REPORT

May 6, 2014

ENGLISHMAN RIVER WATER SERVICE SURFACE WATER INTAKE AND TREATMENT PLAN

Pre-Design Geotechnical Investigation

Submitted to:
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Report Number: 1314770018-003-R-Rev0-2000

Distribution:

2 Copies - CH2MHill
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Golder Associates

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1.0 INTRODUCTION

Golder Associates Ltd (Golder) was retained by CH2MHill to provide preliminary geotechnical, archeological and landscape architectural recommendations to CH2MHill as part of a design for the Englishman River Water Service (ERWS) surface water intake and treatment plant for the City of Parksville, British Columbia (the City). A geotechnical subsurface investigation of the proposed water treatment plant and pumping station locations was conducted by Golder to obtain information for use in the design.

The original scope was expanded to include a preliminary investigation of a new shop building for the City. This was discussed during a pre-planning site meeting held on November 8, 2013 between Golder and ERWS and finalized via email to CH2MHill on November 11, 2013.

This report should be read in conjunction with the "*Important Information and Limitations of This Report*" (Appendix A). We specifically draw the reader's attention to this information, as it is essential for the proper use and interpretation of this report.

2.0 SITE DESCRIPTION

The proposed ERWS project site is located in the City of Parksville B.C. on central Vancouver Island. The site is located adjacent to the Englishman River, as shown on Figure 1.

Available surficial geology mapping[1,2] indicates that post-glacial Capilano Sediments comprising fluvial deposits with a terrace morphology are present in the north part of the project area. The fluvial materials consist of deltaic deposits of gravel and sand, commonly underlain by silt and clay. The mapping indicates that Capilano Sediment marine deposits overlying Vashon Drift till are present in the south portion of the project area (adjacent to the Englishman River). Bedrock outcrops occur near the project area along the banks of the Englishman River. Bedrock mapping of the area[3] indicates that the regional bedrock generally comprises formations from the lower portion of the Nanaimo Group. Based on the available information, it is likely that the bedrock underlying the surficial deposits on the site is composed of shale, siltstone, and sandstone of the Haslam Formation.

For ease of discussion, the project site has been divided into three distinct areas based on the proposed structures:

1) intake and pump station;

2) water treatment plant (WTP) and new shop building; and

3) transfer pipes.

[1] Fyles, J. G., 1963. Surflcial geology of Horne Lake and Parksville map-areas, Vancouver Island, British Columbia : Geological Survey of Canada, Memoir 318, 142 p.

[2] Fyles, J.G. (1963). Surficial geology, Parksville, Vancouver Island, British Columbia; Geological Survey of Canada, Map 1112A

[3] Mustard, P.S., 1994: The Upper Cretaceous Nanaimo Group, Georgia Basin: in Geology and Geological Hazards of the Vancouver Region, Southwestern British Columbia, (ed.) J.W.H. Monger; Geological Survey of Canada, Bulletin 481, p. 27 -95.

2.1 Intake and Pump Station

Golder understands that the intake and pump station will be located within Top Bridge Park, located to the south of Highway 19 (Figures 1 and 2). The proposed pump station will be constructed on a relatively flat topographic bench that supports second growth forest cover. The Englishman River is located to the south at an elevation that is approximately 3 m below that of the bench. The river bank between the bench and river bed slopes steeply (1 horizontal: 1 vertical [1H:1V], or steeper) and contains visible cobbles and boulders. Highway 19 is located to the north of the proposed pump station, approximately 10 m vertically above the bench. The slope between the Highway and bench is vegetated with alder trees, salal, and ferns, and has a slope of approximately 1.5H: 1V. Visual indications of slope instability were not observed on the 1.5H:1V slope at the time of Golder's site visits.

2.2 Water Treatment Plant (WTP) and New Shop Building

The WTP will be located within the City of Parksville Public Works Yard located at 1116 Herring Gull Way (Figures 1 and 3), which is approximately 400 m northeast of the proposed intake location.

The proposed WTP will be located on the south side of the Public Works Yard in an area currently used for gravel and salt storage, and parking. The topography of the proposed location is relatively flat with sand and gravel surfacing. To the west of the Public Works Yard is an historic gravel pit, which is generally covered by grass with sparse trees on the slopes and edges.

2.3 Conveyance Pipes

The conveyance pipes will cross beneath Highway 19 and E & N Railway, extending between the two structures. The route for the conveyance piping was not finalized at the time of this field investigation. Future investigations will be required to determine any geotechnical constraints associated with construction of the conveyance piping.

3.0 GEOTECHNICAL INVESTIGATION

A geotechnical subsurface investigation of the areas of the intake structure and pump station, new shop building and water treatment plant was carried out on December 9, 10 and 11, 2013. Boreholes MW13-01 to MW13-04 were advanced using a track mounted sonic drill rig supplied and operated by Drillwell Enterprises Ltd. of Duncan, BC. The four boreholes were advanced through the subsurface material to depths ranging between 9.8 and 31.1 m below ground surface (m bgs). One hand auger borehole (HA13-05) was advanced through the subsurface along the river bank near the proposed intake structure, to approximately 0.4 m bgs. The Record of Boreholes summary logs are provided in Appendix B.

Borehole locations were determined by Golder geotechnical personnel based on the proposed foundation locations indicated in the field by Mike Squire (ERWS) on December 9, 2013. Borehole locations were recorded in the field using a handheld GPS device with approximately 3 m accuracy. Borehole locations are shown on Figures 1, 2 and 3 with respect to proposed structures.

The drilling investigation was conducted under the full-time supervision of a member of Golder's geotechnical staff, who visually examined and logged the subsurface conditions encountered, collected soil samples for review and laboratory testing, and photographed the sonic core runs. The subsurface soil stratigraphy was visually inspected and logged based on sonic drill continuous core runs. Samples were collected directly from the split barrel sampler used in Standard Penetration Testing (SPT). SPT methods were also used to assess in-situ relative density and consistency of the soils. SPT testing was conducted using a 63.5 kg automatic hammer dropped 760 mm. A 50 mm wide open sampler was driven 600 mm (24 in) and the SPT blow "N" value was determined based on the blow count between 150 and 450 mm of driving.

Disturbed samples (76 total) collected from the sonic core runs and SPTs were transported to Golder's geotechnical testing laboratory in Victoria, B.C. for laboratory index testing.

Boreholes BH13-02 and BH13-03 were backfilled with bentonite and borehole cuttings for consistency with requirements under the BC Groundwater Protection Regulation. Monitoring wells were installed in MW13-01 and MW13-04 to monitor groundwater levels.

Laboratory Testing

The following laboratory tests were carried out on select samples at Golder's geotechnical testing laboratory:

- Natural water content (ASTM D 4959) – 10 samples;
- Atterberg limit determination (ASTM D 4318) – 3 samples; and
- Particle Size analysis of Soils (ASTM C136) – 10 samples.

Results of the water content and Atterberg limit determinations are provided on individual borehole logs in the Record of Boreholes sheets in Appendix B. Results of the particle size analyses are provided in Appendix C.

4.0 SUBSURFACE STRATIGRAPHY

The soil descriptions provided in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves judgement and Golder infers the accuracy of soil descriptions to the extent that is common in current geotechnical practice. The depths to stratigraphic changes are generally approximate and inferred since there is frequently a gradual transition between soil types. Detailed soil descriptions, groundwater conditions, natural water contents, Atterberg limits and SPT blow counts are presented in the attached Record of Boreholes in Appendix B. Variation in the subsurface conditions should be expected, requiring caution when interpreting conditions between boreholes.

For discussion purposes, the subsurface soils encountered during the investigation have been separated based on proposed development area, and grouped into stratigraphic units.

4.1 Intake and Pump Station

The proposed intake structure and pump station will be constructed on a topographic bench located approximately 3 m above the elevation of the adjacent Englishman River. The soils underlying the lower bench are generally described by the following stratigraphic units (in order of increasing depth below ground surface) based on the observed physical characteristics and properties:

- topsoil;
- fluvial deposits; and
- glacial till.

Topsoil

A layer of topsoil consisting of silty sand was encountered from surface to 0.7 m bgs in MW13-04 and the maximum depth of investigation (0.5 m bgs) of HA13-05. The topsoil encountered was described as dark grey, loose to compact, non-cohesive, moist, and containing organics and woody debris.

Fluvial Deposits

Fluvial deposits were encountered underlying the topsoil in MW13-04. The Fluvial deposits were encountered for a thickness of 5.9 m. The Fluvial material encountered was described as a mixture of granular matrix materials and cobbles/boulders. The granular material was described as a brown/grey, moist, very dense, sand and gravel with some non-plastic fines. Rootlets were encountered to a depth of 2.5 m bgs in MW13-04. The cobbles and boulders encountered were composed of a mixture of granite and andesite; rounded edges were described on some of the boulder rock cores recovered.

Standard Penetration Test (SPT) resistance ('N') values of 41 to >50 blows per 300 mm were recorded within this unit. SPT values may not be representative of actual field density conditions in this unit due to the presence of cobbles and boulders, which periodically blocked the advance of the sampler during testing.

Glacial Till

Inferred glacial till was encountered underlying the fluvial deposits in MW13-04 from 6.7 m bgs to the maximum depth of investigation (11.3 m bgs). The till was described as a dark grey, compact to very dense, moist, silty sand to silty sand and gravel.

Standard Penetration Test (SPT) resistance ('N') values of 29 to 56 blows per 300 mm were recorded within this unit. Water contents of 7.2 to 11.4 percent (average of 9.9 percent) were measured in samples of this material. The measured liquid limit within a sample of this material was 14. The measured plastic limit within a sample of this material was 16. The calculated plasticity index and liquidity index were -2 and 2.3 respectively.

Bedrock

Bedrock was not encountered during the subsurface investigation.

4.2 Water Treatment Plant and New Shop Building

The proposed water treatment plant and new shop building will be located within The City's Public Works Yard. The soils beneath the Public Works Yard are generally described by the following stratigraphic units (in order of increasing depth below ground surface) based on the observed physical properties:

- Stratified gravelly sand;
- Glacio-marine clayey silt; and
- Glacial till.

Stratified Gravelly Sand

Deposits of stratified gravelly sand to sand and gravel interpreted to be part of the Capilano Sediments deposit were encountered from surface to 16.8 m bgs in MW13-01 and the maximum depth of investigation in BH13-02 and BH13-03 (18.9 m bgs and 9.8 m bgs respectively). The unit was described as dense to very dense, with stratified layers of sand, gravelly sand or sand and gravel and trace fines. The observed stratification was based on grain size and sorting with variable colouring from red-brown to dark grey. Cobbles were observed throughout the layer in the core runs and also inferred based on drill reaction. Woody debris and tree roots were observed within the gravelly sand up to 3.6 m bgs in BH13-03. The gravelly sand was generally described as moist except in BH13-02, below 16.1 m bgs where it was described as wet.

Standard Penetration Test (SPT) resistance ('N') values of 28 to 80 blows per 300 mm were recorded in moist samples of this material and an 'N' value of 17 was recorded in the wet sample of this material.

Glacio-Marine Clayey Silt

Glacio-marine clayey silt, interpreted to be part of the Capilano Sediments, was encountered underlying the stratified gravelly sand in MW13-01. The clayey silt had an approximate thickness of 4.6 m in MW13-01. The material encountered was described as dark grey, varved, with black, clayey silt. The consistency of the layer varied with depth from soft to very stiff. Some sand and gravel was encountered within the clayey silt unit at 16.8 m bgs; the observed amount of sand and gravel gradually increased with depth until 21.3 m bgs. At that depth, the material is described as a silty sand and gravel. The observed water content of the soil also increased with depth from water contents greater than the plastic limit of the soil to water contents approximately equal to the liquid limit of the soil (w>PL to w~LL) with free water observed below 21 m. Shells (<5 mm in size) were observed within this material.

