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GOVERNMENT OF NUNAVUT

Cambridge Bay, NU

Geotechnical Site Investigation - Potential Borrow Sources

307034-00016-00-SS-REP-0001

15 November 2012

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PROJECT 307034-00016 - CAMBRIDGE BAY, NU

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Issued for Internal Review	H. Blyth / J.Gibson	B. Smith	L. Martin/ S.Khera	20-Sep-12		
B	Issued for Client Review	H. Blyth / J.Gibson	B. Smith	L. Martin / S. Khera	01-Oct-12		
0	Issued for Client Use	JG H. Blyth / J.Gibson	LRM B. Smith	LRM L. Martin / S. Khera	15-Nov-12		

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Any questions concerning the information or its interpretation should be directed to Lee Martin.

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1. INTRODUCTION

The Government of Nunavut through the Department of Community and Government Services is seeking to upgrade the runway and expand the apron of the Cambridge Bay airport, as well as construct a new tank farm. In order to facilitate these projects, sources of granular and clay borrow materials are required, and therefore, WorleyParsons Canada Services Inc. (WorleyParsons) was contracted to perform a geotechnical investigation of potential borrow locations. The investigation included discussions with local agencies to discuss regulatory process requirements, jurisdictional considerations and collection of community information.

1.1 Purpose and Scope

This geotechnical investigation was undertaken to confirm that sufficient granular and clay materials are available to meet construction requirements and to evaluate the quality of the borrow sources that can be made available to the contractors.

The estimated volumes of material required for these two projects may be summarized as follows:

Table A Approximate Material Volume Required

Material	Estimated Volume – Airport Upgrades (cubic metres)	Estimated Volume – Tank Farm and Access Road (cubic metres.)
Granular Wearing Course	16,600	5,200
Granular Base	48,600	1,250
Granular Sub-Base	21,100	1,100
Select Granular Pit Run Fill	27,500	1,100
Common Fill	10,500	6,500
Sub-total	124,300	15,150
Total Volume Required	**139,450 cubic metres**	

The scope of work included eight boreholes using an air-track drilling rig contracted from Bernie's Ltd. of Yellowknife, Northwest Territories (NWT), and 20 test pits excavated using a hydraulic rubber tired backhoe from Kitnuna Corporation of Cambridge Bay.

2. GEOTECHNICAL INVESTIGATION

2.1 Background Information

Prior to starting the work, WorleyParsons discussed potential borrow sites with the Nunavut Impact Review Board (NIRB), Kitikmeot Inuit Association (KIA), Community and Government Service (CGS) and a local contractor, Kitnuna Corporation.

Present community aggregate borrow sites are located at Quarry Pit Nos. 1A and 1B which are known as the “Cottage Pit” (Figure 1).The present source for clay borrow is Quarry Pit No. 3, known as “The Community Pit” (Figure 1).

The granular materials including base and sub base will be manufactured by crushing and screening pit run gravel. The granular wearing course requires a small addition of clay to the crushed aggregate to act as a binder.

Based on the proposed quarry pit locations shown in Figure 1, and the available literature which included the Terrain Unit Mapping and Feasibility Study for the Cambridge Bay Airport Improvements Project (WorleyParsons, 2010) and a 1:250,000 surficial geology map of Cambridge Bay (Sharpe, 1993), the following locations were identified as potential borrow sites.

Granular Borrow

- Quarry Pit Nos. 1A and 1B – These two sites are currently active as the main community gravel source.
- Proposed Quarry Pit No. 2 – Quarry Pit No. 2 consists of an extensive, post-glacial, marine beach ridge deposit with considerable potential as an aggregate source.

Clay Borrow

- Quarry Pit No. 3 – Quarry Pit No. 3 is the current active clay source for Cambridge Bay.
- Quarry Pit Nos. 4 and 5 – Potential clay sources.

It should be noted that an esker approximately 13 km in length is located northeast of the community as shown in Figure 1. This esker appears to have both cultural and archeological significance in the region, as seen by the cemetery and tent rings on its southern kilometer, however, to the north and in the surrounding esker complex there may be significant aggregate available if required. The quantity and quality has not been investigated as part of this study.

2.2 Field Investigation

Prior to the initiation of a drilling and excavation program to evaluate potential borrow pit sites, the field visit included several meetings with territorial and federal agency representatives, two site reconnaissance's with representatives from the Department of Community and Government Services and Kitnuna Projects Inc., confirmation of access to proposed sites and identification of the sites to be included in the drilling and geotechnical investigation. Following discussions with the various organizations in the community, the locations of the boreholes and test pits were finalized.

The field investigation commenced on August 28, 2012 and was completed on August 31, 2012. The geotechnical investigation coincided with a site reconnaissance and environmental investigation also conducted by WorleyParsons, to support the work of the Geotechnical Investigation. The environmental aspects of the investigation are referred to in a separate report (WorleyParsons, 2012).

The investigation comprised eight geotechnical boreholes and 20 test pits located, as shown in Figure 1. Table B presents details of the borehole and test pit locations, final depths, surface elevations and relative area. Investigation locations were determined by a handheld GPS.

Table B Approximate Borehole and Test Pit Locations

Test ID	Easting (mNAD83)	Northing (mNAD83)	Surface Elevation (mASL)*	Test Depth (m)	Pit ID
BH-1	489559	7665803	34	6	1B
BH-2	489756	7665689	30	6	1B
BH-3	489887	7665352	17	6	1B
BH-4	489726	7665402	29	6	1B
BH-5	489637	7665446	36	6	1B
BH-6	489087	7665362	34	6	1A
BH-7	489313	7665516	42	6.7	1B
BH-8	489637	7665911	36	5.3	1B
TP-1A	489559	7665802	34	1	1B
TP-1B	489756	7665689	30	1.3	1B
TP-2	489725	7665401	29	1.2	1B
TP-3	489887	7665352	17	1.3	1B
TP-4	490003	7665124	12	1.6	1B
TP-5	489637	7665445	36	1.4	1B
TP-6	489377	7665510	29	1.5	1B

Test ID	Easting (mNAD83)	Northing (mNAD83)	Surface Elevation (mASL)*	Test Depth (m)	Pit ID
TP-7	489307	7665409	35	1.5	1B
TP-8	489300	7665363	29	1.6	1B
TP-9	489118	7665431	27	1	1A
TP-10	489394	7665907	31	1	5
TP-11	488931	7665473	25	0.7	5
TP-12	488943	7666571	41	1.2	2
TP-13	489025	7666568	40	1.2	2
TP-14	489601	7666385	33	1.4	2
TP-15	490993	7666456	23	1.5	4
TP-16	492482	7666912	18	2.2	4
TP-17	493447	7667009	25	2	4
TP-18	496544	7667149	8.0	2.5	3
TP-19	496542	7667198	6.8	2.5	3

Note: *Ground surface elevation (mASL) obtained from hand held GPS.

The field work was conducted using the following contractors.

- Bernie's Ltd – contractor selected for drilling boreholes, using an Air Track 3100A drill rig.
- Kitnuna Corporation – contractor selected for undertaking test pits, using a John Deere, Rubber Tired Backhoe.

The field work was supervised by WorleyParsons' Senior Geologist, who logged boreholes and test pits and collected disturbed samples for laboratory testing.

Borehole depths ranged from 5.3 m to 6.75 m below existing grade and were located within Quarry Pit No. 1A and Quarry Pit No. 1B (Figure 1). Highly disturbed samples were taken every 2.5 ft. (approximately 0.75 m) within each borehole to assess the stratigraphy. Due to the drilling method, the samples recovered from the Air Track drill rig were highly disturbed and were retained for visual inspection and basic laboratory testing purposes only. The samples were double-wrapped in plastic bags to preserve moisture and labelled with the sample depth and borehole identification.

A total of 20 test pits were excavated predominantly in Quarry Pit Nos. 1A and 1B (Figure 1). Test pits were also excavated in Quarry Pit Nos. 2, 3, 4, and 5. The test pits were advanced to depth of 0.70 m to 2.50 m below existing ground to refusal, in frozen ground. Representative samples were retained from the test pits and placed in five-gallon plastic pales with sealable lids.

Upon completion, the samples were sent to Solum laboratories in Calgary for laboratory testing and storage.

2.3 Laboratory Testing

Representative soil samples from the test pits were selected for laboratory testing. The laboratory test program included water contents and visual identifications on all borehole samples. Atterberg limits and particle size analysis were undertaken on bulk samples taken from the test pits. All testing was undertaken in accordance with ASTM standard procedures. The results of the tests are presented in Appendix 1 and on the attached borehole logs, test pit logs and are discussed throughout the text of this report. A table is presented at the beginning of Appendix 1 which links laboratory samples with the associated test pit.

3. SITE CONDITIONS

3.1 General

Cambridge Bay is located on the south side of Victoria Island in the Kitikmeot Region of Nunavut. This region is known for its short cool summers and long cold winters, with an annual average precipitation of less than 50 cm. Cambridge Bay is part of the Victoria Lowland subdivision of the Arctic Lowland Physiographic Region, which extends from King William and Prince of Wales Islands in the east and encompasses all but the Shaler Mountains on Victoria Island (Dyke and Dredge, 1989; Bostock, 1970a and b). This area is primarily underlain by near flat lying Paleozoic (544-251 million year old (my) sedimentary rock. The major landforms are bedrock-controlled; however, Quaternary glaciations have scoured and altered bedrock surfaces, eroding from 5.5 m to 8 m of rock (Kaszycki and Shilts, 1980) to form secondary relief features such as ridges, valleys and shallow glacial basins.

3.2 Regional Geology

The bedrock within the Cambridge Bay area consists of near flat lying and jointed Palaeozoic (Dyke and Dredge, 1989) carbonate (limestone), sandstone and weak calcareous shale. The natural bedrock outcrops within the study area are weathered and frost shattered (WorleyParsons, 2010).

The Quaternary history of this area is poorly represented in stratigraphic section and commonly only contains material sufficient for minimal ages to be assigned (Dyke and Dredge, 1989). This said, a proximal history can be attained from the surrounding Arctic region. The Quaternary history in this region begins with the earliest and most extensive glaciation, the Laurentide ice advance. This advance appears to have occurred between the Early Quaternary (1.64 my before present [mybp]) and the Early Wisconsinan (0.65 mybp) (Dyke and Dredge, 1989; Vincent and Prest, 1987). Though the number of glaciations between this and the most recent glaciation, loosely termed the Late Wisconsinan Glaciation, is not known, erosional features combined with thick, interglacial colluvial deposits indicate more than one non-glacial interval between these advances (Dyke and Dredge, 1989). Deposition from the last glacial period occurred between nine and approximately 40,000 years ago (ka bp) and deglaciation from this period was complete by about eight ka bp (Dyke and Dredge, 1989). The Cambridge Bay area was ice free sometime between 9 and 11 ka bp (Sharp, 1984).

Glacial and post-glacial surface deposits include glacial moraine and/or glacial marine diamicton up to 5 m or more in thickness (WorleyParsons, 2010). Post-glacial deposits include marine beach ridges, eskers, lacustrine, organic, and lesser colluvial deposits (Sharpe, 1993). Permafrost, which may be up to several hundreds of metres thick (Canada Permafrost, 1995), is present throughout the study area, except below bodies of water exceeding 2 m in depth. The maximum depth of annual thaw (also referred to as the active layer) generally ranges from 1 m to 2 m in depth.

Surface drainage during the thaw season is controlled by the presence of the underlying permafrost, such that groundwater flow is generally restricted to the active layer (WorleyParsons, 2010). As a result, surface drainage is generally poor and surface water is often confined in low-lying closed depressions. Tundra ponds and lakes are common throughout the area, while topographic highs are generally dry and well drained.

Post glacial sea level measurements taken in Bathurst Inlet, approximately 200 km south of Cambridge Bay, suggest a post glacial marine high stand about 230 m above present sea level (Dyke and Dredge, 1989; Blake, 1963). This emergence averages approximately 10 m per century during the first one to two thousand years of deglaciation, decreasing to 0.66 m / century to the present day (Dyke and Dredge, 1989). It is from these marine high stands that the raised beach deposits in the Cambridge Bay area were formed.

3.3 Subsurface Conditions

Boreholes and test pits were logged in accordance with the Unified Soils Classification System, as per the Canadian Foundation Engineering Manual 4th Ed. (CFEM, 2006) and are provided in Appendices 3 and 4. WorleyParsons explanatory notes for logging soil based on the Canadian Foundation Engineering Manual are presented in Appendix 2.

The drilling and test pit program encountered the following geological units.

- **Glaciomarine Beach Ridge**: Consists of variable stratigraphy which is generally grey to brown fine to coarse grained gravelly SAND at the surface with variable amounts of cobbles, interbedded with fine gravel up to boulders. The gravel and boulders are comprised of various lithologies but primarily frost shattered, sub-angular to angular siltstone bedrock. Thick deposits of sand are also present throughout the unit. Due to the drilling method and small number of boreholes it is difficult to ascertain whether the sand is present as lenses or as continuous layers throughout the profile.
- **Glacial Till**: Consists of a brown diamicton (well-graded sediments ranging from clay to boulders), typically comprising a fine to coarse clayey gravelly SAND with variable amounts of silt, cobbles, and boulders. The proportion of silts and clays in the glacial till is highly variable.
- **Glaciolacustrine**: Consists of grey-brown, fine grained SAND with some non-plastic silt, gravel, and cobbles.
- **Frost Shattered Bedrock / Bedrock:** Consists of brown and grey, siltstone / shale, calcareous in part. The frost shattered zone overlying sound bedrock appears to be approximately 1 m to 1.5 m thick. The structure of the bedrock, including defects and bedding, was not possible to assess from the boreholes due to the drilling method; however, the open pit face in Quarry Pit No. 3 suggests that the bedrock at ground surface to approximately 2.5 m is moderately strong to strong and comprised of alternating sandstone and siltstone, dipping at approximately 5 deg. to the north.

The lateral and vertical extent of each unit is described for each borrow source below. The in situ soil descriptions presented on borehole logs were deduced from highly disturbed cuttings recovered with an air track drill. Surface elevations for each test location were obtained using a hand held GPS which typically has an accuracy of ±10 m, horizontally and vertically.

3.3.1 Granular Borrow Sources

Quarry Pit Nos. 1A and 1B

Quarry Pits Nos. 1A and 1B are the present aggregate source sites for the community of Cambridge Bay and as such were the preferred target for exploration. Eight boreholes were drilled (BH-1 to BH-8) to depths ranging from 5.3 m to 6.75 m below existing ground level. A single bead thermistor was installed to 6 m in four of the boreholes on completion (BH-1, BH-2, BH-3, and BH-7). The single bead thermistors were installed to assess ground temperature and measurements were taken approximately 24 and 48 hours after installation to allow the temperature to stabilise. Ground temperature ranged from approximately -7 deg. C to -9 deg. C. Ten test pits (TP-1A to TP-9) were excavated and ranged from 1.0 m to 1.60 m below existing grade, all of which refused on frozen ground. The borehole and test pit locations are shown in Figure 1.

Based on the results of the site investigation within Quarry Pit Nos. 1A and 1B, the site has a generalised subsurface profile consisting of approximately 1.0 m to more than 6.75 m of glaciomarine beach deposits, overlying 0.5 m to more than 4.5 m of glacial till which is underlain by a thin layer (less than 1.5 m) of frost shattered bedrock which in turn is underlain by bedrock. The cross section provided in Figure 3 gives an approximate indication to the lateral and vertical extent of the geological units. As shown, the beach deposits appear greatest in the vicinity of BH-6 and BH-7 (over 6 m) and decrease to less than1 m to the south (TP-4).

Quarry Pit No. 2

Quarry Pit No. 2 appears to be an extensive, post-glacial, marine beach ridge deposit with an aerial extent of approximately 300,000 metres squared, trending northwest of the Quarry Pit No. 1B area (refer to Figure 1). During this investigation, three Test Pits (TP-12, TP-13 and TP-14) were excavated at the south end of Quarry Pit No. 2 and encountered from 1.2 m to 1.4 m of glaciomarine beach deposits prior to refusal in frozen ground.

3.3.2 Clay Borrow Sources

Quarry Pit No. 3

Granular Wearing Course necessary for airport runway improvements must contain or be supplemented with, between 8% and 25% fines. In the past, the clayey siltstone used for this purpose has been excavated from Quarry Pit No. 3, hauled to Quarry Pit No. 1B and fed into the crusher to mix with the aggregate. As the natural gravel contains some fines, the exact proportion of fines added depends on the proportion and plasticity of the clay in the natural fines, which can be expected to vary. Given a 25% input of fines (clay / siltstone) to the required 22,000 metres squared of granular wearing course, it is estimated that about between 5,500 cubic metres of fines will be required.

Two test pits (TP-18 and TP-19) were excavated within Quarry Pit No. 3, in the active quarry zone. The excavated face adjacent to each test pit was approximately 2.5 m from the existing ground surface and comprised of grey, gently dipping, massively interbedded sandstone and siltstone. Both test pits were excavated to 2.5 m below existing grade (approximately 5.0 m below ground surface) and encountered a grey to dark grey, thinly bedded, highly fractured, very weak to weak siltstone / claystone. The lateral and vertical extent of this siltstone / claystone unit (historically this material has been referred to as clay) is currently unknown. Based on a preliminary airphoto review, in conjunction with the 2.5 m thickness identified in our test pits, we estimate that at least 7,000 cubic metres of claystone is available from this source.

Quarry Pit No. 4

Three sites were sampled in the general area of Proposed Quarry Pit No. 4. The most promising sites from the Quarry Pit No. 4 area were TP-16 (approximately 50% fines) on the southeast side of the potential quarry it and TP-17 (approximately 55% fines), which is located approximately 1 km east of TP-16. .

Table C is a comparison of the percentage of clay and plasticity index for materials sampled from Quarry Pit No.3 and Quarry Pit No.4. As shown, the clay content and plasticity index is very similar for both quarry pits. Quarry Pit No.4 is comprised of glacial till and the clay content is therefore likely to be highly variable laterally and vertically. In addition, the near surface glacial till often contains a significant volume of excess ice, so that the material would have to be thawed and dried before it could be used as clay binder in the gravel wearing course. In any event, only minimal data is available for Quarry Pit No.4, and additional investigation may be required to accurately assess the volumes of clay available, its properties and the difficulties of extracting and processing the material.

Table C Comparison of Quarry Pit No.3 and Quarry Pit No.4

Quarry Pit No.	Test Pit No.	Sample No.	% Clay	Plasticity Index (PI)
3	Stockpile*	CB-1	10	18
3	TP-19	CB-19	17	10
4	TP-16	CB-15	26	17
4	TP-17	CB-16	9	8
4	TP-17	CB-17	19	8

* Stockpile sample taken from Quarry Pit No. 1B. Sample originally excavated from Quarry Pit No.3.

Quarry Pit No. 5

Two sites in Proposed Quarry Pit No. 5 were sampled (TP-10 and TP-11, refer to Figure 1). The material was highly variable ranging from beach deposits to glacial till.

4. RECOMMENDATIONS

Granular Borrow

Based on the results from this investigation, Quarry Pit Nos. 1A and 1B are expected to contain sufficient granular resource to sustain the proposed airport and tank farm projects. At present, the topographic information available for the area is insufficient to accurately estimate the total granular material resource present in Quarry Pit Nos. 1A and 1B. Elevations within this report are based on hand held GPS and surface elevations based on a Digital Elevation Model (DEM) with a 20 m accuracy; however, the total raw, unprocessed granular resource in this area appears to be on the order of 500,000 cubic metres. More detailed field investigations and an accurate topographic survey would be required to reliably assess the total volume of granular materials available at this location.

The material in the pit is expected to be highly variable with respect to the proportion of coarse gravel, cobbles, and boulders and it is expected that the contractor will have to excavate material from several different locations within the pit to obtain material suitable for crushing. A suggested boundary for the quarry pit is shown on Figure 4. It should be noted that granular material may be present outside the boundary lines shown on Figure 4; however, this has not been confirmed.

If Quarry Pit Nos. 1A and 1B prove unsuitable with respect to quantities of granular borrow, Quarry Pit No. 2 appears to be a reasonable alternative source of granular material and should contain sufficient volume to meet the requirements of the airport upgrading and the construction of the tank farm and access roads if necessary. Using a conservative average thickness of 1.2 m, it is estimated that in excess of 300,000 cubic metres of granular borrow is available in Quarry Pit No. 2. It would be necessary to drill boreholes in this area to determine the lateral and vertical extents of granular borrow material within Quarry Pit No. 2.

The esker east of Cambridge Bay appears to contain abundant granular material however, the results of this exploration program suggests that further investigation of the esker as a borrow alternative is unnecessary at this time.

Clay Borrow

Currently, the source of fines for use in the manufacture of road gravel is in Quarry Pit No. 3, located about 1 km southwest of the community. This source of clay is a very weak, highly fractured siltstone / claystone, overlain by approximately 2.5 m of massive, competent interbedded siltstone and sandstone. We believe that there should be a sufficient volume of fines in this source to meet the requirements of the airport upgrading and tank farm projects. There is concern that there may be restrictions with respect to excavating additional material from this pit since it is understood that this area is being considered as a site for future buildings.

In the event that it is not possible to extract sufficient fine grained material from Quarry Pit No. 3, WorleyParsons has identified an alternative source (Quarry Pit No. 4) which should meet the requirements of the projects. Quarry Pit No. 4 is located in a low, poorly drained area and the material contains a significant proportion of excess ice. Therefore, it is expected that special procedures will be required to excavate, thaw and dry the clay obtained from this pit so that it can be made suitable for mixing with crushed gravel to manufacture wearing course gravel. These requirements could significantly increase construction costs and could delay project completion.

5. CLOSURE

We trust that this report meets your current requirements and provides suitable documentation for your records. If you have any questions or require further details, please contact the undersigned at any time.

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WorleyParsons, 2012, Cambridge Bay Borrow Sources, Environmental Aspects

Figures

105°15'0"W
105°10'0"W
105°5'0"W
105°0'0"W
104°55'0"W
69°8'0"N
69°6'0"N
7670000
7668000
7666000
7664000
490000
495000
500000
N
Cambridge Bay
Quarry Pit 2
Quarry Pit 3
Quarry Pit 4
Quarry Pit 5
Quarry Pit 1A
Quarry Pit 1B
SEE INSET
TP-16
TP-17
TP-18
TP-19
TP-12
TP-13
TP-14
TP-15
TP-10
BH-8
BH-1
TP-1A
BH-2
TP-1B
TP-11
BH-7
TP-6
BH-5
TP-5
TP-7
TP-8
BH-6
TP-9
BH-4
TP-2
BH-3
TP-3
TP-4
1:40,000
0 0.5 1
Kilometers

Legend

- Borehole / Test Pit Location
- Proposed Quarry Pit (CGS)
- Approximate Location and Direction of Esker

B SHEET SCALE: SHOWN

CUSTOMER

OneWay™ to zero harm

Date:	19/11/2012
Drawn by:	Y.M.
Edited by:	K.R.
App'd by:	J.G.

"This drawing is prepared for the use of our customer as specified in the accompanying report. WorleyParsons Canada Ltd. assumes no liability to any other party for any representations contained in this drawing."

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CAMBRIDGE BAY GRAVEL SOURCING STUDY
GEOTECHNICAL SITE INVESTIGATION
BOREHOLE AND TEST PIT LOCATIONS

WORLEYPARSONS PROJECT No.	FIGURE #:	REV.
307034-00016	1	0

FILE LOCATION: U:\YYR\307034\00017_GN_CamBayRdGe\10_Eng\16_Geomatics\mxds\Cross_Sections\Borehole_TP_Locations.mxd

PLOT DATE & TIME: 24/04/2012 1:32:08 PM
SAVE DATE & TIME: 24/04/2012 1:32:08 PM

USER NAME: ashling.mulcahy
ISSUING OFFICE: BURNABY GIS

105°17'0"W
105°16'0"W
105°15'0"W
105°14'0"W
69°6'0"N
7666000
7665000
489000
490000
491000
N
A
A'
TP-10
BH-8
BH-1
TP-1A
BH-2
TP-1B
Quarry Pit 5
TP-11
BH-7
TP-6
BH-5
TP-5
TP-7
BH-4
TP-2
BH-6
TP-8
TP-9
BH-3
TP-3
Quarry Pit 1B
Quarry Pit 1A
TP-4
1:7,500
0 100 200
Meters

Legend

- Borehole / Test Pit Location
- Proposed Quarry Pit (CGS)
- Cross Section Location

B SHEET SCALE: SHOWN

CUSTOMER

OneWay™ to zero harm

Date:	19/11/2012
Drawn by:	Y.M.
Edited by:	K.R.
App'd by:	J.G.

WorleyParsons
resources & energy

CAMBRIDGE BAY GRAVEL SOURCING STUDY
GEOTECHNICAL SITE INVESTIGATION
GEOLOGICAL CROSS SECTION PLAN

WORLEYPARSONS PROJECT No.	FIGURE #:	REV.
307034-00016	2	0

FILE LOCATION: U:\YVR\307034\00017_GN_CamBayRdge\10_Eng\16_Geomatics\mxds\Cross_Sections\Cross_Section_Plan.mxd
PLOT DATE & TIME: 24/04/2012 1:32:08 PM
SAVE DATE & TIME: 24/04/2012 1:32:08 PM
USER NAME: ashling.mulcahy
ISSUING OFFICE: BURNABY GIS

A

A'

NOTE:
Surface elevations may be inaccurate.

BH-8
BH-1
BH-2
BH-5
BH-4
BH-3
TP-4

?
?
?
?

ESTIMATED ELEVATION (MASL)

50
40
30
20
10
0

0
200
400
600
800
1000

DISTANCE (M)

NOTE:
The depths of the various geological units are only accurate at borehole locations. The boundaries of the geological units between the boreholes are for illustrative purposes only and may not be accurate.

Legend

- Glaciomarine Beach Ridge
- Glacial Till
- Frost Shattered Bedrock
- Bedrock
- Digital Elevation Model (DEM) - 20m accuracy
- Interpreted Geological Boundary
- Inferred Geological Boudnary

B SHEET SCALE: N/A

OneWay™ to zero harm

Date:	19/11/2012
Drawn by:	Y.M.
Edited by:	K.R.
App'd by:	J.G.

CUSTOMER

WorleyParsons
resources & energy

CAMBRIDGE BAY GRAVEL SOURCING STUDY
GEOTECHNICAL SITE INVESTIGATION
GEOLOGICAL SECTION A - A'

WORLEYPARSONS PROJECT No. 307034-00016

FIGURE #: 3

REV. 0

FILE LOCATION: U:\YVR\307034\00017_GN_CamBayRdge\10_Eng\16_Geomatics\mxds\Cross_Sections\sectionA_RevA.mxd

PLOT DATE & TIME: 24/04/2012 1:32:08 PM
SAVE DATE & TIME: 24/04/2012 1:32:08 PM
USER NAME: ashling.mulcahy
ISSUING OFFICE: BURNABY GIS

105°17'0"W
105°16'0"W
105°15'0"W
105°14'0"W
69°6'0"N
7666000
7665000
489000
490000
491000
N
TP-10
BH-8
BH-1
TP-1A
BH-2
TP-1B
BH-7
TP-6
TP-11
BH-5
TP-5
TP-7
BH-4
TP-2
BH-6
TP-9
TP-8
BH-3
TP-3
TP-4
1:7,500
0 100 200
Meters

Legend

- Borehole / Test Pit Location
- Proposed Granular Quarry Pit Boundary

B SHEET SCALE: SHOWN

CUSTOMER

OneWay™ to zero harm

Date:	19/11/2012
Drawn by:	Y.M.
Edited by:	K.R.
App'd by:	J.G.

"This drawing is prepared for the use of our customer as specified in the accompanying report. WorleyParsons Canada Ltd. assumes no liability to any other party for any representations contained in this drawing."

