation (m)[a]	Observed Ground Conditions[b]
		Easting (m)	Northing (m)		
Access Road	Site 1	655,723	5,497,877	1,531	Road cut: slightly weathered sandstone, 0.1 m veneer of vegetated top soil.
Little Wheeler and Wheeler Valley	Site 2	654,096	5,497,255	1,767	Road cut: sandstone with ravel material along road, thin veneer of vegetated top soil.
	Site 3 (near TP-A)	655,006	5,497,050	1,728	Road cut: moderately weathered sandstone, thin veneer of vegetated top soil.
	Site 4	655,764	5,496,586	1,845	Road cut: vertically interbedded sandstone and mudstone, folds and fossils visible, 0.1 m veneer of vegetated top soil.
Snowslide Creek	Site 5	656,660	5,495,391	1,916	Road cut: moderately weathered sandstone.
	Site 6	655,420	5,494,274	1,806	Road cut: interbedded sandstone and coal, 0.1 to 2 m vegetated top soil and scree.
	Site 7	657,615	5,494,212	1,613	Road cut: slightly weathered sandstone, massive, 0.1 to 1 m vegetated top soil.

a) Site reconnaissance locations and elevations determined via GPS in the field by Golder personnel.

b) Observed ground conditions are only representative of the exposed materials on road cuts and may differ from actual ground conditions.

3.3 Additional Hand Samples Collected by Teck Coal

Three additional hand samples were collected by Teck Coal's Andrew Bidwell, P. Eng., on August 17, 2015, along the proposed access road. These samples were collected due to site inaccessibility at the time of test pitting in July. The approximate locations of the hand samples are shown in Figure 2. A summary of the hand samples collected by Teck Coal is presented in Table 3.

Table 3: Summary of Hand Samples

Area Investigated	Test Pit No.	UTM[a]		Ground Elevation[a] (Z, in m)	Total Depth Excavated (m)	Approximate Depth to Bedrock from Ground Surface (m)
		Easting (X, in m)	Northing (Y, in m)			
Access Road	TP-F	657,748	5,496,542	1,460	0.6	bedrock not encountered
	TP-G	657,056	5,496,558	1,494	0.6	bedrock not encountered
	TP-H	656,696	5,496,925	1,550	0.6	bedrock not encountered

a) Hand sample locations and elevations were located via a GPS unit in the field by Teck Coal personnel in the approximate area of Golder's proposed locations (Golder 2015b).

3.4 Laboratory Analysis

A laboratory testing program was carried out to characterize the soils and weathered bedrock. Samples were collected from 14 pits from a range of depths within each pit. Three hand samples were also collected by Teck Coal. The samples were transported to Golder's Calgary geotechnical laboratory, where testing was carried out on selected soil samples in accordance with relevant ASTM standards. A summary of the laboratory tests and relevant test standards as carried out is provided in Table 4

Table 4: Summary of Laboratory Testing

Test	Relevant Test Standard	Quantity	Test Description
Natural water content	ASTM D2216	30	Index testing is used to identify key soil parameters used to classify soils and further understand their behaviour and characteristics.
Particle size analysis	ASTM D6913	17	
Atterberg limits	ASTM D4318	11	
Standard Proctor maximum dry density	ASTM D698	2	Maximum dry density and optimal water content, required for direct shear calibration.
Large direct shear	ASTM D3080	1	Consolidated drained shear strength.

A summary of the samples and the corresponding laboratory tests is presented in Table 5.

Table 5: Summary of Laboratory Testing Program

Area Investigated	Test Pit / Site Reconnaissance Location	Sample ID	Stratum Depth (m)		Natural Water Content	Atterberg Limits	Sieve	Proctor	Samples Combined for Large Direct Shear
			From	To					
Wheeler Valley	TP15-01	GS01	0.2	0.4	1		1		
	TP15-01	GS03	1.7	1.9	1				
	TP15-02	GS01	0.4	0.8	1				
	TP15-02	GS02	3.0	3.2	1		1		
	TP15-03	GS02	3.5	3.7	1		1		
	TP15-04	GS02	1.1	1.3	1		1		
	TP15-04	GS04	2.8	3.0	1				
	TP15-05	GS01	0.7	0.9	1	1	1		
	TP15-05	GS02	1.8	2.0	1		1		
	TP15-06	GS01	0.3	0.4	1	1	1		
	TP15-06	GS02	1.2	1.4	1				
	TP15-06	GS03	2.3	2.5	1	1	1		
	TP15-07	GS01	0.5	0.6	1				
	TP15-07	GS02	1.2	1.4	1	1	1		
	TP15-07	GS04	3.5	4.0	1				

Area Investigated	Test Pit / Site Reconnaissance Location	Sample ID	Stratum Depth (m)		Natural Water Content	Atterberg Limits	Sieve	Proctor	Samples Combined for Large Direct Shear
			From	To					
Snowslide Creek	TP15-10	GS02	3.0	3.2	1	1	1	1(h)	1(i)
	TP15-10	GS03	4.5	4.7	1			1(h)	1(i)
	TP15-11	GS02	3.0	4.0	1		1	1(h)	1(i)
	TP15-12	GS01	0.8	1.2	1		1		
	TP15-13	GS01	0.5	1.0	1	1(a)	1(d)	1(h)	1(i)
	TP15-13	GS02	1.6	1.8	1	1(a)	1(d)	1(h)	1(i)
	TP15-14	GS01	0.8	1.2	1		1(e)		
	TP15-14	GS02	1.8	2.2	1		1(e)		
	TP15-14	GS03	4.0	4.5				1(h)	1(i)
	TP15-15	GS01	0.5	1.0	1	1(b)	1(f)	1(h)	1(i)
	TP15-15	GS02	2.5	2.7	1	1(b)	1(f)	1(h)	1(i)
	TP15-15	GS03	4.5	4.9				1(h)	1(i)
Access Road	TP15-C	GS01	0.4	0.7				1(h)	1(i)
	TP15-E	GS01	0.5	1.0	1	1(c)	1(g)	1(h)	1(i)
	TP15-E	GS02	2.0	2.5	1	1(c)	1(g)	1(h)	1(i)
	TP15-E	GS03	4.0	4.5				1(h)	1(i)
	GHP-F	GS1	0.1	0.6	1	1			
	GHP-G	GS1	0.1	0.6	1	1			
	GHP-H	GS1	0.1	0.6	1	1			

Note: (a), (b), (c), (d), (e), (f), (g), (h), and (i) denote samples that were combined into a composite sample for a single test.

Sample materials collected during the field investigation were combined into a composite sample with an adequate volume to allow for laboratory testing. The composite samples are shown above in Table 5 and the results of the testing are summarized in Section 3.5.

3.5 Laboratory Test Results

3.5.1 Index Testing

Index testing for the 2015 field program included Atterberg limits and particle size analysis testing. Natural water content testing was also carried out; the results of those tests are presented together with a discussion observed groundwater conditions in Section 3.6.

3.5.1.1 Atterberg Limits Testing

Atterberg limits tests were performed on 11 samples in accordance with ASTM D4318 *Standard Test Method of Liquid Limit, Plastic Limit and Plasticity* (ASTM 2010b). Detailed results are presented in Appendix B and a summary is presented in Table 6.

Table 6: Summary of Atterberg Limits

Test Pit ID	Sample No.	Sample Depth (m)		Atterberg Limit Test Results			Natural Water Content (%)
		From	To	Liquid Limit	Plastic Limit	Plasticity Index	
TP15-05	GS01	0.7	0.9	28	20	8	12.5
TP15-06	GS01	0.3	0.4	35	15	20	11.4
TP15-06	GS03	2.3	2.5	39	16	23	14.8
TP15-07	GS02	1.2	1.4	35	17	18	15.4
TP15-10	GS02	3.0	3.2	24	15	9	11.0
TP15-13	GS01	0.5	1.0	30	20	10	11.3
TP15-15	GS01	0.5	1.0	33	18	15	13.3
TP15-E	GS01	0.5	1.0	25	16	9	12.1
G-TP-F	GS1	0.1	0.6	36	21	15	9.4
G-TP-G	GS1	0.1	0.5	45	24	21	13.0
G-TP-H	GS1	0.1	0.6	30	20	10	6.2

A summary plot of liquid limit versus plasticity index is presented in Chart 1. The fine fraction of samples selected for Atterberg limits testing plot near or above the A line (the solid black line running from the lower left to the upper right in the Chart 1) with a range of liquid limits of 24% to 45%.

