Block F Development

Stormwater Management Plan

Musqueam Capital Corp.

Block F, University Endowment Lands
File # 12-125
October 2015

Report prepared by:
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1.0 INTRODUCTION

Colliers International is proposing to develop an 8.8-hectare piece of forested land bound by University Boulevard, Toronto Road, Acadia Road and Ortona Avenue located within the University Endowment Lands. The proposed project involves rezoning and subdividing of the Block F property along with the construction of townhouse to high-rise residential units, a community centre and 30,000 square feet of retail space. The phased project will provide housing for 2,150 to 2,500 people in the next ten years.

R. F. Binnie & Associates Ltd., the Civil Engineering consultant for the Block F Development, has prepared the following report and associated drawings to comprise the Stormwater Management Plan for this site. The plan has been prepared as a condition of permit approval, and all items in the Stormwater Management Plan are to be reflected in the detailed design of the drainage facilities for the project.

2.0 EXISTING CONDITIONS

The existing property is currently undeveloped with the exception of two walking trails, Fairview Trail and Sword Fern Trail, dividing the property into quadrants (see Appendix A for map of Block F). The site is surrounded by housing developments to the north and west and an elementary school to the south. University Chapel and the University Golf Club are located to the east on the opposite side of University Boulevard.

Drainage infrastructure in the surrounding area is limited to a 375mm main on Ortona Avenue to service a relatively new housing development at the intersection of Ortona Avenue and Acadia Road. Cutthroat Creek (a small drainage ditch) is located along Ortona Avenue at the southeast corner of the site. Drainage of Acadia Road is taken care of by catchbasins that discharge directly into the heavily forested Block F property. A series of ditches along University Boulevard convey storm flows to a 300mm storm culvert beneath University Boulevard. See the storm network plan in Appendix B for reference.

Three geotechnical reports were prepared by exp Services Inc dated July 25, 2013; January 21, 2015; and September 30, 2015. These reports indicate that the site consists of fill underlain with sand to silty sand. Groundwater seepage was encountered at depths of 1.6 to 1.8m on top of till-like soils. This was interpreted as perched groundwater and may vary seasonally. Based on file information, the regional water table is expected to be in the order of 60m below the excavations depths. The September 2015 report indicates that the native soils in the location of the proposed wetlands at a depth of 0.5m have an average infiltration rate of approximately 67.6mm/hr. The geotechnical reports can be found in Appendix C.

3.0 PROPOSED DEVELOPMENT

The proposed development will consist of townhouse to high-rise residential housing, a community centre, retail space, green space, extensions and upgrades to the UEL underground utilities, upgrades to the surrounding streets, and construction of two new east-west roads (refer to the Site Plan in

Appendix D). Development of Block F will cause a decrease in pervious ground surface areas, thus decreasing the potential for rainwater infiltration.

An impact assessment conducted by Urban Systems (see Appendix E) has determined the extent of the downstream upgrade requirements for the storm and sanitary systems. Part of the upgrades to the storm system includes replacing an undersized culvert beneath University Boulevard as shown in the drawing in Appendix B. To prevent flooding on University Boulevard during large storm events, the culvert is proposed to be upgraded from 300mm to 675mm as specified in the impact assessment. Details about the culvert upgrade are discussed further in Section 7.

4.0 HYDROLOGIC ANALYSIS

The stormwater management plan outlined in this report considers the entire Block F as the storm catchment area. The site has been divided into two catchments for the analysis (See stormwater management drawings in Appendix F for reference), Catchment A and Catchment B, with areas of 7.6 hectares and 1.2 hectares respectively. The 8.8-hectare (22-acre) property is a high point in the local topography and does not have any tributary flow from nearby areas to consider.

4.1 IDF DATA

Rainfall data for the 100-year, 24-hour storm was obtained from Environment Canada Vancouver UBC Rainfall Intensity-Duration-Frequency (IDF) Data as summarized in Table 1.