WorleyParsons
resources & energy

CAMBRIDGE BAY GRAVEL SOURCING STUDY
GEOTECHNICAL SITE INVESTIGATION
PROPOSED QUARRY PIT BOUNDARY

WORLEYPARSONS PROJECT No.	FIGURE #:	REV.
307034-00016	4	0

FILE LOCATION: U:\YVR\307034\00017_GN_CamBayRdGe\10_Eng\16_Geomatics\mxds\Cross_Sections\Proposed_Quarry_Pit_Boundary.mxd

PLOT DATE & TIME: 24/04/2012 1:32:08 PM
SAVE DATE & TIME: 24/04/2012 1:32:08 PM

USER NAME: ashling.mulcahy
ISSUING OFFICE: BURNABY GIS

Appendices

Appendix 1 Laboratory Results

SOLUM™
CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL
TESTING LABORATORY

September 24, 2012

Worley Parsons
Suite 500, 151 Canada Olympic Rd SW
Calgary, AB T3B 5R5

Attention: Bruce Smith

Worley Parsons Project #: 307034-00017
Worley Parsons Project Name: N/A

Geotechnical Laboratory Testing Report (Part 2)

SOLUM Job #: 00101120912(113)
Received: September 12, 2012
# of Samples Received: 16 pails

Test	Quantity	ASTM Designation
Water (Moisture) Content	70	D2216
Greater Than No.200 Sieve Analysis	11	C136

Saad A.M. Farag
Principal
Solum Consultants Ltd.

K. Cao
Laboratory Manager
Solum Consultants Ltd.

Total Cover Pages: 1

9, 3620 29 Street NE, Calgary, AB T1Y 5Z8
Ph: (403) 250-3035 Fax: (403) 250-3021 Email: solum@mts.net

Laboratory Analysis Summary

SOLUM™
CONSULTANTS LTD.
GEOTECHNICAL & MATERIAL
TESTING LABORATORY

#9, 3620 - 29 Street, NE
Calgary, Alberta T1Y 5Z8
Ph: (403)250-3035
Fax: (403)250-3021
Email: solum@mts.net
www.solumconsultantsltd.com

Project Number:	307034-00016
Client:	Worley Parsons
Project Name:	N/A
Location:	N/A
Tested By:	KC/SF
Reviewed By:	
Date Reviewed:	22-Sep-12 (dd-mm-yy)

Results

Sample ID	Depth (m)	Particle Size Analysis*			
		Cobble Size (%) (75-300mm)	Gravel Size (%) (4.75-75mm)	Sand Size (%) (0.075-4.5mm)	Fines (%) (<0.075 mm)
CB-1	N/A	0.0	0.0	79.8	20.2
CB-2	N/A	0.0	0.0	83.1	16.9
CB-4	N/A	0.0	52.1	42.8	5.1
CB-5	N/A	0.0	62.5	35.0	2.5
CB-7	N/A	0.0	62.3	34.5	3.2
CB-8	N/A	0.0	77.6	18.5	3.9
CB-9	N/A	0.0	59.9	34.1	6.0
CB-12	N/A	0.0	65.6	29.0	5.4
CB-13	N/A	0.0	54.0	42.5	3.5
CB-18	N/A	0.0	0.0	62.8	37.2
CB19	N/A	0.0	0.0	22.1	77.9

Note: Gravels bigger than 3" were excluded.

Water (Moisture) Content (ASTM D2216)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

Project Number:	307034-00017		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Tested By:	KC/SF	Reviewed By:	SF
Date Tested:	23-Sep-12	(dd-mmm-yy)	

Borehole ID: BH-1

Sample ID	1	2	3	4	5	6
Depth (ft)	0.0 - 0.0	0.5 - 2.5	2.5 - 5.0	5.0 - 7.5	7.5 - 10.0	10.0 - 12.5
Depth (m)	0.00 - 0.00	0.15 - 0.76	0.76 - 1.52	1.52 - 2.29	2.29 - 3.05	3.05 - 3.81
Wet Sample Weight +Tare (g)	81.42	81.68	84.44	79.93	82.44	59.58
Dry Sample Weight +Tare (g)	77.56	79.32	82.39	77.52	78.70	56.02
Weight of Water (g)	3.86	2.36	2.05	2.41	3.74	3.56
Tare (g)	11.90	16.40	14.02	13.95	14.15	11.77
Weight of Dry Soil (g)	65.66	62.92	68.37	63.57	64.55	44.25
Water Content (%)	5.9	3.8	3.0	3.8	5.8	8.0

Sample ID	7	8	9			
Depth (ft)	12.5 - 15.0	15.0 - 17.5	17.5 - 20.0			
Depth (m)	3.81 - 4.57	4.57 - 5.33	5.33 - 6.10			
Wet Sample Weight +Tare (g)	80.16	69.30	71.60			
Dry Sample Weight +Tare (g)	75.03	64.93	67.92			
Weight of Water (g)	5.13	4.37	3.68			
Tare (g)	13.87	11.32	11.37			
Weight of Dry Soil (g)	61.16	53.61	56.55			
Water Content (%)	8.4	8.2	6.5			

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Water (Moisture) Content (ASTM D2216)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

Project Number:	307034-00017		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Tested By:	KC/SF	Reviewed By:	SF
Date Tested:	23-Sep-12	(dd-mmm-yy)	

Borehole ID: BH-2

Sample ID	1	2	3	4	5	6
Depth (ft)	0.0 - 0.3	0.3 - 2.5	2.5 - 5.0	5.0 - 7.5	7.5 - 10.0	10.0 - 12.5
Depth (m)	0.00 - 0.09	0.09 - 0.76	0.76 - 1.52	1.52 - 2.29	2.29 - 3.05	3.05 - 3.81
Wet Sample Weight +Tare (g)	105.59	80.12	98.52	71.13	61.50	92.25
Dry Sample Weight +Tare (g)	98.13	76.25	84.94	64.06	55.29	82.35
Weight of Water (g)	7.46	3.87	13.58	7.07	6.21	9.90
Tare (g)	11.79	14.18	13.90	14.94	14.02	16.75
Weight of Dry Soil (g)	86.34	62.07	71.04	49.12	41.27	65.60
Water Content (%)	8.6	6.2	19.1	14.4	15.0	15.1

Sample ID	7	8	9			
Depth (ft)	12.5 - 15.0	15.0 - 17.5	17.5 - 20.0			
Depth (m)	3.81 - 4.57	4.57 - 5.33	5.33 - 6.10			
Wet Sample Weight +Tare (g)	66.42	76.50	98.65			
Dry Sample Weight +Tare (g)	64.04	72.81	95.19			
Weight of Water (g)	2.38	3.69	3.46			
Tare (g)	14.14	14.22	15.44			
Weight of Dry Soil (g)	49.90	58.59	79.75			
Water Content (%)	4.8	6.3	4.3			

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Water (Moisture) Content (ASTM D2216)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

Project Number:	307034-00017		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Tested By:	KC/SF	Reviewed By:	SF
Date Tested:	23-Sep-12	(dd-mmm-yy)	

Borehole ID: BH-3

Sample ID	1	2	3	4	5	6
Depth (ft)	0.0 - 0.4	0.5 - 2.5	2.5 - 5.0	5.0 - 7.5	7.5 - 10.0	10.0 - 12.5
Depth (m)	0.00 - 0.12	0.15 - 0.76	0.76 - 1.52	1.52 - 2.29	2.29 - 3.05	3.05 - 3.81
Wet Sample Weight +Tare (g)	181.72	172.32	203.52	209.27	209.74	201.86
Dry Sample Weight +Tare (g)	174.42	168.14	184.92	191.10	192.19	189.80
Weight of Water (g)	7.30	4.18	18.60	18.17	17.55	12.06
Tare (g)	28.02	30.35	25.99	26.26	25.22	25.60
Weight of Dry Soil (g)	146.40	137.79	158.93	164.84	166.97	164.20
Water Content (%)	5.0	3.0	11.7	11.0	10.5	7.3

Sample ID	7	8	9			
Depth (ft)	12.5 - 15.0	15.0 - 17.5	17.5 - 20.0			
Depth (m)	3.81 - 4.57	4.57 - 5.33	5.33 - 6.10			
Wet Sample Weight +Tare (g)	150.20	151.54	139.31			
Dry Sample Weight +Tare (g)	146.92	147.15	135.26			
Weight of Water (g)	3.28	4.39	4.05			
Tare (g)	23.76	27.14	25.22			
Weight of Dry Soil (g)	123.16	120.01	110.04			
Water Content (%)	2.7	3.7	3.7			

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Water (Moisture) Content (ASTM D2216)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

Project Number:	307034-00017		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Tested By:	KC/SF	Reviewed By:	SF
Date Tested:	23-Sep-12	(dd-mmm-yy)	

Borehole ID: BH-4

Sample ID	1	2	3	4	5	6
Depth (ft)	0.0 - 0.0	0.5 - 2.5	2.5 - 5.0	5.0 - 7.5	7.5 - 10.0	10.0 - 12.5
Depth (m)	0.00 - 0.00	0.15 - 0.76	0.76 - 1.52	1.52 - 2.29	2.29 - 3.05	3.05 - 3.81
Wet Sample Weight +Tare (g)	142.96	166.67	158.36	194.04	156.56	143.86
Dry Sample Weight +Tare (g)	140.28	162.47	151.79	173.70	151.83	135.56
Weight of Water (g)	2.68	4.20	6.57	20.34	4.73	8.30
Tare (g)	36.58	26.57	26.55	28.27	28.70	31.24
Weight of Dry Soil (g)	103.70	135.90	125.24	145.43	123.13	104.32
Water Content (%)	2.6	3.1	5.2	14.0	3.8	8.0

Sample ID	7	8	9			
Depth (ft)	12.5 - 15.0	15.0 - 17.5	17.5 - 20.0			
Depth (m)	3.81 - 4.57	4.57 - 5.33	5.33 - 6.10			
Wet Sample Weight +Tare (g)	144.69	197.27	170.90			
Dry Sample Weight +Tare (g)	132.13	176.73	160.66			
Weight of Water (g)	12.56	20.54	10.24			
Tare (g)	26.14	26.46	24.28			
Weight of Dry Soil (g)	105.99	150.27	136.38			
Water Content (%)	11.9	13.7	7.5			

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Water (Moisture) Content (ASTM D2216)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

Project Number:	307034-00017		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Tested By:	KC/SF	Reviewed By:	SF
Date Tested:	23-Sep-12	(dd-mmm-yy)	

Borehole ID: BH-5

Sample ID	1	2	3	4	5	6
Depth (ft)	0.0 - 0.0	0.5 - 2.5	2.5 - 5.0	5.0 - 7.5	7.5 - 10.0	10.0 - 12.5
Depth (m)	0.00 - 0.00	0.15 - 0.76	0.76 - 1.52	1.52 - 2.29	2.29 - 3.05	3.05 - 3.81
Wet Sample Weight +Tare (g)	163.76	150.17	170.73	153.27	184.14	145.30
Dry Sample Weight +Tare (g)	157.81	146.40	163.47	147.69	175.52	138.58
Weight of Water (g)	5.95	3.77	7.26	5.58	8.62	6.72
Tare (g)	26.53	26.97	38.65	26.57	36.94	27.51
Weight of Dry Soil (g)	131.28	119.43	124.82	121.12	138.58	111.07
Water Content (%)	4.5	3.2	5.8	4.6	6.2	6.1

Sample ID	7	8	9			
Depth (ft)	12.5 - 15.0	15.0 - 17.5	17.5 - 20.0			
Depth (m)	3.81 - 4.57	4.57 - 5.33	5.33 - 6.10			
Wet Sample Weight +Tare (g)	135.87	167.00	141.15			
Dry Sample Weight +Tare (g)	131.90	161.30	136.82			
Weight of Water (g)	3.97	5.70	4.33			
Tare (g)	27.82	26.29	24.75			
Weight of Dry Soil (g)	104.08	135.01	112.07			
Water Content (%)	3.8	4.2	3.9			

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Water (Moisture) Content (ASTM D2216)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

Project Number:	307034-00017		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Tested By:	KC/SF	Reviewed By:	SF
Date Tested:	23-Sep-12	(dd-mmm-yy)	

Borehole ID: BH-6

Sample ID	1	2	3	4	5	6
Depth (ft)	0.0 - 0.3	0.3 - 2.5	2.5 - 5.0	5.0 - 7.5	7.5 - 10.0	10.0 - 12.5
Depth (m)	0.00 - 0.09	0.09 - 0.76	0.76 - 1.52	1.52 - 2.29	2.29 - 3.05	3.05 - 3.81
Wet Sample Weight +Tare (g)	174.17	170.41	160.98	154.87	228.80	190.90
Dry Sample Weight +Tare (g)	168.76	158.34	150.65	148.93	218.79	178.60
Weight of Water (g)	5.41	12.07	10.33	5.94	10.01	12.30
Tare (g)	34.86	26.83	28.09	27.13	38.97	27.12
Weight of Dry Soil (g)	133.90	131.51	122.56	121.80	179.82	151.48
Water Content (%)	4.0	9.2	8.4	4.9	5.6	8.1

Sample ID	7	8				
Depth (ft)	12.5 - 15.0	15.0 - 17.5				
Depth (m)	3.81 - 4.57	4.57 - 5.33				
Wet Sample Weight +Tare (g)	145.37	193.41				
Dry Sample Weight +Tare (g)	137.74	181.56				
Weight of Water (g)	7.63	11.85				
Tare (g)	27.94	36.27				
Weight of Dry Soil (g)	109.80	145.29				
Water Content (%)	6.9	8.2				

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Water (Moisture) Content (ASTM D2216)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

Project Number:	307034-00017		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Tested By:	KC/SF	Reviewed By:	SF
Date Tested:	23-Sep-12	(dd-mmm-yy)	

Borehole ID: BH-7

Sample ID	1	2	3	4	5	6
Depth (ft)	0.5 - 2.5	2.5 - 5.0	5.0 - 7.5	7.5 - 10.0	10.0 - 12.5	12.5 - 15.0
Depth (m)	0.15 - 0.76	0.76 - 1.52	1.52 - 2.29	2.29 - 3.05	3.05 - 3.81	3.81 - 4.57
Wet Sample Weight +Tare (g)	250.39	260.47	264.44	206.43	266.79	191.65
Dry Sample Weight +Tare (g)	245.92	257.92	249.99	199.24	260.24	186.37
Weight of Water (g)	4.47	2.55	14.45	7.19	6.55	5.28
Tare (g)	26.46	26.92	38.10	26.57	36.89	27.49
Weight of Dry Soil (g)	219.46	231.00	211.89	172.67	223.35	158.88
Water Content (%)	2.0	1.1	6.8	4.2	2.9	3.3

Sample ID	7	8	9			
Depth (ft)	15.0 - 17.5	17.5 - 20.0	20.0 - 20.5			
Depth (m)	4.57 - 5.33	5.33 - 6.10	6.10 - 6.25			
Wet Sample Weight +Tare (g)	182.03	206.33	226.03			
Dry Sample Weight +Tare (g)	173.84	201.97	222.58			
Weight of Water (g)	8.19	4.36	3.45			
Tare (g)	27.65	25.98	24.73			
Weight of Dry Soil (g)	146.19	175.99	197.85			
Water Content (%)	5.6	2.5	1.7			

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Water (Moisture) Content (ASTM D2216)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

Project Number:	307034-00017		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Tested By:	KC/SF	Reviewed By:	SF
Date Tested:	23-Sep-12	(dd-mmm-yy)	

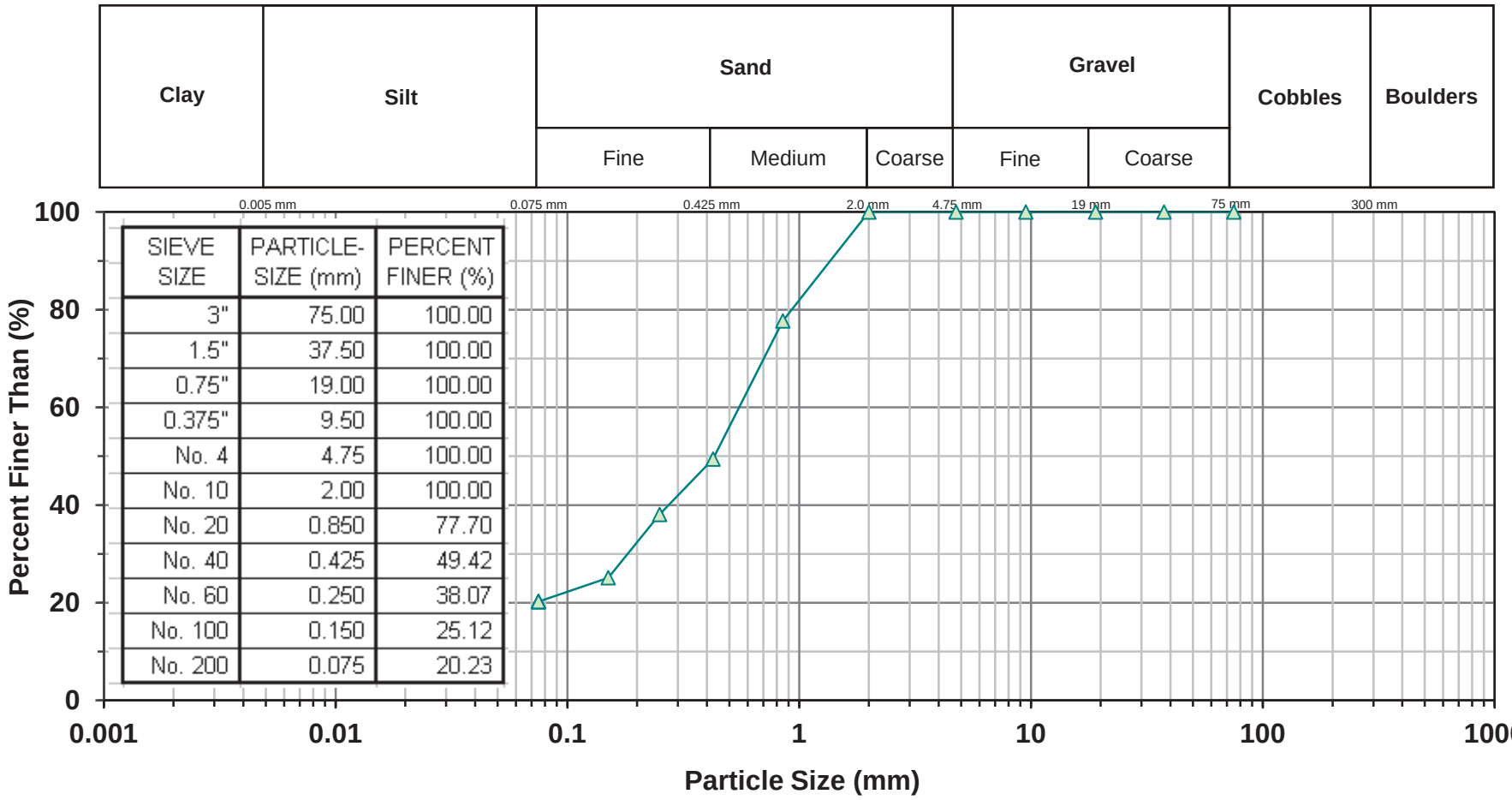
Borehole ID: BH-8

Sample ID	1	2	3	4	5	6
Depth (ft)	0.0 - 0.5	0.5 - 2.5	2.5 - 5.0	5.0 - 7.5	7.5 - 10.0	10.0 - 12.5
Depth (m)	0.00 - 0.15	0.15 - 0.76	0.76 - 1.52	1.52 - 2.29	2.29 - 3.05	3.05 - 3.81
Wet Sample Weight +Tare (g)	149.60	169.60	260.76	186.84	246.70	197.21
Dry Sample Weight +Tare (g)	139.92	165.47	246.07	170.86	221.62	175.22
Weight of Water (g)	9.68	4.13	14.69	15.98	25.08	21.99
Tare (g)	35.37	26.82	27.62	26.86	38.67	26.96
Weight of Dry Soil (g)	104.55	138.65	218.45	144.00	182.95	148.26
Water Content (%)	9.3	3.0	6.7	11.1	13.7	14.8

Sample ID	7	8				
Depth (ft)	12.5 - 15.0	15.0 - 17.5				
Depth (m)	3.81 - 4.57	4.57 - 5.33				
Wet Sample Weight +Tare (g)	173.54	253.29				
Dry Sample Weight +Tare (g)	155.08	224.17				
Weight of Water (g)	18.46	29.12				
Tare (g)	27.53	35.50				
Weight of Dry Soil (g)	127.55	188.67				
Water Content (%)	14.5	15.4				

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						

Sample ID						
Depth (ft)						
Depth (m)						
Wet Sample Weight +Tare (g)						
Dry Sample Weight +Tare (g)						
Weight of Water (g)						
Tare (g)						
Weight of Dry Soil (g)						
Water Content (%)						



SIEVE SIZE	PARTICLE-SIZE (mm)	PERCENT FINER (%)
3"	75.00	100.00
1.5"	37.50	100.00
0.75"	19.00	100.00
0.375"	9.50	100.00
No. 4	4.75	100.00
No. 10	2.00	100.00
No. 20	0.850	77.70
No. 40	0.425	49.42
No. 60	0.250	38.07
No. 100	0.150	25.12
No. 200	0.075	20.23

Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00017

Sample ID: CB-1

Depth: N/A

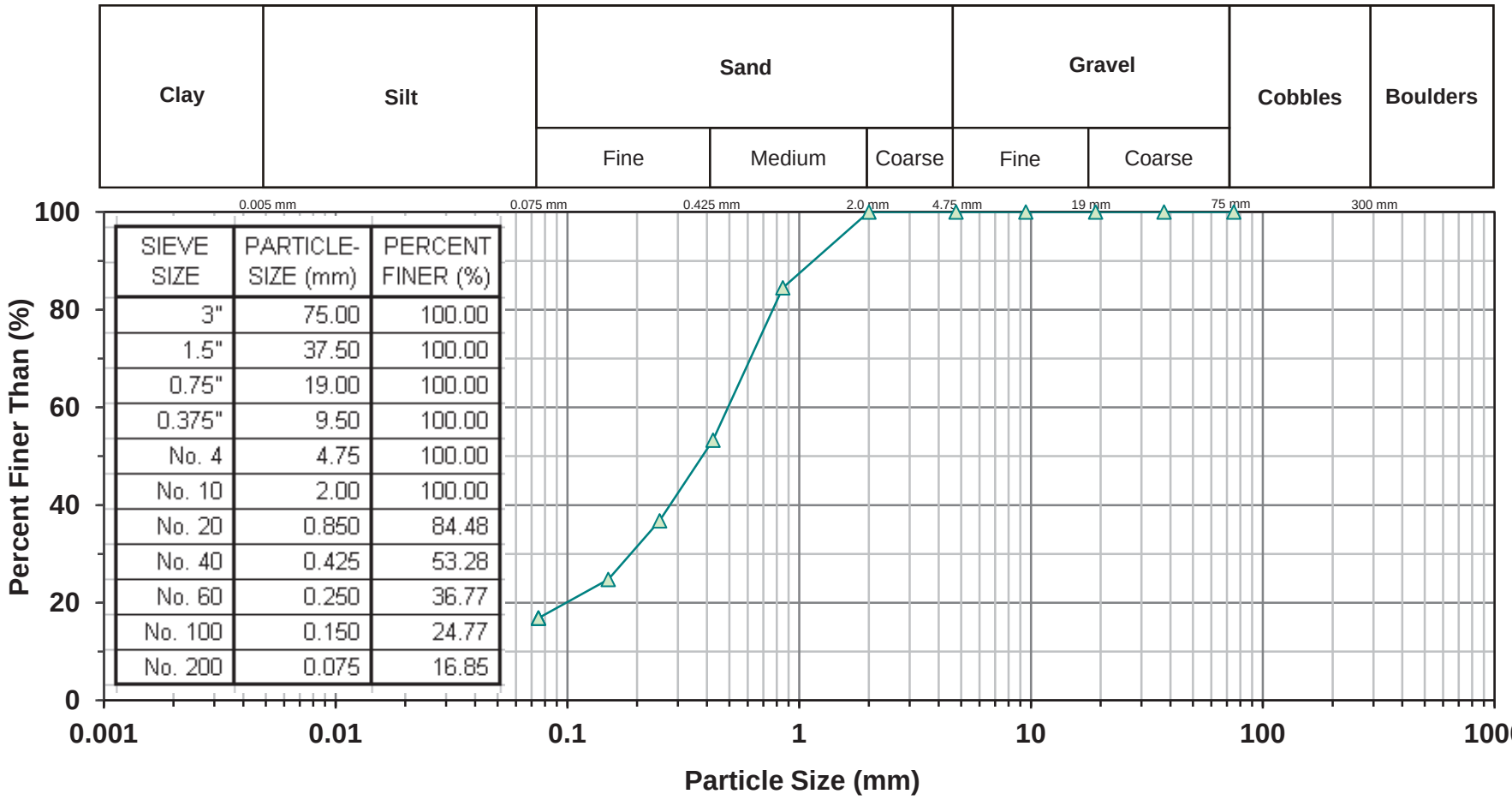
Particle Size (%)

Cobbles:	0.0
Gravel:	0.0
Sand:	79.8
Fines:	20.2

Tested by: **KC/SF**

Date Tested: **23-Sep-12**

Approved by: **SF**



SIEVE SIZE	PARTICLE-SIZE (mm)	PERCENT FINER (%)
3"	75.00	100.00
1.5"	37.50	100.00
0.75"	19.00	100.00
0.375"	9.50	100.00
No. 4	4.75	100.00
No. 10	2.00	100.00
No. 20	0.850	84.48
No. 40	0.425	53.28
No. 60	0.250	36.77
No. 100	0.150	24.77
No. 200	0.075	16.85

Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00017

Sample ID: CB-2

Depth: N/A

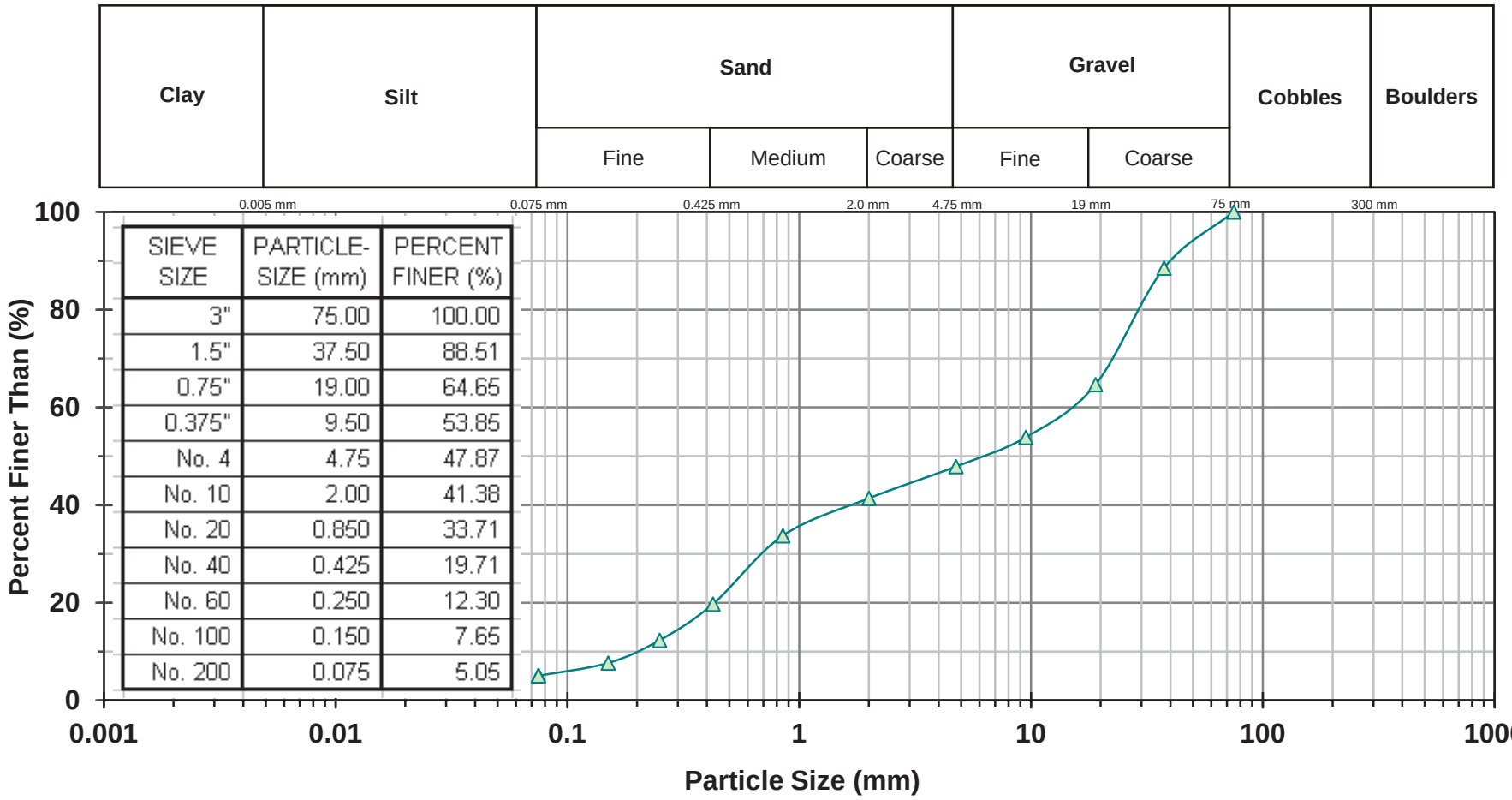
Particle Size (%)