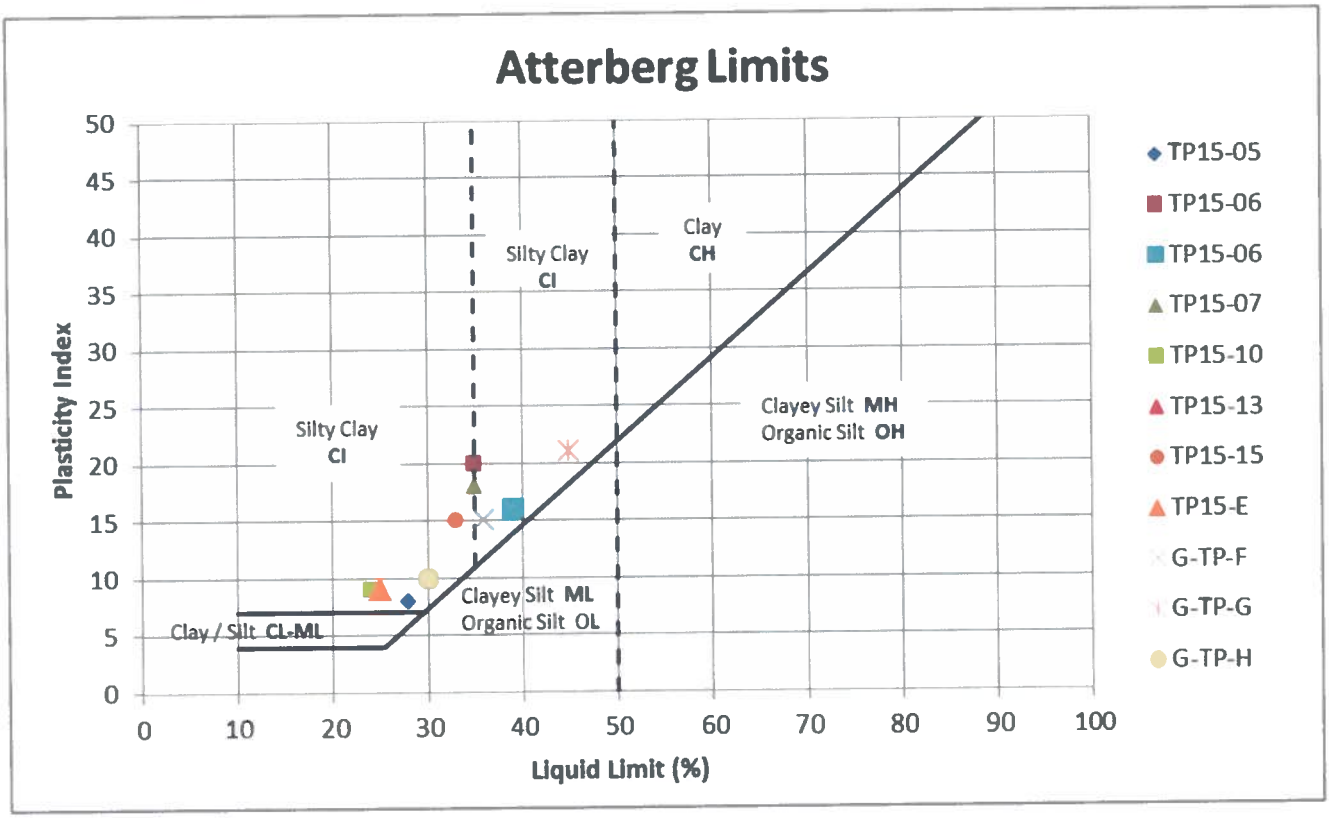


Chart 1: Atterberg Limits of Selected Samples from the July 2015 Coal Mountain Operations Phase 2 Geotechnical Program

Detailed laboratory results are provided in Appendix B.

3.5.1.2 *Particle Size Analysis Testing*

Particle size analysis testing was performed on 16 samples and conducted using ASTM D6913 *Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis* (ASTM 2009). The test was conducted on 16 samples with particle sizes greater than the #200 sieve (0.075 mm). Particles were separated into gravel, sand, and fines; silt and clay sized particles were reported together as fines. Cobble- and boulder-sized particles were not included in the samples during test pit sampling. Estimates of cobble and boulder content are shown on the Records of Test Pit presented in Appendix A. The results of the particle size distribution determination are summarized in Table 7.

Table 7: Summary of Particle Size Distribution

Test Pit ID	Sample No.	Soil Classification[a]	Sample Depth (m)		Sieve			Natural Water Content (%)
			From	To	Gravel (%)	Sand (%)	Fines (%)	
TP15-01	GS01	sandy CLAYEY GRAVEL	0.2	0.4	62	27	11	7.8
TP15-02	GS02	sandy GRAVEL	3.0	3.2	67	26	8	11.1
TP15-03	GS02	SILTY GRAVEL and SAND	3.5	3.7	42	41	16	15.0
TP15-04	GS02	SILTY SAND	1.1	1.3	5	69	26	17.1
TP15-05	GS01	sandy CLAYEY GRAVEL	0.7	0.9	42	24	34	12.5
TP15-05	GS02	sandy CLAYEY GRAVEL	1.8	2.0	42	34	24	11.5
TP15-06	GS01	sandy CLAYEY GRAVEL	0.3	0.4	40	26	34	11.4
TP15-06	GS03	sandy CLAYEY GRAVEL	2.3	2.5	40	30	30	14.8
TP15-07	GS02	gravelly CLAYEY SAND and SILTY CLAY	1.2	1.4	23	34	44	15.4
TP15-10	GS02, GS03	gravelly CLAYEY SAND	3.0	4.7	30	37	33	11.0
TP15-11	GS02	gravelly CLAYEY SAND	3.0	4.0	32	36	32	14.4
TP15-12	GS01	sandy GRAVEL and SAND	0.8	1.2	51	40	8	13.8
TP15-13	GS01, GS02	sandy CLAYEY GRAVEL	0.5	1.8	56	24	20	10.0
TP15-14	GS01, GS02	sandy SILTY GRAVEL	0.8	2.2	54	30	16	10.2
TP15-15	GS01, GS02	sandy CLAYEY GRAVEL	0.5	2.7	33	22	45	12.6
TP15-E	GS01, GS02	sandy CLAYEY GRAVEL	0.5	2.5	38	29	33	12.5

a) Detailed soil classifications are presented in Records of Test Pit in Appendix A.

The particle size distribution range for the CMO2 geotechnical program samples is presented in Chart 2.

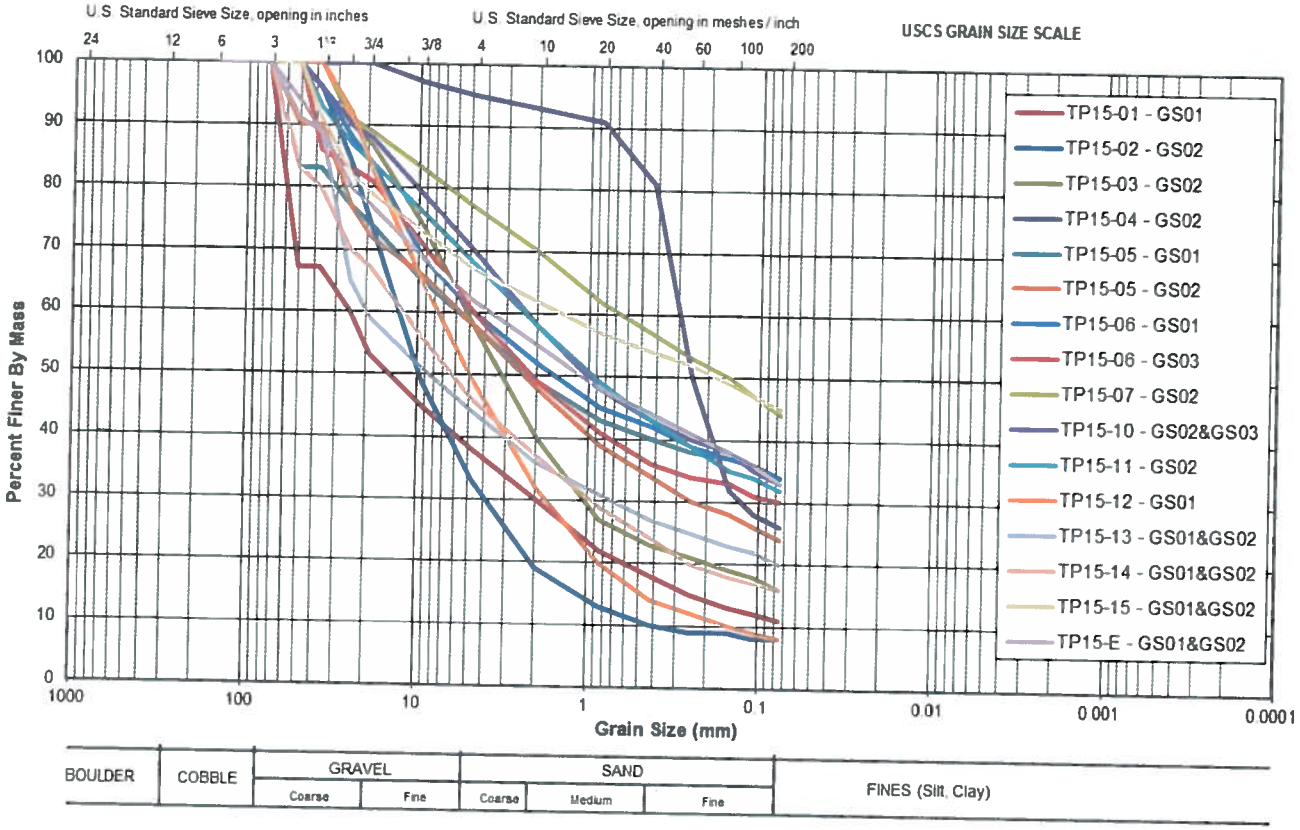


Chart 2: Summary of Particle Size Distribution of Selected Samples from the July 2015 Coal Mountain Operations Phase 2 Geotechnical Program

Detailed laboratory results for the grain size analyses (sieves) are provided in Appendix B.