Table 1 – Block F Rainfall Data

Storm Duration	1:5-year Rainfall Intensity (mm/h)	1:100-year Rainfall Intensity (mm/h)
5 min	49.3	90.8
10 min	35.1	62.4
15 min	28.6	50.4
30 min	18.8	31.5
1 hour	12.7	20.6
2 hour	8.2	11.9
6 hour	5.2	7.4
12 hour	4.2	6.3
24 hour	3.0	4.7

The full scope of rainfall data can be found in Appendix G along with the extrapolation for the 1:6-month storm events. This data has been plotted in the graphs found in Appendix G and was used to determine generic equations for the drainage basin rainfall intensity (y) given a storm of any duration (x) for the 1:6-month, 1:5-year and 1:100-year events. These numbers were then used throughout the rational method calculations which is further explored in Section 4.3

4.2 TIME OF CONCENTRATION

The time of concentration (T_c) was estimated based on the Overland Method formula. The time of concentration differs between the existing site and the developed site because the Overland Method formula accounts for ground conditions. The development will cause an increase in the runoff coefficient and inversely a decrease in the time of concentration. Calculations for the time of concentration can be found in Appendix H. In summary, the T_c for Catchment A decreases from 45 minutes to 12 minutes, and from 31 minutes to 8.5 minutes for Catchment B for the 1:5-year storm event. The time of concentration is used to determine rainfall intensities and runoff flows in the Rational Method calculations.

4.3 RATIONAL METHOD

The rational method was used to estimate the stormwater runoff flows and volumes for the project site. In using this method, peak flows can be estimated for the site in its existing condition and can be predicted for the proposed condition using the following equation:

$$Q = RAIN$$

where

Q = the peak rate of runoff (*m^3/s*)

R = runoff coefficient (see calculations)

A = effective area of the catchment (in hectares, *ha)*

I = rainfall intensity (*mm/h*)

N = conversion factor (1/360)

The Rational Method calculations in Appendix I show that the development will cause a significant increase in the amount of rainwater running off of the Block F property. The purpose of this stormwater management plan is to reduce that excess runoff to acceptable levels as specified by the governing agencies for this project. Stormwater management criteria is further discussed in the following sections.

5.0 STORMWATER MANAGEMENT CRITERIA

The stormwater management plan for the redevelopment of Block F must satisfy the criteria set by two separate agencies; the Department of Fisheries and Oceans (DFO) and the University Endowment Lands (UEL).

5.1 DFO STORMWATER MANAGEMENT REQUIREMENTS

The DFO has specified requirements for stormwater runoff rates, runoff volumes, and quality. The requirements are summarized in Table 2.

Table 2 – DFO Stormwater Guidelines

Objective	Target
Detention or Release Rate Control	Reduce post-development flows (volume, shape and peak instantaneous rates) to pre-development levels for the 6-month, 24-hour and the 5-year, 24-hour precipitation events
Volume Reduction	Retain the 6-month, 24-hour post-development volume from impervious areas on-site and infiltrate into the ground. If infiltration is not possible, the rate of discharge from the "volume reduction BMPs" will be equal to the calculated release rate of an infiltration system.
Water Quality	Collect and treat the volume of the 24-hour precipitation event equaling 90% of the total rainfall from impervious areas with suitable BMPs

Calculations regarding the DFO Guidelines can be found in Appendix J.

5.2 UEL STORMWATER MANAGEMENT REQUIREMENTS

The University Endowment Lands criteria for stormwater management is to restrict the 100-year post-development runoff rate to that of the pre-developed condition. Calculations for the 100-year storm detention volume can be found in Appendix K.

5.3 ADDITIONAL STORMWATER MANAGEMENT CRITERIA

This stormwater management plan satisfies all of the mandatory stormwater runoff requirements for the development of Block F. Once the site has been divided into smaller properties, the developer of each property will proceed with applying for a LEED Stormwater Credit. Each lot will have further storm water management attributes to enhance its LEED credit rating.

6.0 STORMWATER DETENTION

Based on the calculations shown in Appendices J and K, R. F. Binnie & Associates has selected the most constraining criteria from the DFO and UEL sources and designed a stormwater management plan that will satisfy both. The governing criteria is summarized as follows:

- Reduce the post-development flows to pre-development rates for the 1:5-year 24-hour storm event (DFO rate requirement)
- Retain the 1:5-year runoff *volumes* to pre-development levels (DFO volume requirement)
- Collect and treat runoff from impervious areas using Best Management Practices (DFO water quality requirement).

The DFO criteria governs in all three scenarios.

In restricting the stormwater runoff release rate, onsite detention will be required to accommodate the stormwater as is it being held back. For this application, a wetland/detention pond has been selected as the preferred method for storing stormwater before releasing it into the downstream storm system. The wetland will provide means of storage to satisfy the stormwater management criteria, but additionally will serve as a park amenity for the development. A proposed walking trail will cross over the wetland via a series of bridges and will provide a natural-looking green space for residents and visitors.