Cobbles:	0.0
Gravel:	0.0
Sand:	83.1
Fines:	16.9

Tested by: **KC/SF**

Date Tested: **23-Sep-12**

Approved by: **SF**



SIEVE SIZE	PARTICLE-SIZE (mm)	PERCENT FINER (%)
3"	75.00	100.00
1.5"	37.50	88.51
0.75"	19.00	64.65
0.375"	9.50	53.85
No. 4	4.75	47.87
No. 10	2.00	41.38
No. 20	0.850	33.71
No. 40	0.425	19.71
No. 60	0.250	12.30
No. 100	0.150	7.65
No. 200	0.075	5.05

Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00017

Sample ID: CB-4

Depth: N/A

A visual examination of the material in the field indicates that it contains approximately 30 to 40% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

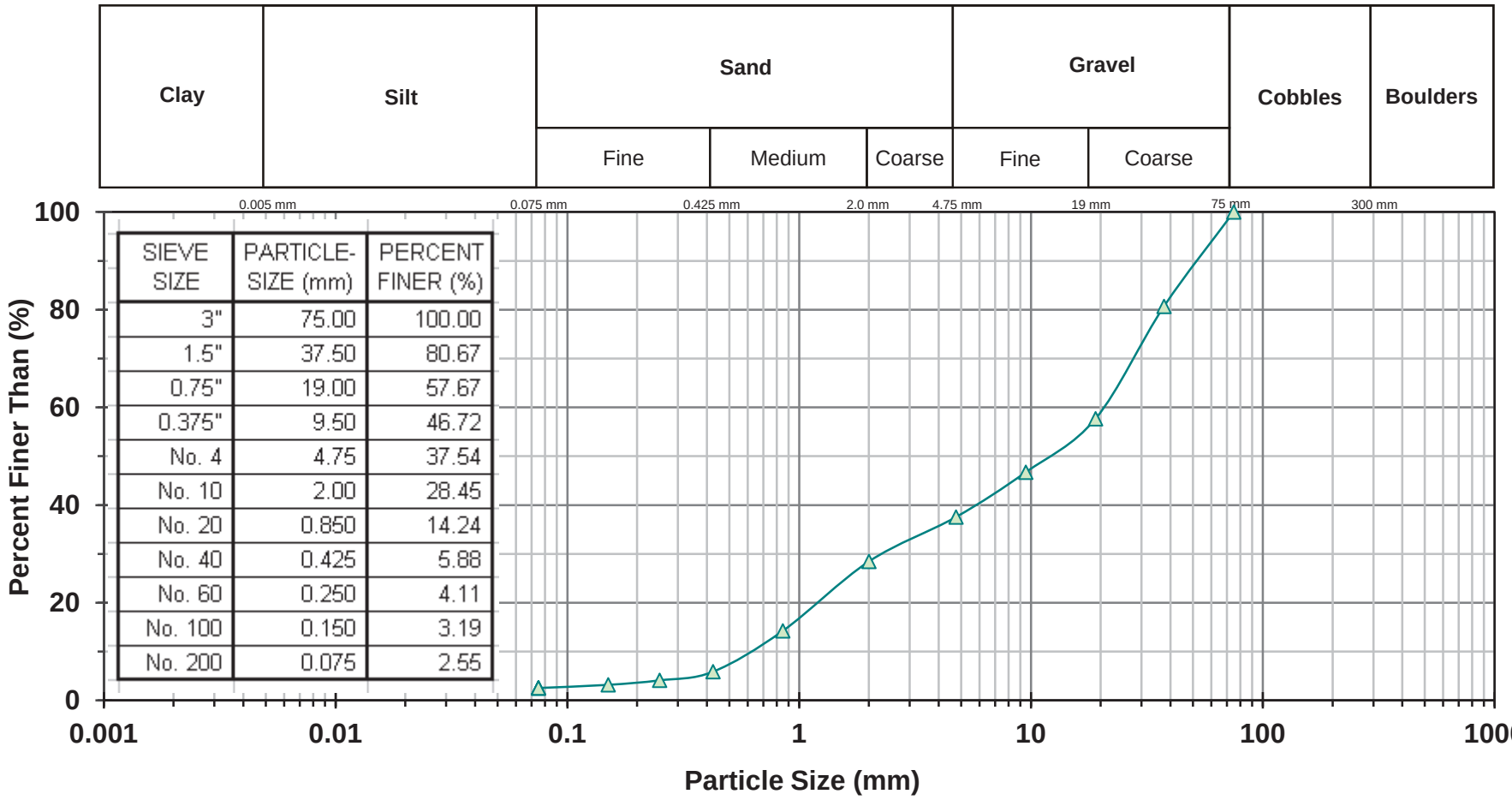
Particle Size (%)

Cobbles:	0.0
Gravel:	52.1
Sand:	42.8
Fines:	5.1

Tested by: **KC/SF**

Date Tested: **23-Sep-12**

Approved by: **SF**



SIEVE SIZE	PARTICLE-SIZE (mm)	PERCENT FINER (%)
3"	75.00	100.00
1.5"	37.50	80.67
0.75"	19.00	57.67
0.375"	9.50	46.72
No. 4	4.75	37.54
No. 10	2.00	28.45
No. 20	0.850	14.24
No. 40	0.425	5.88
No. 60	0.250	4.11
No. 100	0.150	3.19
No. 200	0.075	2.55

Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

Client: Worley Parsons

Project No.: 307034-00017

Sample ID: CB-5

Depth: N/A

N/A

A visual examination of the material in the field indicates that it contains approximately 35 to 45% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

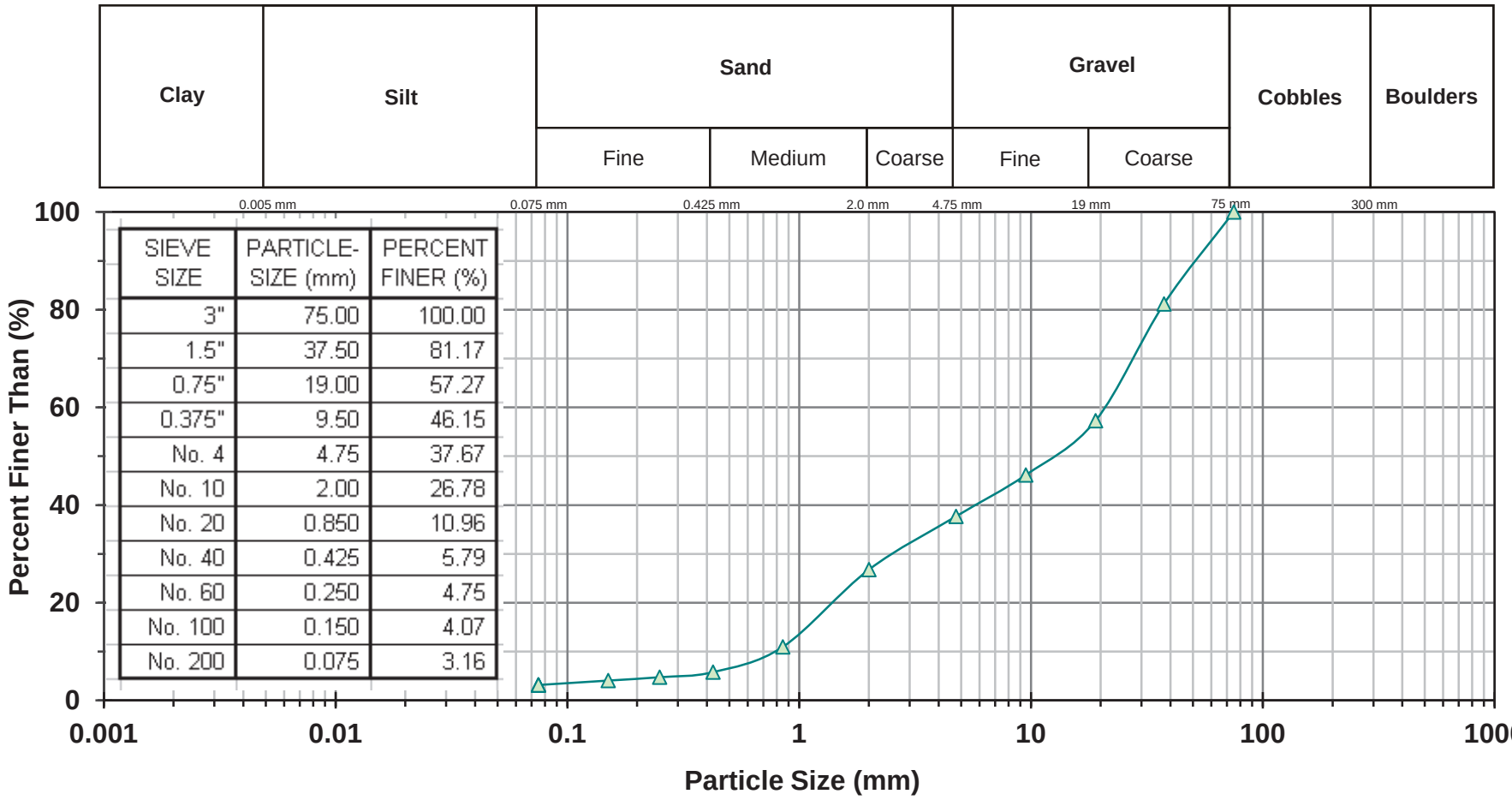
Particle Size (%)

Cobbles:	0.0
Gravel:	62.5
Sand:	35.0
Fines:	2.5

Tested by: **KC/SF**

Date Tested: **23-Sep-12**

Approved by: **SF**



Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00017

Sample ID: CB-7

Depth: N/A

A visual examination of the material in the field indicates that it contains approximately 10 to 20% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

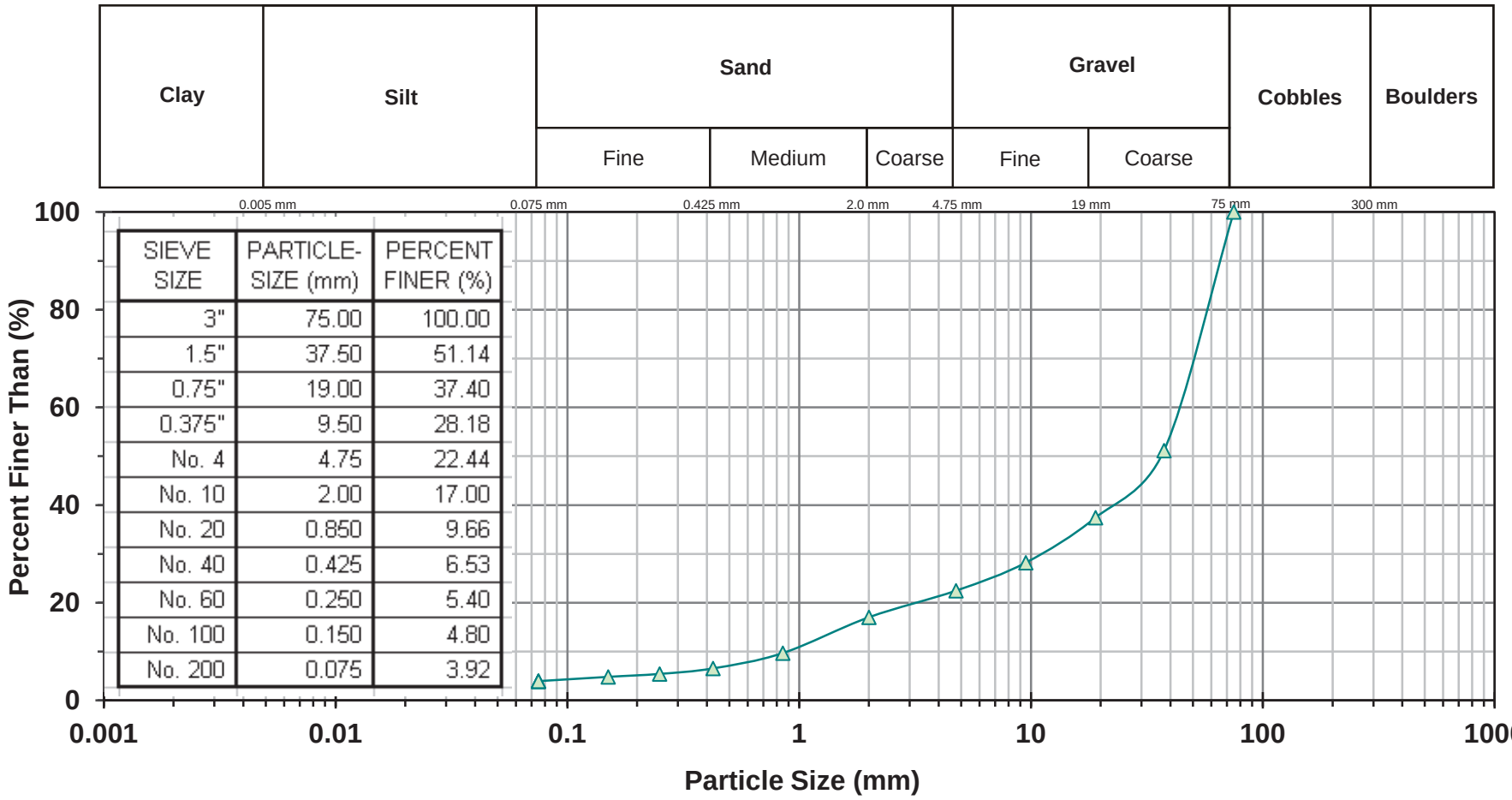
Particle Size (%)

Cobbles:	0.0
Gravel:	62.3
Sand:	34.5
Fines:	3.2

Tested by: **KC/SF**

Date Tested: **23-Sep-12**

Approved by: **SF**



SIEVE SIZE	PARTICLE-SIZE (mm)	PERCENT FINER (%)
3"	75.00	100.00
1.5"	37.50	51.14
0.75"	19.00	37.40
0.375"	9.50	28.18
No. 4	4.75	22.44
No. 10	2.00	17.00
No. 20	0.850	9.66
No. 40	0.425	6.53
No. 60	0.250	5.40
No. 100	0.150	4.80
No. 200	0.075	3.92

Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00017

Sample ID: CB-8

Depth: N/A

A visual examination of the material in the field indicates that it contains approximately 40 to 50% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

Particle Size (%)

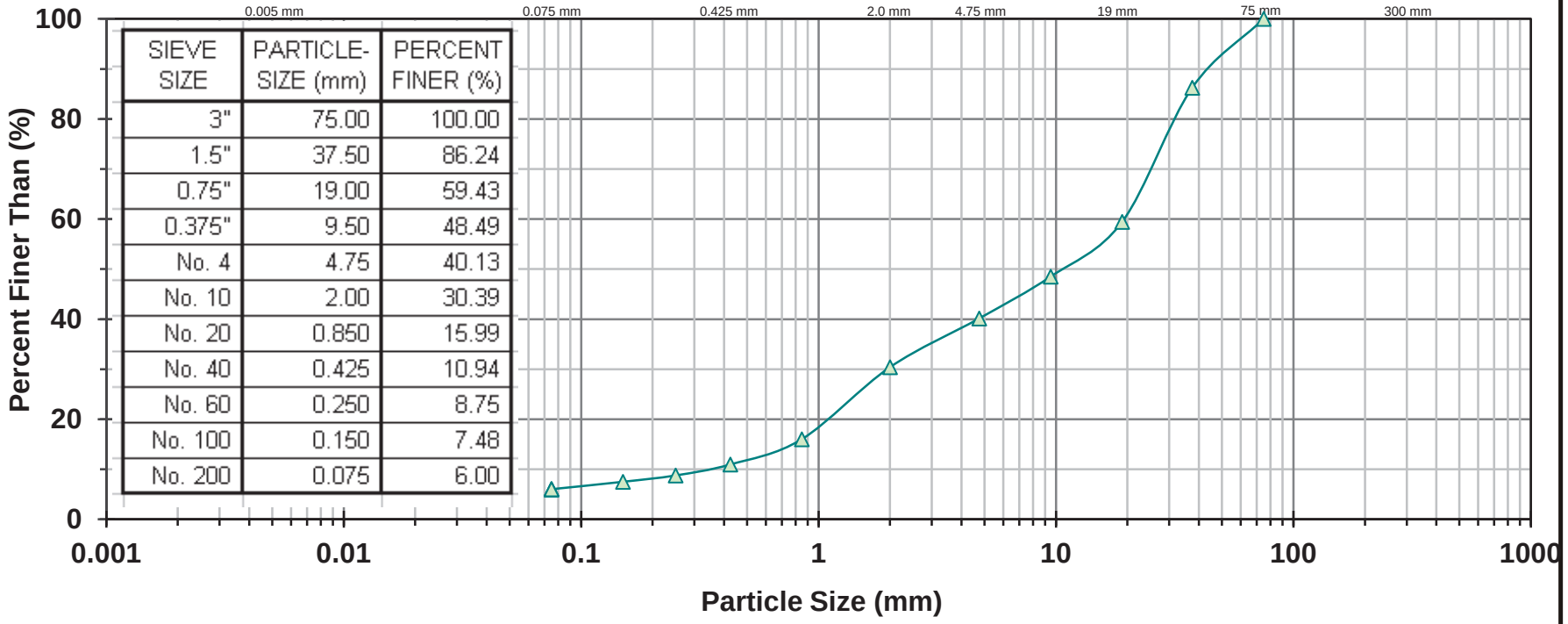
Cobbles:	0.0
Gravel:	77.6
Sand:	18.5
Fines:	3.9

Tested by: **KC/SF**

Date Tested: **23-Sep-12**

Approved by: **SF**

Clay	Silt	Sand			Gravel		Cobbles	Boulders
		Fine	Medium	Coarse	Fine	Coarse		



SIEVE SIZE	PARTICLE-SIZE (mm)	PERCENT FINER (%)
3"	75.00	100.00
1.5"	37.50	86.24
0.75"	19.00	59.43
0.375"	9.50	48.49
No. 4	4.75	40.13
No. 10	2.00	30.39
No. 20	0.850	15.99
No. 40	0.425	10.94
No. 60	0.250	8.75
No. 100	0.150	7.48
No. 200	0.075	6.00

Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00017

Sample ID: CB-9

Depth: N/A

A visual examination of the material in the field indicates that it contains approximately 15 to 25% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

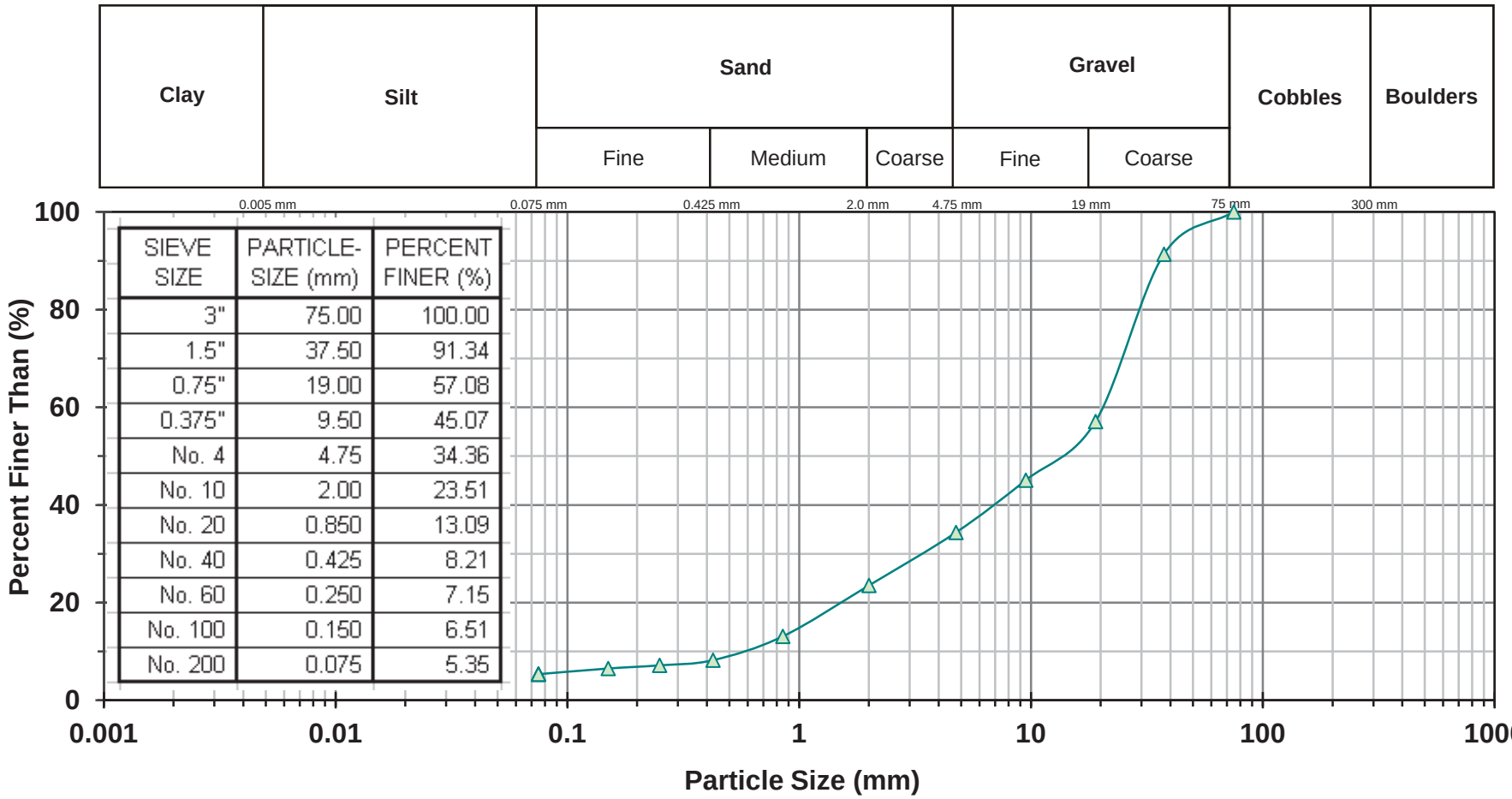
Particle Size (%)

Cobbles:	0.0
Gravel:	59.9
Sand:	34.1
Fines:	6.0

Tested by: **KC/SF**

Date Tested: **23-Sep-12**

Approved by: **SF**



SIEVE SIZE	PARTICLE-SIZE (mm)	PERCENT FINER (%)
3"	75.00	100.00
1.5"	37.50	91.34
0.75"	19.00	57.08
0.375"	9.50	45.07
No. 4	4.75	34.36
No. 10	2.00	23.51
No. 20	0.850	13.09
No. 40	0.425	8.21
No. 60	0.250	7.15
No. 100	0.150	6.51
No. 200	0.075	5.35

Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00017

Sample ID: CB-12

Depth: N/A

A visual examination of the material in the field indicates that it contains approximately 45 to 55% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

Particle Size (%)

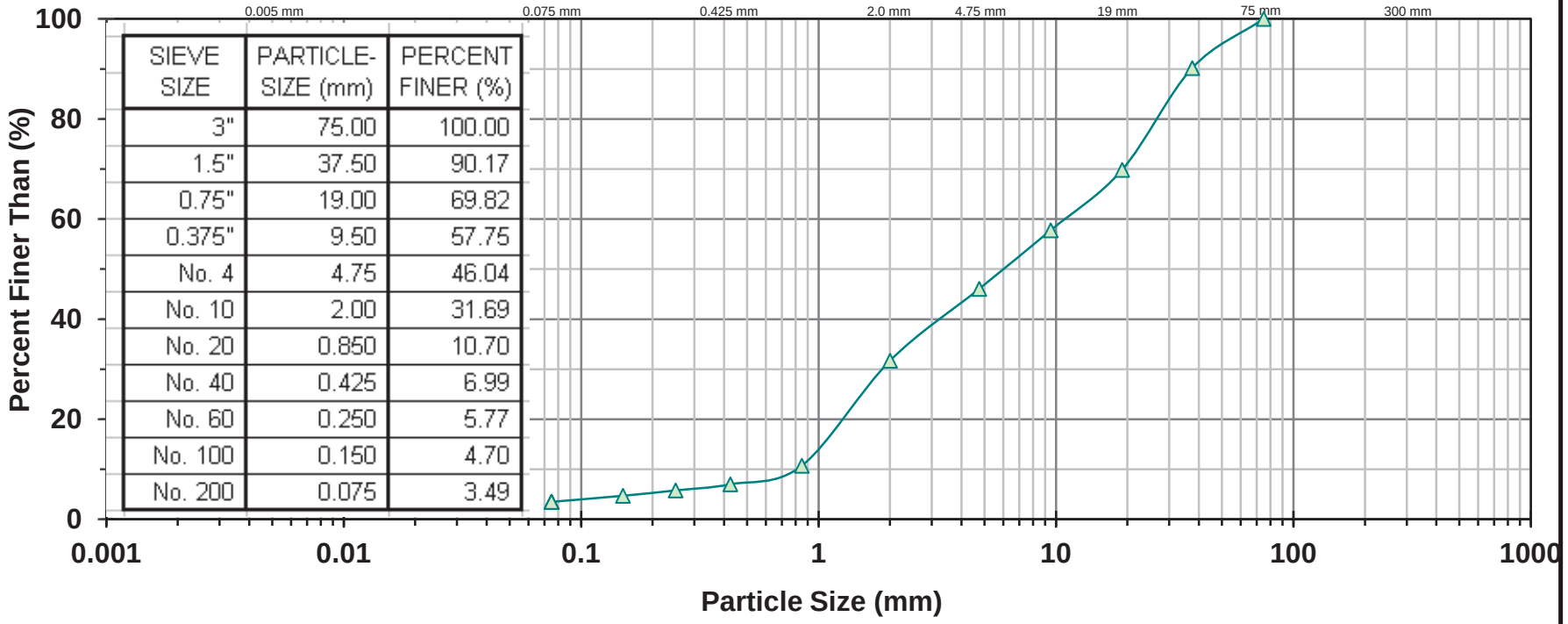
Cobbles:	0.0
Gravel:	65.6
Sand:	29.0
Fines:	5.4