Standard Penetration Test (SPT) resistance ('N') values of 13 to 50 blows per 300 mm (increasing with depth) were recorded in samples of this unit. The index properties are summarized in Table 2 below:

Table 1: Clayey Silt Index Properties

Index Property	Range	Average
Water Content	9.6% to 25.4 %	20.7%
Liquid Limit	24% to 32%	28%
Plastic Limit	16% to 17%	16%
Plasticity Index	7 to 16	-
Liquidity Index	0.6 to 1	-

Glacial Till

Glacial till, interpreted to be part of the Vashon Drift surficial geologic unit, was encountered underlying the glacio-marine silt in MW13-01, from 21.3 m bgs to the maximum depth of investigation 31.1 m bgs. The till was generally described as very dense, moist, dark grey, silty sand and gravel. Beds of grey to brown, moist to wet, sand and gravel with trace to some non-plastic fines up to 1 m thick were encountered within the till. Cobbles were encountered throughout the till unit.

Standard Penetration Test (SPT) resistance ('N') values of 61 to 97 blows per 300 mm (increasing with depth) were recorded in samples of this unit.

Water contents of 5.6 to 10.6 percent (average of 8.8 percent) were measured in samples of this material.

5.0 GROUNDWATER

During the site investigation, 51 mm (2 inch) diameter PVC pipe standpipe piezometers were installed in MW13-01 and MW13-02, to measure groundwater levels. Monitoring well installation details are provided on the Record of Boreholes in Appendix B. Water levels in the monitoring wells were read immediately after installation. The water levels measured at the time of installation are provided in Table 2.

Table 2: Groundwater Levels

Monitoring Well ID	Dec 10/11, 2013
MW13-01	16.70 m bgs
MW13-04	9.95 m bgs

These water levels should be considered as preliminary indications of actual groundwater levels and not indicative of stabilized water levels, which would require further monitoring.

6.0 RECOMMENDATIONS AND DESIGN CONSIDERATIONS

6.1 Intake and Pump Station

At the time of preparation of this report, Golder had not been provided with anticipated foundation layouts or loads for the intake and pump station. However, the gravel and sand (fluvial) deposits encountered in the area of the proposed intake and pump station are generally considered to be suitable foundation materials for the proposed structures. Based on the available information a preliminary design allowable bearing pressure of 150 kPa is considered suitable for preliminary design. Foundation dimensions and depths will be required to determine the final design bearing pressures for the site.

Based on the available information regarding the proposed intake structure and pump station at the time of preparation of this report and the groundwater observations at the time of the investigation, it is not anticipated that groundwater will be encountered during excavation for construction of the pump station. However, as the intake structure extends down to the level of the river, groundwater can be expected during excavations associated with the intake structure. Boulders were encountered during drilling of MW13-04, as such, it is anticipated that boulders may be encountered during excavations associated with the intake structure and pump station. Bedrock outcrops are present in the river, and although bedrock was not encountered during the investigation, it may be present within the footprint of the intake structure.

6.2 Water Treatment Plant and New Shop Building

At the time of preparation of this report, Golder had not been provided with anticipated foundation layouts or loads for water treatment plant and new shop building. The stratified sand and gravel material encountered in the area of the proposed water treatment plant and new shop building is generally considered suitable foundation material for the proposed structures. Based on the available information a preliminary design allowable bearing pressure of 150 kPa is considered suitable for preliminary design. Foundation dimensions and depths will be required to determine the final design bearing pressure for the site.

Based on the available information regarding the proposed water treatment plant and new shop building at the time of preparation of this report, and the groundwater observations at the time of the investigation, it is not anticipated that groundwater will be encountered during excavation for construction water treatment plant and new shop building. Cobbles and boulders were encountered during drilling of MW13-01, and BH13-02, as such, it is anticipated that boulders may be encountered during excavations associated with the water treatment plant and new shop building.

6.3 Conveyance Pipes

Investigations were not conducted along the proposed conveyance pipe route, as the route had not been finalized at the time of the subsurface investigation, or at the time of preparation of this report. However, based on the results of the subsurface investigation at the proposed water treatment plant and pump station locations, it is inferred that excavations for the conveyance pipes will likely encounter generally granular materials, which may contain cobbles and boulders. Subsurface investigations along the proposed conveyance route will be required to assess the soil conditions for final design.

6.4 Seismic Design Considerations

Current seismic design loads, based on the 2012 British Columbia Building Code (BCBC), are determined from ground motions corresponding to a design seismic event with a two percent probability of exceedance in 50 years (an average return period of 2,475 years). For a given seismic response Site Class, the effects of shaking level and period are incorporated via the acceleration (Fa) and velocity (Fv) based site coefficients defined in Tables 4.1.8.4B and C, respectively, of the 2012 BCBC.

The effects of local site conditions are characterized based on the average SPT blow counts of the soil. Based on the standard blow counts in MW13-01 ranging between 13 and 97 (average = 48), the site is classified as a Site Class D (stiff soil) based on the classification criteria listed in Table 4.1.8.4.A, in Section 4.1.8.4 of the 2012 BCBC.

The earthquake provisions of the National Building Code and the BC Building Code are intended to reduce the risk of collapse of a structure due to an earthquake, but are not intended to ensure that no damage to the structure will occur.

6.4.1 Site-Specific Seismic Parameters for Foundation Design

A site-specific seismic hazard calculation was obtained from the Natural Resources Canada (NRC) for firm ground conditions in accordance with 2010 seismic hazard maps of Canada, and based on location of the site relative to inferred seismic sources and attenuation relationships[4]. The resulting peak horizontal; ground acceleration (PGA) and the five percent damped spectral response acceleration (Sa) values at periods (T) of 0.2, 0.5, 1.0, and 2.0 seconds corresponding to the 2,475-year design earthquake are provided in Table 3, below.

[4] http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/index_2010-eng.php, July 2013

These accelerations are applicable to Site Class C (very dense soil and soft rock) sites according to the 2012 BCBC and are used to linearly interpolate values for Site Class D soils based on Tables 4.1.8.4B and C of the 2012 BCBC.

Table 3: PGA and Spectral Accelerations for Site Class C

PGA	S_a (0.2)	S_a (0.5)	S_a (1.0)	S_a (2.0)
0.43g	0.89g	0.62g	0.33g	0.17g

6.4.2 Preliminary Liquefaction Susceptibility Assessment

Liquefaction susceptibility was assessed based on criteria presented in the Canadian Foundation Engineering Manual[5] (CFEM) and the Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils (NCEER-97-0022). The liquefaction susceptibility of a site is influenced by soil type, relative density of the soils, confining pressure, stress due to an earthquake event, duration of an earthquake event, and soil drainage conditions. Based on the SPT blow counts, available groundwater information, and soil plasticity data, the soils encountered are not considered to be subject to liquefaction under the design earthquake loading. However, the groundwater levels observed during the site investigation are considered preliminary, and additional monitoring of groundwater levels is required to confirm this assessment.

6.5 Further Assessments

We recommend that supplemental geotechnical subsurface investigations be conducted once the arrangement of facilities has been finalized. The extent of additional investigations will depend on the proposed loads and layouts of the facilities. The recommended additional geotechnical investigation will be used to assess the variability of the subsurface conditions across the site and confirm the geotechnical interpretations presented in this report. This information will be used to provide design bearing pressures, evaluate potential settlement of the structures, confirm preliminary liquefaction susceptibility assessment findings, and provide detailed geotechnical recommendations to meet the project requirements based on the proposed design.

Future investigations will also be required to determine geotechnical constraints associated with construction of the transfer pipes, once the alignment of these has been confirmed.

[5] Canadian Geotechnical Society, “Canadian Foundation Engineering Manual, Fourth Edition”, 2006.

7.0 CLOSURE

We trust this report provides the information suitable for your current needs. If you have any questions, please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.

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Geotechnical Engineer

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Geotechnical Engineer

Reviewed by:

Jeff Fillipone, Ph.D., P.Geo.
Principal, Senior Geologist

AER/SEM/JAF/smh/lh

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\\golder.gds\gal\Victoria\Active\2013\1477\13-1477-0018 CH2MHill ERWS Intake Parksville\09 CAD\GIS\Mapping\MXD\General\FIGURE 1 - SITE PLAN.mxd

LEGEND

Label	
BOREHOLE	LOT BOUNDARY
HAND AUGER HOLE	LOWLIFT PUMPING STATION
CONTOUR (5 M INTERVAL)	NEW SHOP BUILDING (APPROX. LOCATION)
HIGHWAY	PROPOSED WATER TREATMENT FACILITY
LOCAL ROAD	WATERBODY

100 0 100

SCALE 1:2,500 METRES

PROJECT
CH2M HILL
ENGLISHMAN RIVER WATER SERVICE INTAKE
PARKSVILLE, BC

TITLE
SITE PLAN

REFERENCE

SERVICE LAYER CREDITS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY. BASE DATA FROM CANVEC DEPARTMENT OF NATURAL RESOURCES, PROVINCE OF BRITISH COLUMBIA. CONTOURS INTERPOLATED FROM CANADIAN DIGITAL ELEVATION DATA (CDED), OBTAINED FROM GEOBASE. IMAGERY FROM ARCGIS BASEMAPS SERVICE.
WATER TREATMENT PLANT AND WATER INTAKE DATA PROVIDED BY CH2M HILL
DATUM: NAD83 PROJECTION: UTM ZONE 10

Golder Associates

PROJECT	13-1477-0018		FILE No.	
DESIGN	AR	14 JAN 2014	SCALE AS SHOWN	REV. 0
GIS	AD	29 JAN 2014		
CHECK	SEM	07 MAR. 2014		
REVIEW	JAF	07 MAR. 2014		

FIGURE: 1

\\golder.gds\gal\Victoria\Active\2013\1477\13-1477-0018 CH2MHill ERWS Intake Parksville\09 CAD\GIS\Mapping\MXD\General\FIGURE 2 - INTAKE AND PUMP STATION.mxd

LEGEND

- BOREHOLE
- HAND AUGER HOLE
- CONTOUR (1 m INTERVAL)
- LOWLIFT PUMPING STATION

10 0 10
SCALE 1:250 METRES

REFERENCE

BASE DATA FROM CANVEC DEPARTMENT OF NATURAL RESOURCES, PROVINCE OF BRITISH COLUMBIA. CONTOURS INTERPOLATED FROM CANADIAN DIGITAL ELEVATION DATA (CDED), OBTAINED FROM GEOBASE. IMAGERY AND CONTOUR DATA PROVIDED BY THE CITY OF PARKSVILLE.
WATER TREATMENT PLANT AND WATER INTAKE DATA PROVIDED BY CH2M HILL
DATUM: NAD83 PROJECTION: UTM ZONE 10