3.5.2 Standard Proctor Maximum Dry Density Testing

One Standard Proctor Maximum Dry Density (SPMDD) test was performed in accordance with ASTM D698 *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort* (ASTM 2012). The purpose of the SPMDD test was to determine a target density of composite soil sample selected for direct shear strength testing, which will be discussed in the following section. Detailed results are presented in Appendix B, and are summarized in Section 3.5.2.

Table 8: Standard Proctor Results

Test Pit ID	Sample No.	Sample Depth (m)		Maximum Dry Density (kg/m^3)	Optimum Water Content (%)
		From	To		
TP15-10	GS02	3.0	3.2	2,025	10.6
TP15-10	GS03	4.5	4.7		
TP15-11	GS02	3.0	4.0		
TP15-13	GS01	0.5	1.0		
TP15-13	GS02	1.6	1.8		
TP15-14	GS03	4.0	4.5		
TP15-15	GS01	0.5	1.0		
TP15-15	GS02	2.5	2.7		
TP15-15	GS03	4.5	4.9		
TP15-C	GS01	0.4	0.7		
TP15-E	GS01	0.5	1.0		
TP15-E	GS02	2.0	2.5		
TP15-E	GS03	4.0	4.5		

3.5.3 Direct Shear Strength Testing

One large direct shear test was completed on a composite specimen with samples from Test Pits TP15-10, 11, 13, 14, 15, C, and E (as shown in Table 5). A particle size analysis test was carried out on the composite sample. A compaction process was used to set the sample in the testing box based on the SPMDD test performed prior to the direct shear test (Section 3.5.2).

3.5.3.1 Particle Size Analysis Testing of Direct Shear Composite Sample

Particle size analysis testing was performed on the composite direct shear sample and conducted using ASTM D6913 *Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis* (ASTM 2009). The test was conducted on particle sizes greater than the #200 sieve (0.075 mm). Particles were separated into gravel, sand, and fines; silt and clay sized particles were reported together as fines. Oversized aggregate greater than 25 mm was removed from the test material and not included in the testing procedure.

Chart 3 shows the particle size distribution range for composite direct shear sample from the CMO2 geotechnical program.

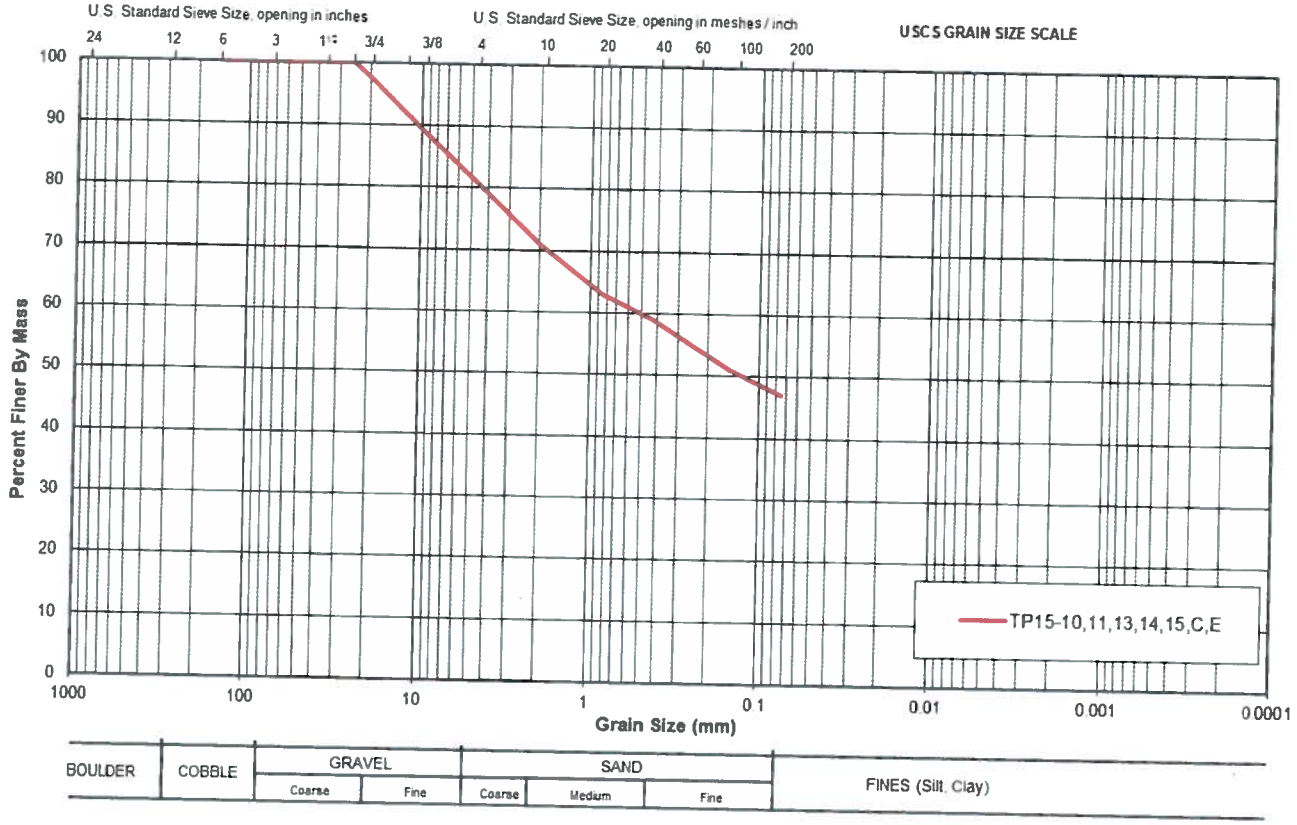


Chart 3: Summary of Particle Size Distribution of Selected Samples for Direct Shear Testing from the July 2015 Coal Mountain Operations Phase 2 Geotechnical Program

3.5.3.2 Compaction of Direct Shear Composite Sample

The reconstituted sample was compacted in six lifts to an initial density of approximately 2,050 kg/m^3 based on the results of the SPMDD test (Section 3.5.2). The density was selected based on the estimated in-situ conditions. An optimum water content of 8.5% ±2% was maintained while compacting the lifts in the direct shear box.

3.5.3.3 Summary of Direct Shear Strength Testing on Composite Sample

A direct shear test was conducted according to the ASTM D3080-04 *Standard Test Method for Direct Shear Test of Soils under Consolidated Drained Conditions* (ASTM 2004). The shear box used for the test was approximately 151 mm by 251 mm with a depth of 150 mm and a volume of approximately 5,681 cm^3. A summary of the results from the direct shear test is presented in Table 9.

Table 9: Direct Shear Testing Results

Test Pit ID	Sample No.	Sample Depth (m)		Soil Classification	Normal Stress (kPa)	Peak Shear Stress (kPa)	Peak Friction Angle (°)	Cohesion (kPa)
		From	To					
Composite sample, as presented in Tables 5 and 8.				Sandy CLAYEY GRAVEL	105	154	32	86
					252	242		
					515	411		

The peak shear strength friction angle has been interpreted in terms of the Mohr-Coulomb linear failure criteria based on best-fit interpolations of direct shear test results. A plot of normal stress versus shear stress for the composite sample from the 2015 test program is shown in Chart 4. The detailed direct shear laboratory test results are presented in Appendix B.