Tested by: **KC/SF**

Date Tested: **23-Sep-12**

Approved by: **SF**

Clay	Silt	Sand			Gravel		Cobbles	Boulders
		Fine	Medium	Coarse	Fine	Coarse		



SIEVE SIZE	PARTICLE-SIZE (mm)	PERCENT FINER (%)
3"	75.00	100.00
1.5"	37.50	90.17
0.75"	19.00	69.82
0.375"	9.50	57.75
No. 4	4.75	46.04
No. 10	2.00	31.69
No. 20	0.850	10.70
No. 40	0.425	6.99
No. 60	0.250	5.77
No. 100	0.150	4.70
No. 200	0.075	3.49

Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00017

Sample ID: CB-13

Depth: N/A

A visual examination of the material in the field indicates that it contains approximately 35 to 45% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

Particle Size (%)

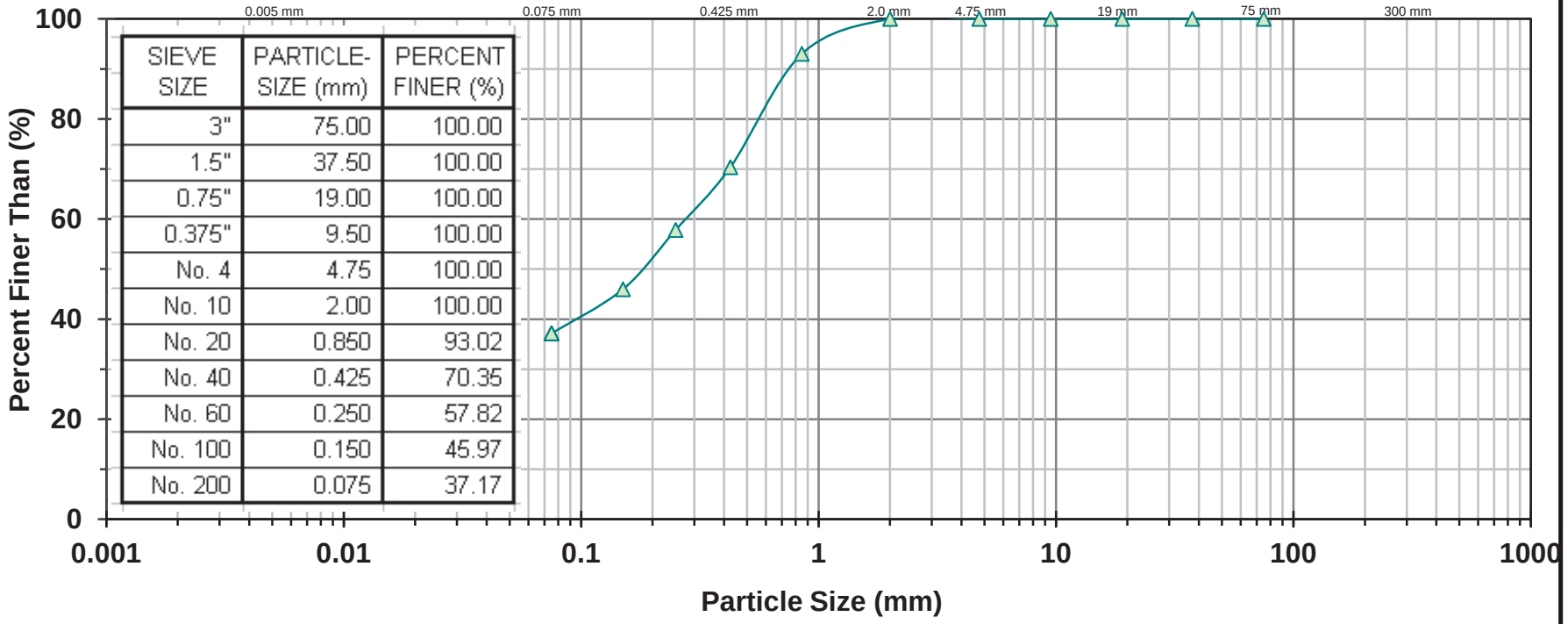
Cobbles:	0.0
Gravel:	54.0
Sand:	42.5
Fines:	3.5

Tested by: **KC/SF**

Date Tested: **23-Sep-12**

Approved by: **SF**

Clay	Silt	Sand			Gravel		Cobbles	Boulders
		Fine	Medium	Coarse	Fine	Coarse		



SIEVE SIZE	PARTICLE-SIZE (mm)	PERCENT FINER (%)
3"	75.00	100.00
1.5"	37.50	100.00
0.75"	19.00	100.00
0.375"	9.50	100.00
No. 4	4.75	100.00
No. 10	2.00	100.00
No. 20	0.850	93.02
No. 40	0.425	70.35
No. 60	0.250	57.82
No. 100	0.150	45.97
No. 200	0.075	37.17

Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00017

Sample ID: CB-18

Depth: N/A

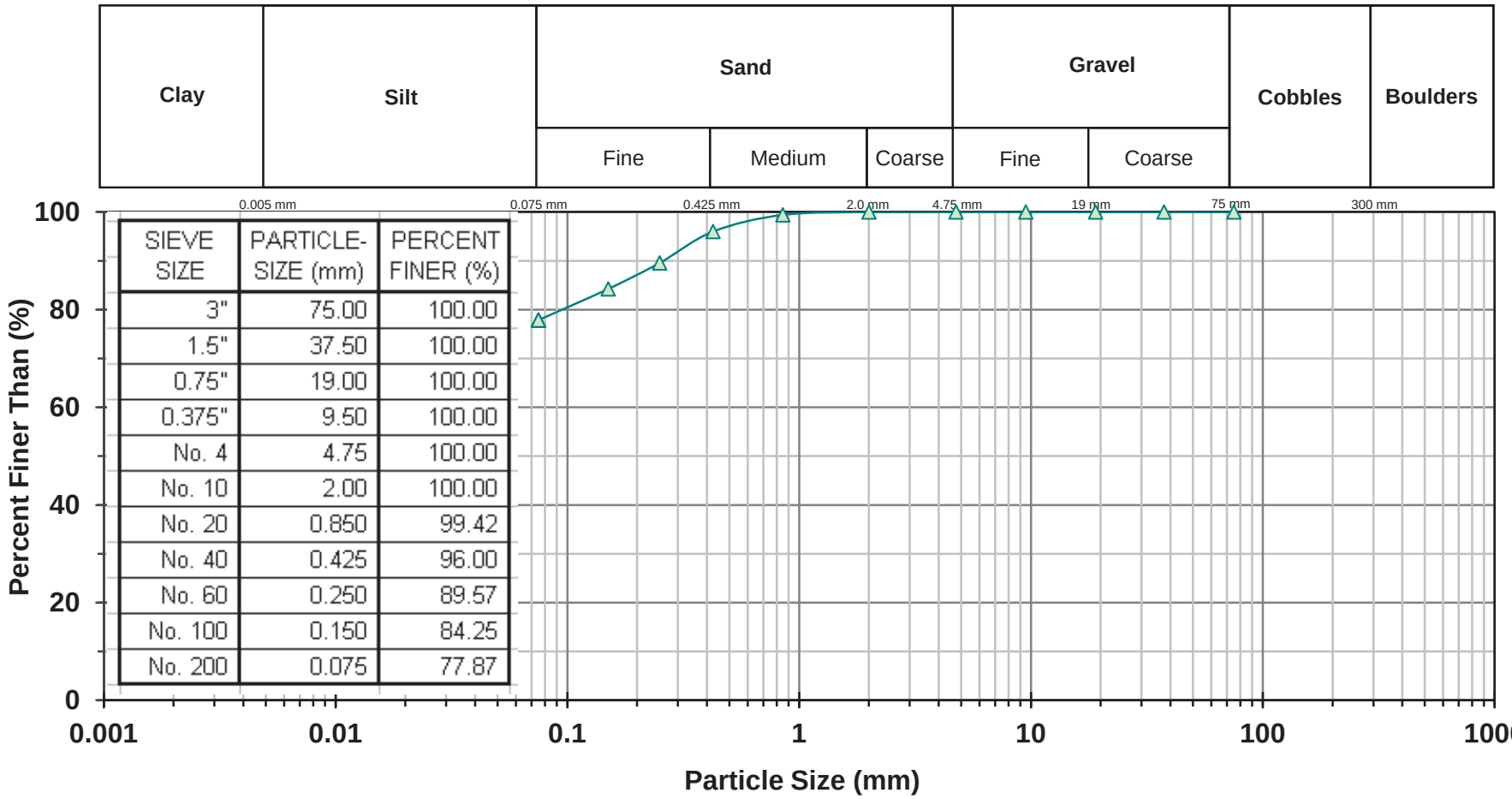
Particle Size (%)

Cobbles:	0.0
Gravel:	0.0
Sand:	62.8
Fines:	37.2

Tested by: **KC/SF**

Date Tested: **23-Sep-12**

Approved by: **SF**



SIEVE SIZE	PARTICLE-SIZE (mm)	PERCENT FINER (%)
3"	75.00	100.00
1.5"	37.50	100.00
0.75"	19.00	100.00
0.375"	9.50	100.00
No. 4	4.75	100.00
No. 10	2.00	100.00
No. 20	0.850	99.42
No. 40	0.425	96.00
No. 60	0.250	89.57
No. 100	0.150	84.25
No. 200	0.075	77.87

Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00017

Sample ID: CB-19

Depth: N/A

Particle Size (%)

Cobbles:	0.0
Gravel:	0.0
Sand:	22.1
Fines:	77.9

Tested by: **KC/SF**

Date Tested: **23-Sep-12**

Approved by: **SF**

SOLUM™
CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL
TESTING LABORATORY

September 23, 2012

Worley Parsons
Suite 500, 151 Canada Olympic Rd SW
Calgary, AB T3B 5R5

Attention: Bruce Smith

Worley Parsons Project #: 307034-00016
Worley Parsons Project Name: N/A

Geotechnical Laboratory Testing Report (Part 1)

SOLUM Job #: 00101120912(113)
Received: September 12, 2012
# of Samples Received: 16 pails

Test	Quantity	ASTM Designation
Water (Moisture) Content	8	D2216
Atterberg Limits	8	D4318
Particle-Size Analysis (Full Gradation)	8	D422

Saad A.M. Farag
Principal
Solum Consultants Ltd.

K. Cao
Laboratory Manager
Solum Consultants Ltd.

Total Cover Pages: 1

9, 3620 29 Street NE, Calgary, AB T1Y 5Z8
Ph: (403) 250-3035 Fax: (403) 250-3021 Email: solum@mts.net

Laboratory Analysis Summary

SOLUM™ CONSULTANTS LTD.
GEOTECHNICAL & MATERIAL TESTING LABORATORY

#9, 3620 - 29 Street, NE
Calgary, Alberta T1Y 5Z8
Ph: (403)250-3035
Fax: (403)250-3021
Email: solum@mts.net
www.solumconsultantsltd.com

Project Number:	307034-00016
Client:	Worley Parsons
Project Name:	N/A
Location:	N/A
Tested By:	KC/SF
Reviewed By:	
Date Reviewed:	22-Sep-12 (dd-mm-yy)

Results

Sample ID	Depth (m)	Moisture Content(%)	Atterberg Limits				Particle Size Analysis					Soil Classification** Group Symbols
			Liquid Limit(%)	Plastic Limit(%)	Plastic Index(%)	Classification* (USCS)	Cobble Size (%) (75-300mm)	Gravel Size (%) (4.75-75mm)	Sand Size (%) (0.075-4.5mm)	Silt Size (%) (0.005-0.075 mm)	Clay Size (%) (<0.005mm)	
CB3	N/A	24.3	24	13	11	CL	0.0	60.4	29.1	7.4	3.1	GC
CB6	N/A	13.2	25	13	12	CL	0.0	19.5	40.9	23.1	16.5	SC
CB10	N/A	14.2	20	20	0	NP	0.0	8.0	37.7	31.9	22.4	ML
CB11	N/A	11.5	24	13	11	CL	0.0	16.6	59.8	10.2	13.4	SC
CB14	N/A	12.7	19	11	8	CL	0.0	34.4	40.2	14.5	10.9	SC
CB15	N/A	12.2	30	13	17	CL	0.0	11.6	39.9	22.4	26.1	SC
CB16	N/A	10.2	20	12	8	CL	0.0	10.1	70.8	10.4	8.7	SC
CB17	N/A	11.1	19	11	8	CL	0.0	2.3	45.3	33.6	18.8	CL

* Note: Soil classification is for material less than 0.425 mm (material used for Atterberg Limits), this includes the fine sand, silt and clay fraction of the sample.

** Note: Soil classification is for the whole sample. Soil classification uses the Atterberg Limits results and the percent fines, percent sand and percent gravel as described in ASTM D2487.

Atterberg Limits (ASTM D4318) - Method A

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

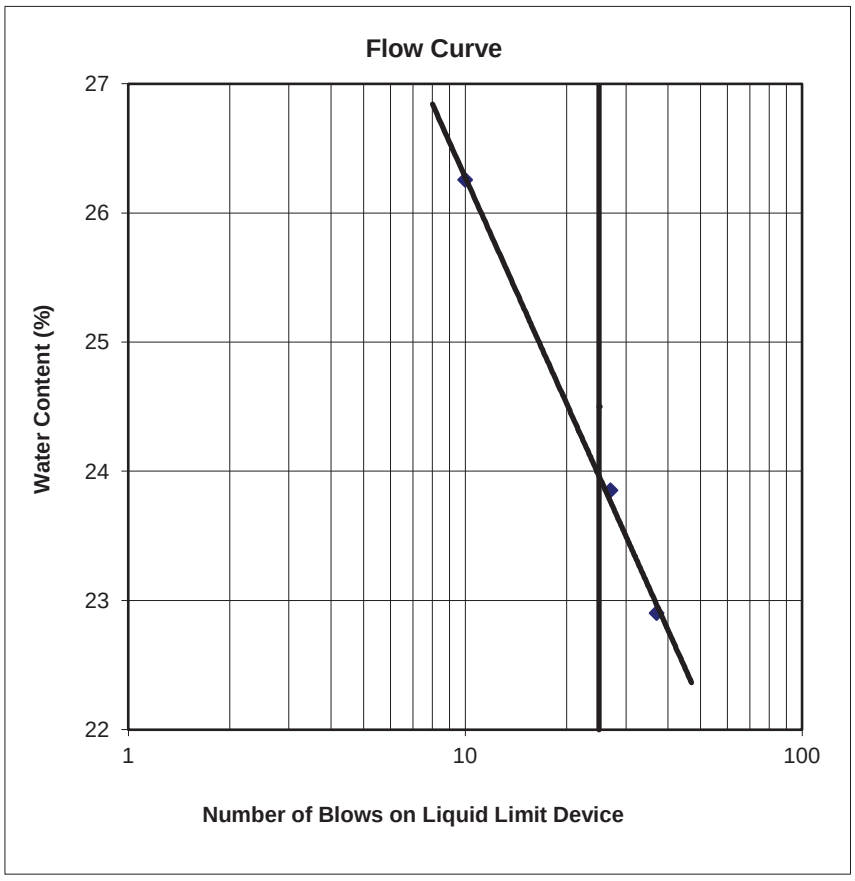
Project Number:	307034-00016		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Sample ID	CB3	Depth:	N/A
Tested By:	KC	Reviewed By:	SF
Date Tested:	22-Sep-12	(dd-mmm-yy)	

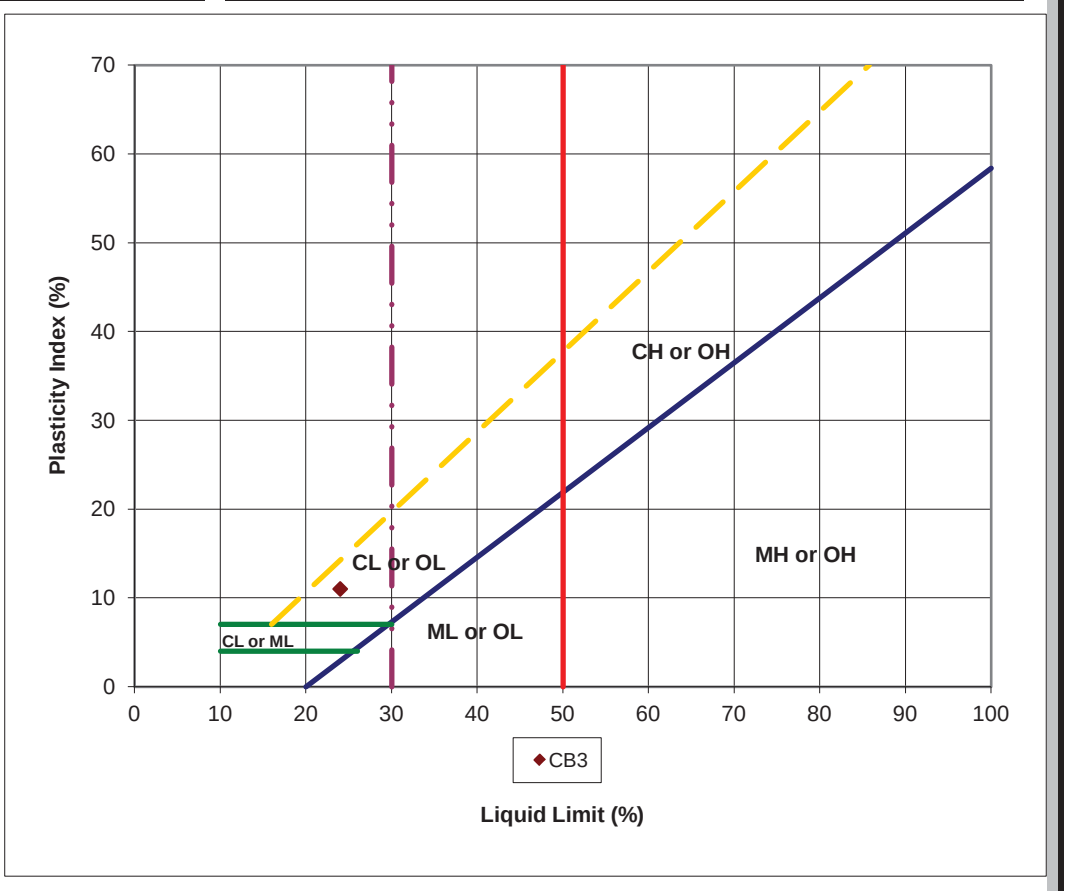
Sample Information

	Liquid Limit (Air Dried) - Multipoint Method			Liquid Limit (Oven Dried)	
Container ID	1	2	3		
Number of Blows	10	27	37		
Wet Sample Weight +Tare (g)	26.52	24.01	23.54		
Dry Sample Weight +Tare (g)	23.49	21.62	21.33		
Weight of Water (g)	3.03	2.39	2.21		
Tare (g)	11.95	11.60	11.68		
Weight of Dry Soil (g)	11.54	10.02	9.65		
Water Content (%)	26.3	23.9	22.9		

	Plastic Limit	
Container ID	4	5
Wet Sample Weight +Tare (g)	37.92	35.87
Dry Sample Weight +Tare (g)	35.16	33.42
Weight of Water (g)	2.76	2.45
Tare (g)	14.04	13.99
Weight of Dry Soil (g)	21.12	19.43
Water Content (%)	13.1%	12.6%
Average Water Content (%)	12.8	

Results	
Liquid Limit (Air Dried) (%)	24
Liquid Limit (Oven Dried) (%)	---
LL % Difference	---
Plastic Limit (%)	13
Plasticity Index (%)	11
-40 Mesh Sieve (y/n)	y
Unified Soil Classification System	CL





Atterberg Limits (ASTM D4318) - Method A

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

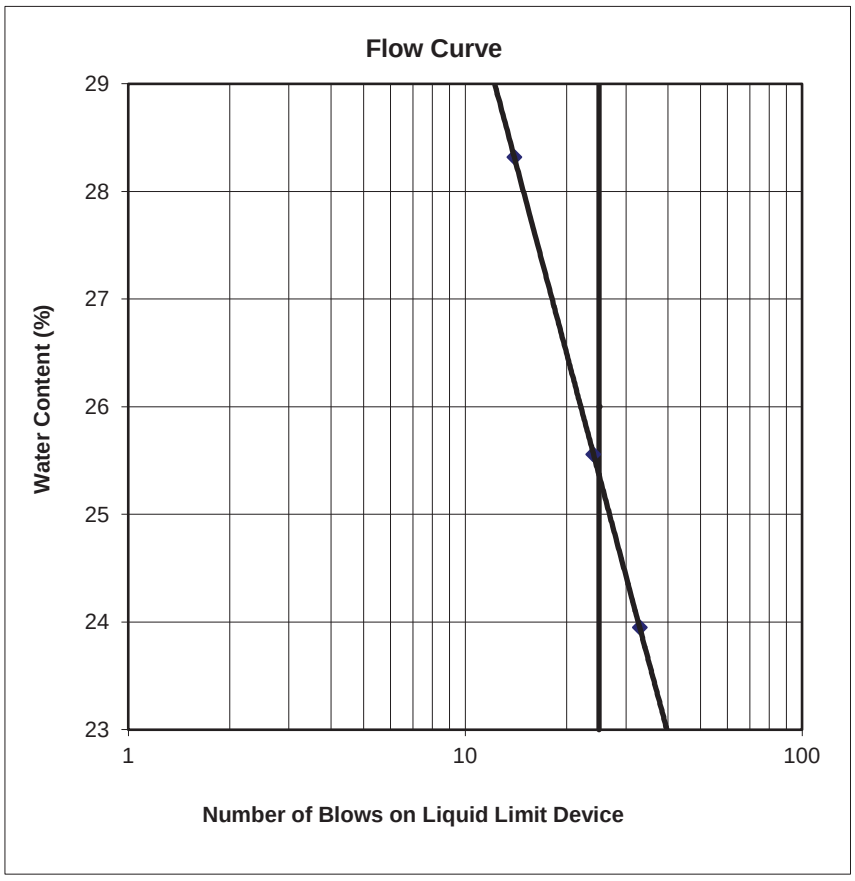
Project Number:	307034-00016		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Sample ID	CB6	Depth:	N/A
Tested By:	KC	Reviewed By:	SF
Date Tested:	22-Sep-12	(dd-mmm-yy)	

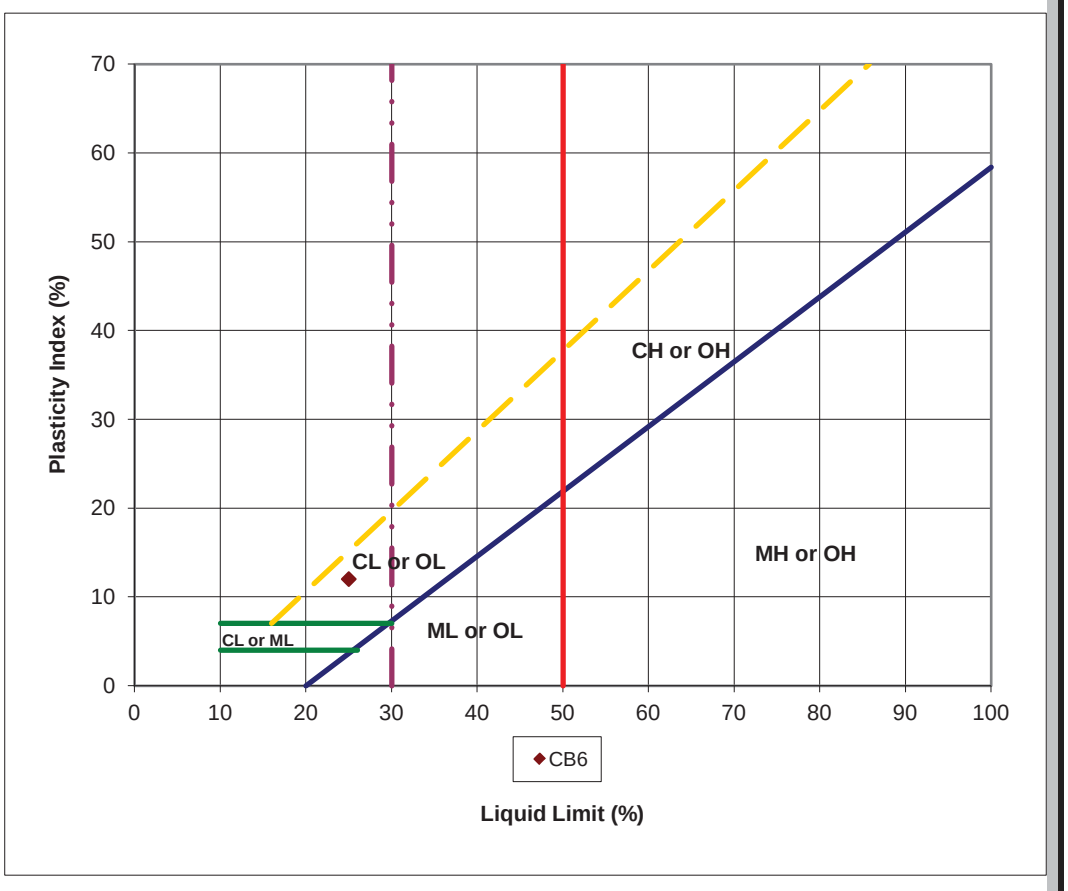
Sample Information

	Liquid Limit (Air Dried) - Multipoint Method			Liquid Limit (Oven Dried)	
Container ID	1	2	3		
Number of Blows	14	24	33		
Wet Sample Weight +Tare (g)	24.55	24.50	26.61		
Dry Sample Weight +Tare (g)	21.67	21.86	23.82		
Weight of Water (g)	2.88	2.64	2.79		
Tare (g)	11.50	11.53	12.17		
Weight of Dry Soil (g)	10.17	10.33	11.65		
Water Content (%)	28.3	25.6	23.9		

	Plastic Limit	
Container ID	4	5
Wet Sample Weight +Tare (g)	35.57	35.98
Dry Sample Weight +Tare (g)	33.01	33.41
Weight of Water (g)	2.56	2.57
Tare (g)	14.17	13.62
Weight of Dry Soil (g)	18.84	19.79
Water Content (%)	13.6%	13.0%
Average Water Content (%)	13.3	

Results	
Liquid Limit (Air Dried) (%)	25
Liquid Limit (Oven Dried) (%)	---
LL % Difference	---
Plastic Limit (%)	13
Plasticity Index (%)	12
-40 Mesh Sieve (y/n)	y
Unified Soil Classification System	CL





Atterberg Limits (ASTM D4318) - Method A

SOLUM™ CONSULTANTS LTD.