Sizing of the wetland was calculated using the rational method. As shown in the calculations in Appendix J and K, the required detention for the 1:5-year storm will still provide enough detention to accommodate the 1:100-year runoff requirement set by the UEL. The wetland detention facility for Catchment A will need to provide 891.7m^3 of storage while the area of the bioswales and wetland combined must total a minimum of 2,290m^2 in order to provide adequate infiltration. Catchment B will require 122.6m^3 of detention and 350m^2 of infiltration area which are to be split between parcels H, I, and J. After it is treated, stormwater from the parcels in Catchment B will discharge into Cutthroat Creek.

7.0 FLOW CONTROL

Stormwater discharge will be maintained using flow-control manholes. Each flow-control manhole outlet will have an orifice specifically sized to limit the release rates as required and will cause the excess flows to accumulate in the proposed detention facilities (see Appendix B for locations of the flow-control manholes). Outlet sizing will be determined during detailed design.

The flow-control manholes will also be equipped with a high-flow bypass to allow larger storm events to avoid the constriction. This is a precautionary measure in place to ensure there will be no flooding of the wetlands/park area and lots H, I and J during severe storm events.

The proposed wetlands will act as the detention facility for Catchment A. The proposed flow-control manhole situated at the inlet of the upgraded culvert beneath University Boulevard will ensure that the increased size of the culvert will not be allowing large flows into the receiving water way at all times, only during severe storm events when the flow restriction must be bypassed. The culvert upgrade also provides opportunity to install riprap at the inlet and outlet for proper erosion control. Headwalls may also be considered for scour protection. It is assumed that the receiving watercourses will be capable of accommodating the rare bypassed storm event.

8.0 WATER QUALITY

Water quality is important when discharging into natural waterways as the quality of the runoff directly impacts the overall health of the receiving streams or lakes. Water quality will be handled using the following Best Management Practices for treatment and reduction of total suspended solids (TSS) levels:

8.1 LANDSCAPING

A minimum of 600mm of topsoil overlain by sod and other absorbent landscaping materials will comprise the finished soft surface areas around the building. The topsoil acts as a natural filter for the rainwater prior to infiltrating into the ground. Landscaped areas such as the proposed wetlands and bio-swales will provide initial opportunity to reduce the TSS levels in the storm runoff as it travels overland.

8.2 CATCHBASINS AND OIL WATER SEPARATORS

Water quality from hard surface runoff is a concern. In particular, runoff from roads and parking areas often contain oils from vehicular traffic which can then be deposited into receiving downstream watercourses.

The use of catchbasins located throughout the roads and parking lots will provide an initial opportunity to treat hard surface runoff through the use of catchbasin sumps and trapping hoods which will reduce TSS levels. Oil and grit interceptors will be located along Roads A and B near University Boulevard to provide initial treatment for runoff from the roads before being discharged into the bio swales for further refinement (see Appendix F for interceptor locations).

9.0 CONCLUSION

Colliers International is proposing to develop Block F, an 8.8-hectare forested site located within the University Endowment Lands (UEL). The development will consist of townhouse to high-rise residential units, a community centre, retail space, green space, construction of two new roads, and upgrades to the surrounding UEL roads and utilities. Upgrades to the existing storm and sanitary infrastructure have been designed based on recommendations in a Utility Impact Assessment completed by Urban Systems.

The development of the site will inhibit the land's ability to infiltrate rainwater and will cause an excess flow and volume of runoff. This stormwater management plan has been designed to limit the excess runoff to acceptable levels as specified by the two governing agencies for this project; the Department of Fisheries and Oceans, and the UEL. The development will use a combination of detention facilities and storm system upgrades to achieve the applicable criteria.

Water quality will be ensured using best management practices. The use of absorbent landscaping will improve the quality of surface runoff before it is released to the municipal storm system. The installation of sump catchbasins with trapping hoods as well as oil/water separators will also aid in achieving acceptable water qualities for discharge into natural waterways.