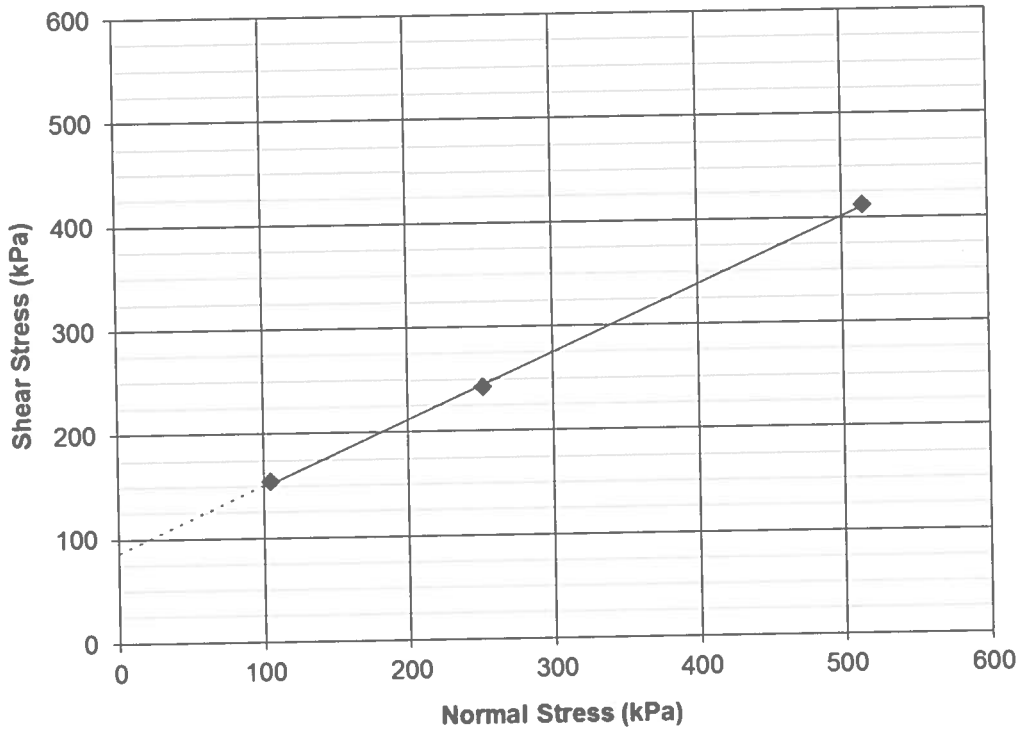


Chart 4: Direct Shear Test Results for Composite Sample from the July 2015 Coal Mountain Operations Phase 2 Geotechnical Program

The shear strength obtained from this investigation was compared to direct shear testing completed in 2013 at the site as well as other sites within the Elk Valley. The combined test results are presented in Figure 4. The results from the CMO2 site agree with other data from the area and plot above an overall average friction angle of 35°.

3.6 Groundwater Conditions

3.6.1 Water Table / Seepage Observations

The observed groundwater levels during the test pit inspection are summarized in Table 10.

Table 10: Summary of Groundwater Conditions

Area	Test Pit ID	Groundwater Level below Ground Surface (m)
Wheeler Valley	TP15-01	1.5
	TP15-02	dry
	TP15-03	5.0
	TP15-04	dry
	TP15-05	2.0
	TP15-05A	dry
	TP15-06	1.5
	TP15-07	0.6 (potential water from ditch)
Snowslide Creek	TP15-08	dry
	TP15-09	dry
	TP15-10	3.0
	TP15-11	dry
	TP15-12	dry
	TP15-13	dry
	TP15-14	dry
	TP15-15	0.5 (potential water from ditch)
	TP15-16	dry
Access Road	TP-15-B	dry
	TP-15-C	dry
	TP-15-D	1.0
	TP-15-E	1.0 (potential water from ditch)

3.6.2 Natural Water Content Testing

Natural water content testing was conducted on all test pit samples according to ASTM D2216-10 *Standard Test Method for Determination of Water (Moisture) Content of Soil and Rock by Mass* (ASTM 2010a). Water contents ranged from 6.2% to 17.1%. The laboratory testing results are summarized in Table 11; detailed index test results are presented in Appendix B and displayed in Chart 5.

Table 11: Summary of Natural Water Content

Test Pit ID	Sample ID	Sample Depth[a]		Water Content (%)
		From (m)	To (m)	
TP15-1	GS01	0.2	0.4	7.8
	GS03	1.7	1.9	14.2
TP15-2	GS01	0.4	0.8	13.6
	GS02	3.0	3.2	11.1
TP15-3	GS02	3.5	3.7	15.0
TP15-4	GS02	1.1	1.3	17.1
	GS04	2.8	3.0	12.3
TP15-5	GS01	0.7	0.9	12.5
	GS02	1.8	2.0	11.5
TP15-6	GS01	0.3	0.4	11.4
	GS02	1.2	1.4	12.3
	GS03	2.3	2.5	14.8
TP15-7	GS01	0.5	0.6	15.0
	GS02	1.2	1.4	15.4
	GS04	3.5	4.0	11.3
TP15-10	GS02	3.0	3.2	11.0
	GS03	4.5	4.7	11.0
TP15-11	GS02	3.0	4.0	14.4
TP15-12	GS01	0.8	1.2	13.8
TP15-13	GS01	0.5	1.0	11.3
	GS02	1.6	1.8	8.8
TP15-14	GS01	0.8	1.2	9.8
	GS02	1.8	2.2	10.6
TP15-15	GS01	0.5	1.0	13.3
	GS02	2.5	2.7	11.9
TP15-E	GS01	0.5	1.0	12.1
	GS02	2.0	2.5	12.9
G-TP-F	GS1	0.1	0.6	9.4
G-TP-G	GS1	0.1	0.6	13.0

a) All depths are below ground surface within each test pit, and are therefore the elevation for each sample varies.

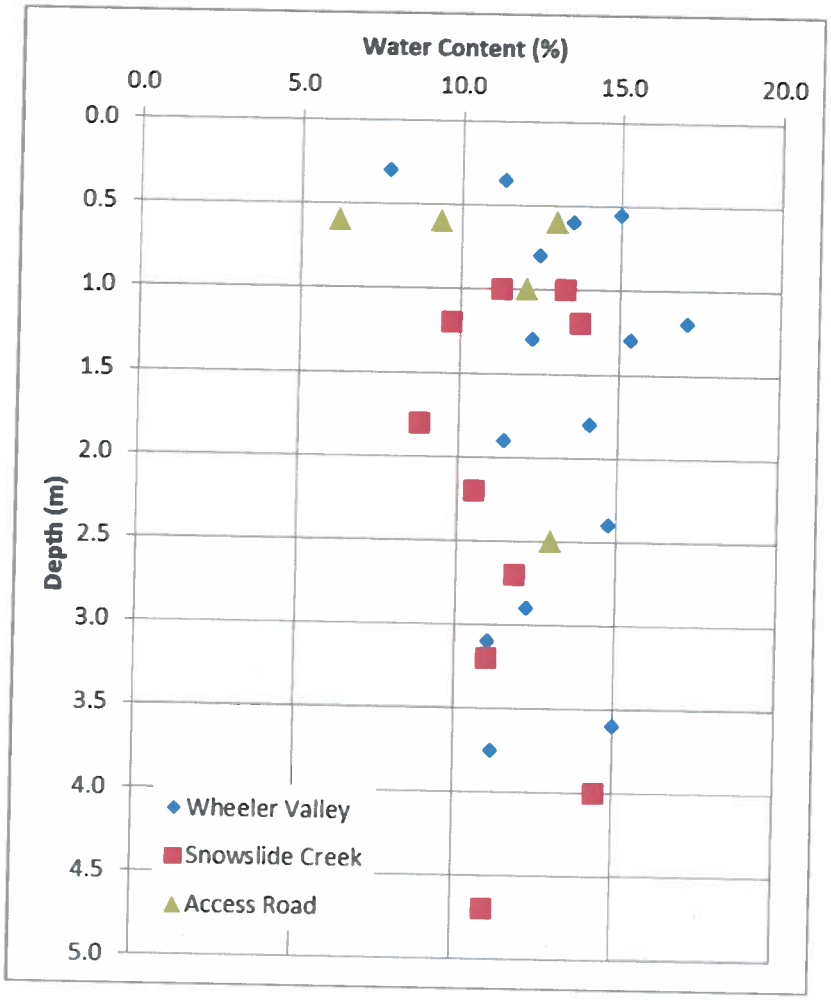


Chart 5: Water Content of Selected Samples from the July 201 5Coal Mountain Operations Phase 2 Geotechnical Field Program

Note: All depths are below ground surface within each test pit, and therefore the elevation for each sample varies.