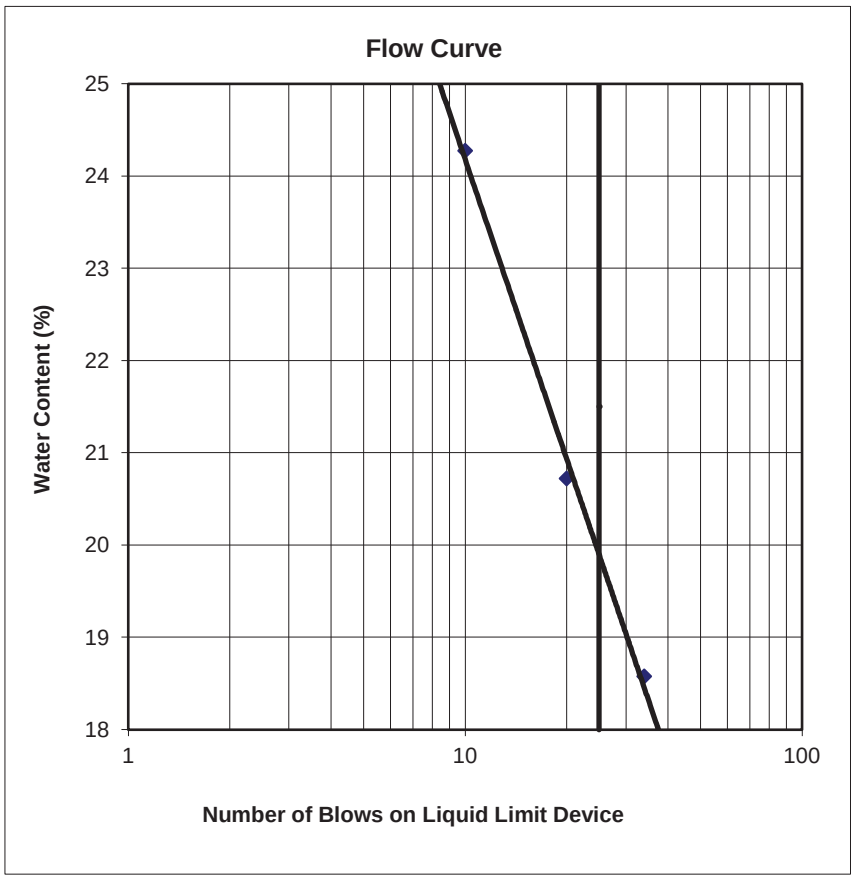
GEOTECHNICAL & MATERIAL TESTING LABORATORY

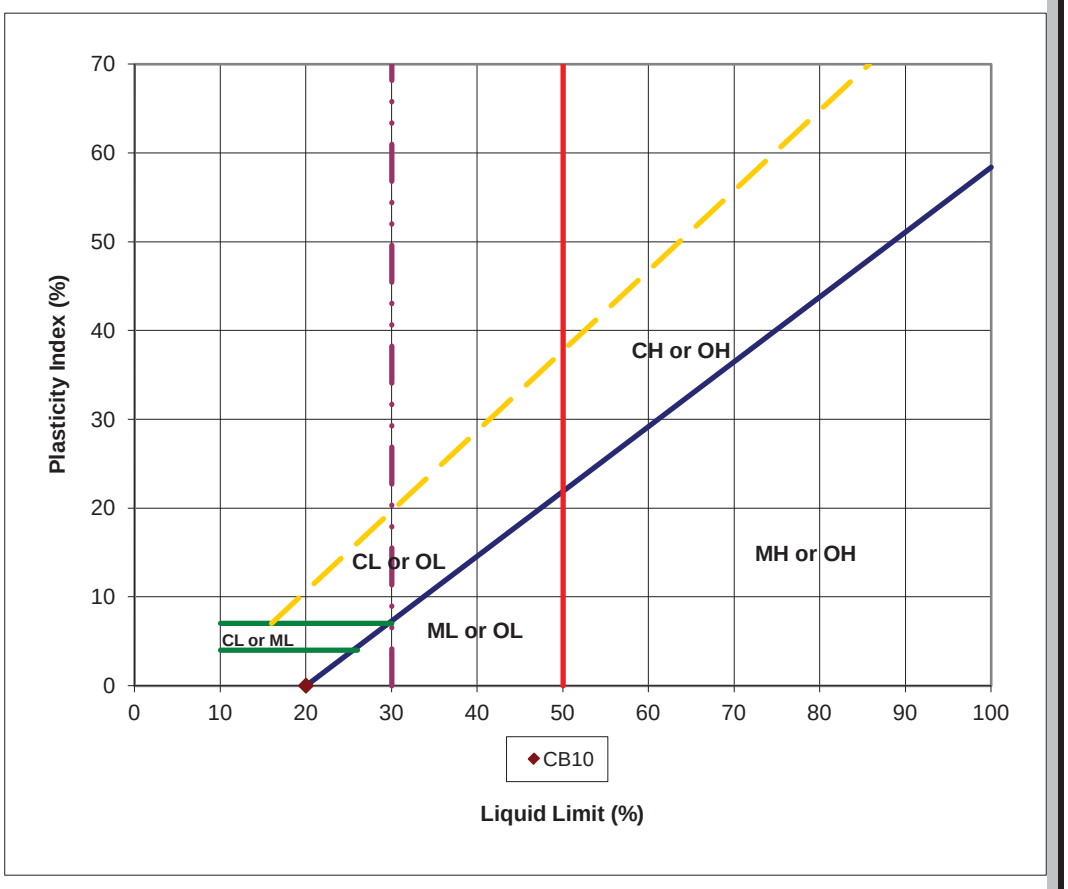
Project Number:	307034-00016		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Sample ID	CB10	Depth:	N/A
Tested By:	KC	Reviewed By:	SF
Date Tested:	22-Sep-12	(dd-mmm-yy)	

Sample Information

	Liquid Limit (Air Dried) - Multipoint Method			Liquid Limit (Oven Dried)	
Container ID	1	2	3		
Number of Blows	10	20	34		
Wet Sample Weight +Tare (g)	25.98	31.38	32.17		
Dry Sample Weight +Tare (g)	23.22	27.99	28.96		
Weight of Water (g)	2.76	3.39	3.21		
Tare (g)	11.85	11.63	11.68		
Weight of Dry Soil (g)	11.37	16.36	17.28		
Water Content (%)	24.3	20.7	18.6		

	Plastic Limit		Results	
Container ID	4	5	Liquid Limit (Air Dried) (%)	20
Wet Sample Weight +Tare (g)	34.58	35.18	Liquid Limit (Oven Dried) (%)	---
Dry Sample Weight +Tare (g)	31.32	31.67	LL % Difference	---
Weight of Water (g)	3.26	3.51	Plastic Limit (%)	20
Tare (g)	14.83	13.62	Plasticity Index (%)	0
Weight of Dry Soil (g)	16.49	18.05	-40 Mesh Sieve (y/n)	y
Water Content (%)	19.8%	19.4%	Unified Soil Classification System	NP
Average Water Content (%)	19.6			





Atterberg Limits (ASTM D4318) - Method A

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

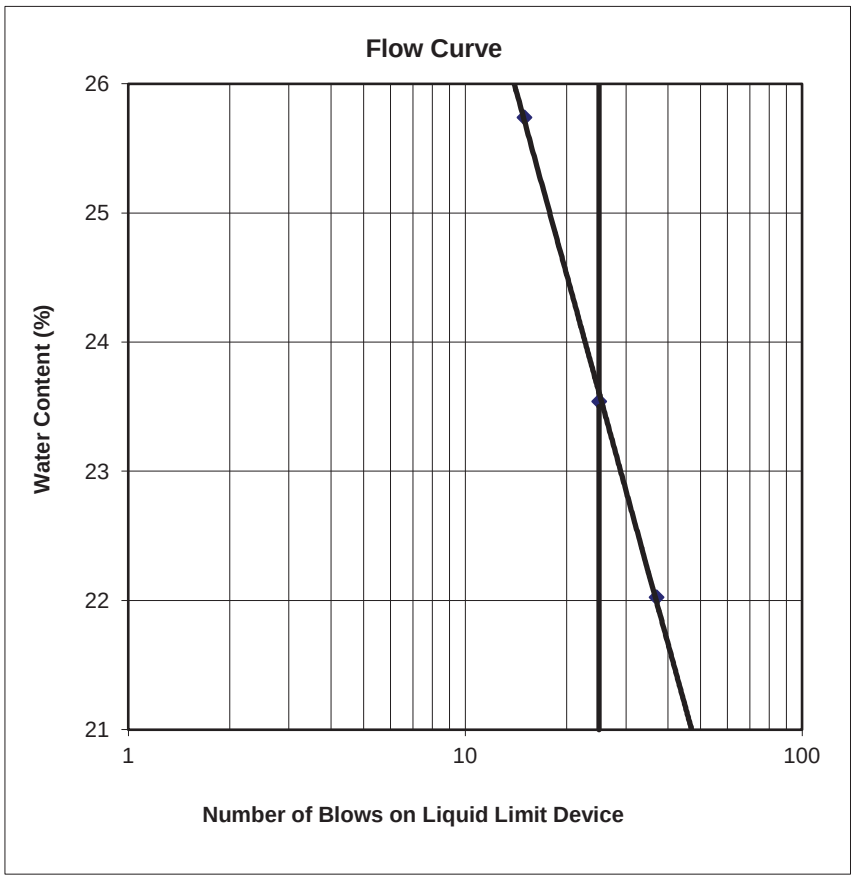
Project Number:	307034-00016		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Sample ID	CB11	Depth:	N/A
Tested By:	KC	Reviewed By:	SF
Date Tested:	22-Sep-12	(dd-mmm-yy)	

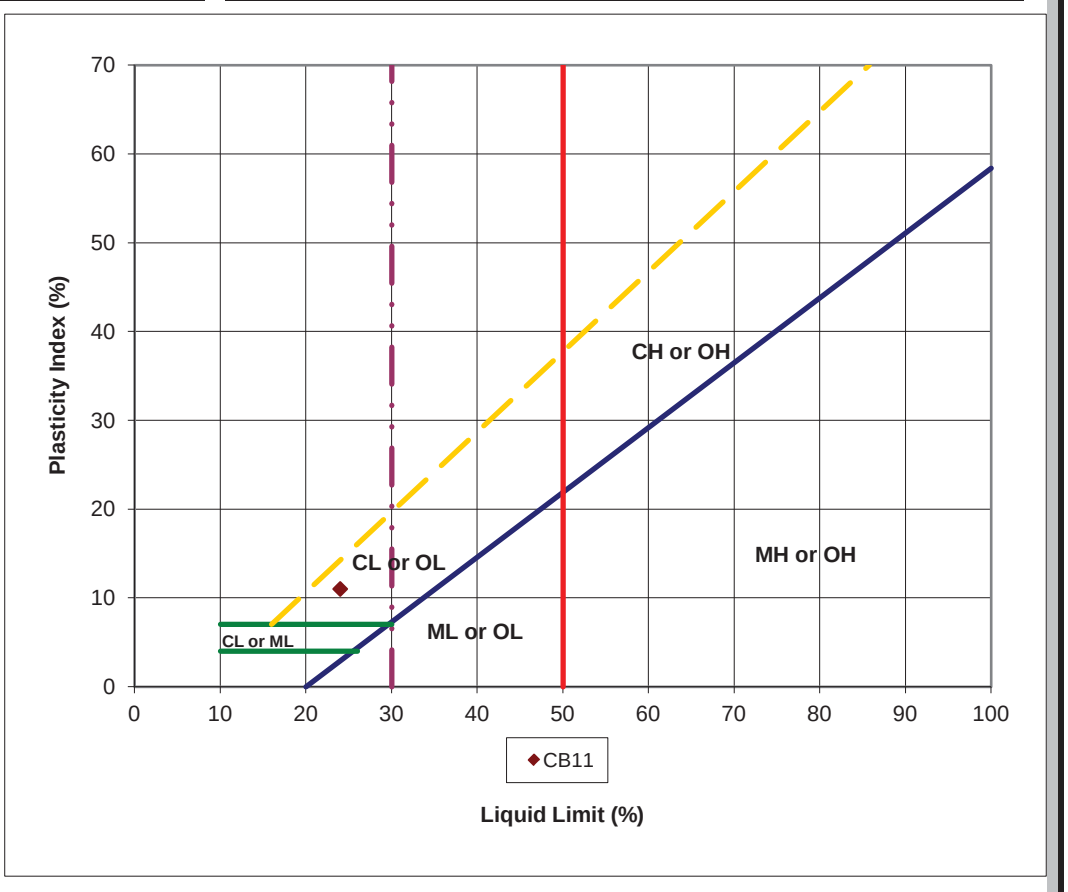
Sample Information

	Liquid Limit (Air Dried) - Multipoint Method			Liquid Limit (Oven Dried)	
Container ID	1	2	3		
Number of Blows	15	25	37		
Wet Sample Weight +Tare (g)	23.17	24.56	23.67		
Dry Sample Weight +Tare (g)	20.82	22.02	21.45		
Weight of Water (g)	2.35	2.54	2.22		
Tare (g)	11.69	11.23	11.37		
Weight of Dry Soil (g)	9.13	10.79	10.08		
Water Content (%)	25.7	23.5	22.0		

	Plastic Limit	
Container ID	4	5
Wet Sample Weight +Tare (g)	32.29	31.62
Dry Sample Weight +Tare (g)	30.21	29.63
Weight of Water (g)	2.08	1.99
Tare (g)	14.04	13.62
Weight of Dry Soil (g)	16.17	16.01
Water Content (%)	12.9%	12.4%
Average Water Content (%)	12.6	

Results	
Liquid Limit (Air Dried) (%)	24
Liquid Limit (Oven Dried) (%)	---
LL % Difference	---
Plastic Limit (%)	13
Plasticity Index (%)	11
-40 Mesh Sieve (y/n)	y
Unified Soil Classification System	CL





Atterberg Limits (ASTM D4318) - Method A

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

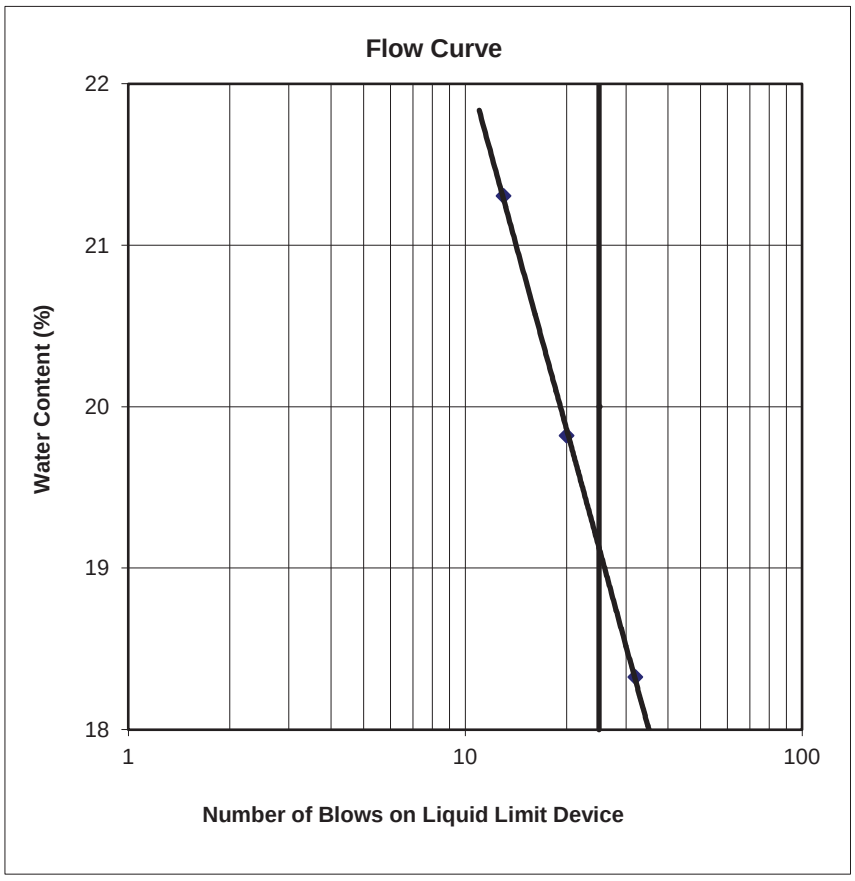
Project Number:	307034-00016		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Sample ID	CB14	Depth:	N/A
Tested By:	KC	Reviewed By:	SF
Date Tested:	22-Sep-12	(dd-mmm-yy)	

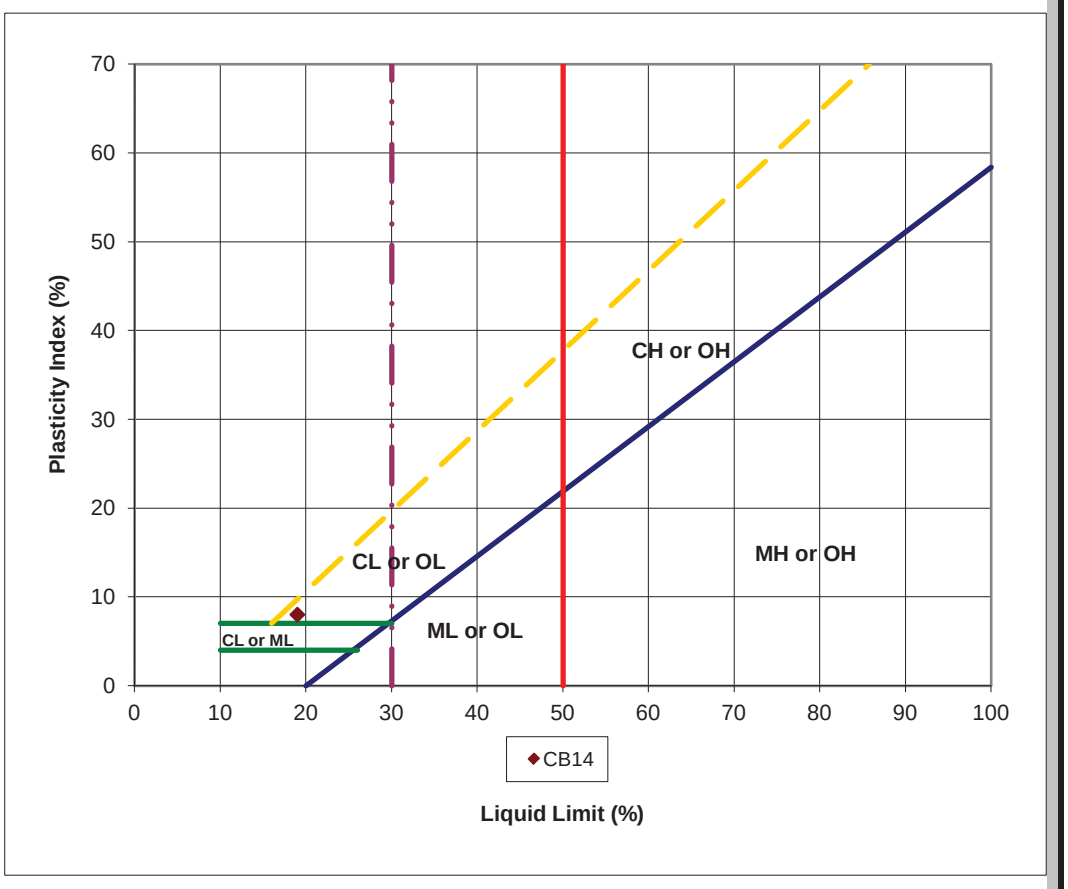
Sample Information

	Liquid Limit (Air Dried) - Multipoint Method			Liquid Limit (Oven Dried)	
Container ID	1	2	3		
Number of Blows	13	20	32		
Wet Sample Weight +Tare (g)	25.18	25.32	23.53		
Dry Sample Weight +Tare (g)	22.83	23.11	21.67		
Weight of Water (g)	2.35	2.21	1.86		
Tare (g)	11.80	11.96	11.52		
Weight of Dry Soil (g)	11.03	11.15	10.15		
Water Content (%)	21.3	19.8	18.3		

	Plastic Limit	
Container ID	4	5
Wet Sample Weight +Tare (g)	38.46	35.29
Dry Sample Weight +Tare (g)	36.05	33.27
Weight of Water (g)	2.41	2.02
Tare (g)	14.28	13.62
Weight of Dry Soil (g)	21.77	19.65
Water Content (%)	11.1%	10.3%
Average Water Content (%)	10.7	

Results	
Liquid Limit (Air Dried) (%)	19
Liquid Limit (Oven Dried) (%)	---
LL % Difference	---
Plastic Limit (%)	11
Plasticity Index (%)	8
-40 Mesh Sieve (y/n)	y
Unified Soil Classification System	CL





Atterberg Limits (ASTM D4318) - Method A

SOLUM™ CONSULTANTS LTD.

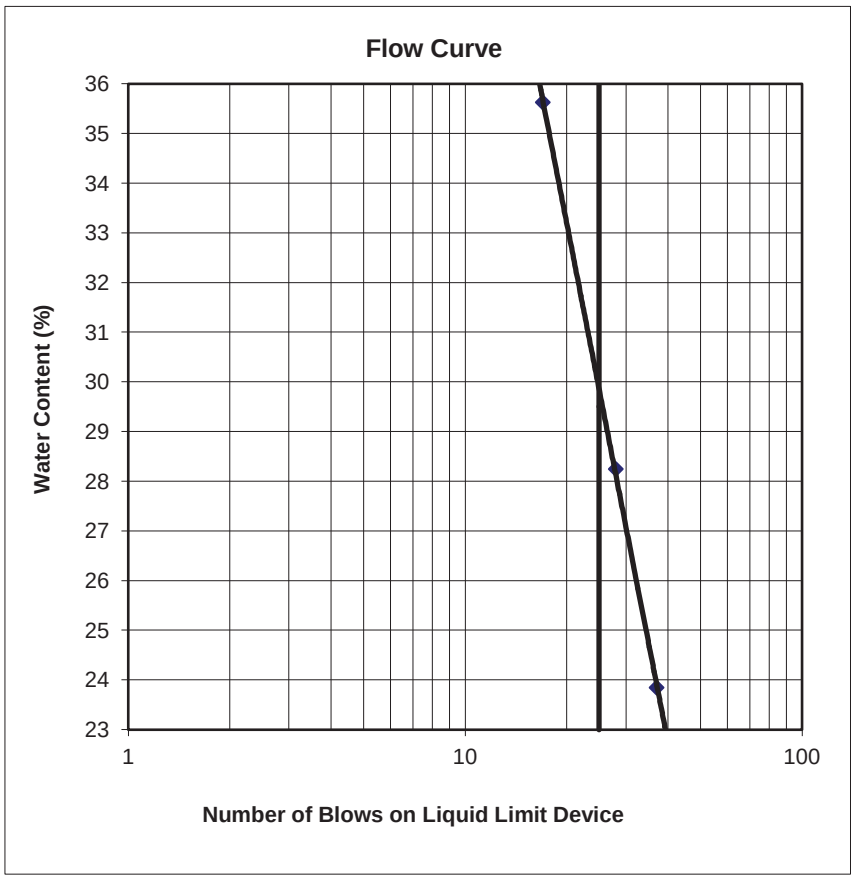
GEOTECHNICAL & MATERIAL TESTING LABORATORY

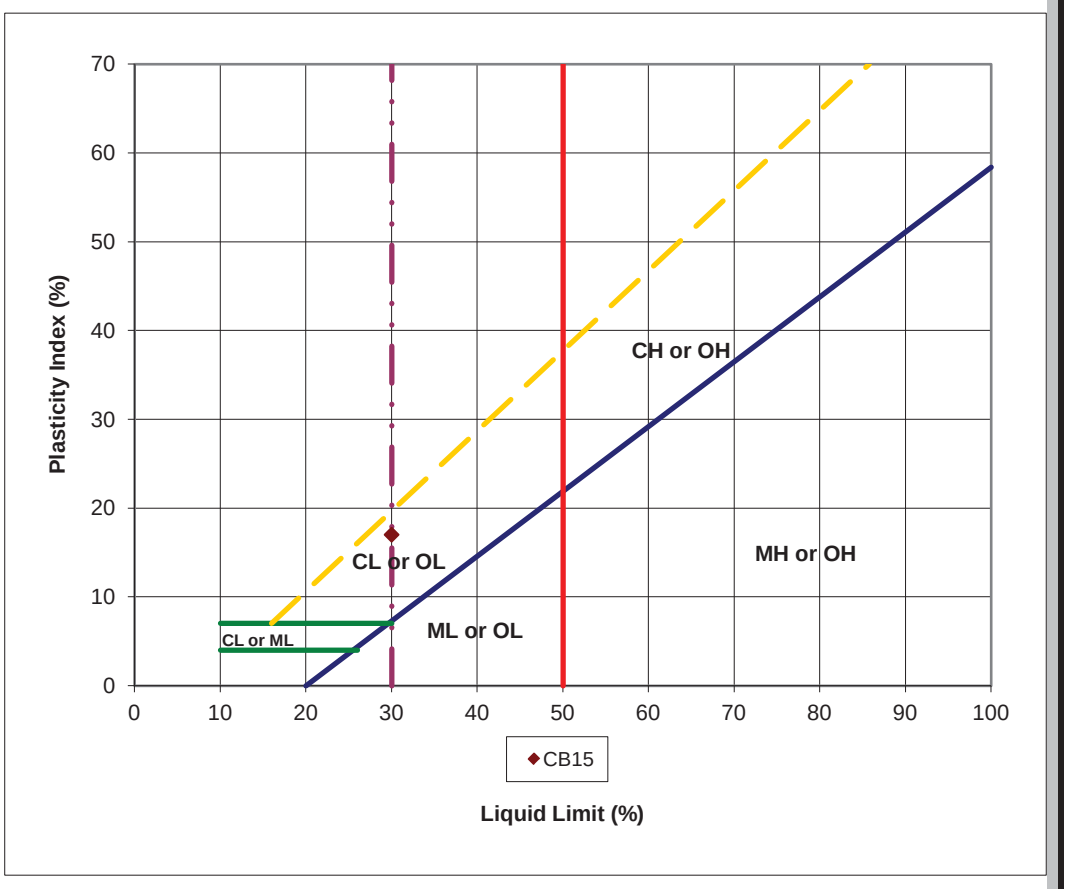
Project Number:	307034-00016		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Sample ID	CB15	Depth:	N/A
Tested By:	KC	Reviewed By:	SF
Date Tested:	22-Sep-12	(dd-mmm-yy)	

Sample Information

	Liquid Limit (Air Dried) - Multipoint Method			Liquid Limit (Oven Dried)	
Container ID	1	2	3		
Number of Blows	17	28	37		
Wet Sample Weight +Tare (g)	25.92	24.75	23.67		
Dry Sample Weight +Tare (g)	22.14	21.79	21.35		
Weight of Water (g)	3.78	2.96	2.32		
Tare (g)	11.53	11.31	11.62		
Weight of Dry Soil (g)	10.61	10.48	9.73		
Water Content (%)	35.6	28.2	23.8		

	Plastic Limit		Results	
Container ID	4	5	Liquid Limit (Air Dried) (%)	30
Wet Sample Weight +Tare (g)	36.71	35.76	Liquid Limit (Oven Dried) (%)	---
Dry Sample Weight +Tare (g)	34.09	33.29	LL % Difference	---
Weight of Water (g)	2.62	2.47	Plastic Limit (%)	13
Tare (g)	14.21	13.67	Plasticity Index (%)	17
Weight of Dry Soil (g)	19.88	19.62	-40 Mesh Sieve (y/n)	y
Water Content (%)	13.2%	12.6%	Unified Soil Classification System	CL
Average Water Content (%)	12.9			





Atterberg Limits (ASTM D4318) - Method A

SOLUM™ CONSULTANTS LTD.