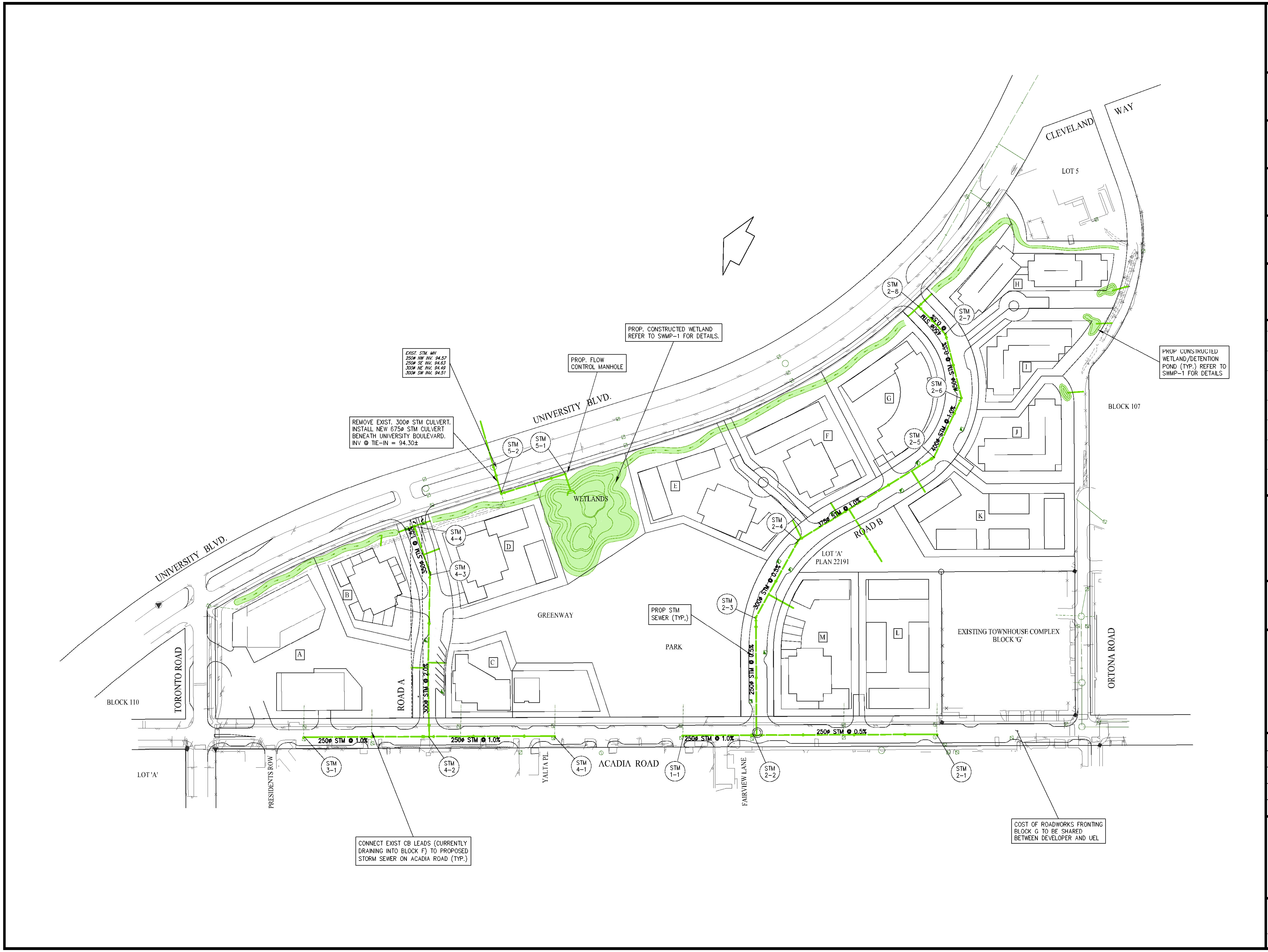
Should you require additional information please contact the undersigned.

Author	Reviewed By
Cassidy Warn, GradTech Designer	Russell Warren, P.Eng Senior Project Manager

APPENDIX A – BLOCK F MAP


University Golf Club
University Blvd
Sword Fern Trail
Fairview Trail
Acadia Rd
Melfa Rd
University Blvd
Kings Rd
Toronto Rd
Fairview Ave
Allison Rd
Western Pkwy
Wesbrook

APPENDIX B – STORM SYSTEM UPGRADES



BENCHMARK:

MONUMENT UEL #28
CVD28GVRD DATUM
EL. 91.709M

SITE SCALE FACTOR: 0.9996

SURVEYED BY:
R.F. BINNIE & ASSOCIATES

CIVIC ADDRESS:

LEGAL DESCRIPTION:

LOT 'A'
PLAN 22191
DL140
NEW WESTMINSTER DISTRICT

SCALE:
0 1:1000 50m

This drawing must not be reproduced without the written permission of R.F. Binnie & Associates Ltd.
This drawing is not to be used for construction unless it is stamped "ISSUED FOR CONSTRUCTION" and signed by R.F. Binnie & Associates Ltd. It is the contractor's responsibility to ensure that he is in possession of the latest revision of this drawing.