APPENDIX A

Records of Test Pit

PROJECT No.: 1527423 / 4000
CLIENT: Teck Coal Limited
PROJECT: Coal Mountain Phase 2 Project
LOCATION: Sparwood, B.C.
N: 5496843.0 E: 657420.0

RECORD OF TEST PIT: TP15-05

EXCAVATION DATE: July 13, 2015

SHEET 1 OF 1
DATUM: UTM NAD 83
TEST PIT DIMENSIONS:
10 m Length x 2.5 m Width

DEPTH SCALE METRES	EXCAVATION METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY %	SHEAR STRENGTH Cu, kPa (nat V + Q - ●, rem V ⊕ U - ◐, Pocket Pen - ■) 20 40 60 80 / WATER CONTENT PERCENT Wp W Wl, NP - Non-Plastic, 10 20 30 40	GRADATION % GRAVEL	GRADATION % SAND	GRADATION % FINES	PLASTICITY	FROZEN GROUND DESCRIPTION	ADDITIONAL LAB TESTING	PIEZOMETER, STANDPIPE, THERMISTOR INSTALLATION OR SEEPAGE OBSERVATION
0	Excavator Bucket (Cat 345 - Saw Toothed)	Ground Surface		1430.00											
		(ML) sandy CLAYEY SILT, medium plasticity, trace gravel; brown; with rootlets, cohesive, w<PL, soft.		0.00 / 1429.75											
		(GC) sandy CLAYEY GRAVEL, fine to coarse sub-angular gravel, fine to coarse sand; dark grey; with cobbles (5% by volume), cohesive, w<PL, firm.		0.25 / 1429.00	GS01	GS		O —	42	24	34				
1		**(GC)** sandy CLAYEY GRAVEL, fine to coarse sub-angular gravel, fine to coarse sand; dark grey; with cobbles (10% by volume) and boulders (10% by volume), cohesive, w<PL, stiff.		1.00											
2					GS02	GS		O	42	34	24				
		SANDSTONE, moderately weathered, fine grained, grey, very strong.		1427.20 / 2.80 / 1427.00	GS03	GS									
3		End of Test Pit.		3.00											
4															
5															
6															

DEPTH SCALE
1 : 50

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: DJF
CHECKED: JKH

REV: 0

PROJECT No.: 1527423 / 4000

CLIENT: Teck Coal Limited
PROJECT: Coal Mountain Phase 2 Project
LOCATION: Sparwood, B.C.
N: 5496846.0 E: 657419.0

RECORD OF TEST PIT: TP15-05A

EXCAVATION DATE: July 14, 2015

SHEET 1 OF 1
DATUM: UTM NAD 83

TEST PIT DIMENSIONS:
7 m Length x 2 m Width

DEPTH SCALE METRES	EXCAVATION METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY %	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○, Pocket Pen - ■) 20 40 60 80 / WATER CONTENT PERCENT Wp W Wl NP - Non-Plastic 10 20 30 40	GRADATION %: GRAVEL	SAND	FINES	PLASTICITY	FROZEN GROUND DESCRIPTION	ADDITIONAL LAB TESTING	PIEZOMETER, STANDPIPE, THERMISTOR INSTALLATION OR SEEPAGE OBSERVATION
		Ground Surface		1444.00										
0	Cat 345 - Saw Toothed Excavator Bucket	**(ML)** sandy CLAYEY SILT, medium plasticity, some sub-angular gravel, trace organics; brown; with cobbles (10% by volume) and boulders (10% by volume), cohesive, w~PL, firm.		0.00										
				1443.60										
		(GM/SM) SILTY GRAVEL and SAND, fine to coarse sub-angular gravel, fine to coarse sand; dark grey; with cobbles (10% by volume) and boulders (10% by volume), trace coal, non-cohesive, moist to wet, compact.		0.40	GS01	GS								
1														-wet from 1.1 m to bottom of test pit.
2					GS02	GS								
3														
4					GS03	GS								
5				1438.50										
		End of Test Pit.		5.50										
6														

DEPTH SCALE
1 : 50

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: DJF
CHECKED: JKH

REV
0

PROJECT No.: 1527423 / 4000
CLIENT: Teck Coal Limited
PROJECT: Coal Mountain Phase 2 Project
LOCATION: Sparwood, B.C.
N: 5496674.0 E: 657859.0

RECORD OF TEST PIT: TP15-06

EXCAVATION DATE: July 13, 2015

SHEET 1 OF 1
DATUM: UTM NAD 83
TEST PIT DIMENSIONS
5 m Length x 2 m Width

DEPTH SCALE METRES	EXCAVATION METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY %	SHEAR STRENGTH Cu kPa (nat V. + Q - ●, rem V. ⊕ U - ◐, Pocket Pen - ■) / WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic)	GRADATION % GRAVEL	GRADATION % SAND	GRADATION % FINES	PLASTICITY	FROZEN GROUND DESCRIPTION	ADDITIONAL LAB TESTING	PIEZOMETER, STANDPIPE, THERMISTOR INSTALLATION OR SEEPAGE OBSERVATION
0	Cat 345 - Saw Toothed Excavator Bucket	Ground Surface		1401.00											
		(GC) sandy CLAYEY GRAVEL, fine to coarse sub-angular gravel, fine to coarse sand, medium plasticity silty clay, dark grey, with cobbles (20% by volume), cohesive, w<PL, firm to very stiff. -0.8 m diameter boulder at 0.8 m depth. -trace coal, wet, loose to compact from 1.0 m depth.		0.00	GS01	GS			40	26	34				
1					GS02	GS									
2															
3					GS03	GS			40	30	30				
4					GS04	GS									
5															
		End of Test Pit		1395.50 5.50											
6															

DEPTH SCALE
1 : 50

Golder Associates

SOIL CLASSIFICATION SYSTEM: GACS
LOGGED: DJF
CHECKED: JKH

REV
0

National IM Server GINT_GAL_NATIONALIM Unique Project ID Output Form BC_TESTPIT WITH PHOTO JAY.gpj 9/15/15

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.*, SAND and GRAVEL, SAND and CLAY)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test (CPT)
An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size
TP	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
2. Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N_{60} values.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

APPENDIX B

Laboratory Testing Results (Test Pit Samples)

September 17, 2015
Reference No. 1527423-2015-122-R-Rev0-4000

Golder Associates

B-1 Atterberg Limit Testing

September 17, 2015
Reference No. 1527423-2015-122-R-Rev0-4000

Golder Associates

Golder Associates

Atterberg Limits (ASTM D 4318)

Project No.: 1527423
Short Title: Teck/2015 Gap Analysis/CMO2 - Test Pitting Field Investigation
Tested By: DS

Phase: 4000.4500
Lab No.: B569-08
Date: 5-Aug-15

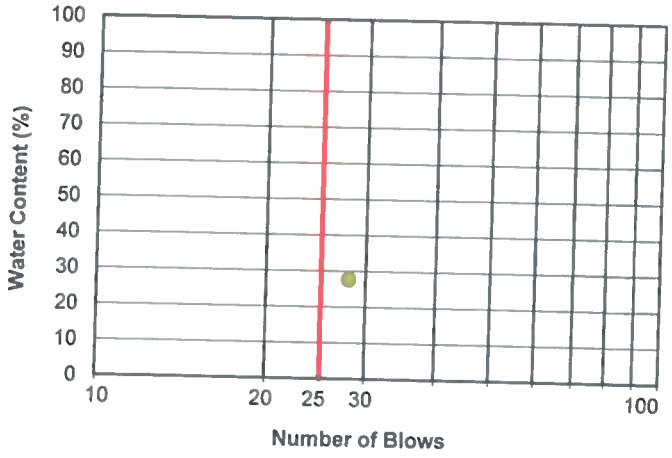
Borehole: TP15-5 Sample No.: GS01 Depth: 0.7-0.9 m

Liquid Limit Determination:		
Number of Blows	28	28
Blow Correction Factor	1.01	1.01
Mass of wet sample + tare (g)	29.14	33.33
Mass of dry sample + tare (g)	26.83	31.44
Mass of tare (g)	18.61	24.63
Weight of Water (g)	2.31	1.89
Weight of dry soil (g)	8.22	6.81
Water Content (%)	28.1	27.8
Liquid Limit	28.0	28.0

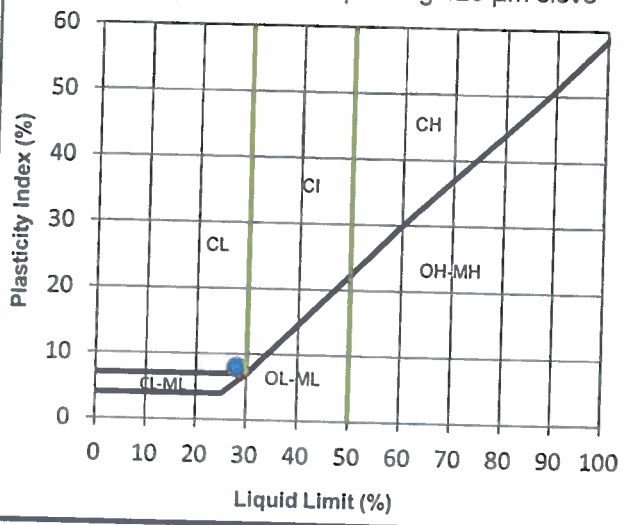
Natural Water Content:	
As Received Water Content (%)	12.5%