PROJECT
CH2M HILL
ENGLISHMAN RIVER WATER SERVICE INTAKE
PARKSVILLE, BC

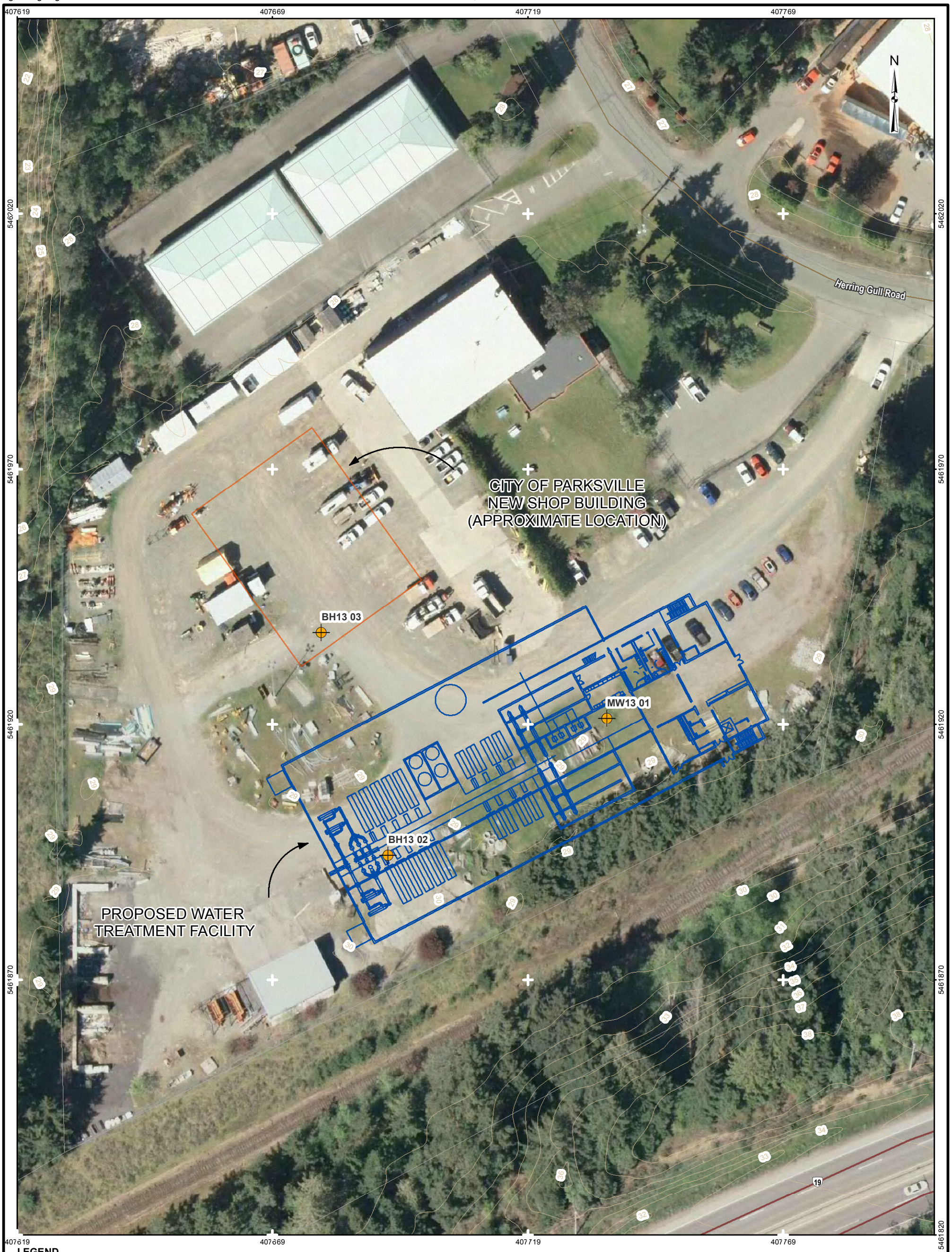
TITLE
INTAKE STRUCTURE AND PUMP STATION - BOREHOLE LOCATIONS

Golder Associates

PROJECT	13-1477-0018		FILE No.	
DESIGN	AR	14 JAN 2014	SCALE AS SHOWN	REV. 0
GIS	AD	29 JAN 2014		
CHECK	SEM	07 MAR. 2014		
REVIEW	JAF	07 MAR. 2014		

FIGURE: 2

\\golder.gds\gal\Victoria\Active\2013\1477\13-1477-0018 CH2MHill ERWS Intake Parksville\09 CAD\GIS\Mapping\MXD\General\FIGURE 3 - WATER TREATMENT PLANT AND SHOP .mxd



LEGEND

Label

- BOREHOLE
- CONTOUR (1 m INTERVAL)
- LOCAL ROAD
- HIGHWAY
- PROPOSED WATER TREATMENT FACILITY
- LOT BOUNDARY

25 0 25

SCALE 1:700 METRES

REFERENCE

SERVICE LAYER CREDITS: . BASE DATA FROM CANVEC DEPARTMENT OF NATURAL RESOURCES, PROVINCE OF BRITISH COLUMBIA. CONTOURS INTERPOLATED FROM CANADIAN DIGITAL ELEVATION DATA (CDED), OBTAINED FROM GEOBASE. IMAGERY FROM ARCGIS BASEMAPS SERVICE. CONTOUR DATA PROVIDED BY THE CITY OF PARKSVILLE.
WATER TREATMENT PLANT AND WATER INTAKE DATA PROVIDED BY CH2M HILL
DATUM: NAD83 PROJECTION: UTM ZONE 10

PROJECT
CH2M HILL
ENGLISHMAN RIVER WATER SERVICE INTAKE
PARKSVILLE, BC

TITLE
WATER TREATMENT PLANT AND NEW SHOP BUILDING - BOREHOLE LOCATIONS

Golder Associates

PROJECT	13-1477-0018		FILE No.	
DESIGN	AR	14 JAN 2014	SCALE AS SHOWN	REV. 0
GIS	AD	29 JAN 2014		
CHECK	SEM	07 MAR. 2014		
REVIEW	JAF	07 MAR. 2014		

FIGURE: 3

APPENDIX A

Important Information and Limitations of this Report

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated

and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

APPENDIX B

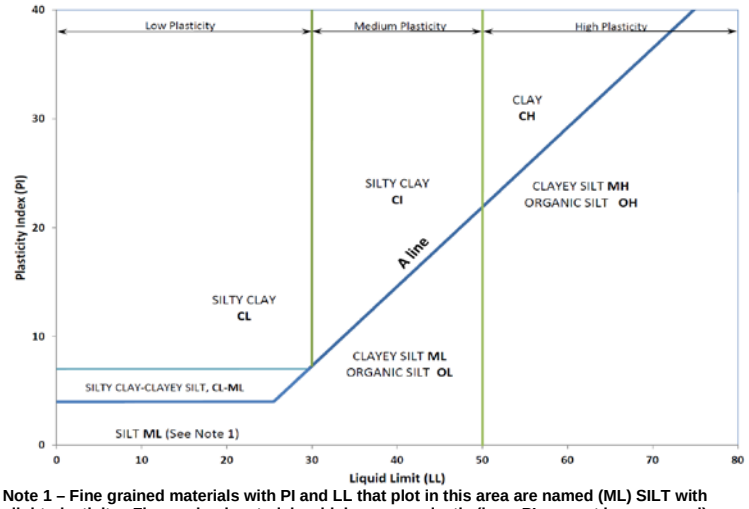
Record of Boreholes

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil		Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
					Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)		Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
					Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
					Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
				Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
					None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)		Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% (see Note 2)	CL	SILTY CLAY
				Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
				Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures								30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat								75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to ~~or~~ indicate~~s~~ a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL, SAND and CLAY)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size
TP	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
2. Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N_{60} values.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

PROJECT No.: 13-1477-0018 / 2000

RECORD OF MONITORING WELL: MW13-01

SHEET 1 OF 4

CLIENT: CH2M HILL

DATUM: Geodetic

PROJECT: ERWS Surface Water Intake and Treatment Plant

LOCATION: NE Corner of Water Treatment Plant

DRILLING DATE: December 9-10, 2013

DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

N: ~5461921.03 E: ~407734.25 UTM NAD83 Zone: 10

Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

INCLINATION: -90°

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●; rem V. ⊕ U - ○; Pocket Pen - ■; 20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp — W — Wl; NP - Non-Plastic; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface												Stick-up = 0.94 m
0	Geoprobe 8140LS Sonic	TOPSOIL - (SP/GP) SAND and GRAVEL, some non-plastic fines; dark brown, organics; non-cohesive, wet, compact.		0.00										
		(SP/GP) SAND and GRAVEL, trace non-plastic fines; grey, contains cobbles up to 100mm; non-cohesive, moist, dense.		0.30	1	GS								Bentonite/ Concrete
1		- Roots/wood debris at 1.37 m depth.												
		(GP) GRAVEL, trace to some sand, trace fines; grey; non-cohesive, moist, very dense.		1.52	2	SPT	38	51						
2		(SP/GP) SAND and GRAVEL; light brown, contains cobbles; non-cohesive, moist, dense.		2.13										
					3	GS								
3					4	SPT	83	37						Cuttings
4					5	GS								
					6	SPT	71	42						
5		- Layer of gravelly SAND (100 mm thick) at 5.18 m depth												Bentonite
					7	GS								
		- Layer of SILTY SAND (100 mm thick) at 5.79 m depth												
6					8	SPT	71	53						
7					9	GS								
					10	SPT	58	28						
8														Cuttings
					11	GS								
9		- Layer of fine subrounded gravel (300 mm thick) at 8.84 m depth												
		- Very dense below 9.14 m depth												
					12	SPT	67	69						
10														
		CONTINUED NEXT PAGE												

DEPTH SCALE

1 : 50

LOGGED: A. Ramey

CHECKED: S. Morse

Golder Associates

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PROJECT No.: 13-1477-0018 / 2000

RECORD OF MONITORING WELL: MW13-01

SHEET 2 OF 4

CLIENT: CH2M HILL
PROJECT: ERWS Surface Water Intake and Treatment Plant
LOCATION: NE Corner of Water Treatment Plant
N: ~5461921.03 E: ~407734.25 UTM NAD83 Zone: 10
Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

DRILLING DATE: December 9-10, 2013
DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

DATUM: Geodetic

INCLINATION: -90°

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
10	Geoprobe 8140LS Sonic	(SP/GP) SAND and GRAVEL; light brown, contains cobbles; non-cohesive, moist, dense. *(continued)*			13	GS						Cuttings
		(SP) gravelly SAND, trace fines; light brown, contains cobbles up to 90 mm dia; non-cohesive, moist, very dense.		10.67								
11					14	GS						
12												Bentonite
					15	SPT	67	62				
13												
					16	GS						
14		- Layer of fine SAND (200 mm thick) at 14.33 m depth										
15					17	SPT	73	52				Silica Sand and Slotted PVC Pipe
16		(SM) SILTY SAND; red-brown, pockets of red sand; non-cohesive, moist, dense.		15.85	18	GS						
17		(ML) CLAYEY SILT, some fine sand; dark grey varved with black, contains shells, (MARINE); cohesive, w>PL, soft to firm.		16.76	19	GS						
18												
		(MH) gravelly, sandy, CLAYEY SILT; dark grey; cohesive, w>PL, firm to stiff.		18.29	20	SPT	100	13				Bentonite
19												
					21	GS						
20		*CONTINUED NEXT PAGE*										

SHEAR STRENGTH Cu, kPa — nat V. + Q - ● rem V. ⊕ U - ○ Pocket Pen - ■ (20 40 60 80)

WATER CONTENT PERCENT — Wp W Wl (10 20 30 40) NP - Non-Plastic

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: A. Ramey
CHECKED: S. Morse

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PROJECT No.: 13-1477-0018 / 2000