ISSUED: M/D/Y	REVISION	DESCRIPTION
10/21/15	4	ISSUED FOR COORDINATION
08/27/15	3	REVISED PER AECOM RESUBMSSION REVIEW
04/30/15	2	REZONING SUBMISSION
02/28/14	1	RE-ISSUED FOR REZONING SUBMISSION

PROJECT:

BLOCK F
MUSQUEAM
DEVELOPMENT

CLIENT:
COLLIERS INTERNATIONAL

CONSULTANT:
BINNIE
Your Challenges. Our Solutions. Build with Binnie.

R.F. BINNIE & ASSOCIATES LTD.
205 - 4946 Canada Way,
Burnaby, BC V5G 4H7
TEL 604 420 1721
BINNIE.com

DATE: 3/27/13
DRAWN:
DESIGN:
CHECKED: CHECKED
SCALE: 1:1000m
SEAL:

SHEET TITLE:

CONCEPTUAL
SERVICING PLAN

STORM

DRAWING NO.: CSP-2
REV. 4
RFB JOB No. 12–125
SHEET 3 OF 9

APPENDIX C – GEOTECHNICAL REPORT

July 25, 2013 Reference No. VAN-00213751-A0

Musqueam Capital Corporation
6615 Salish Drive
Vancouver BC V6N 4C4

c/o Colliers International Consulting
19th Floor – 200 Granville Street
Vancouver, BC V6C 2R6 Email: Gordon.easton@colliers.com

Attention: Gordon Easton, BA, M.E.S, MCIP

Re: **Block F, Acadia and University Blvd., UBC**
Preliminary Geotechnical Report

Dear Sir:

1.0 INTRODUCTION

As requested, **exp** Services Inc. (**exp**) has completed a preliminary geotechnical report for the above-noted site.

The geotechnical work was performed in general accordance with **exp**'s proposal dated 2013 June 11. The purpose of the exploration was to provide a geotechnical report outlining the soil conditions encountered. However, for preliminary discussion purposes, some geotechnical interpretations and opinions are provided to illustrate the effects of the site specific exploration data on development considerations. The final use and interpretation of the findings should be incorporated into a building project under the direction of the geotechnical engineer.

Analysis of the soil or ground water with respect to environmental issues was beyond the scope of the geotechnical investigations. Appendix A contains our "Interpretation & Use of Study and Report" and forms an integral part of this report and must be included with any copies of this report.

2.0 PROPOSED DEVELOPMENTS AND SITE DESCRIPTION

The community consultation process has examined a number of key features of the site and the subsequent site plans for finalizing a rezoning application for residential building development. As part of the servicing strategy, options are being considered for retaining and reconstructing a wetland area as well as a rain garden area along University Blvd. to act as part of the storm water management system.

The main project elements include the following:

- Park, Greenways, Trails, including wetlands
- Community Building
- Daycare Facilities
- Range of homes, from ground-oriented townhouses to lower and higher apartment buildings.

The site is located at the southwest corner of the intersection of University Blvd. and Toronto Road, near UBC in Vancouver, BC. The site is bounded by Acadia Road to the west, Toronto Road to the north, University Blvd. to the east and residential development, a church plus U-Hill School to the south. The site is triangular-shaped, and it has approximate dimensions of about 520m along Acadia Road and University Blvd., 60m on Toronto Road to 290m along the south side of the site.

The topography generally slopes down very gently toward the north and east. The current site is heavily forested with a mix of deciduous and coniferous trees and medium to thick undergrowth.

The topography adjacent to the site generally slopes down very gently and away from the site perimeters. The site is generally bounded by residential and urban developments.

3.0 GEOLOGICAL SETTING

The Geological Survey of Canada surficial geology map indicates the site is underlain by Vashon Drift and Capilano sediments. These materials generally consist of glacial drift, a silty sand and gravel. Pre-Vashon sands underlie the site at depth. Surficial deposits may include raised beach and silt materials, deposited since glacial activity within the last ten thousand years.