Plastic Limit Determination:		
Mass of wet sample + tare (g)	19.63	19.01
Mass of dry sample + tare (g)	18.12	17.61
Mass of tare (g)	10.79	10.68
Weight of Water (g)	1.51	1.40
Weight of dry soil (g)	7.33	6.93
Water Content (%)	20.60	20.20
Average Water Content (%)		20.40

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit = 28 %
Plastic Limit = 20 %
Plasticity Index = 8

Comments:

Reviewed:

Golder Associates

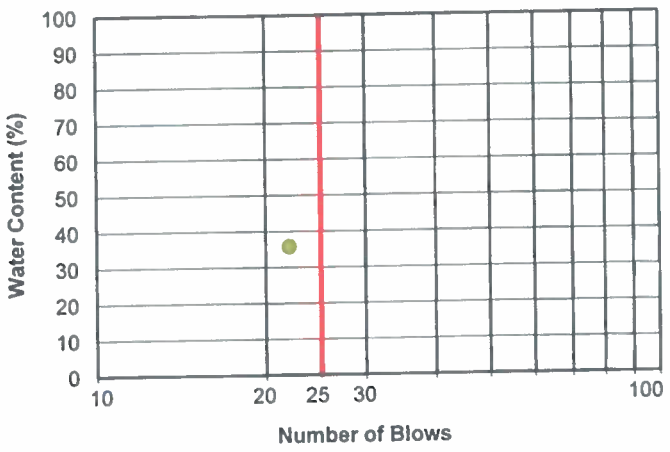
Atterberg Limits (ASTM D 4318)

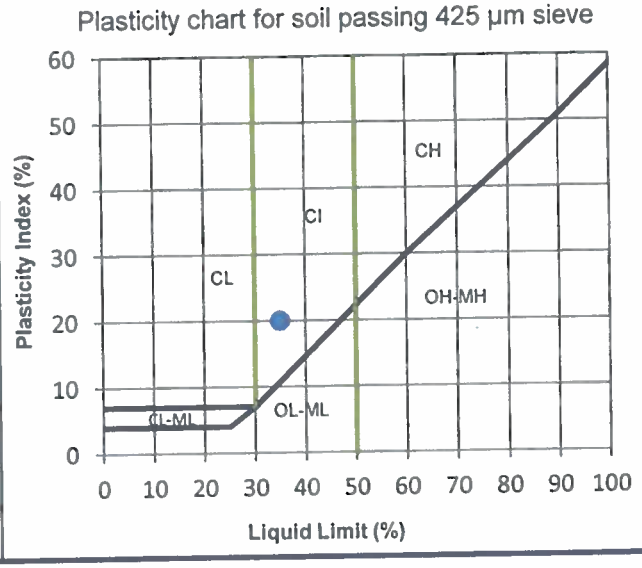
Project No.: 1527423
Short Title: Teck/2015 Gap Analysis/CMO2 - Test Pitting Field Investigation
Tested By: DS

Phase: 4000.4500
Lab No.: B569-10
Date: 5-Aug-15

Borehole: TP15-6 Sample No.: GS01 Depth: 0.3-0.4 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	22	22	As Received Water Content (%)		11.4%
Blow Correction Factor	0.99	0.99	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	36.79	31.04	Mass of wet sample + tare (g)	18.41	21.16
Mass of dry sample + tare (g)	31.98	27.26	Mass of dry sample + tare (g)	17.31	19.77
Mass of tare (g)	18.58	16.75	Mass of tare (g)	10.05	10.83
Weight of Water (g)	4.81	3.78	Weight of Water (g)	1.10	1.39
Weight of dry soil (g)	13.4	10.51	Weight of dry soil (g)	7.26	8.94
Water Content (%)	35.9	36.0	Water Content (%)	15.15	15.55
Liquid Limit	35.0	35.0	Average Water Content (%)		15.35





Liquid Limit = 35 %
Plastic Limit = 15 %
Plasticity Index = 20

Comments:

Reviewed:

Golder Associates

Atterberg Limits (ASTM D 4318)

Project No.: 1527423
Short Title: Teck/2015 Gap Analysis/CMO2 - Test Pitting Field Investigation
Tested By: DS

Phase: 4000.4500
Lab No.: B569-12
Date: 5-Aug-15

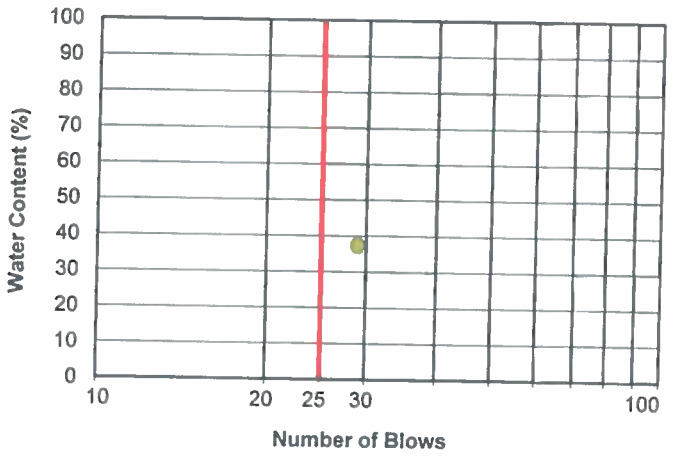
Borehole: TP15-6 Sample No.: GS03 Depth: 2.3-2.5 m

Liquid Limit Determination:		
Number of Blows	29	29
Blow Correction Factor	1.02	1.02
Mass of wet sample + tare (g)	32.66	33.12
Mass of dry sample + tare (g)	28.88	29.64
Mass of tare (g)	18.89	20.30
Weight of Water (g)	3.78	3.48
Weight of dry soil (g)	9.99	9.34
Water Content (%)	37.8	37.3
Liquid Limit	39.0	38.0

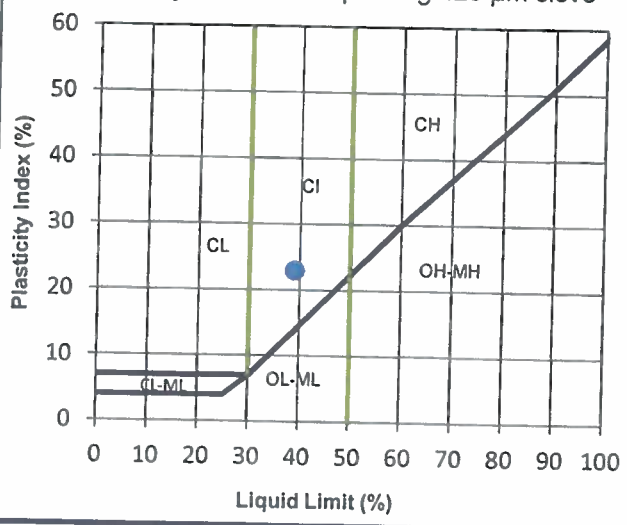
Natural Water Content:	
As Received Water Content (%)	14.8%

Plastic Limit Determination:		
Mass of wet sample + tare (g)	21.29	20.47
Mass of dry sample + tare (g)	19.89	19.13
Mass of tare (g)	10.81	10.73
Weight of Water (g)	1.40	1.34
Weight of dry soil (g)	9.08	8.40
Water Content (%)	15.42	15.95
Average Water Content (%)		15.69

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit = 39 %
Plastic Limit = 16 %
Plasticity Index = 23

Comments:

Reviewed:

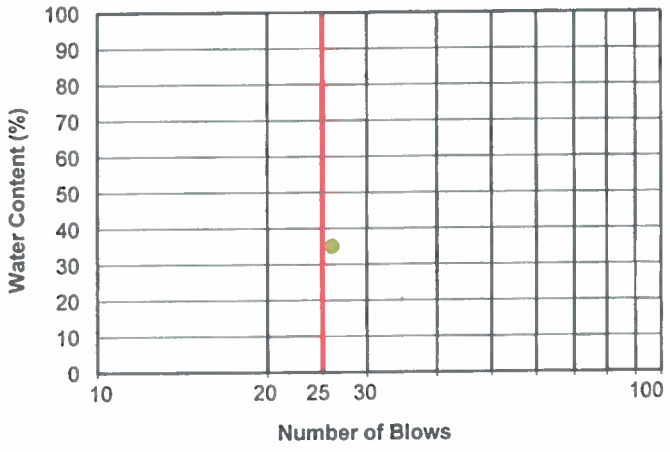
Golder Associates

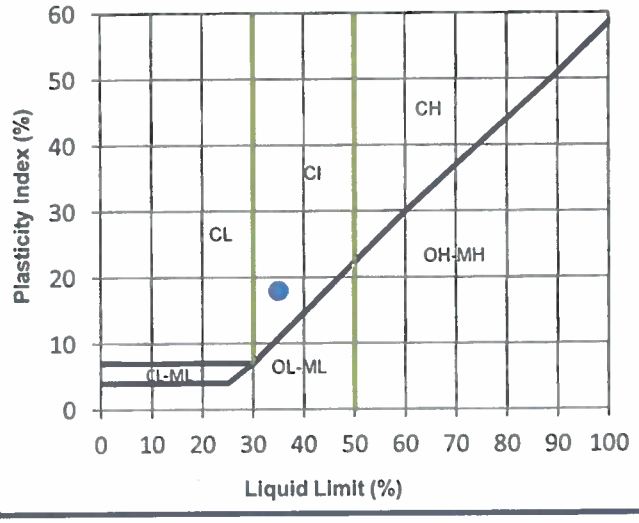
Atterberg Limits (ASTM D 4318)