RECORD OF MONITORING WELL: MW13-01

SHEET 3 OF 4

CLIENT: CH2M HILL

DATUM: Geodetic

PROJECT: ERWS Surface Water Intake and Treatment Plant

LOCATION: NE Corner of Water Treatment Plant

DRILLING DATE: December 9-10, 2013

DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

N: ~5461921.03 E: ~407734.25 UTM NAD83 Zone: 10

Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

INCLINATION: -90°

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
20	Geoprobe 8140LS Sonic	(MH) gravelly, sandy, CLAYEY SILT; dark grey; cohesive, w>PL, firm to stiff. *(continued)*			22							
21		- w~LL (wet to free water) below 21.03 m depth										
		(SM/GM) SILTY SAND and GRAVEL; dark grey; non-cohesive, wet, very dense.		21.34								
22		(SP/GP) SAND and GRAVEL, some non-plastic fines; grey-brown, contains cobbles; non-cohesive, moist to wet, very dense.		22.25	24	GS						
23		(SM/GM) SILTY SAND and GRAVEL; dark grey, contains cobbles; non-cohesive, moist, very dense.		23.16								
24					25	GS						
					26	SPT	87	61				
25												Bentonite
26		(SP) gravelly SAND, some non-plastic fines; dark grey; non-cohesive, moist, dense.		26.21	27	GS						
		(SM/GM-SP/GP) SILTY SAND and GRAVEL to SAND and GRAVEL, some non-plastic fines; dark grey, thin to medium bands of fine sand (20-300 mm thick), coarse sand or silt between layer of mixed matrix (~300-500 mm thick), contains cobbles up to 80 mm dia; non-cohesive, moist, very dense.		26.52	28	GS						
27												
					29	SPT	79	83				
28												
29					30	GS						
30		*CONTINUED NEXT PAGE*										

SHEAR STRENGTH Cu, kPa — nat V. + Q - ● rem V. ⊕ U - ○ Pocket Pen - ■ (20 40 60 80)

WATER CONTENT PERCENT — Wp W WI (10 20 30 40) NP - Non-Plastic

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: A. Ramey

CHECKED: S. Morse

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PROJECT No.: 13-1477-0018 / 2000

RECORD OF MONITORING WELL: MW13-01

SHEET 4 OF 4

CLIENT: CH2M HILL

DATUM: Geodetic

PROJECT: ERWS Surface Water Intake and Treatment Plant

LOCATION: NE Corner of Water Treatment Plant

DRILLING DATE: December 9-10, 2013

DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

N: ~5461921.03 E: ~407734.25 UTM NAD83 Zone: 10

Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

INCLINATION: -90°

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY %	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●; rem V. ⊕ U - ○; Pocket Pen - ■) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl; NP - Non-Plastic) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
30												
31	Geoprobe 8140LS Sonic				31	SPT	92	97				Bentonite
		End of Monitoring Well.		31.09								
32												
33												
34												
35												
36												
37												
38												
39												
40												

DEPTH SCALE

1 : 50

LOGGED: A. Ramey

CHECKED: S. Morse

Golder Associates

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PROJECT No.: 13-1477-0018 / 2000

RECORD OF BOREHOLE: BH13-02

SHEET 1 OF 2

CLIENT: CH2M HILL

DATUM: Geodetic

PROJECT: ERWS Surface Water Intake and Treatment Plant

LOCATION: SW Corner of Water Treatment Plant

DRILLING DATE: December 10-11, 2013

DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

N: ~5461894.17 E: ~407691.41 UTM NAD83 Zone: 10

Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

INCLINATION: -90°

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface							SHEAR STRENGTH Cu, kPa: nat V. + Q - ●; rem V. ⊕ U - ○; Pocket Pen - ■ (20 40 60 80)	WATER CONTENT PERCENT: Wp — W — Wl; NP - Non-Plastic (10 20 30 40)		
0	Geoprobe 8140LS Sonic	(SP/GP) SAND and GRAVEL, fine to coarse sand, fine to coarse, angular gravel, some non-plastic fines; light grey, contains cobbles and boulders; non-cohesive, very moist, dense.		0.00	1	GS						Bentonite
1												
2					2	SPT	70	59				
3		(SP/GP) SAND and GRAVEL, fine to coarse sand, fine to coarse, subrounded gravel, trace fines; dark grey; non-cohesive, moist, dense.		3.05	3	SPT	58	33				Cuttings
4					4	GS						
5					5	SPT	70	49				
6					6	GS						
		(SP) gravelly SAND, trace fines; grey; non-cohesive, moist, very dense.		6.10	7	SPT	70	34				
7					8	GS						Bentonite
8					9	SPT	75	50				
		(SP/GP) SAND and GRAVEL, trace fines; grey, contains cobbles; non-cohesive, moist, very dense.		8.23								
		(SP) gravelly SAND, trace fines; brown; moist, very dense.		8.53	10	GS						
9					11	SPT	83	64				
				9.75								
10		*CONTINUED NEXT PAGE*										

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: A. Ramey

CHECKED: S. Morse

File:GINT_GAL_NATIONALIM Output FormBC_BOREHOLE (AUTO) Template:LOCALHOST: GINT_GAL_TEMPLATE_DEV Library:_GAL LIBRARY.GLB tstgelais 3/10/14

PROJECT No.: 13-1477-0018 / 2000

RECORD OF BOREHOLE: BH13-02

SHEET 2 OF 2

CLIENT: CH2M HILL

DATUM: Geodetic

PROJECT: ERWS Surface Water Intake and Treatment Plant

LOCATION: SW Corner of Water Treatment Plant

DRILLING DATE: December 10-11, 2013

DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

N: ~5461894.17 E: ~407691.41 UTM NAD83 Zone: 10

Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

INCLINATION: -90°

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○, Pocket Pen - ■; 20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT (Wp — W — Wl; NP - Non-Plastic; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
10	Geoprobe 8140LS Sonic	(SP/GP) SAND and GRAVEL, some fines; light grey; non-cohesive, moist, very dense. *(continued)*										Bentonite
		(SP) gravelly SAND, trace fines; light brown; non-cohesive, moist, very dense.		10.52	12	GS						
11		(SP/GP) SAND and GRAVEL, some fines; light grey; non-cohesive, moist, very dense.		11.28								
12		(SP) gravelly SAND, trace fines; light brown, stratified, contains cobbles up to 110 mm dia; non-cohesive, moist, very dense.		11.89	13	SPT	92	68				
13		- Layer of SAND and GRAVEL, trace fines; light grey (100 mm thick) at 13.11 m depth			14	GS						
14		- Layer of (SM) SILTY fine SAND; dark grey (100 mm thick) at 14.02 m depth - Layer of (SP/GP) SAND and GRAVEL, some fines; light grey (200 mm thick) at 14.17 m depth			15	GS						Cuttings
15												
16		- Wet, compact to dense below 16.15 m depth			16	SPT	83	72				
17					17	GS						
18					18	SPT	108	17				Bentonite
19		End of Borehole.		18.90								
20												

DEPTH SCALE

1 : 50

LOGGED: A. Ramey

CHECKED: S. Morse

Golder Associates

File:GINT_GAL_NATIONALIM Output Form:BC_BOREHOLE (AUTO) Template:LOCALHOST: GINT_GAL_TEMPLATE_DEV Library:_GAL LIBRARY.GLB tstgelais 3/10/14

PROJECT No.: 13-1477-0018 / 2000

RECORD OF BOREHOLE: BH13-03

SHEET 1 OF 1

DATUM: Geodetic

CLIENT: CH2M HILL

PROJECT: ERWS Surface Water Intake and Treatment Plant

LOCATION: COP New Shop Building

N: ~5461937.87 E: ~407678.33 UTM NAD83 Zone: 10

Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

DRILLING DATE: December 10, 2013

DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

INCLINATION: -90°

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface								
0	Geoprobe 8140LS Sonic	(SP) gravelly SAND, some to trace non-plastic fines; red-brown, contains organics; non-cohesive, moist, dense.		0.00	1	GS				Bentonite
1		(SP/GP) SAND and GRAVEL, trace fines; light grey, contains cobbles up to 200 mm dia; non-cohesive, moist, very dense.		0.91	2	GS				
					3	SPT	71	80		
2		- Grey-brown below 2.44 m depth								
					4	GS				
3					5	SPT	50	57		
		(SP) SAND, trace fine gravel, trace fines; red-brown, contains a tree root; non-cohesive, moist, dense.		3.51						
4					6	GS				
		- Lens of SILTY SAND (100 mm thick) at 4.57 m depth		4.57						
		(SP) gravelly SAND, trace fines; light brown, cobbles up to 80 mm dia; non-cohesive, moist, dense.			7	SPT	100	44		Cuttings
5					8	GS				
		(SP/GP) SAND and GRAVEL; light brown; non-cohesive, moist, dense.		5.49	9	GS				
6					10	SPT	79	56		
7		(SP) gravelly SAND, some fines; light brown, contains cobbles up to 100 mm dia, contains stratified layers (100 mm to 200 mm thick) of fine, medium or coarse SAND; non-cohesive, moist, dense.		7.01	11	GS				
					12	SPT	75	42		
8					13	GS				
										Bentonite
9		- Compact below 9.14 m depth								
		- red mottled staining at 9.45 m depth			14	SPT	71	29		
10		End of Borehole.		9.75						

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ●; rem V. ⊕ U - ○; Pocket Pen - ■; 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp — W — Wl; NP - Non-Plastic; 10 20 30 40

DEPTH SCALE

1 : 50

LOGGED: A. Ramey

CHECKED: S. Morse

Golder Associates

PROJECT No.: 13-1477-0018 / 2000

RECORD OF MONITORING WELL: MW13-04

SHEET 1 OF 2

CLIENT: CH2M HILL

DATUM: Geodetic

PROJECT: ERWS Surface Water Intake and Treatment Plant

LOCATION: Pump Station

DRILLING DATE: December 10-11, 2013

DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

N: ~5461636.97 E: ~407499.83 UTM NAD83 Zone: 10

Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

INCLINATION: -90°

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●; rem V. ⊕ U - ○; Pocket Pen - ■) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT (Wp — W — Wl; NP - Non-Plastic) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
		Ground Surface										
0	Geoprobe 8140LS Sonic	TOPSOIL - (SM) SILTY SAND; dark brown to black, contains organics (wood debris, rootlets, organic fluff; non-cohesive, moist, loose to compact.		0.00								Bentonite
1		(SP/GP) SAND and GRAVEL, some non-plastic fines; dark brown, contains rootlets; non-cohesive, moist, compact.		0.76	1	SPT						Cuttings
2												
3		Mixture of: (SP/GP) SAND and GRAVEL, some non-plastic fines; brown to grey; non-cohesive, moist, very dense; and, COBBLES and BOULDERS. - Boulders inferred based on drill reaction and size of sonic rock cores.		2.59	2	GS						
					3	SPT						
4					4	GS						
					5	SPT	67	>50				
5					6	SPT/GS						Bentonite
6												
7		(SM) SILTY SAND, trace rounded gravel; dark grey; non-cohesive, moist, compact.		6.71	7	GS						
		- Some gravel below 7.62 m depth			8	SPT	100	29				
8												Silica Sand and Slotted PVC Pipe
9					9	GS						
		(SP/SM) SILTY SAND to SAND, some non-plastic fines; dark grey; non-cohesive, moist, compact.		9.14	10	SPT						
				9.75	11	GS						
10		*CONTINUED NEXT PAGE*										

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: A. Ramey

CHECKED: S. Morse

File:GINT_GAL_NATIONALIM Output Form:BC_BOREHOLE (AUTO) Template:LOCALHOST: GINT_GAL_TEMPLATE_DEV Library:_GAL LIBRARY GLB tstgelais 3/10/14

PROJECT No.: 13-1477-0018 / 2000

RECORD OF MONITORING WELL: MW13-04

SHEET 2 OF 2

CLIENT: CH2M HILL

DATUM: Geodetic

PROJECT: ERWS Surface Water Intake and Treatment Plant

LOCATION: Pump Station

DRILLING DATE: December 10-11, 2013

DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

N: ~5461636.97 E: ~407499.83 UTM NAD83 Zone: 10

Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

INCLINATION: -90°

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	RECOVERY %	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
10	Geoprobe 8140LS Sonic	(SM/GM) SILTY SAND and GRAVEL; dark grey; non-cohesive, moist, very dense. *(continued)*			11	GS				○		Slough
11					12	SPT	58	56				
		End of Monitoring Well.		11.28								
12												
13												
14												
15												
16												
17												
18												
19												
20												

SHEAR STRENGTH Cu, kPa — nat V. + Q - ● rem V. ⊕ U - ○ Pocket Pen - ■ (20 40 60 80)

WATER CONTENT PERCENT — Wp ⊢ W ⊣ Wl (10 20 30 40) NP - Non-Plastic

DEPTH SCALE

1 : 50

LOGGED: A. Ramey

CHECKED: S. Morse

Golder Associates

File:GINT_GAL_NATIONALIM Output Form:BC_BOREHOLE (AUTO) Template:LOCALHOST: GINT_GAL_TEMPLATE_DEV Library:_GAL LIBRARY GLB 1stgelais 3/10/14

PROJECT No.: 13-1477-0018 / 2000

RECORD OF HAND AUGER: HA13-05

SHEET 1 OF 1

CLIENT: CH2M HILL

DATUM: Geodetic

PROJECT: ERWS Surface Water Intake and Treatment Plant

LOCATION: River Bank

DRILLING DATE: December 11, 2013

DRILLING CONTRACTOR: Drillwell Enterprises Ltd.