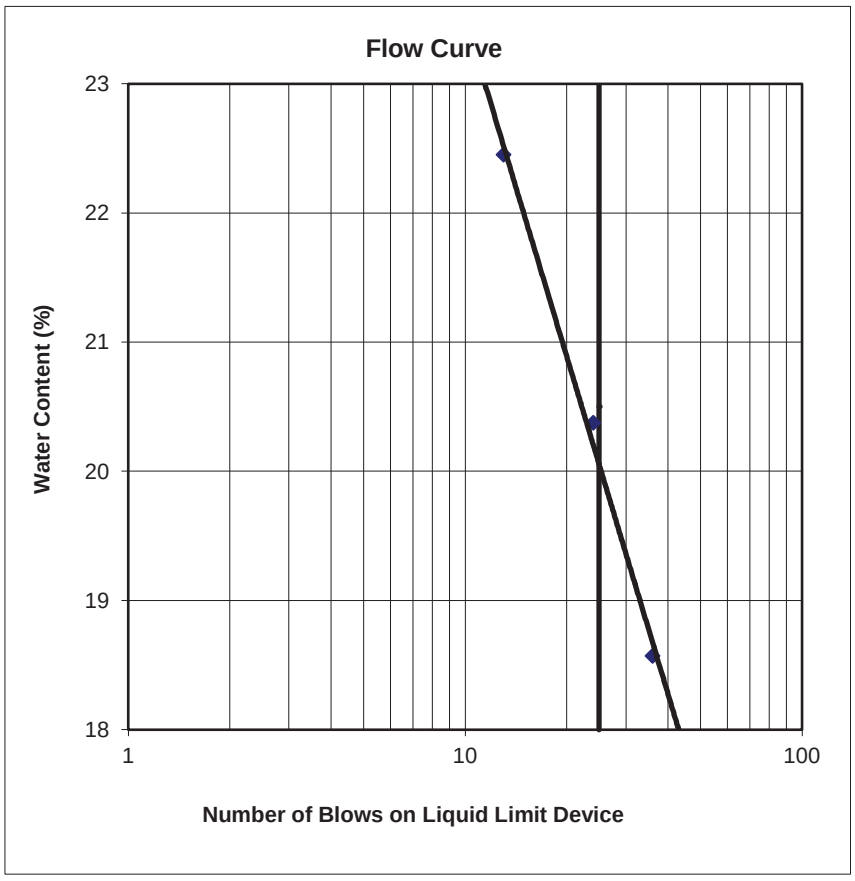
GEOTECHNICAL & MATERIAL TESTING LABORATORY

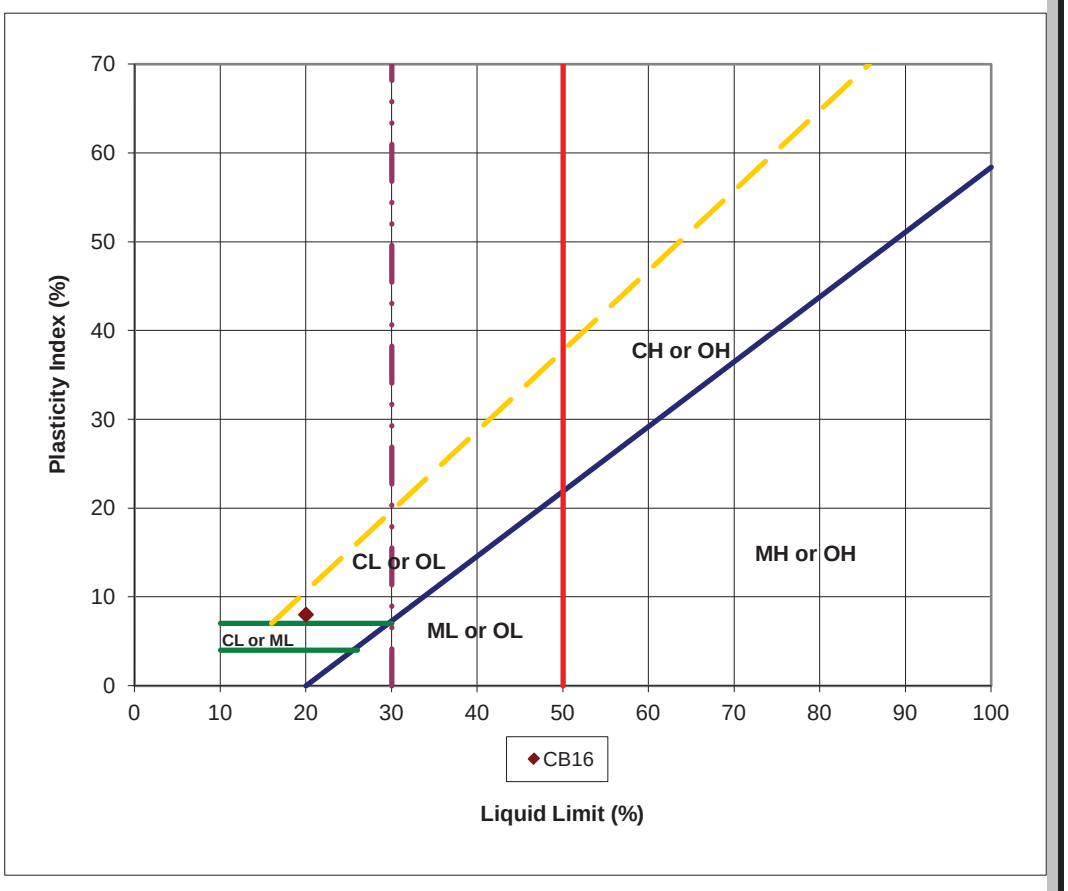
Project Number:	307034-00016		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Sample ID	CB16	Depth:	N/A
Tested By:	KC	Reviewed By:	SF
Date Tested:	22-Sep-12	(dd-mmm-yy)	

Sample Information

	Liquid Limit (Air Dried) - Multipoint Method			Liquid Limit (Oven Dried)	
Container ID	1	2	3		
Number of Blows	13	24	36		
Wet Sample Weight +Tare (g)	22.52	25.64	25.25		
Dry Sample Weight +Tare (g)	20.56	23.25	23.12		
Weight of Water (g)	1.96	2.39	2.13		
Tare (g)	11.83	11.52	11.65		
Weight of Dry Soil (g)	8.73	11.73	11.47		
Water Content (%)	22.5	20.4	18.6		

	Plastic Limit		Results	
Container ID	4	5	Liquid Limit (Air Dried) (%)	20
Wet Sample Weight +Tare (g)	40.47	38.32	Liquid Limit (Oven Dried) (%)	---
Dry Sample Weight +Tare (g)	37.72	35.77	LL % Difference	---
Weight of Water (g)	2.75	2.55	Plastic Limit (%)	12
Tare (g)	14.00	13.62	Plasticity Index (%)	8
Weight of Dry Soil (g)	23.72	22.15	-40 Mesh Sieve (y/n)	y
Water Content (%)	11.6%	11.5%	Unified Soil Classification System	CL
Average Water Content (%)	11.6			





Atterberg Limits (ASTM D4318) - Method A

SOLUM™ CONSULTANTS LTD.

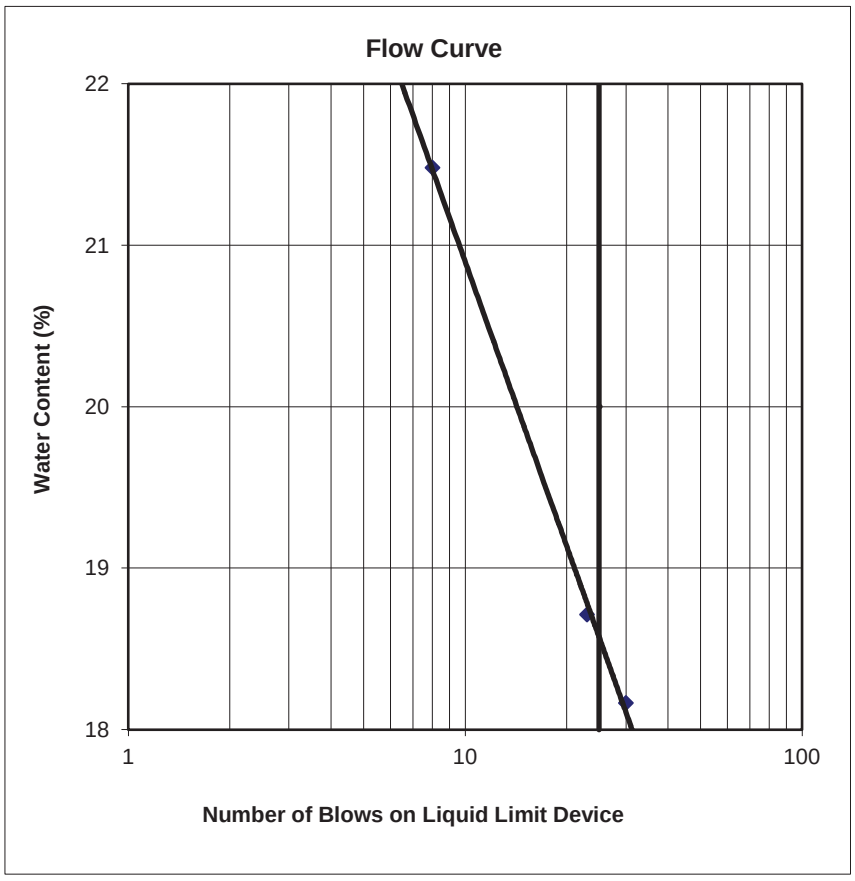
GEOTECHNICAL & MATERIAL TESTING LABORATORY

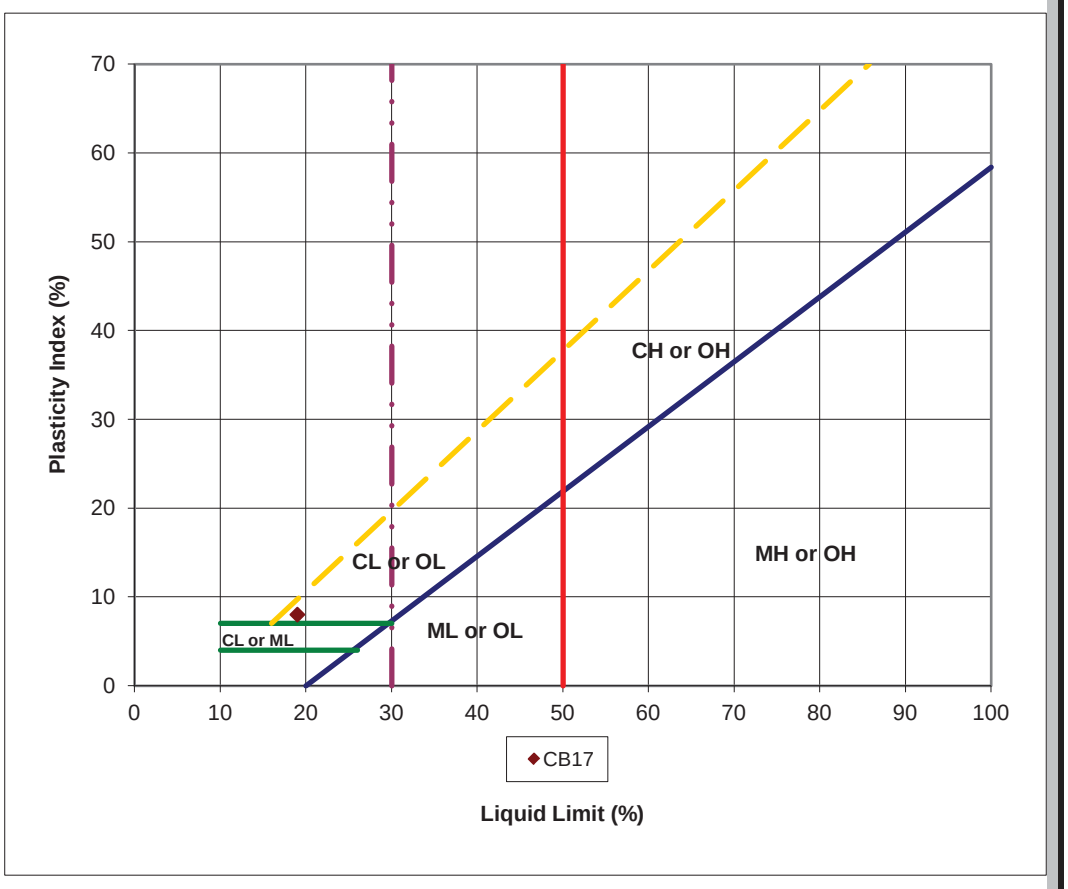
Project Number:	307034-00016		
Client:	Worley Parsons		
Project Name:	N/A		
Location:	N/A		
Sample ID	CB17	Depth:	N/A
Tested By:	KC	Reviewed By:	SF
Date Tested:	22-Sep-12	(dd-mmm-yy)	

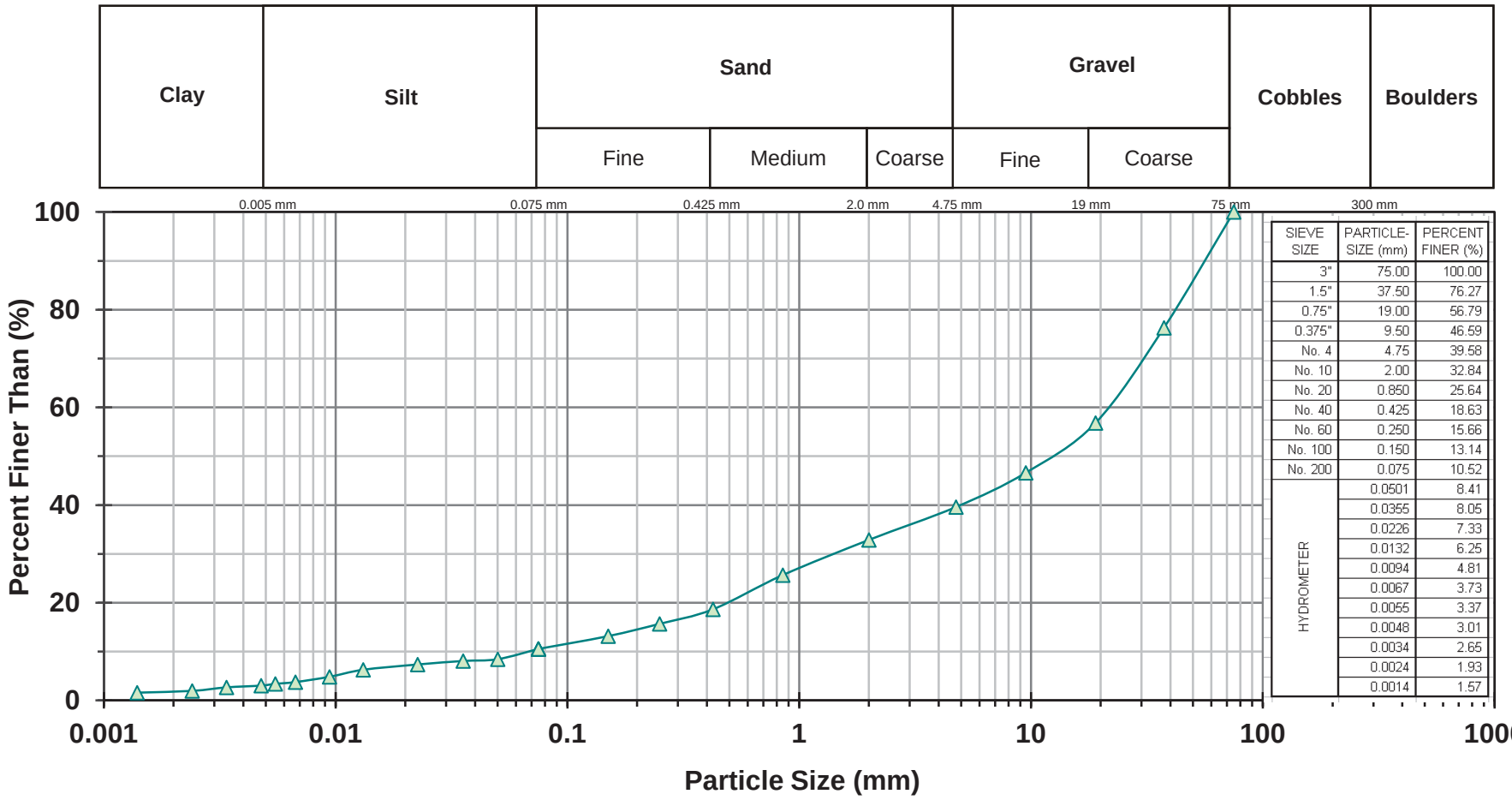
Sample Information

	Liquid Limit (Air Dried) - Multipoint Method			Liquid Limit (Oven Dried)	
Container ID	1	2	3		
Number of Blows	8	23	30		
Wet Sample Weight +Tare (g)	26.63	23.42	24.89		
Dry Sample Weight +Tare (g)	23.96	21.56	22.99		
Weight of Water (g)	2.67	1.86	1.90		
Tare (g)	11.53	11.62	12.53		
Weight of Dry Soil (g)	12.43	9.94	10.46		
Water Content (%)	21.5	18.7	18.2		

	Plastic Limit		Results	
Container ID	4	5	Liquid Limit (Air Dried) (%)	19
Wet Sample Weight +Tare (g)	36.85	23.09	Liquid Limit (Oven Dried) (%)	---
Dry Sample Weight +Tare (g)	34.68	22.18	LL % Difference	---
Weight of Water (g)	2.17	0.91	Plastic Limit (%)	11
Tare (g)	13.99	13.85	Plasticity Index (%)	8
Weight of Dry Soil (g)	20.69	8.33	-40 Mesh Sieve (y/n)	y
Water Content (%)	10.5%	10.9%	Unified Soil Classification System	CL
Average Water Content (%)	10.7			







Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.
GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

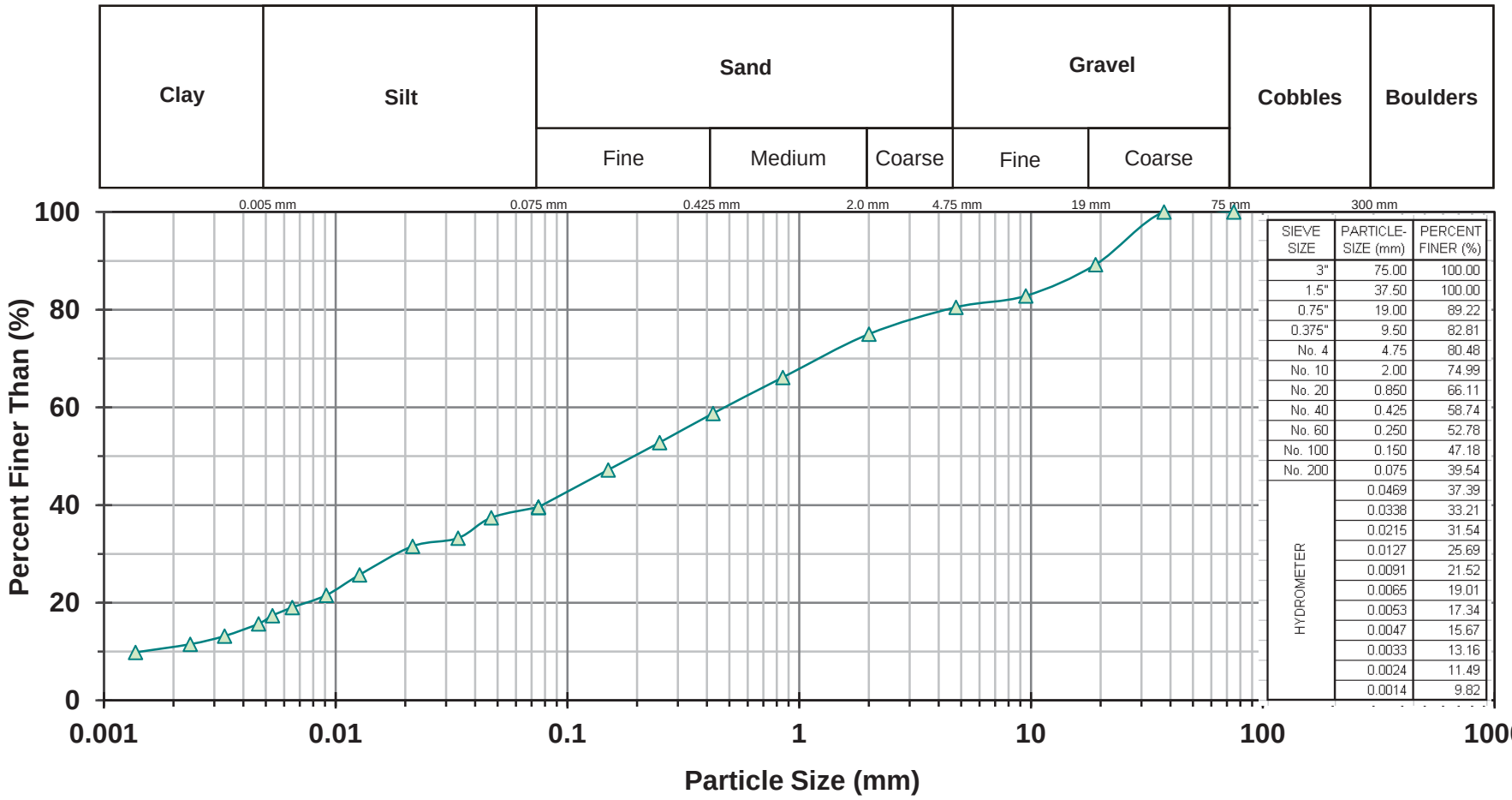
Client: Worley Parsons
Project No.: 307034-00016
Sample ID: CB3
Depth: N/A

A visual examination of the material in the field indicates that it contains approximately 5 to 15% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

Particle Size (%)

Cobbles:	0.0
Gravel:	60.4
Sand:	29.1
Silt:	7.4
Clay:	3.1

Tested by: **KC/SF**
Date Tested: **22-Sep-12**
Approved by: **SF**



SIEVE SIZE	PARTICLE-SIZE (mm)	PERCENT FINER (%)
3"	75.00	100.00
1.5"	37.50	100.00
0.75"	19.00	89.22
0.375"	9.50	82.81
No. 4	4.75	80.48
No. 10	2.00	74.99
No. 20	0.850	66.11
No. 40	0.425	58.74
No. 60	0.250	52.78
No. 100	0.150	47.18
No. 200	0.075	39.54
HYDROMETER	0.0469	37.39
	0.0338	33.21
	0.0215	31.54
	0.0127	25.69
	0.0091	21.52
	0.0065	19.01
	0.0053	17.34
	0.0047	15.67
	0.0033	13.16
	0.0024	11.49
	0.0014	9.82

Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00016

Sample ID: CB6

Depth: N/A

A visual examination of the material in the field indicates that it contains up to 10% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

Particle Size (%)

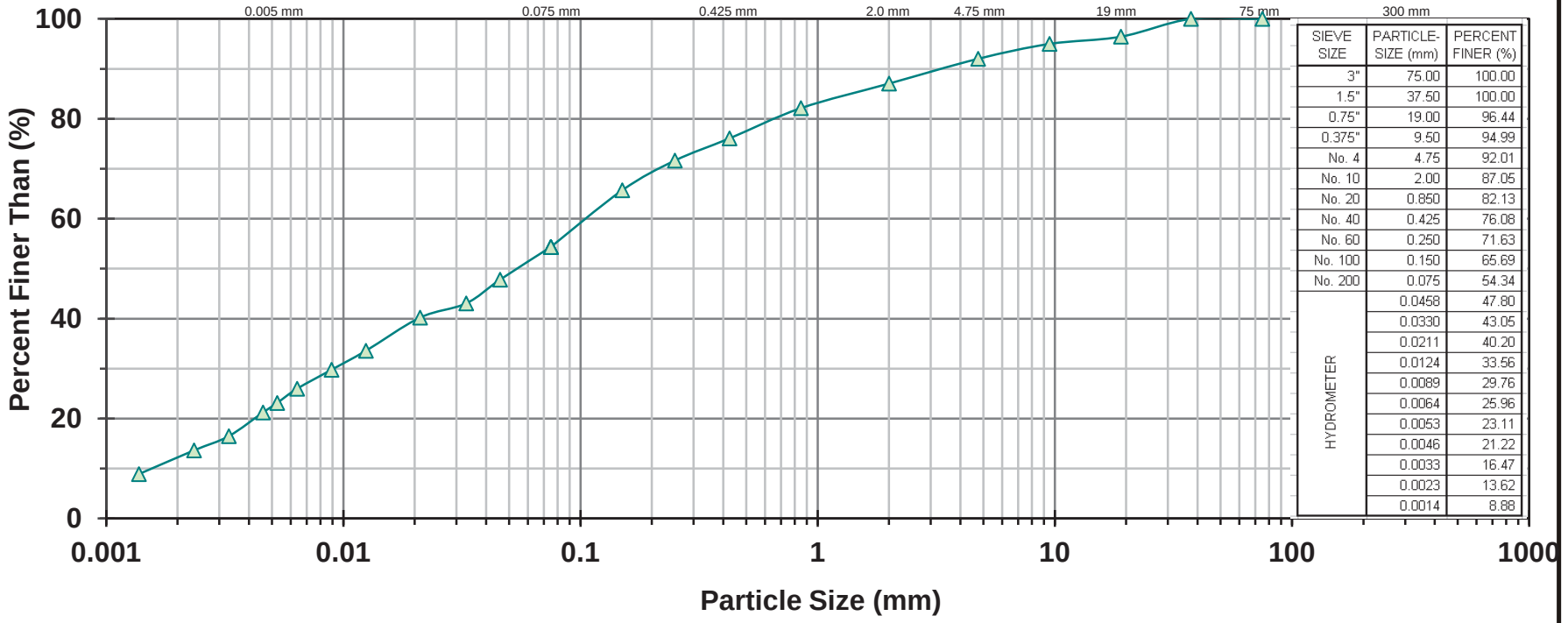
Cobbles:	0.0
Gravel:	19.5
Sand:	40.9
Silt:	23.1
Clay:	16.5

Tested by: **KC/SF**

Date Tested: **22-Sep-12**

Approved by: **SF**

Clay	Silt	Sand			Gravel		Cobbles	Boulders
		Fine	Medium	Coarse	Fine	Coarse		



SIEVE SIZE	PARTICLE-SIZE (mm)	PERCENT FINER (%)
3"	75.00	100.00
1.5"	37.50	100.00
0.75"	19.00	96.44
0.375"	9.50	94.99
No. 4	4.75	92.01
No. 10	2.00	87.05
No. 20	0.850	82.13
No. 40	0.425	76.08
No. 60	0.250	71.63
No. 100	0.150	65.69
No. 200	0.075	54.34
HYDROMETER	0.0458	47.80
	0.0330	43.05
	0.0211	40.20
	0.0124	33.56
	0.0089	29.76
	0.0064	25.96
	0.0053	23.11
	0.0046	21.22
	0.0033	16.47
	0.0023	13.62
	0.0014	8.88

Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00016

Sample ID: CB10

Depth: N/A

A visual examination of the material in the field indicates that it contains up to 10% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

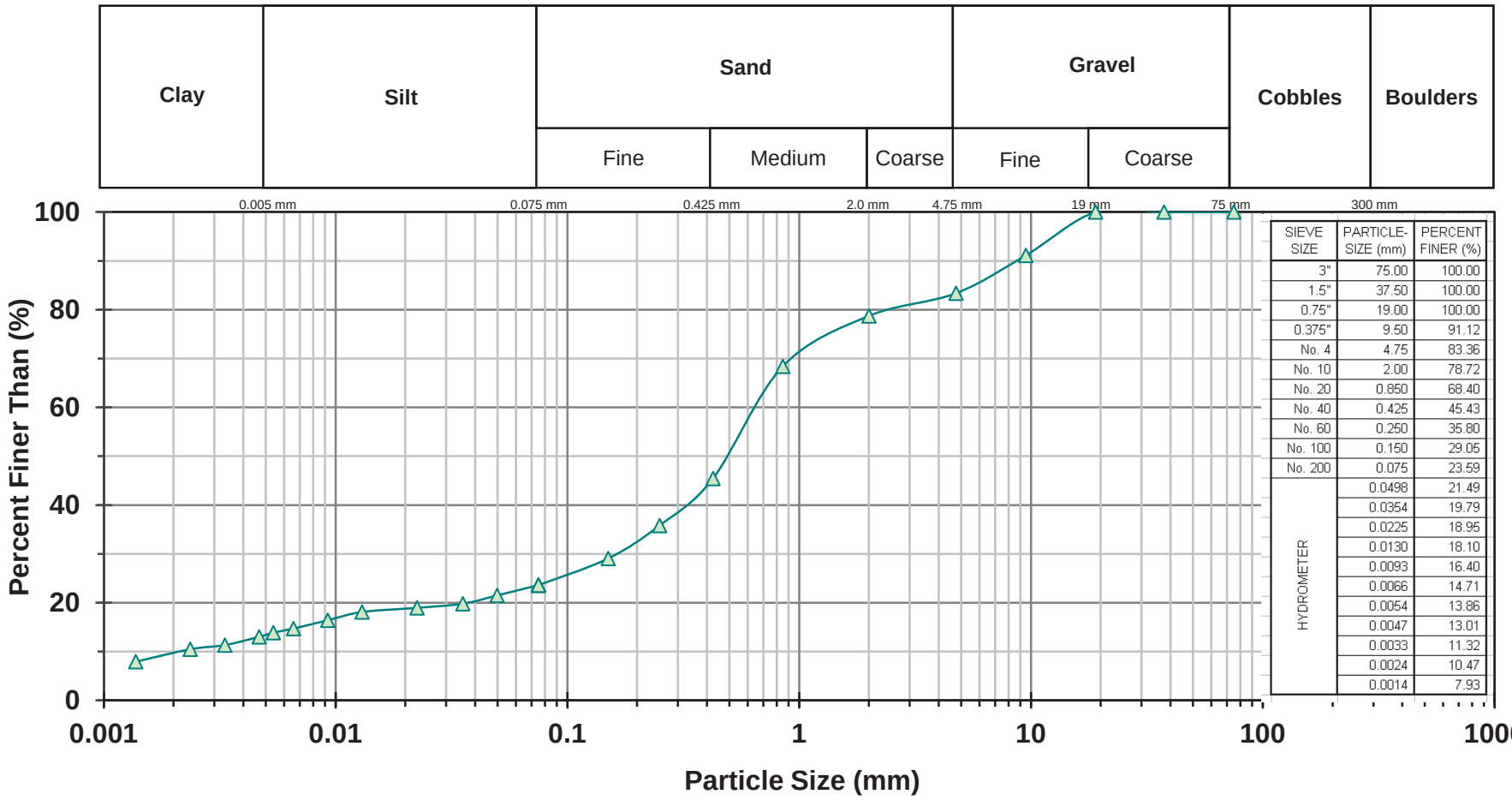
Particle Size (%)