Project No.:	1527423	Phase:	4000.4500
Short Title:	Teck/2015 Gap Analysis/CMO2 - Test Pitting Field Investigation	Lab No.:	B569-14
Tested By:	DS	Date:	5-Aug-15

Borehole: TP15-7 Sample No.: GS02 Depth: 1.2-1.4 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	26	26	As Received Water Content (%)		15.4%
Blow Correction Factor	1.01	1.01	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	41.18	34.07	Mass of wet sample + tare (g)	19.74	20.83
Mass of dry sample + tare (g)	37.39	30.13	Mass of dry sample + tare (g)	18.46	19.43
Mass of tare (g)	26.61	18.92	Mass of tare (g)	10.59	11.10
Weight of Water (g)	3.79	3.94	Weight of Water (g)	1.28	1.40
Weight of dry soil (g)	10.78	11.21	Weight of dry soil (g)	7.87	8.33
Water Content (%)	35.2	35.1	Water Content (%)	16.26	16.81
Liquid Limit	35.0	35.0	Average Water Content (%)		16.54





Liquid Limit =	35	%
Plastic Limit =	17	%
Plasticity Index =	18	

Comments: _____

Reviewed: _____

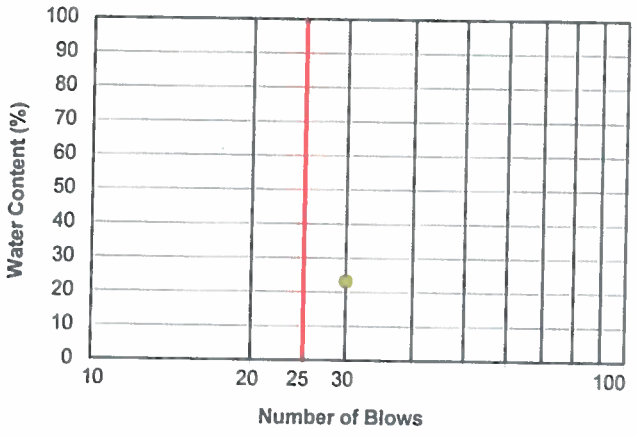
Golder Associates

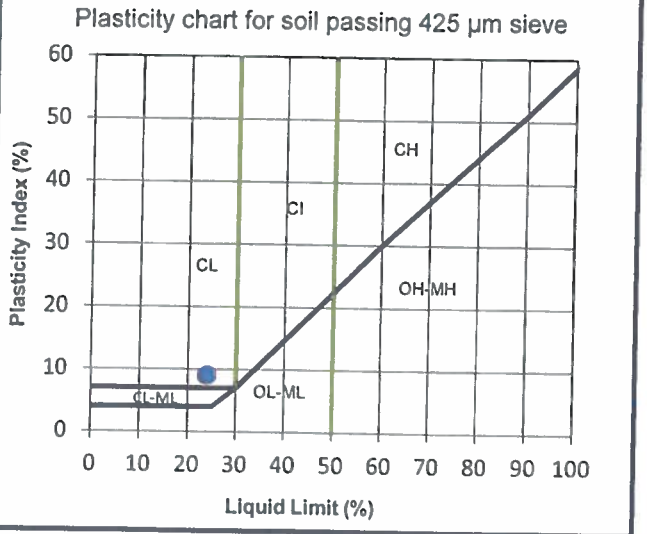
Atterberg Limits (ASTM D 4318)

Project No.:	1527423	Phase:	-
Short Title:	Teck/2015 Gap Analysis/CMO2 - Test Pitting	Lab No.:	B598-01
Tested By:	DS	Date:	21-Aug-15

Borehole: TP15-10 Sample No.: GS02 Depth: 3.0-3.2 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	30	30	As Received Water Content (%)		11.0%
Blow Correction Factor	1.02	1.02	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	40.31	30.82	Mass of wet sample + tare (g)	21.33	21.74
Mass of dry sample + tare (g)	37.67	28.26	Mass of dry sample + tare (g)	20.02	20.36
Mass of tare (g)	26.34	17.22	Mass of tare (g)	11.10	10.87
Weight of Water (g)	2.64	2.56	Weight of Water (g)	1.31	1.38
Weight of dry soil (g)	11.33	11.04	Weight of dry soil (g)	8.92	9.49
Water Content (%)	23.3	23.2	Water Content (%)	14.69	14.54
Liquid Limit	24.0	24.0	Average Water Content (%)		14.61





Liquid Limit = 24 %
Plastic Limit = 15 %
Plasticity Index = 9

Comments:

Reviewed:

Golder Associates

Atterberg Limits (ASTM D 4318)

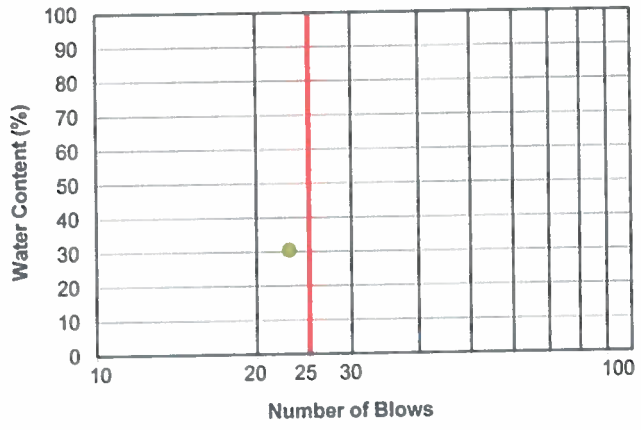
Project No.: 1527423
Short Title: Teck/2015 Gap Analysis/CMO2 - Test Pitting
Tested By: DS

Phase: -
Lab No.: B598-06
Date: 21-Aug-15

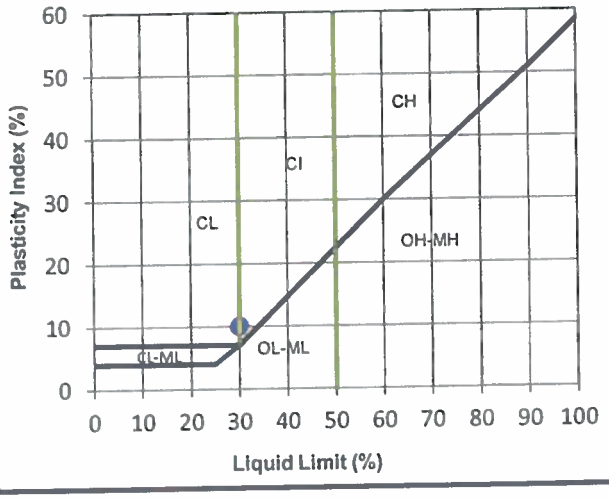
Borehole: TP15-13 Sample No.: GS01 Depth: 0.5-1.0 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	23	23	As Received Water Content (%)		11.3%
Blow Correction Factor	0.99	0.99	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	38.11	39.50	Mass of wet sample + tare (g)	20.28	20.78
Mass of dry sample + tare (g)	34.95	36.02	Mass of dry sample + tare (g)	18.61	19.16
Mass of tare (g)	24.66	24.61	Mass of tare (g)	10.32	11.10
Weight of Water (g)	3.16	3.48	Weight of Water (g)	1.67	1.62
Weight of dry soil (g)	10.29	11.41	Weight of dry soil (g)	8.29	8.06
Water Content (%)	30.7	30.5	Water Content (%)	20.14	20.10
Liquid Limit	30.0	30.0	Average Water Content (%)		20.12

Liquid Limit Test



Plasticity chart for soil passing 425 µm sieve



Liquid Limit = 30 %
Plastic Limit = 20 %
Plasticity Index = 10

Comments: _____

Reviewed: _____

Golder Associates

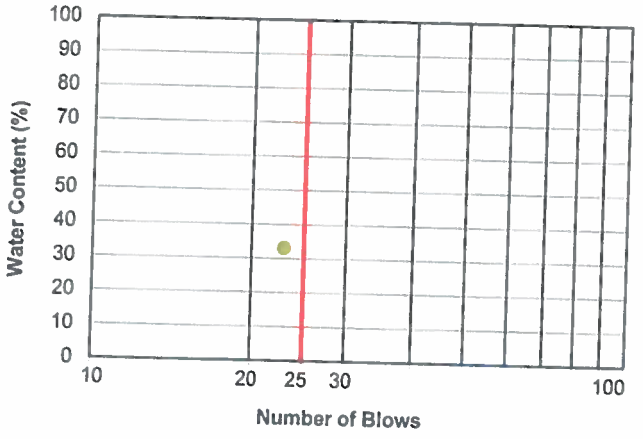
Atterberg Limits (ASTM D 4318)