N: ~5461608.14 E: ~407494.62 UTM NAD83 Zone: 10

Note: Northing and Easting Coordinates have been determined by GPS in the field and are approximate only.

INCLINATION: -90°

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY %	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Pocket Pen -; Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl; NP - Non-Plastic) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER, STANDPIPE OR THERMISTOR INSTALLATION
0		Ground Surface												
	Hand Augering	(SM) SILTY SAND; dark grey, contains roots; non-cohesive, moist, compact.		0.00	1	GS								Cuttings
		End of Hand Auger.		0.46										
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: A. Ramey

CHECKED: S. Morse

File:GINT_GAL_NATIONALIM Output Form:BC_BOREHOLE (AUTO) Template:LOCALHOST: GINT_GAL_TEMPLATE_DEV Library:_GAL LIBRARY.GLB tstgelais 3/10/14

APPENDIX C

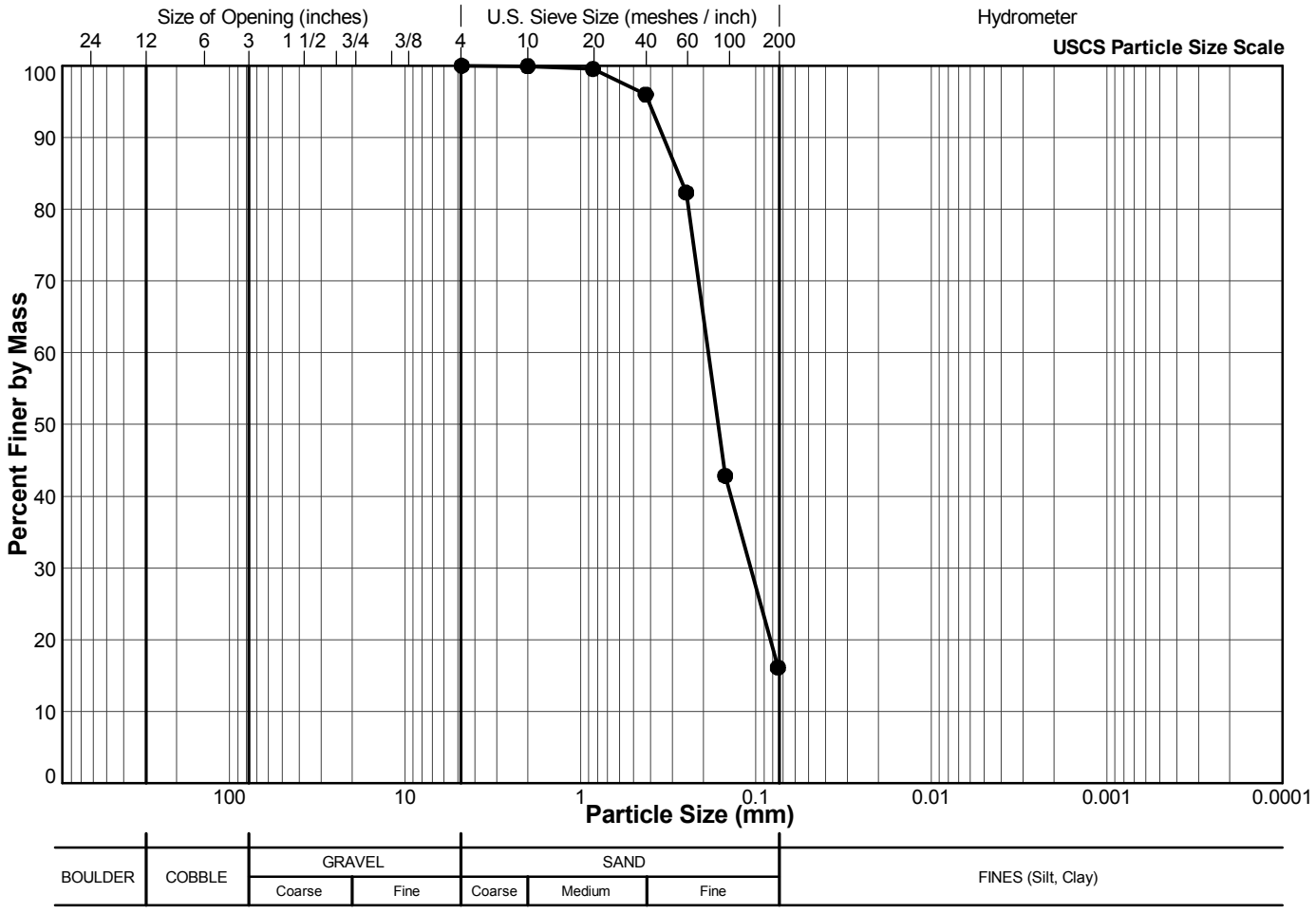
Laboratory Index Testing Results

Golder Associates

SUMMARY OF PARTICLE SIZE DISTRIBUTION

Reference(s)
ASTM C136

Client:	CH2M HILL	**Sample Location:**	BH13-02
Project:	ERWS Surface Water Intake and Treatment Plant	**Sample No.:**	17
Location:	Parksville, BC	**Depth Interval (m):**	16.46 to 17.37
Project No.:	13-1477-0018 **Phase:** 2000	**Lab Schedule No.:**	



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
#4 US MESH	4.75		100.0
#10 US MESH	2		99.9
#20 US MESH	0.85		99.5
#40 US MESH	0.425		96.0
#60 US MESH	0.25		82.3
#100 US MESH	0.15		42.8
#200 US MESH	0.075		16.1

JP	12/19/2013	DGM	12/30/2013
Tech	Date	Checked	Date

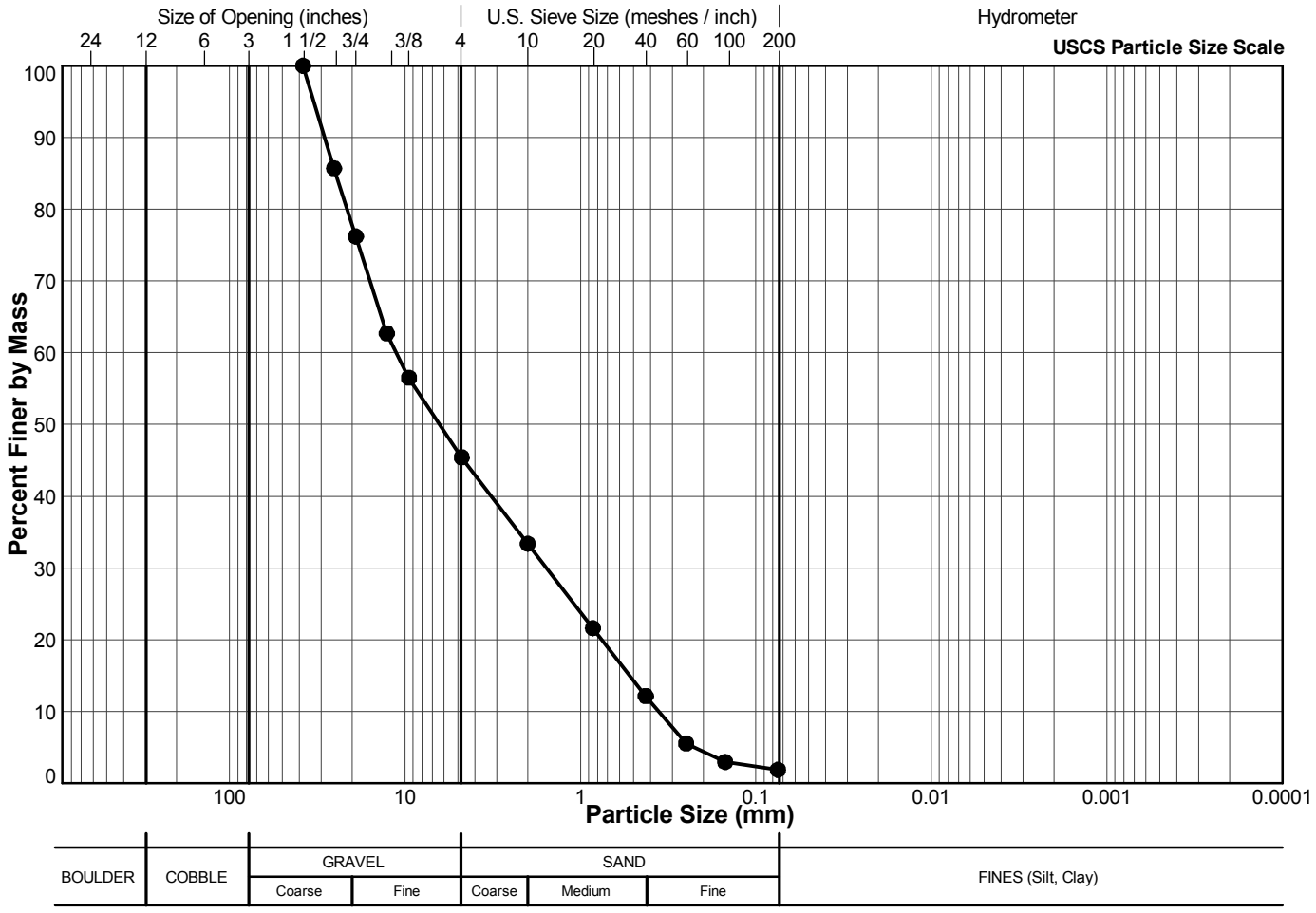
File:GINT_GAL_NATIONALIM Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) Template:LOCALHOST: GINT_GAL_TEMPLATE_DEV Library_GAL LIBRARY.GLB DMackie 12/30/13

Golder Associates Ltd.
3795 Carey Road Victoria, British Columbia, Canada V8Z 6T8
Tel: (250) 881-7372 Fax: (250) 881-7470 www.golder.com

SUMMARY OF PARTICLE SIZE DISTRIBUTION

Reference(s)
ASTM C136

Client:	CH2M HILL	**Sample Location:**	BH13-03
Project:	ERWS Surface Water Intake and Treatment Plant	**Sample No.:**	4
Location:	Parksville, BC	**Depth Interval (m):**	2.44 to 3.05
Project No.:	13-1477-0018 **Phase:** 2000	**Lab Schedule No.:**	



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
1 1/2"	38.1		100.0
1"	25.4		85.7
3/4"	19.1		76.2
1/2"	12.7		62.7
3/8"	9.5		56.5
#4 US MESH	4.75		45.4
#10 US MESH	2		33.4
#20 US MESH	0.85		21.6
#40 US MESH	0.425		12.1
#60 US MESH	0.25		5.5
#100 US MESH	0.15		2.9
#200 US MESH	0.075		1.9