According to Vancouver's Old Streams Map (Public Library), a former stream headwaters may be situated east of the site. Materials associated with stream headwaters may include sand and silt and some organic rich materials.

Based on **exp** file information, the recent land uses in the vicinity of the site or on portions of the site may include the following:

- Pre-1920, logging;
- Circa 1920's, clearing on north-side of site and construction of University Blvd;
- Circa 1950's, construction of Acadia Camp and rapid urban expansion, e.g., U-Hill School, etc.

In general, the site and adjacent areas have likely undergone little change in the last 20 to 30 years, as compared to a few decades prior.

4.0 FIELD WORK AND LABORATORY TESTING

The geotechnical exploration for this project was conducted on 2013 July 17 and 18. The exploration consisted of the following:

- Four (4) hand dug pits to depths of 0.5 to 0.9m below existing ground surface (designated HP13-01 to HP13-04, inclusive)
- Five (5) test pits (designated TP13-01 and TP13-05) dug to depths from about 1.8 to 2.7m below existing ground surface using a rubber-tired backhoe.

At HP13-01, a percolation test was done by measuring the time for water to infiltrate into the hand dug pit. On the day of the field work, the weather was mainly sunny and warm. Generally, the ground surface in the vicinity of test area was free of ponding water.

The percolation test was completed by hand excavating to 0.17m below ground surface and placing water into the pit. Tests were repeated until the water percolation rate varied less than 2 minutes per inch in two (2) consecutive trials.

Three trials of percolation testing yielded an average of 8.8 minutes / 25mm drop in the water level.

The geotechnical exploration was carried out under the supervision of a geotechnical technician from **exp**, who located the test pits, logged the subsurface conditions and gathered soil samples for further classification and laboratory testing. The laboratory tests included natural moisture content on selected soil samples. The test pits were backfilled with the excavated materials upon completion.

The approximate hand dug and machine dug test pit locations are shown on the attached Test Hole Location Plan, Figure 1 in Appendix B. Soil descriptions of each test pit including the moisture content test results are included in the test hole logs in Appendix C. The elevations shown on the test pit logs have3 been estimated based on topographic plan dated 2013 May 22 by R.F. Binnie & Associates Ltd.

5.0 SOIL AND GROUNDWATER CONDITIONS

The available test holes and nearby records generally encountered the following soil types:

UNIT F	**FILL**
	- Silty Sand - Some till-like soil - Some asphalt debris, a bottle and plastic wrap - Moisture contents 13 to 23% - Encountered at TP13-03 and 04 to depths of 0.3 to 0.5m
UNIT A	**SILT to Organic SILT, PEAT**
UNIT A1	**Topsoils, sods – thin**
UNIT A2	**PEAT to Organic Silt** - Dark brown - Soft to firm - Moisture content: 75% to 350% - Encountered at HP13-01 to 13-04 to depths of 0.2 to 0.5m
UNIT A3	**SILT and SAND** - Some organics - Compact to stiff - Moisture contents: 33 to 85% - Encountered at 0.2 to 0.5m depths in HP13-01 and 13-04 - Encountered to 0.3 to 1.1m depths in TP13-03 to 13-05; three of five test pits
UNIT B	**SAND, some silt to Silty SAND**
	- Fine to medium grained - Trace to some silt, trace to some gravel - Compact to dense - 1 to 2m thick in test pits
UNIT C	**TILL-LIKE (Sandy SILT) SOILS**
	- Very stiff - Some gravel - Encountered at 1.6 to 1.8m depths in the test pits
UNIT D	**SAND SOILS**
	- Not encountered in the recent test holes, but inferred at depth based on local knowledge - Generally compact to dense

Groundwater

At the time of the test pits, slight groundwater seepage was encountered at depths of 1.6 to 1.8m, on top of the till-like soils. The pits were dry otherwise, except at about 0.3m depth in hand pits. The groundwater seepage is interpreted to be perched groundwater near the till-like soil surface. The perched water level may vary and fluctuate seasonally and in response to climatic conditions and local land use. Based on file information, the regional water table is anticipated to be at great depth in the order of about 60m below grade, at the bottom of the Quadra Sand.

It should be noted that the above subsurface conditions were encountered at the test hole locations only. The actual soil and groundwater conditions may vary between the test holes.

6.0 CHARACTERIZATION – SUBSURFACE CONDITIONS

The characterization of subsurface conditions should recognize key considerations.