Cobbles:	0.0
Gravel:	8.0
Sand:	37.7
Silt:	31.9
Clay:	22.4

Tested by: **KC/SF**

Date Tested: **22-Sep-12**

Approved by: **SF**



Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.
GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

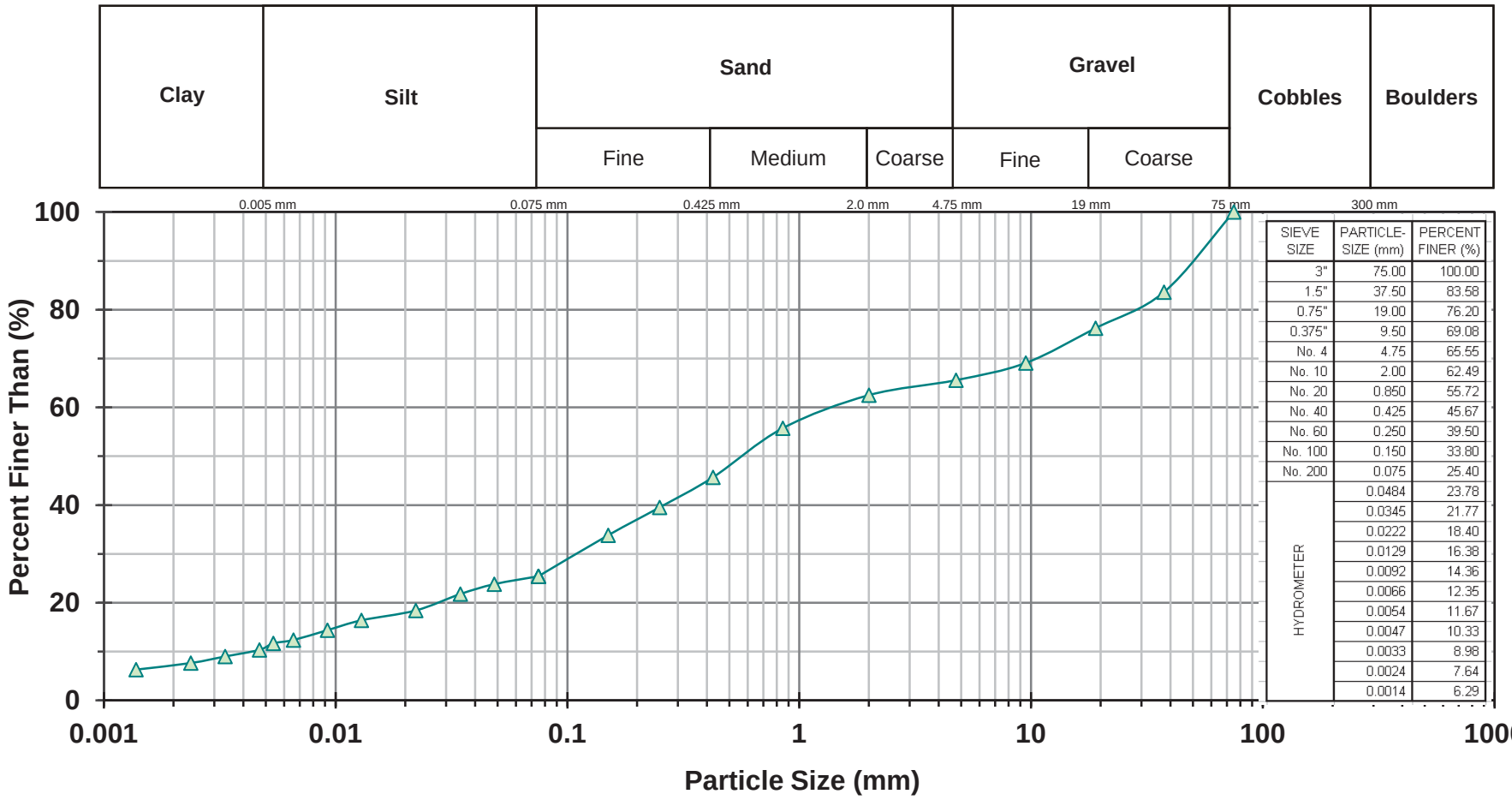
Client: Worley Parsons
Project No.: 307034-00016
Sample ID: CB11
Depth: N/A

A visual examination of the material in the field indicates that it contains approximately 25 to 35% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

Particle Size (%)

Cobbles:	0.0
Gravel:	16.6
Sand:	59.8
Silt:	10.2
Clay:	13.4

Tested by: **KC/SF**
Date Tested: **22-Sep-12**
Approved by: **SF**



Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00016

Sample ID: CB14

Depth: N/A

A visual examination of the material in the field indicates that it contains approximately 15 to 25% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

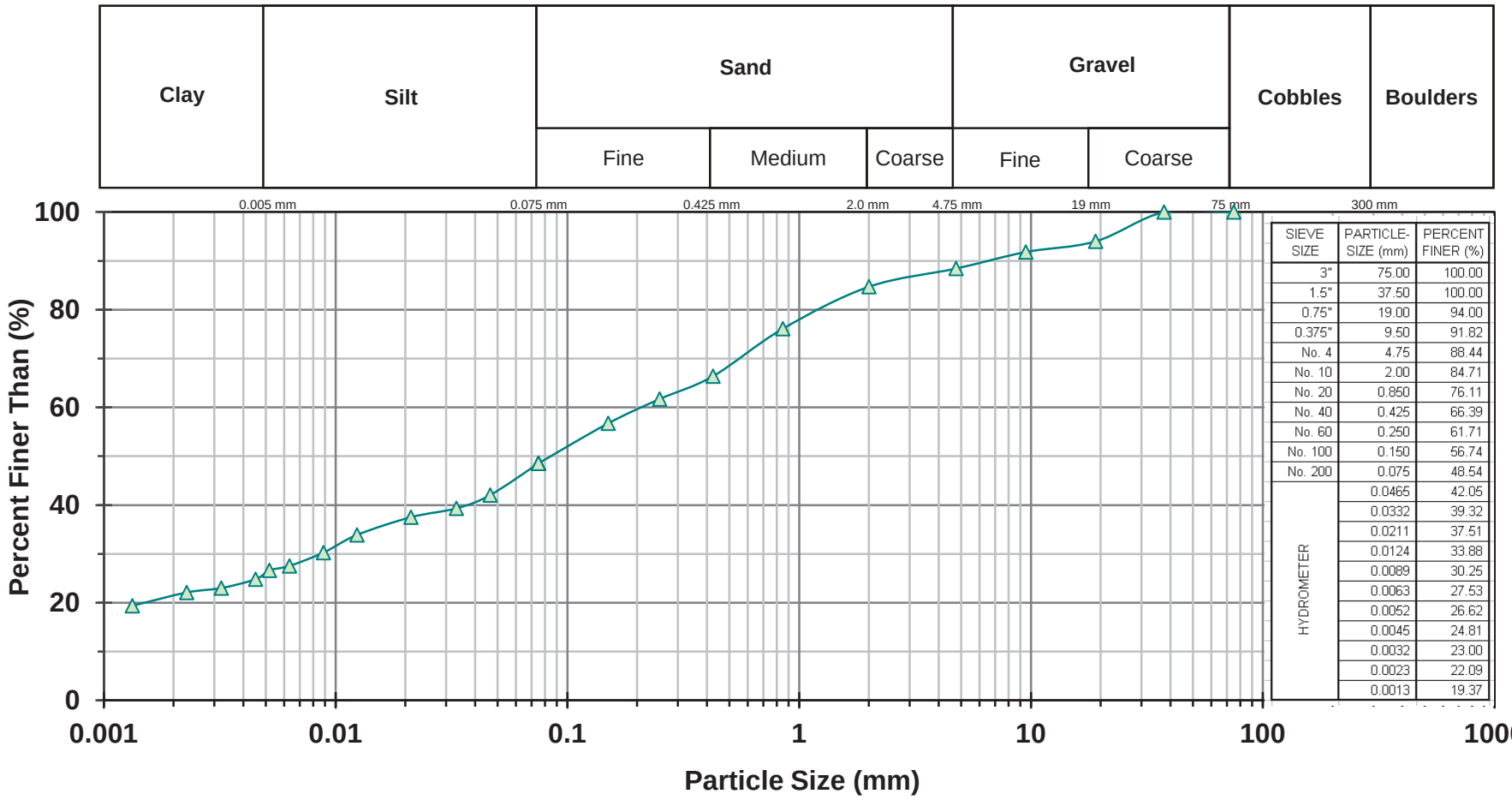
Particle Size (%)

Cobbles:	0.0
Gravel:	34.4
Sand:	40.2
Silt:	14.5
Clay:	10.9

Tested by: **KC/SF**

Date Tested: **22-Sep-12**

Approved by: **SF**



Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00016

Sample ID: CB15

Depth: N/A

A visual examination of the material in the field indicates that it contains up to 10% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

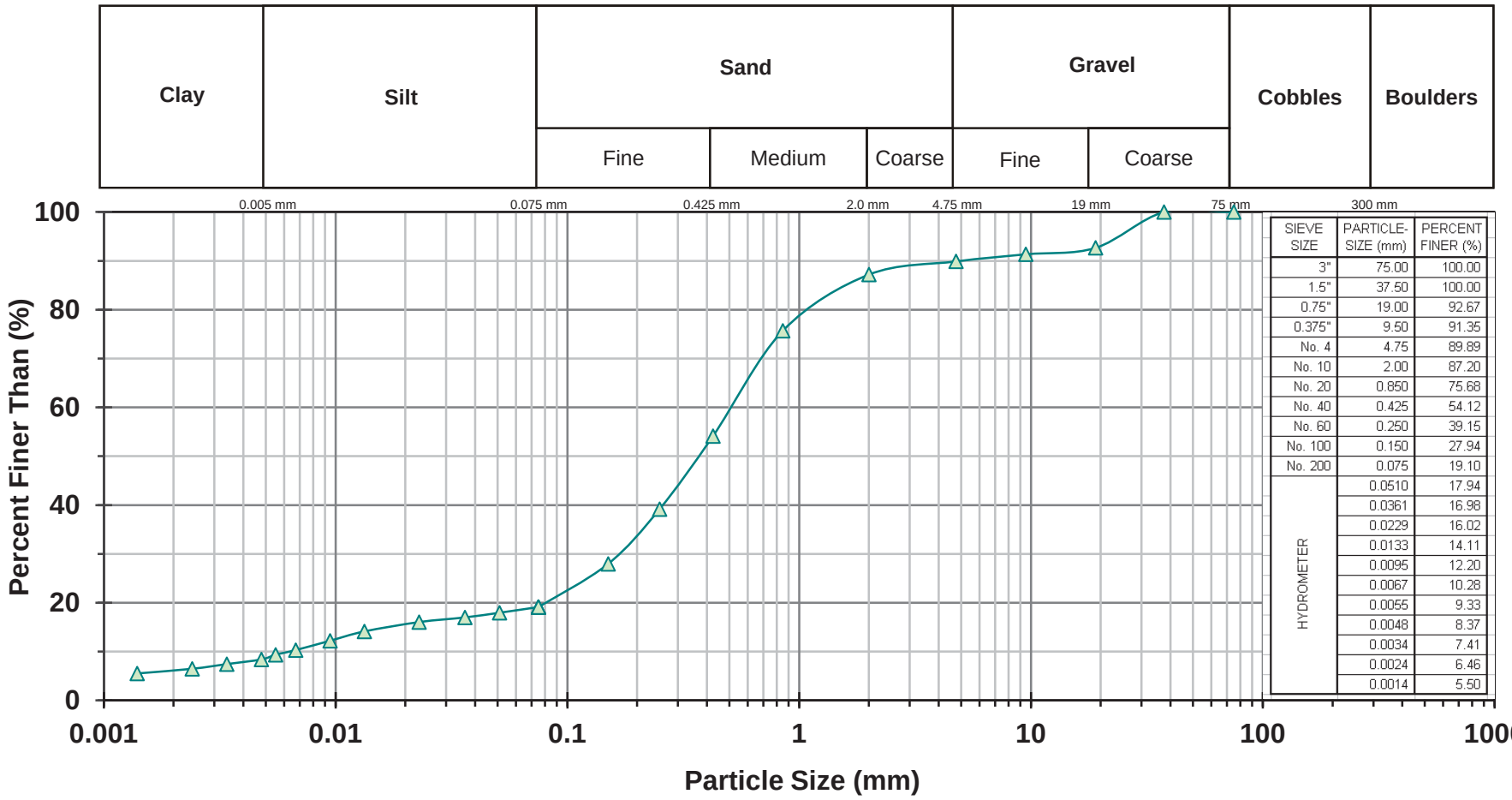
Particle Size (%)

Cobbles:	0.0
Gravel:	11.6
Sand:	39.9
Silt:	22.4
Clay:	26.1

Tested by: **KC/SF**

Date Tested: **22-Sep-12**

Approved by: **SF**



Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.
GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

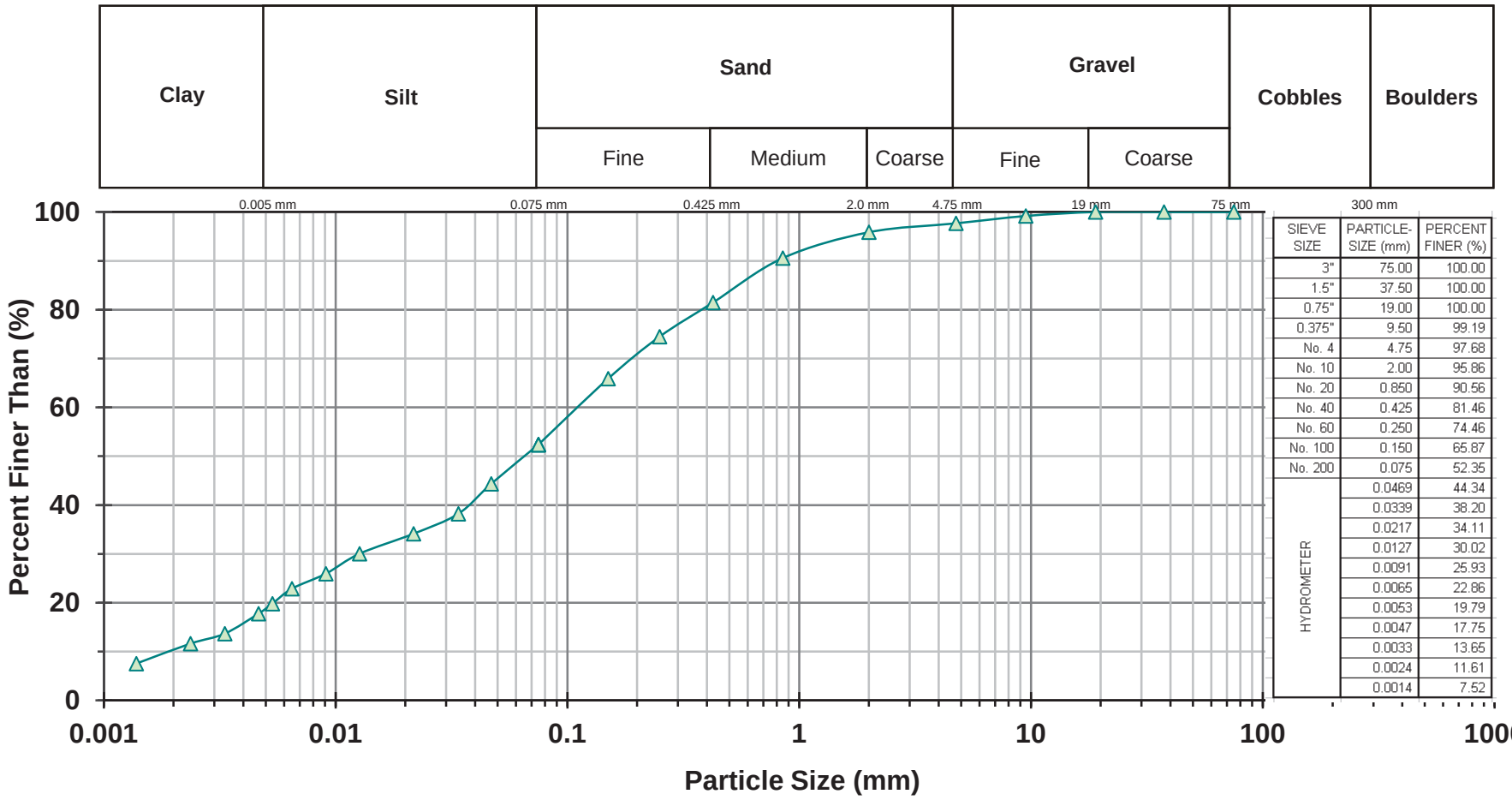
Client: Worley Parsons
Project No.: 307034-00016
Sample ID: CB16
Depth: N/A

A visual examination of the material in the field indicates that it contains up to 5% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

Particle Size (%)

Cobbles:	0.0
Gravel:	10.1
Sand:	70.8
Silt:	10.4
Clay:	8.7

Tested by: **KC/SF**
Date Tested: **22-Sep-12**
Approved by: **SF**



SIEVE SIZE	PARTICLE-SIZE (mm)	PERCENT FINER (%)
3"	75.00	100.00
1.5"	37.50	100.00
0.75"	19.00	100.00
0.375"	9.50	99.19
No. 4	4.75	97.68
No. 10	2.00	95.86
No. 20	0.850	90.56
No. 40	0.425	81.46
No. 60	0.250	74.46
No. 100	0.150	65.87
No. 200	0.075	52.35
HYDROMETER	0.0469	44.34
	0.0339	38.20
	0.0217	34.11
	0.0127	30.02
	0.0091	25.93
	0.0065	22.86
	0.0053	19.79
	0.0047	17.75
	0.0033	13.65
	0.0024	11.61
	0.0014	7.52

Particle Size Analysis (ASTM C136/D422)

SOLUM™ CONSULTANTS LTD.

GEOTECHNICAL & MATERIAL TESTING LABORATORY

N/A

Client: Worley Parsons

Project No.: 307034-00016

Sample ID: CB17

Depth: N/A

A visual examination of the material in the field indicates that it contains up to 5% of particles greater than 75mm. Particles greater than 75mm were not sampled nor included in the sieve analysis and therefore the particle size distribution shown here must be adjusted accordingly.

Particle Size (%)

Cobbles:	0.0
Gravel:	2.3
Sand:	45.3
Silt:	33.6
Clay:	18.8

Tested by: **KC/SF**

Date Tested: **22-Sep-12**

Approved by: **SF**

Appendix 2 Borehole and Test Pit Explanatory Notes

BOREHOLE LOG

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Sheet 1 of 1

BOREHOLE NO:

SHEET: OF

CLIENT:	DATE COMMENCED:
PROJECT:	DATE COMPLETED:
LOCATION:	LOGGED BY:
JOB NUMBER:	CHECKED BY:

Drill Contractor:	Bore Size:	Hole Angle:	Easting:	Surface RL:
Drill Model:	Drill Fluid:	Bearing:	Northing:	Datum:

1 Method	2 Casing	3 Drill Rate (min / m)	4 RL (m)	4 Depth (m)	5 Geological Unit	6 Graphic Log	7 Classification Symbol	8 Material Description	9 Moisture Condition	10 Consistency / Strength	11 Cementation / Weathering	12 Sample / Test	13 Lab Tests: CaCO3%	13 Lab Tests: PSD/MC	13 Lab Tests: Att. Limits	13 Lab Tests: Particle Density	14 Field Records / Comments	15 Water
Washbore	SW	4.2	13.5	0	Dune Sands		SP	SAND: medium grained angular quartz, pale grey, trace silt.	D	MD	Uc		95	X		X	TOPSOIL	
																	Material description based on SPT samples and observation of cutting returns and drill character	
			13.0	0.5			SP-SM	...with some silt, becoming dark grey	M			SPT 8,4,10 N=14					...partial loss circulation	15:00 24/2/05
									W									
			12.5	1.0			CI	SANDY CLAY: medium plasticity, red.		F		U			X		HV: 40-45kPa	

KEY TO BOREHOLE LOG

The top section of the log is self explanatory giving details of the project including the client, location, drill contractor, job number, date, logger, drill information and survey data. The main part of the log is summarised below.

1 METHOD: Drill method; washbore, hollow auger, solid auger etc

2 CASING: Depth and size of casing or open hole

3 DRILL RATE: Time to drill interval (minutes per metre)

4 RL/DEPTH: Elevation relative to datum and distance in metres below ground level

5 GEOLOGICAL UNIT: Identification of the geological unit (if known) or symbol used for identification of geological unit on site plan

6 GRAPHIC LOG: Graphic pattern of material type

7 CLASSIFICATION SYMBOL: Field assessment of soil classification

8 MATERIAL DESCRIPTION: Lithologic description in order; soil type, plasticity, particle characteristics, colour and minor components. For rock includes comments on texture/fabric and mineral composition

9 MOISTURE CONDITION: Natural moisture condition in soil

10 CONSISTENCY/STRENGTH: For soils, generally only applicable if measured in field e.g. penetration test, hand vane. For rock use strength descriptor

11 CEMENTATION/WEATHERING: Cementation descriptor (e.g. sedimentary rocks) or weathering descriptor (e.g. igneous rocks)

12 SAMPLE/TEST: Sample type and interval retrieved for laboratory testing/sediment analysis or field test

13 LABORATORY TESTS: Laboratory test results or type of test (denoted as "X")

14 FIELD RECORD/COMMENTS: Comments on drilling, fluid loss and sampling. Includes comments on soil origin and structure

15 WATER: Water level/depth; time (24hr clock) and date to be provided

EXCAVATION LOG

WorleyParsons resources & energy

EXCAVATION NO:

SHEET: OF

CLIENT: DATE COMMENCED:

PROJECT: DATE COMPLETED:

LOCATION: LOGGED BY:

JOB NUMBER: CHECKED BY:

Contractor: Hole Width: Excav. Depth: Easting: Surface RL:

Equipment Model: Hole Length: Bearing: Northing: Datum:

Method	Support	Excavation Rate (min / m)	RL (m)	Depth (m)	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Condition	Consistency / Strength	Cementation / Weathering	Sample / Test (DCP)	Lab Tests: CaCO3%	Lab Tests: PSD/MC	Lab Tests: Att. Limits	Lab Tests: Particle Density	Field Record / Comments	Water
1	2	3	13.5 4		5	6	CL 7	SANDY CLAY: low plasticity, fine grained calcareous sand, orange, trace silt. 8	9 M	10 St	11 Uc	12 Bs	15	X	X		...dessication cracks at surface 14	15
																	PP=1.5kg/cm^2	
Backhoe	Open Hole	1.2	13.0	0.5	Alluvium			...gravel lens up to 0.1m thick			Uc-Vwk	5						
												7						
												11						
												11						
				1.0								11					...partial collapse pit wall	
			12.5						W			22+						
								...rock fabric evident			XW						...hard digging in weathered material	15:00 24/2/05

KEY TO EXCAVATION LOG

The top section of the log is self explanatory giving details of the project including the client, location, earthmoving contractor, job number, date, logger, equipment information and survey data. The main part of the log is summarised below.

1 METHOD: Excavation method; backhoe, excavator, dozer, natural/existing exposure, shovel

2 SUPPORT: Type and depth of shoring or open hole

3 EXCAVATION RATE: Time to excavate interval (minutes per metre). Time to backfill also to be recorded if appropriate

4 RL/DEPTH: Elevation relative to datum and distance in metres below ground level

5 GEOLOGICAL UNIT: Identification of the geological unit (if known) or symbol used for identification of geological unit on site plan

6 GRAPHIC LOG: Graphic pattern of material type

7 CLASSIFICATION SYMBOL: Field assessment of soil classification

8 MATERIAL DESCRIPTION: Lithologic description in order; soil type, plasticity, particle characteristics, colour and minor components. For rock includes comments on texture/fabric and mineral composition

9 MOISTURE CONDITION: Natural moisture condition in soil

10 CONSISTENCY/STRENGTH: For soils, generally only applicable if measured in field e.g. penetration test, hand vane. For rock use strength descriptor

11 CEMENTATION/WEATHERING: Cementation descriptor (e.g. sedimentary rocks) or weathering descriptor (e.g. igneous rocks)

12 SAMPLE/TEST: Sample type and interval retrieved for laboratory testing/sediment analysis or field test

13 LABORATORY TESTS: Laboratory test results or type of test (denoted as "X")

14 FIELD RECORDS/COMMENTS: Comments on excavation characteristics and sampling. Include comments on soil origin and structure

15 WATER: Water level/depth; time (24hr clock) and date to be provided

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EXPLANATORY NOTES FOR SOIL DESCRIPTION AND CLASSIFICATION

Geotechnical logging is carried out in general accordance with ASTM D2488. The description of soils is based on the Unified Soil Classification system and includes type, plasticity, particle characteristics, colour and minor components. Classification of soils is based on particle size distribution and plasticity, in accordance with Canadian Foundation Engineering Manual 2006 (Identification and Classification of Soil and Rock). The terminology used by WorleyParsons to describe the condition of soils for logging purposes is summarised below. Sheet 2 provides assistance for field description and soil classification.