	JP	**12/19/2013**	**DGM**	**12/30/2013**
	Tech	Date	Checked	Date

File:GINT_GAL_NATIONALIM Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) Template:LOCALHOST: GINT_GAL_TEMPLATE_DEV Library_GAL LIBRARY.GLB DMackie 12/30/13

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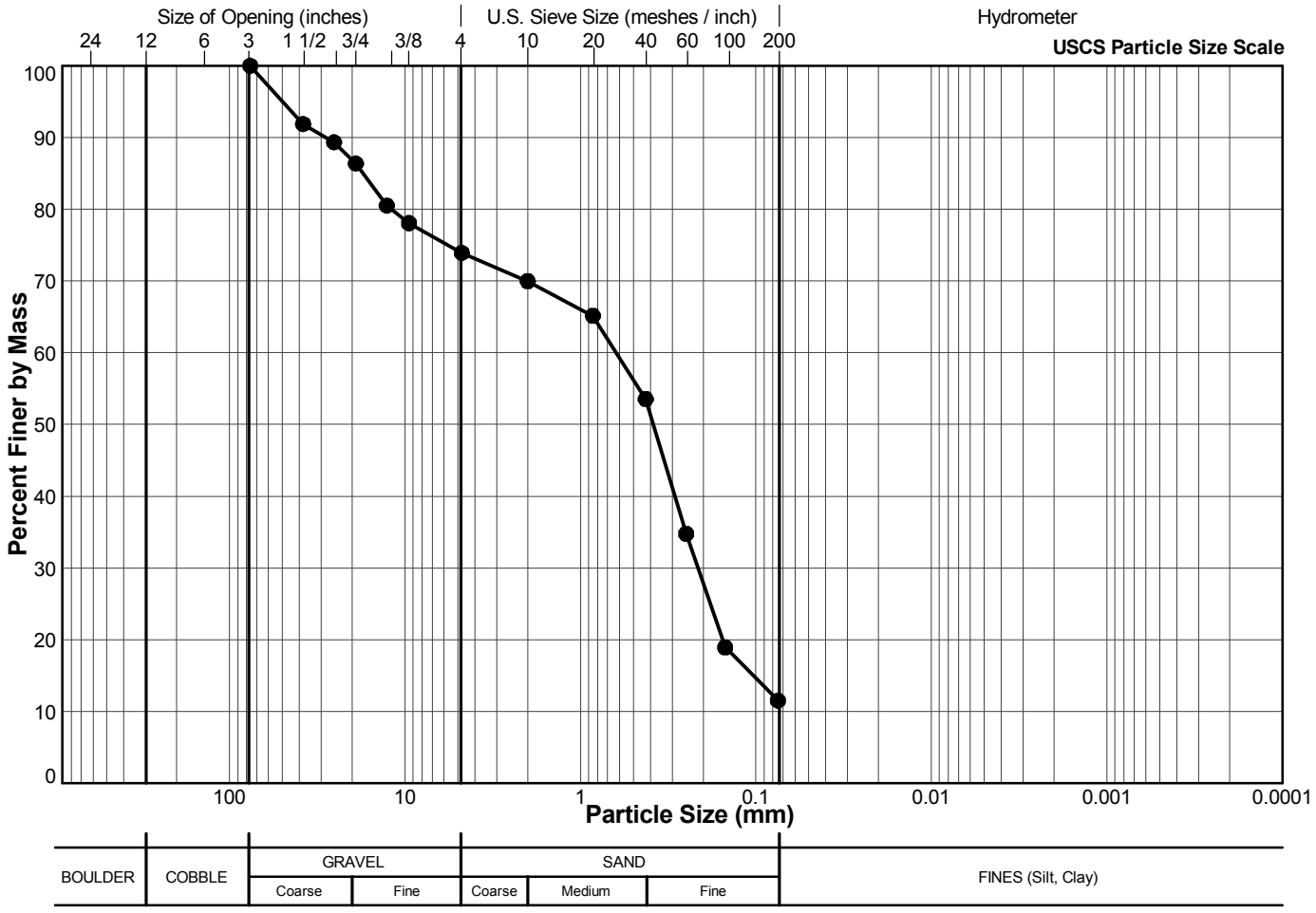
SUMMARY OF PARTICLE SIZE DISTRIBUTION

Reference(s)
ASTM C136

Client:	CH2M HILL	**Sample Location:**	BH13-03
Project:	ERWS Surface Water Intake and Treatment Plant	**Sample No.:**	11
Location:	Parksville, BC	**Depth Interval (m):**	7.01 to 7.62
Project No.:	13-1477-0018 **Phase:** 2000	**Lab Schedule No.:**	



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
3"	76.2		100.0
1 1/2"	38.1		91.9
1"	25.4		89.3
3/4"	19.1		86.4
1/2"	12.7		80.5
3/8"	9.5		78.1
#4 US MESH	4.75		73.9
#10 US MESH	2		70.0
#20 US MESH	0.85		65.2
#40 US MESH	0.425		53.5
#60 US MESH	0.25		34.8
#100 US MESH	0.15		18.9
#200 US MESH	0.075		11.5

JP	12/19/2013	DGM	12/30/2013
Tech	Date	Checked	Date

File:GINT_GAL_NATIONALIM Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) Template:LOCALHOST: GINT_GAL_TEMPLATE_DEV Library_GAL LIBRARY.GLB DMackie 12/30/13

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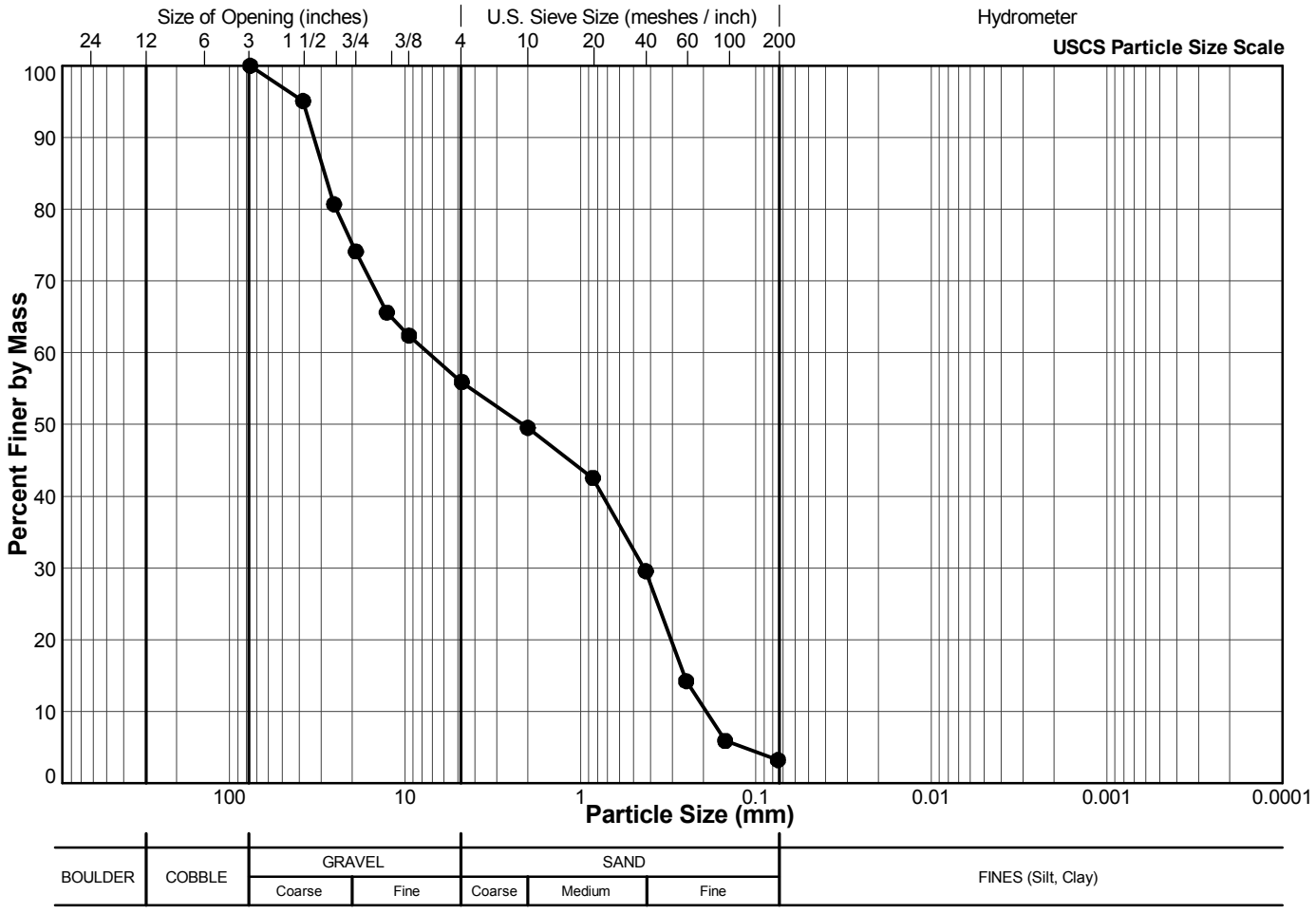
SUMMARY OF PARTICLE SIZE DISTRIBUTION

Reference(s)
ASTM C136

Client:	CH2M HILL	**Sample Location:**	MW13-01
Project:	ERWS Surface Water Intake and Treatment Plant	**Sample No.:**	3
Location:	Parksville, BC	**Depth Interval (m):**	2.44 to 3.05
Project No.:	13-1477-0018 **Phase:** 2000	**Lab Schedule No.:**	



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
3"	76.2		100.0
1 1/2"	38.1		95.1
1"	25.4		80.7
3/4"	19.1		74.1
1/2"	12.7		65.6
3/8"	9.5		62.4
#4 US MESH	4.75		55.9
#10 US MESH	2		49.5
#20 US MESH	0.85		42.5
#40 US MESH	0.425		29.5
#60 US MESH	0.25		14.2
#100 US MESH	0.15		5.9
#200 US MESH	0.075		3.2

JP	12/19/2013	DGM	12/30/2013
Tech	Date	Checked	Date

File:GINT_GAL_NATIONALIM Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) Template:LOCALHOST: GINT_GAL_TEMPLATE_DEV Library_GAL LIBRARY.GLB DMackie 12/30/13