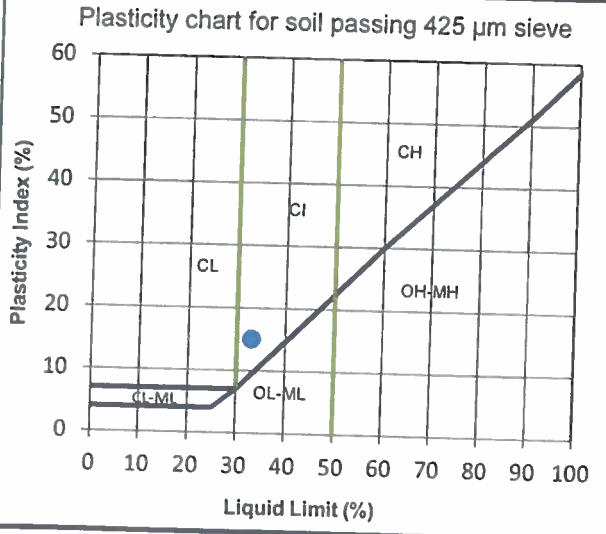
Project No.: 1527423
Short Title: Teck/2015 Gap Analysis/CMO2 - Test Pitting
Tested By: DS

Phase: -
Lab No.: B598-10
Date: 21-Aug-15

Borehole: TP15-15 Sample No.: GS01 Depth: 0.5-1.0 m

Liquid Limit Determination:			Natural Water Content:		
Number of Blows	23	23	As Received Water Content (%)		13.3%
Blow Correction Factor	0.99	0.99	**Plastic Limit Determination:**		
Mass of wet sample + tare (g)	28.99	34.88	Mass of wet sample + tare (g)	21.06	20.60
Mass of dry sample + tare (g)	25.95	31.51	Mass of dry sample + tare (g)	19.51	19.10
Mass of tare (g)	16.77	21.36	Mass of tare (g)	10.77	10.72
Weight of Water (g)	3.04	3.37	Weight of Water (g)	1.55	1.50
Weight of dry soil (g)	9.18	10.15	Weight of dry soil (g)	8.74	8.38
Water Content (%)	33.1	33.2	Water Content (%)	17.73	17.90
Liquid Limit	33.0	33.0	Average Water Content (%)		17.82





Liquid Limit = 33 %
Plastic Limit = 18 %
Plasticity Index = 15

Comments:

Reviewed:

Exploration Work type	Comment	Days			Totals
Personnel (Name)* / Position	**Field Days (list actual days)**	**Days**	**Rate**	**Subtotal***	
Silenus, Forestry Technician	April 27 - 30, 2015	1	$0.00	$900.00	
Guardian First Aid	May 4 - August 31, 2015	44	$0.00	$31,800.00	
Norwest Engineering	May 5 - 30, 2015	28	$0.00	$47,386.00	
Golder Associates Engineering	July 13 - 16, 2015	4	$0.00	$6,100.00	
Glenwest Express	Aug 20 - September 1, 2015	9	$0.00	$24,860.00	
CMO supervisor	May 4 - October 21, 2015	48	$0.00	$41,175.00	
CMO equipment operator	May 4 - October 21, 2016	48	$0.00	$25,031.00	
				$177,252.00	**$177,252.00**
Office Studies	**List Personnel (note - Office only, do not include field days**				
Literature search			$0.00	$0.00	
Database compilation			$0.00	$0.00	
Computer modelling			$0.00	$0.00	
Reprocessing of data	Norwest and Golder Engineering		$0.00	$28,000.00	
General research			$0.00	$0.00	
Report preparation	Norwest and Golder Engineering		$0.00	$17,529.00	
Other (specify)					
				$45,529.00	**$45,529.00**
Airborne Exploration Surveys	**Line Kilometres / Enter total invoiced amount**				
Aeromagnetics			$0.00	$0.00	
Radiometrics			$0.00	$0.00	
Electromagnetics			$0.00	$0.00	
Gravity			$0.00	$0.00	
Digital terrain modelling			$0.00	$0.00	
Other (specify)			$0.00	$0.00	
				$0.00	**$0.00**
Remote Sensing	**Area in Hectares / Enter total invoiced amount or list personnel**				
Aerial photography			$0.00	$0.00	
LANDSAT			$0.00	$0.00	
Other (specify)			$0.00	$0.00	
				$0.00	**$0.00**
Ground Exploration Surveys	**Area in Hectares/List Personnel**				
Geological mapping					
Regional		*note: expenditures here*			
Reconnaissance		*should be captured in Personnel*			
Prospect		*field expenditures above*			
Underground	Define by length and width				
Trenches	Define by length and width			$0.00	**$0.00**
Ground geophysics	**Line Kilometres / Enter total amount invoiced list personnel**				
Radiometrics					
Magnetics					
Gravity					
Digital terrain modelling					
Electromagnetics	*note: expenditures for your crew in the field*				
SP/AP/EP	*should be captured above in Personnel*				
IP	*field expenditures above*				
AMT/CSAMT					
Resistivity					
Complex resistivity					
Seismic reflection					
Seismic refraction					
Well logging	508 meters			$5,320.00	
Geophysical interpretation					
Petrophysics					
Other (specify)					
				$5,320.00	**$5,320.00**
Geochemical Surveying	**Number of Samples**	**No.**	**Rate**	**Subtotal**	

Drill (cuttings, core, etc.)	93		$0.00	$70,000.00	
Stream sediment			$0.00	$0.00	
Soil			$0.00	$0.00	
Rock	44		$0.00	$38,000.00	
Water			$0.00	$0.00	
Biogeochemistry	*note: This is for assays or*		$0.00	$0.00	
Whole rock	*laboratory costs*		$0.00	$0.00	
Petrology			$0.00	$0.00	
Other (Carbonization and pilot plant			$0.00	$0.00	
				$108,000.00	**$108,000.00**
Drilling	**No. of Holes, Size of Core and Metres**	**No.**	**Rate**	**Subtotal**	
Diamond			$0.00	$0.00	
Reverse circulation (RC)	8 Holes, 5", 508 metres		$0.00	$220,525.00	
Rotary air blast (RAB)			$0.00	$0.00	
Large Diameter Reverse Flood				$0.00	
				$220,525.00	**$220,525.00**
Other Operations	**Clarify**	**No.**	**Rate**	**Subtotal**	
Trenching	test pits with backhoe	36.0	$0.00	$5,850.00	
Bulk sampling			$0.00	$0.00	
Underground development			$0.00	$0.00	
Other (specify)	Road and Pad Construction			$8,535.00	
				$14,385.00	**$14,385.00**
Reclamation	**Clarify**	**No.**	**Rate**	**Subtotal**	
After drilling	water bars on roads		$0.00	$2,236.00	
Monitoring			$0.00	$0.00	
Other (specify)			$0.00	$0.00	
				$2,236.00	**$2,236.00**
Transportation		**No.**	**Rate**	**Subtotal**	
Airfare			$0.00	$0.00	
Taxi			$0.00	$0.00	
truck rental			$0.00	$8,600.00	
kilometers			$0.00	$0.00	
ATV			$0.00	$0.00	
fuel			$0.00	$0.00	
Helicopter (hours)			$0.00	$0.00	
Fuel (litres/hour)			$0.00	$0.00	
Other					
				$8,600.00	**$8,600.00**
Accommodation & Food	**Rates per day**				
Hotel			$0.00	$0.00	
Camp	day rate or actual costs-specify		$0.00	$0.00	
Meals			$0.00	$0.00	
				$0.00	**$0.00**
Miscellaneous					
Telephone			$0.00	$0.00	
Other (Specify)	diesel fuel		$0.00	$4,722.00	
				$4,722.00	**$4,722.00**
Equipment Rentals					
Field Gear (Specify)			$0.00	$0.00	
Other (Specify)	portapottie		$0.00	$10,300.00	
Other (Specify)	pump instal\extract		$0.00	$6,000.00	
Other (Specify)	water pumps		$0.00	$8,625.00	
Other (Specify)	330 cat backhoe		$0.00	$11,600.00	
				$36,525.00	**$36,525.00**
Freight, rock samples					
			$0.00	$0.00	
			$0.00	$0.00	
				$0.00	**$0.00**

TOTAL Expenditures					**$623,094.00**