MOISTURE CONDITION

Term	Symbol	Field Guide
Dry	D	Looks and feels dry. Cohesive soils usually hard, friable or powdery. Granular soils are cohesionless and free running
Moist	M	Feels cool and darkened in colour. Cohesive soils can be moulded by hand. Granular soils tend to cohere
Wet	W	Feels cool and darkened in colour. Cohesive soils usually weakened and free water forms on hands when remoulding. Granular soils tend to cohere

CONSISTENCY OF COHESIVE SOILS

Term	Symbol	Undrained Shear Strength (kPa)	Field Guide	SPT 'N'
Very Soft	VS	Less than 12	Exudes between fingers when squeezed in hand	< 2
Soft	S	12 to 25	Can be moulded by light finger pressure	2 - 4
Firm	F	25 to 50	Can be moulded by strong finger pressure	4 - 8
Stiff	St	50 to 100	Cannot be moulded by fingers, can be indented by thumb	8 - 15
Very Stiff	VSt	100 to 200	Can be indented by thumb nail	15 - 30
Hard	Hd	More than 200	Can be indented with difficulty by thumb nail	> 30

DENSITY OF GRANULAR SOILS

Term	Symbol	Density Index (%)	SPT 'N'
Very Loose	VL	Less than 15	0 - 4
Loose	L	15 to 35	4 - 10
Compact	MD	35 to 65	10 - 30
Dense	D	65 to 85	30 - 50
Very Dense	VD	More than 85	> 50

PLASTICITY OF FINE GRAINED SOILS

Term	Range of Liquid Limit (%)
Low Plasticity	Less than 30
Medium Plasticity	30 to 50
High Plasticity	More than 50

CLASSFICATION

Term	Field Guide	Material Proportion
noun	Gravel, sand, silt, clay	> 35% and main fraction
"and"	and gravel, and silt, etc	> 35%
adjective	gravelly, sandy, silty, clayey, etc	20% - 35%
"some"	some sand, some silt, etc	10% - 20%
"trace"	trace sand, trace silt, etc	1% - 10%

SAMPLE/TEST (FOR LOG SHEETS)

Details of field testing (and samples retrieved) including the following:

SPT	Standard Penetration Test (blows per 150mm and N value), HB - hammer bouncing, RW - rod weight
U	63mm diameter Thin Walled Tube Sample
HV	Hand Vane Test
PP	Pocket Penetrometer Test
Bs	Bulk Sample
DCP	Dynamic Cone Penetrometer (blows per 150mm)
	Disturbed Sample Interval (laboratory test result can be provided or alternatively type of test indicated "X")

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FIELD DESCRIPTION, IDENTIFICATION AND CLASSIFICATION OF SOILS

MAJOR DIVISIONS				PARTICLE SIZE (mm)	FIELD IDENTIFICATION PROCEDURES				GROUP SYMBOL
COARSE GRAINED SOILS (More than half of material less than 60mm is larger than 0.06mm)	The smallest particle visible to the naked eye is approximately 0.06mm	BOULDERS		200					BO
		COBBLES		60					CO
		GRAVELS (More than half of coarse fraction is larger than 2.0mm)	coarse	20	Well graded gravels, gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength			GW
			medium	6	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels	Predominately one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength			GP
			fine	2.0	Silty gravels, gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength			GM
					Clayey gravels, gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength			GC
		SANDS (More than half of coarse fraction is smaller than 2.0mm)	coarse	0.6	Well graded sands, gravelly sands, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength			SW
			medium	0.2	Poorly graded sands and gravelly sands, little or no fines, uniform sands	Predominately one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength			SP
					Silty sands, sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength			SM
			fine	0.06	Clayey sands, sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength			SC
FINE GRAINED SOILS (More than half of material less than 60mm is smaller than 0.06mm)		SILTS and CLAYS (Liquid limit less than 50%)			Inorganic silts, clayey silts and sandy silts with low plastcity	Field assessment based on fraction smaller than 0.2mm			ML
						Dry strength	Dilatancy	Toughness	
						None to low	Quick to slow	None	
					Inorganic clays, gravelly clays, sandy clays and silty clays with low to medium plasticity	Medium to high	None to very slow	Medium	CL, CI
					Organic silts and silty clays of low plasticity	Low to medium	Slow	Low	OL
		SILTS and CLAYS (Liquid limit more than 50%)			Inorganic silts and micaceous or diatomaceous fine soils of high plasticity	Low to medium	Slow to none	Low to medium	MH
					Inorganic clays of high plasticity	High to very high	None	High	CH
					Organic clays and silts of medium to high plasticity	Medium to high	None to very slow	Low to medium	OH
		HIGHLY ORGANIC SOILS			Peat and other highly organic soils	Identified by colour, odour, spongy feel and generally by fibrous texture			Pt

SOURCE: Based on Figure 1 & 2, ASTM D2488 & Canadian Foundation Engineering Manual 2006

Appendix 3 Borehole Logs

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-1***
SHEET: 1 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***24.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***24.8.2012***
LOCATION:	***QUARRY PIT 1B***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489559.00	**Surface R.L.:**	34 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665803.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		0.0	Glaciomarine Beach Ridge		SP	Gravelly SAND: fine to coarse grained, sub-rounded to rounded, fine to coarse, sub-rounded to sub-angular gravel, comprised of mixed lithologies brown, trace cobbles, sub-angular to angular, comprised of frost shattered bedrock	5.9 3.8	NA	NA	Bs	From 0.0 to 0.05m TOPSOIL Note: Mixed lithologies consists of siltstone, quartzite, volcanics and gneiss
				0.5				...becoming light brown	3.0			Bs	Frozen ground below 1.0m based on TP-1A
				1.0									
				1.5					3.8			Bs	From 1.50m angular fragments evident which are possible cobbles / boulders disturbed by drilling process
				2.0									
				2.5			SP	SAND: medium to coarse grained, rounded to sub-rounded, grey, with some gravel, fine to medium, rounded to sub-rounded, comprised of mixed lithologies	5.8			Bs	From 2.25m angular fragments evident which are possible cobbles disturbed by drilling process
				3.0			SP	Gravelly SAND: fine to coarse grained, sub-rounded to rounded, fine to coarse, sub-rounded to sub-angular gravel, comprised of mixed lithologies brown, trace cobbles, sub-angular to angular, comprised of frost shattered bedrock	8			Bs	
				3.5				...with some non-plastic silt	8.4			Bs	
				4.0									
				4.5			GP-CO	GRAVEL and COBBLES: fine to coarse gravel up to cobbles, sub-rounded to angular comprised granodiorite / gneiss and siltstone, reddish grey, with some sand, fine to coarse grained, sub-rounded to rounded	8.2			Bs	From 4.50 to 5.25m possible boulder broken up through drilling process
				5.0									

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-1***
SHEET: 2 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***24.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***24.8.2012***
LOCATION:	***QUARRY PIT 1B***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489559.00	**Surface R.L.:**	34 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665803.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		5.5	Frost Shattered Bedrock		GP-CO	GRAVEL and COBBLES: fine to coarse gravel up to cobbles, sub-rounded to angular comprised granodiorite / gneiss and siltstone, reddish grey, with some sand, fine to coarse grained, sub-rounded to rounded	8.2	NA	NA	Bs	
							GP	Sandy GRAVEL: fine to coarse, sub-rounded to angular, comprised of siltstone, brown, fine to coarse grained, sub-rounded to angular sand, trace angular cobbles of siltstone	6.5			Bs	
				6.0				End of BH-1 at 6m					Borehole Terminated at 6.0m. Thermistor (#1) installed to 6.00m. Borehole backfilled with drill cuttings. **Caution: The insitu soil descriptions described on this log have been deduced from highly disturbed cuttings recovered with an airtrack drill and may not be accurate.**
				6.5									
				7.0									
				7.5									
				8.0									
				8.5									
				9.0									
				9.5									
				10.0									

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-2***
SHEET: 1 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***25.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***25.8.2012***
LOCATION:	***QUARRY PIT 1B***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489756.00	**Surface R.L.:**	30 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665689.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		0.0	Glaciomarine Beach Ridge		SP	Gravelly SAND: fine to coarse grained, sub-rounded to rounded, fine to coarse, sub-rounded to sub-angular gravel, comprised of mixed lithologies brown, with somecobbles, sub-angular to sub-rounded, comprised of frost shattered bedrock	8.6 6.2	NA	NA	Bs	From 0.0 to 0.10m TOPSOIL Note: Mixed lithologies consists of siltstone, quartzite, shale and gneiss
				0.5			ML	Sandy SILT: low plasticity, fine to coarse grained, sub-rounded to sub-angular, grey, trace gravel and cobbles, trace clay	19.1			Bs	
				1.0								Bs	Frozen ground below 1.2m based on TP-1B
				1.5			SP	SAND: fine to coarse grained, sub-rounded to sub-angular, grey, with some low plasticity silt, with some fine to coarse sub-rounded to angular gravel comprised of mixed lithologies	14.4			Bs	
				2.0								Bs	
				2.5				...gravel content decreasing, becoming a Silty SAND with some clay, medium plasticity	15			Bs	
				3.0	Glacial Till		CH	Silty Sandy CLAY: medium to high plasticity, fine grained sand, brown grey, trace fine gravel comprised of mixed lithologies	15.1			Bs	
				3.5								Bs	
				4.0	Frost Shattered Bedrock		GP-CO	GRAVEL and COBBLES: fine to coarse gravel up to cobble sized fragments, angular, comprised of siltstone, dark grey, trace fine to coarse sand	4.8			Bs	
				4.5	Bedrock			SILTSTONE: recovered as gravel sized angular clasts, grey and brown	6.3			Bs	
				5.0									

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-2***
SHEET: 2 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***25.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***25.8.2012***
LOCATION:	***QUARRY PIT 1B***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489756.00	**Surface R.L.:**	30 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665689.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		5.5	Bedrock			SILTSTONE: recovered as gravel sized angular clasts, grey and brown	6.3 4.3	NA	NA	Bs Bs	
				6.0				End of BH-2 at 6m					Borehole Terminated at 6.0m. Thermistor (#2) installed to 6.00m. Borehole backfilled with drill cuttings. **Caution: The insitu soil descriptions described on this log have been deduced from highly disturbed cuttings recovered with an airtrack drill and may not be accurate.**
				6.5									
				7.0									
				7.5									
				8.0									
				8.5									
				9.0									
				9.5									
				10.0									

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-3***
SHEET: 1 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***26.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***26.8.2012***
LOCATION:	***QUARRY PIT 1B***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489887.00	**Surface R.L.:**	17 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665352.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		0.0	Glaciomarine Beach Ridge		SP	Gravelly SAND: medium to coarse grained, sub-rounded to sub-angular, fine gravel up to cobble sized fragments, sub-rounded to sub-angular comprised of mixed lithologies, yellow brown,	3	NA	NA	Bs	From 0.0 to 0.10m TOPSOIL Note: Mixed lithologies consists of siltstone, quartzite and shale
				0.5			GM	Gravelly Clayey SILT: low plasticity, fine to coarse, sub-rounded to angular comprised of mixed lithologies, grey	11.7			Bs	
				1.0	Glacial Till							Bs	Frozen ground below 1.2m based on TP-3
				1.5			SP	Clayey Gravelly SAND: fine to coarse grained, sub-rounded to sub-angular, fine gravel up to cobble sized fragments, sub-angular to sub-rounded comprised of mixed lithologies, grey, with some low plasticity silt	11			Bs	From 1.50 to 3.00m material is non-sorted to poorly sorted, possible diamicton
				2.0								Bs	
				2.5				...gravel predominanly consists of fragments of gneiss broken through drilling process, likely cobble / boulder	10.5			Bs	
				3.0	Glaciomarine Beach Ridge		GP-CO	GRAVEL and COBBLES: fine gravel up to cobble sized fragments, sub-rounded to sub-angular, comprised of mixed lithologies, light brown grey, trace fine to coarse grained, sub-rounded to sub-angular sand	7.3			Bs	
				3.5								Bs	
				4.0	Frost Shattered Bedrock			...becoming predominantly angular rock fragments with some sand	2.7			Bs	
				4.5								Bs	
				5.0	Bedrock			Calcareous SILTSTONE: recovered as gravel sized angular clasts, light brown grey	3.7			Bs	

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-3***
SHEET: 2 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***26.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***26.8.2012***
LOCATION:	***QUARRY PIT 1B***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489887.00	**Surface R.L.:**	17 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665352.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		5.5	Bedrock			Calcareous SILTSTONE: recovered as gravel sized angular clasts, light brown grey	3.7 3.7	NA	NA	Bs Bs	
				6.0				End of BH-3 at 6m					Borehole Terminated at 6.0m. Thermistor (#3) installed to 6.00m. Borehole backfilled with drill cuttings. **Caution: The insitu soil descriptions described on this log have been deduced from highly disturbed cuttings recovered with an airtrack drill and may not be accurate.**
				6.5									
				7.0									
				7.5									
				8.0									
				8.5									
				9.0									
				9.5									
				10.0									

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-4***
SHEET: 1 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***26.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***26.8.2012***
LOCATION:	***QUARRY PIT 1B***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489726.00	**Surface R.L.:**	29 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665402.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		0.5	Glaciomarine Beach Ridge		SP-GP	SAND and GRAVEL: fine to coarse, sub-rounded to angular comprised of siltstone, fine to coarse grained, sub-rounded to sub-angular sand, light brown, with some cobbles	2.6 3.1	NA	NA	Bs	From 0.0 to 0.10m TOPSOIL Note: Mixed lithologies consists of siltstone, quartzite, shale and gneiss
				1.0				...gravel becoming siltstone and gneiss	5.2			Bs	
				1.5									Frozen ground below 1.2m based on TP-2
				2.0	Glacial Till		SM-SP	Silty SAND: fine to coarse grained, sub-rounded to sub-angular, low plasticity, brown grey, with some fine to coarse, sub-rounded to angular gravel comprised of siltsone and gneiss, with some low plastcity clay	14			Bs	From 1.50 to 6.00m material is non-sorted to poorly sorted, possible diamicton
				2.5			GP-CO	COBBLES and / or BOULDERS: recovered as gravel sized fragments of silttone. brown and grey, trace sand, coarse grained, sub-angular	3.8			Bs	
				3.0				...becoming trace silt, trace angular gravel sized fragments of gneiss	8			Bs	
				3.5									
				4.0			CL	Gravellly Clayey SAND: fine to coarse sand, sub-rounded to sub-angular, medium plasticity, fine to coarse, sub-rounded to sub-angular gravel comprised of siltstone and gneiss, dark grey	11.9			Bs	
				4.5					13.7			Bs	
				5.0									

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-4***
SHEET: 2 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***26.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***26.8.2012***
LOCATION:	***QUARRY PIT 1B***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489726.00	**Surface R.L.:**	29 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665402.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		5.5	Glacial Till		CL	Gravellly Clayey SAND: fine to coarse sand, sub-rounded to sub-angular, medium plasticity, fine to coarse, sub-rounded to sub-angular gravel comprised of siltstone and gneiss, dark grey	13.7	NA	NA	Bs	
								...becoming a gravelley sand, fines content decreasing, non plastic to low plasticity	7.5			Bs	
				6.0				End of BH-4 at 6m					Borehole Terminated at 6.0m. Borehole backfilled with drill cuttings. **Caution: The insitu soil descriptions described on this log have been deduced from highly disturbed cuttings recovered with an airtrack drill and may not be accurate.**
				6.5									
				7.0									
				7.5									
				8.0									
				8.5									
				9.0									
				9.5									
				10.0									

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-5***
SHEET: 1 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***26.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***26.8.2012***
LOCATION:	***QUARRY PIT 1B***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489637.00	**Surface R.L.:**	36 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665446.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		0.0	Glaciomarine Beach Ridge		SP	Gravelly SAND: fine to coarse grained, sub-rounded to sub-angular, fine gravel up to cobble sized fragments, sub-rounded to angular comprised of mixed lithologies, pale brown grey	4.5 3.2	NA	NA	Bs	From 0.0 to 0.10m TOPSOIL Note: Mixed lithologies consists of siltstone, quartzite, shale and gneiss
				0.5								Bs	
				1.0					5.8			Bs	Frozen ground below 1.2m based on TP-5
				1.5			GP-CO	GRAVEL and COBBLES: fine gravel up to cobble sized fragments, angular, comprised of calcareous siltstone, pale brown grey, trace fine sand and non plastic silt	4.6			Bs	
				2.0								Bs	
				2.5					6.2			Bs	
				3.0					6.1			Bs	
				3.5								Bs	
				4.0	Frost Shattered Bedrock				3.8			Bs	
				4.5	Bedrock			Calcareous SILTSTONE: recovered as gravel sized angular clasts, light brown grey	4.2			Bs	
				5.0									

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-5***
SHEET: 2 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***26.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***26.8.2012***
LOCATION:	***QUARRY PIT 1B***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489637.00	**Surface R.L.:**	36 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665446.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		5.5	Bedrock			Calcareous SILTSTONE: recovered as gravel sized angular clasts, light brown grey	4.2 3.9	NA	NA	Bs Bs	
				6.0				End of BH-5 at 6m					Borehole Terminated at 6.0m. Borehole backfilled with drill cuttings. **Caution: The insitu soil descriptions described on this log have been deduced from highly disturbed cuttings recovered with an airtrack drill and may not be accurate.**
				6.5									
				7.0									
				7.5									
				8.0									
				8.5									
				9.0									
				9.5									
				10.0									

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-6***
SHEET: 1 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***26.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***26.8.2012***
LOCATION:	***QUARRY PIT 1A***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489087.00	**Surface R.L.:**	34 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665362.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		0.0	Glaciomarine Beach Ridge		SP-GP	Sandy GRAVEL: fine gravel up to cobble sized fragments, sub-rounded to sub-angular comprised of mixed lithologies, fine to coarse grained, sub-rounded to sub-angular, grey, trace non plastic silt	4	NA	NA	Bs	From 0.0 to 0.10m TOPSOIL
									9.2				
				0.5								Bs	Note: Mixed lithologies consists of siltstone, quartzite, shale and gneiss
								...from 0.75m trace low plasticity clay	8.4				
				1.0								Bs	Frozen ground below 0.80m based on TP-9
				1.5			GP-CO	GRAVEL and COBBLES: fine gravel up to cobble sized fragments, sub-rounded to angular, comprised of siltstone and shale, grey, trace non plastic silt and sand, fine grained	4.9				
				2.0								Bs	
									5.6				
				2.5								Bs	
				3.0					8.1				
				3.5								Bs	
								...from 3.75m gravel fragments include gneiss	6.9				
				4.0								Bs	
				4.5					8.2				
				5.0								Bs	

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-6***
SHEET: 2 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***26.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***26.8.2012***
LOCATION:	***QUARRY PIT 1A***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489087.00	**Surface R.L.:**	34 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665362.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		5.5	Frost Shattered Bedrock		GP-CO	GRAVEL and COBBLES: fine gravel up to cobble sized fragments, sub-rounded to angular, comprised of siltstone and shale, grey, trace non plastic silt and sand, fine grained	8.2	NA	NA	Bs	
				6.0				End of BH-6 at 6m					Borehole Terminated at 6.0m. Borehole backfilled with drill cuttings. **Caution: The insitu soil descriptions described on this log have been deduced from highly disturbed cuttings recovered with an airtrack drill and may not be accurate.**
				6.5									
				7.0									
				7.5									
				8.0									
				8.5									
				9.0									
				9.5									
				10.0									

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-7***
SHEET: 1 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***26.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***26.8.2012***
LOCATION:	***QUARRY PIT 1B***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489313.00	**Surface R.L.:**	42 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665516.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		0.5	Glaciomarine Beach Ridge		SP	Gravelly SAND: fine to coarse grained, sub-rounded to angular, fine gravel up to cobble sized fragments, sub-rounded to sub-angular, comprised of mixed lithologies, orange brown	2	NA	NA	Bs	From 0.0 to 0.10m TOPSOIL Note: Mixed lithologies consists of siltstone, quartzite, shale and gneiss
				1.0					1.1			Bs	
				1.5			GP-CO	GRAVEL and COBBLES: fine gravel up to cobble sized fragments, sub-rounded to sub-angular, comprised of mixed lithologies, orange brown, with some sand, fine to coarse grained, sub-rounded to sub-angular	6.8			Bs	Frozen ground below 1.50m based on TP-6
				2.0								Bs	
				2.5				...ice chips evident, predominantly fine to coarse gravel	4.2			Bs	
				3.0				...material becoming coarser, predominanlty cobbles	2.9			Bs	
				3.5								Bs	
				4.0				...bi-valve shell evident	3.3			Bs	
				4.5					5.6			Bs	
				5.0									

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-7***
SHEET: 2 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***26.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***26.8.2012***
LOCATION:	***QUARRY PIT 1B***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489313.00	**Surface R.L.:**	42 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665516.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		5.5	Glaciomarine Beach Ridge		GP-CO	GRAVEL and COBBLES: fine gravel up to cobble sized fragments, sub-rounded to sub-angular, comprised of mixed lithologies, orange brown, with some sand, fine to coarse grained, sub-rounded to sub-angular	5.6	NA	NA	Bs	
								...material becoming finer, predominatly fine to coarse gravel	2.5			Bs	
				6.0					1.7			Bs	Difficulty retrieving sample below 6.75m, water/ frozen ground and fines indicate possible glacial till. This is inconclusive.
				6.5				End of BH-7 at 6.75m					Borehole Terminated at 6.90m. Thermistor (#4) installed to 6.00m. Borehole backfilled with drill cuttings. **Caution: The insitu soil descriptions described on this log have been deduced from highly disturbed cuttings recovered with an airtrack drill and may not be accurate.**
				7.0									
				7.5									
				8.0									
				8.5									
				9.0									
				9.5									
				10.0									

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-8***
SHEET: 1 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***26.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***26.8.2012***
LOCATION:	***QUARRY PIT 1B / 2***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489637.00	**Surface R.L.:**	36 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665911.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
AIR TRACK	OPEN HOLE	NA		0.0	Glaciomarine Beach Ridge		GP	Sandy GRAVEL: fine gravel up to cobble sized fragments, sub-rounded to angular, comprised of mix lithologies, fine to coarse grained, sub-rounded to sub-angular sand, brown	9.3	NA	NA	Bs	From 0.0 to 0.20m TOPSOIL
							SP	SAND: medium grained, brown	3			Bs	Note: Mixed lithologies consists of siltstone, quartzite, shale and gneiss
				0.5			GP-CO	GRAVEL and COBBLES: fine gravel up to cobble sized fragements, sub-angular to angular, comprised of mixed lithologies, grey, trace sand	6.7			Bs	
				1.0								Bs	Frozen ground below 1.0m inferred from TP-1A
				1.5			GP	Silty GRAVEL: fine to medium, sub-angular to angular, comprised of mixed lithologies, low plasticity silt, grey	11.1			Bs	
				2.0								Bs	
				2.5					13.7			Bs	
				3.0			SM	Silty SAND: fine to medium grained, low plasticity, brown grey	14.8			Bs	
				3.5								Bs	
				4.0				...trace clay, trace gravel, coarse, sub-angular, comprised of mixed litholgies	14.5			Bs	
				4.5	Glacial Till		SC-SM	Clayey Silty SAND: fine to medium grained, medium plasticity, grey	15.4			Bs	From 4.50 to 5.30m material is non-sorted to poorly sorted, possible diamicton
				5.0									

BOREHOLE LOG

WorleyParsons

BOREHOLE: ***BH-8***
SHEET: 2 OF 2
REVISION: 0

CLIENT:	***Community and Government Services, Nunavut***	DATE COMMENCED:	***26.8.2012***
PROJECT:	***Cambridge Bay Granular Borrow Source***	DATE COMPLETED:	***26.8.2012***
LOCATION:	***QUARRY PIT 1B / 2***	LOGGED BY:	***HB***
JOB NUMBER:	***307034-00016***	CHECKED BY:	DRAFT

Drill Contractor:	BERNIE'S LTD	**Bore Size:**	165mm	**Hole Angle:**	-90°	**Easting:**	489637.00	**Surface R.L.:**	36 m
Drill Model:	AIR TRACK 3100A	**Drill Fluid:**	NA	**Bearing:**	NA	**Northing:**	7665911.00	**Datum:**	NAD83

Drilling Method	Casing	Drill Rate (min/m)	ASL (m) LAT	Depth (m) in Ground	Geological Unit	Graphic Log	Classification Symbol	Material Description	Moisture Content %	Consistency/ Strength	Weathering/ Cementation	Sample/ Test	Field Records / Comments
		NA			Glacial Till		SC-SM	Clayey Silty SAND: fine to medium grained, medium plasticity, grey	15.4	NA	NA	Bs	
				5.5				End of BH-8 at 5.3m					Borehole Terminated at 5.30m. Borehole backfilled with drill cuttings. **Caution: The insitu soil descriptions described on this log have been deduced from highly disturbed cuttings recovered with an airtrack drill and may not be accurate.**
				6.0									
				6.5									
				7.0									
				7.5									
				8.0									
				8.5									
				9.0									
				9.5									
				10.0									

Appendix 4 Test Pit Logs and Photographs

TP-1A

TP-1B

APPENDIX 4

TEST PIT PHOTOGRAPHS

TP-2

TP-3

APPENDIX 4

TEST PIT PHOTOGRAPHS

WorleyParsons
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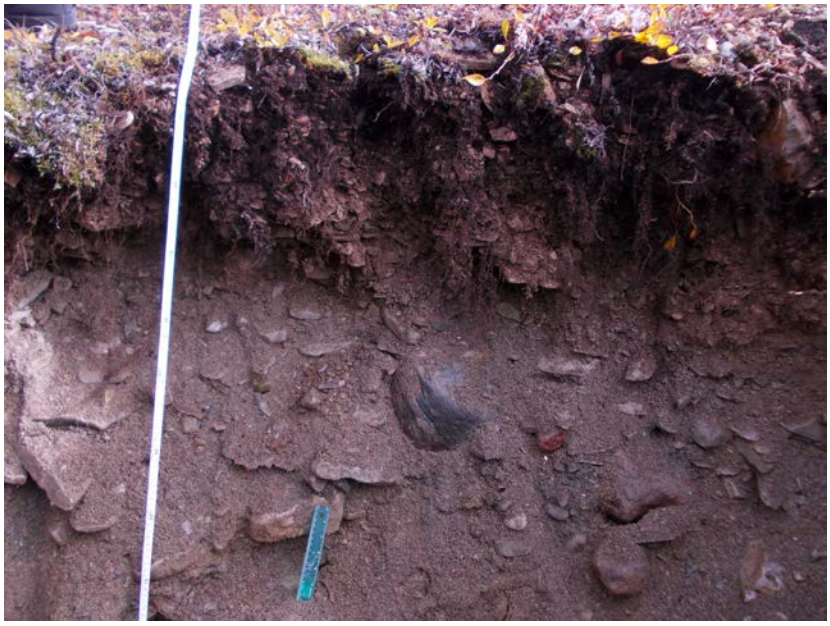
Nunavut

TP-4



TP-5

APPENDIX 4

TEST PIT PHOTOGRAPHS

TP-6

TP-7

APPENDIX 4

TEST PIT PHOTOGRAPHS

TP-8

TP-9

APPENDIX 4

TEST PIT PHOTOGRAPHS

TP-10

TP-11

APPENDIX 4

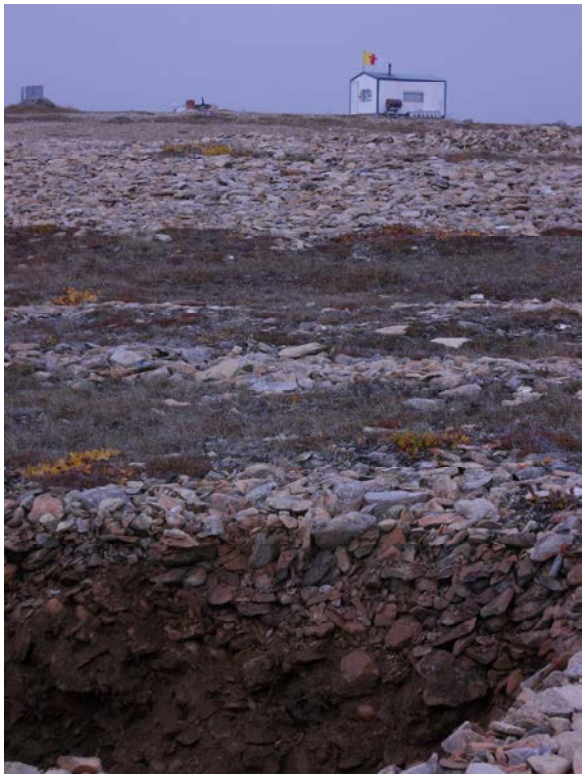
TEST PIT PHOTOGRAPHS

TP-12

TP-13

APPENDIX 4

TEST PIT PHOTOGRAPHS



TP-14

TP-15

TP-16

TP-17

APPENDIX 4

TEST PIT PHOTOGRAPHS

TP-18

TP-19

APPENDIX 4

TEST PIT PHOTOGRAPHS