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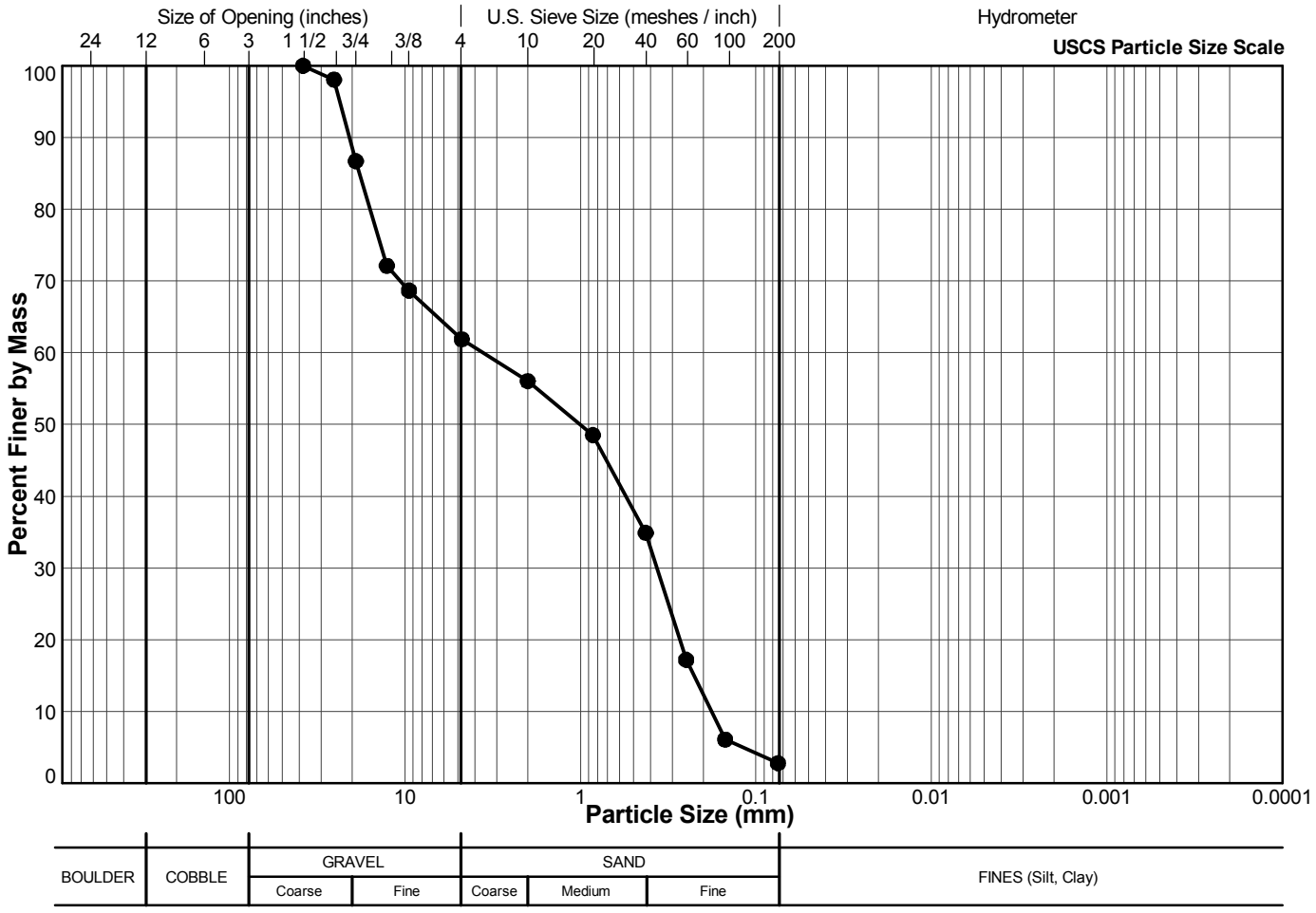
SUMMARY OF PARTICLE SIZE DISTRIBUTION

Reference(s)
ASTM C136

Client:	CH2M HILL	**Sample Location:**	MW13-01
Project:	ERWS Surface Water Intake and Treatment Plant	**Sample No.:**	14
Location:	Parksville, BC	**Depth Interval (m):**	11.28 to 11.58
Project No.:	13-1477-0018 **Phase:** 2000	**Lab Schedule No.:**	



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
1 1/2"	38.1		100.0
1"	25.4		98.1
3/4"	19.1		86.7
1/2"	12.7		72.1
3/8"	9.5		68.7
#4 US MESH	4.75		61.9
#10 US MESH	2		56.0
#20 US MESH	0.85		48.5
#40 US MESH	0.425		34.9
#60 US MESH	0.25		17.2
#100 US MESH	0.15		6.1
#200 US MESH	0.075		2.8

	JP	**12/19/2013**	**DGM**	**12/30/2013**
	Tech	Date	Checked	Date

File:GINT_GAL_NATIONALIM Output Form:_LAB_PARTICLE SIZE (W/ GRADATIONS) Template:LOCALHOST: GINT_GAL_TEMPLATE_DEV Library_GAL LIBRARY.GLB DMackie 12/30/13

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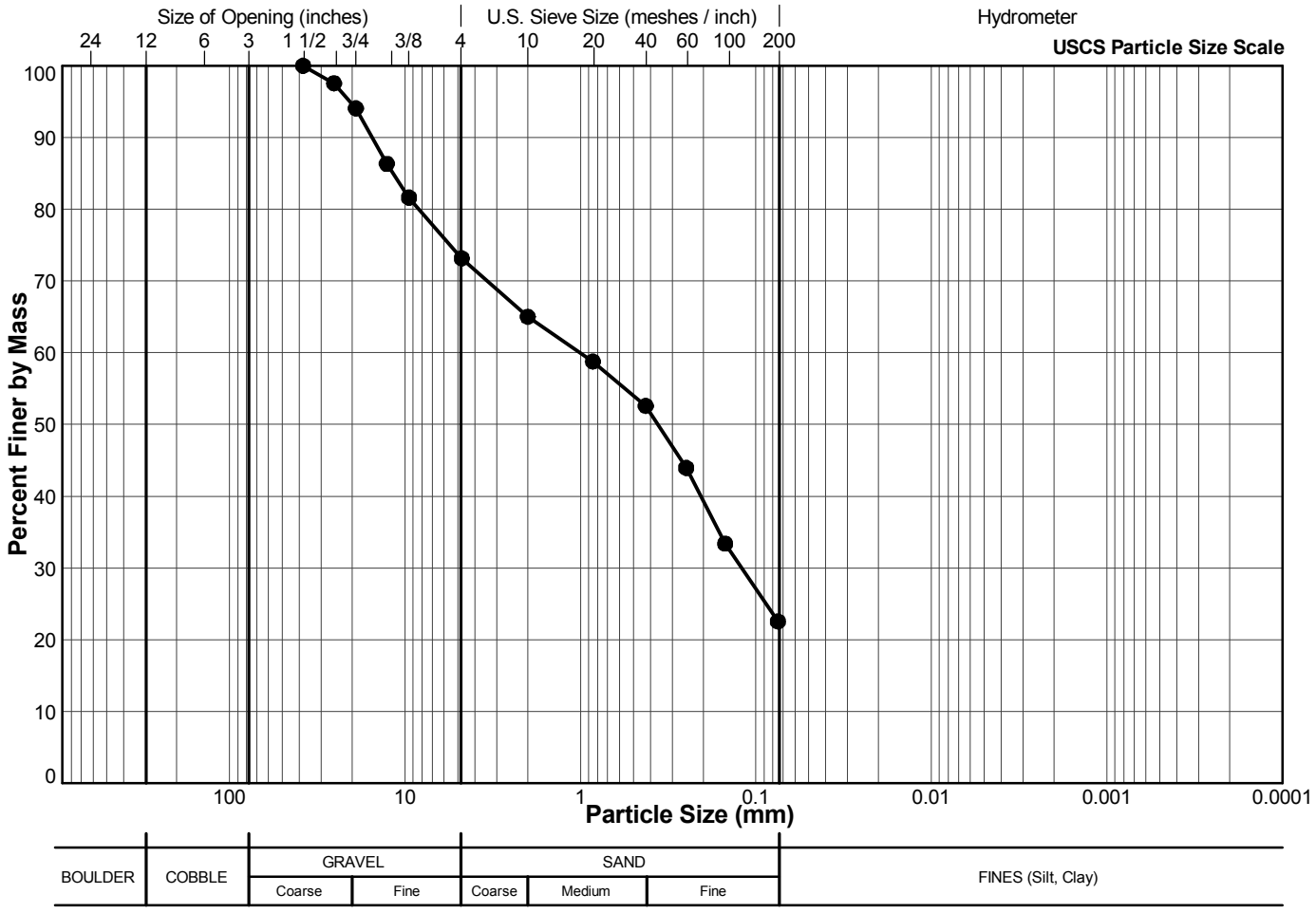
SUMMARY OF PARTICLE SIZE DISTRIBUTION

Reference(s)
ASTM C136

Client:	CH2M HILL	**Sample Location:**	MW13-01
Project:	ERWS Surface Water Intake and Treatment Plant	**Sample No.:**	30
Location:	Parksville, BC	**Depth Interval (m):**	28.96 to 29.57
Project No.:	13-1477-0018 **Phase:** 2000	**Lab Schedule No.:**	



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
1 1/2"	38.1		100.0
1"	25.4		97.6
3/4"	19.1		94.1
1/2"	12.7		86.3
3/8"	9.5		81.6
#4 US MESH	4.75		73.1
#10 US MESH	2		65.0
#20 US MESH	0.85		58.8
#40 US MESH	0.425		52.6
#60 US MESH	0.25		43.9
#100 US MESH	0.15		33.4
#200 US MESH	0.075		22.5

JP	12/19/2013	DGM	12/30/2013
Tech	Date	Checked	Date

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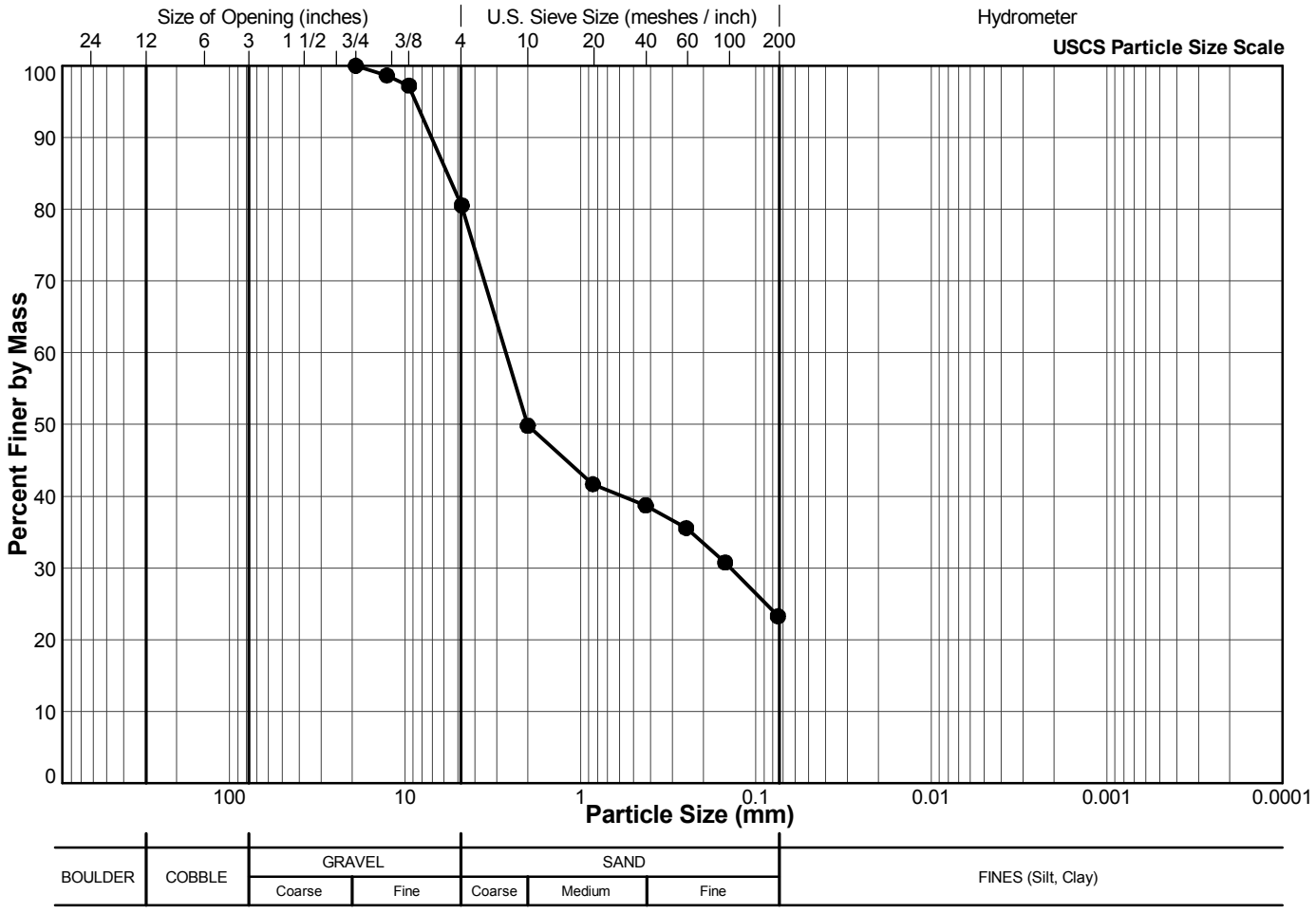
SUMMARY OF PARTICLE SIZE DISTRIBUTION

Reference(s)
ASTM C136

Client:	CH2M HILL	**Sample Location:**	MW13-04
Project:	ERWS Surface Water Intake and Treatment Plant	**Sample No.:**	11
Location:	Parksville, BC	**Depth Interval (m):**	9.75 to 10.67
Project No.:	13-1477-0018 **Phase:** 2000	**Lab Schedule No.:**	



Legend

Sieve Size (USS)	(mm)	Particle Size (mm)	Percent Passing
3/4"	19.1		100.0
1/2"	12.7		98.6
3/8"	9.5		97.2
#4 US MESH	4.75		80.6
#10 US MESH	2		49.8
#20 US MESH	0.85		41.7
#40 US MESH	0.425		38.7
#60 US MESH	0.25		35.5
#100 US MESH	0.15		30.8
#200 US MESH	0.075		23.3

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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

Reference(s)
ASTM D 4318-10

Client:	CH2M HILL	**Monitoring Well ID: MW13-01**
Project:	ERWS Surface Water Intake and Treatment Plant	**Sample No.: 19**
Location:	Parksville, BC	**Depth Interval (m):** 17.37 to 17.98
Project No.:	13-1477-0018 **Phase:** 2000	**Lab Schedule No.:**

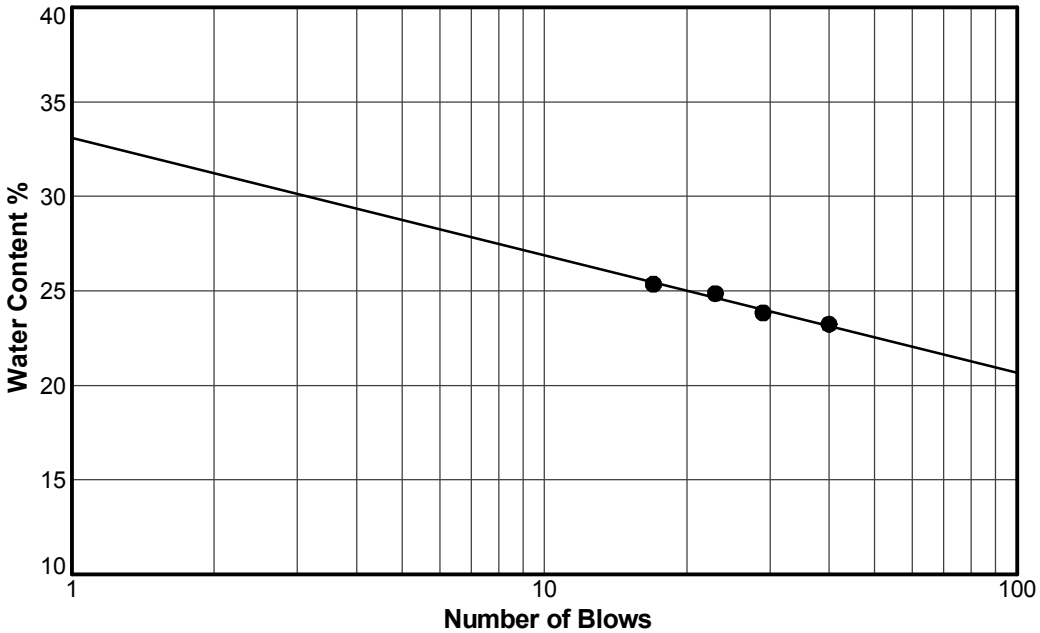
Classification and Definition: CL - Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Wet**

SUMMARY	
Percent Passing #40 Sieve (%)	**ND**
Liquid Limit	**24**
Plastic Limit	**17**
Plasticity Index	**7**
Natural Water Content (%)	**23.7**
Liquidity Index	**1.0**

NP - NON-PLASTIC RESULT
ND - NOT DETERMINED



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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

Reference(s)
ASTM D 4318-10

Client:	CH2M HILL	**Monitoring Well ID: MW13-01**
Project:	ERWS Surface Water Intake and Treatment Plant	**Sample No.: 21**
Location:	Parksville, BC	**Depth Interval (m):** 19.51 to 19.81
Project No.:	13-1477-0018 **Phase:** 2000	**Lab Schedule No.:**

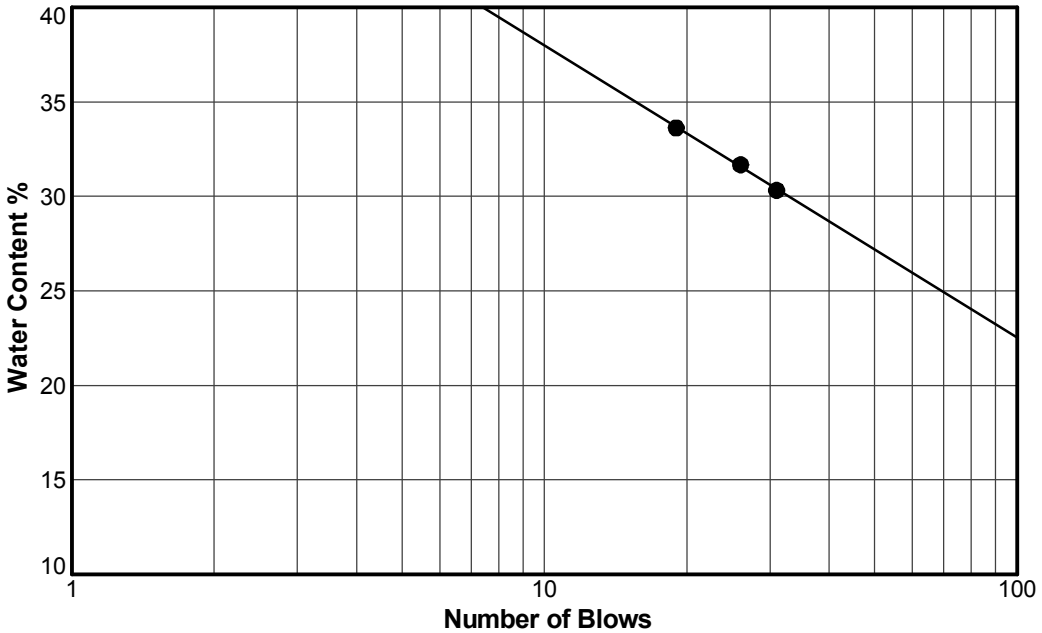
Classification and Definition: CI - Inorganic SILTY CLAY of medium plasticity, sandy or gravelly SILTY CLAY.

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Wet**

SUMMARY	
Percent Passing #40 Sieve (%)	**ND**
Liquid Limit	**32**
Plastic Limit	**16**
Plasticity Index	**16**
Natural Water Content (%)	**25.4**
Liquidity Index	**0.6**

NP - NON-PLASTIC RESULT
ND - NOT DETERMINED



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LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS

Reference(s)
ASTM D 4318-10

Client:	CH2M HILL	**Monitoring Well ID: MW13-04**
Project:	ERWS Surface Water Intake and Treatment Plant	**Sample No.: 9**
Location:	Parksville, BC	**Depth Interval (m):** 8.23 to 9.14
Project No.:	13-1477-0018 **Phase:** 2000	**Lab Schedule No.:**

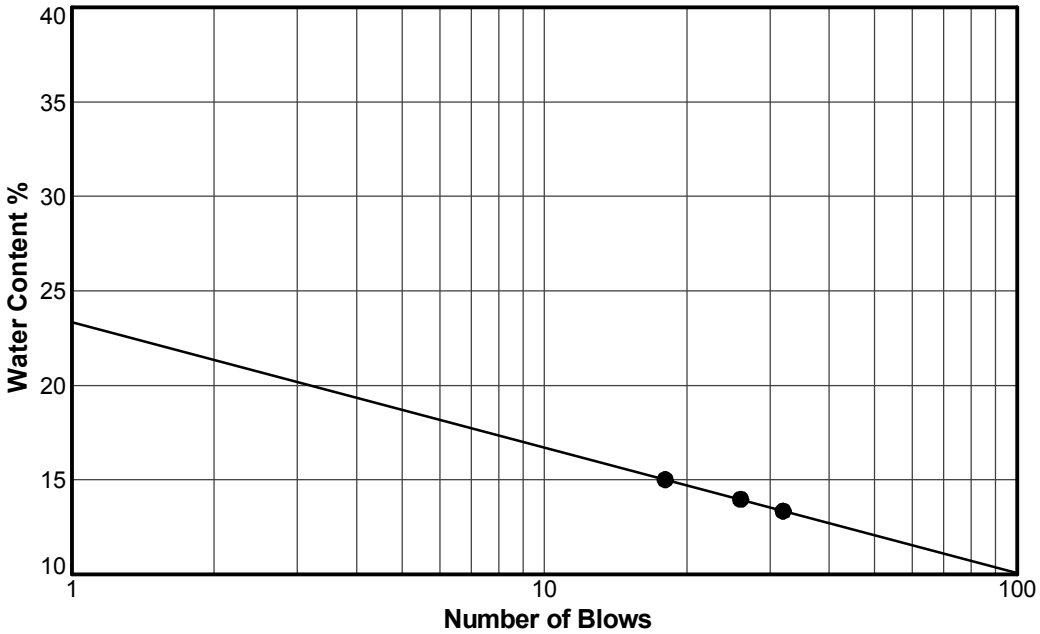
Classification and Definition: ML - Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.

Other Remarks: **N/A**

Test Method: A-Multi Point	**Preparation Method: Wet**

SUMMARY	
Percent Passing #40 Sieve (%)	**ND**
Liquid Limit	**14**
Plastic Limit	**16**
Plasticity Index	**-2**
Natural Water Content (%)	**11.4**
Liquidity Index	

NP - NON-PLASTIC RESULT
ND - NOT DETERMINED



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WATER CONTENT DETERMINATION

Reference(s)
ASTM D 4959

Client:	CH2M HILL	**Project No.:** 13-1477-0018 **Phase:** 2000	
Project:	ERWS Surface Water Intake and Treatment Plant	**Lab Schedule No.:**	
Location:	Parksville, BC		

Sample Location	Sample No.	Sample Interval		Water Content (%)
		Depth (m)	Bottom (m)	
MW13-01	**19**	17.37	17.98	**23.7**
MW13-01	**20**	18.29	18.90	**24.2**
MW13-01	**21**	19.51	19.81	**25.4**
MW13-01	**22**	20.42	20.73	**9.6**
MW13-01	**24**	22.25	22.86	**5.6**
MW13-01	**25**	23.47	24.08	**8.0**
MW13-01	**27**	26.21	26.52	**9.7**
MW13-01	**28**	26.52	27.13	**9.0**
MW13-01	**30**	28.96	29.57	**10.6**
MW13-01	**31**	30.48	31.09	**9.7**
MW13-04	**7**	6.71	7.62	**11.0**
MW13-04	**9**	8.23	9.14	**11.4**
MW13-04	**11**	9.75	10.67	**7.2**

	Checked	Date

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