Unit F – Fill Soils

The available records indicated fill depth ranges from 0.3 to 0.5m in two of the five pits.

Natural Soils

The natural soils were generally associated with the following stratagraphic sequence with increasing depths:

- Soft to firm, post-glacial soils, Unit A2
- Capilano Sediments, Unit A3, and Unit B
- Vashon Drift (glacial relationships, 10 – 14 Ma), Unit C
- Pre-Vashon, older than 10 – 14 Ma; Unit D

Percolation Test and Surface Water

The percolation test showed fair to good percolation rates, consistent with the silty materials encountered and an absence of ponding surface water. The presence of ponding surface water is expected to vary seasonally depending on several factors including the amount of precipitation (dry summers versus wet winters), and the amount of evaporation and evapotranspiration as well as subsurface infiltration characteristics.

7.0 DESIGN AND CONSTRUCTION CONSIDERATIONS

Local knowledge and experience has indicated that conventional concrete foundations may derive favorable support directly on the Unit C or D soils.

The Unit B sand and Unit A3 silt soils are usually considered less favourable than the other natural materials for building support. However, there are routine practices available to deal with the soils, including lower bearing pressure for lightly loaded conventional concrete foundations.

7.1 Footing / Slab Support

It is considered feasible to support proposed buildings on conventional concrete foundations. However, based on available test hole information, some subgrade preparation or equivalent may be anticipated where footings are less than about 1.5m below existing grade. The subgrade preparation details should be a subject of geotechnical design for the building project. For example, for lower buildings the subgrade preparation may include:

- Design for building on competent natural ground and/or engineered structural fills;
- Excavation to remove unsuitable materials and provision of engineered or structural fills as appropriate for design.

The engineered fills/backfills needed may depend on the variance between design grades and actual “suitable bearing levels”.

The footings placed on the dense till-like soil or dense sand may be designed for allowable bearing pressures in the range of 400 kPa to 500 kPa. Footings placed on structural fill over bearing layer soils may be designed for an allowable bearing pressure in range of 200 kPa. The allowable bearing may be increased by 1/3 for transient loading conditions.

7.2 Seismic Design Considerations

The seismic design of the proposed buildings is to incorporate the 2012 BC Building Code (BCBC). The design earthquake refers to a 2% probability of exceedance in 50 years.

Based on the subsurface profile as mentioned above, the average properties of the top 30m are consistent with dense soils, which are considered to be generally non-liquefiable during the design earthquake events of the 2012 BCBC.

For building design complying with 2012 BCBC, the subject site may be classified as Site Class C in accordance with 2012 BCBC (Table 4.1.8.4.A). This site classification may be used to determine the relevant design seismic parameters, such as, appropriate spectral response acceleration values Sa(T) for period T, as well as acceleration and velocity based site coefficients, Fa (for short period structures) and Fv (for long period structures), as per the 2012 BCBC (Table 4.1.8.4 B and C, respectively). In addition, a peak ground acceleration (PGA) of 0.47 may be used for the subject site, based on Appendix C of the 2012 BCBC.

7.3 Structural Fill

Structural fill material required to raise grade under proposed development should consist of well-graded, free draining granular soils as directed by the geotechnical engineer.

Based on the soils encountered in the drill holes, it is considered that most of the on-site soils will be unsuitable for reuse as structural fills for proposed buildings. In particular, the soils encountered in the test holes contained significant fines contents and/or organics. Fine granular soils are expected to be prone to a poor workability, especially during wet work conditions, e.g., late Fall and Winter construction seasons and under bank seepage conditions. However, there were also some soils (portions of Unit B and Unit D, sand to silty sand) which may be feasible to re-use. However, the practicality of re-use depends on many factors and it may only be considered by experienced earthworks contractors working under the most favorable climatic conditions (i.e., during summer months, periods of no rainfalls, etc.), and among other considerations.

7.4 Subsurface Drainage

It is considered feasible to provide conventional building perimeter drainage systems to control groundwater seepages for structural design purposes. The final sizing of the system may include inputs obtained during excavation and construction phases, under the direction of the geotechnical engineer. Details of the drainage should include backfill details which prevent surface water infiltration into backfills so as to impede seepage recharge into the sand (Unit D) aquifer. Surface water runoff should be directed to storm water management, separate from perimeter drainage systems.

7.5 Excavation

It is anticipated that open cut excavation could be completed using conventional excavating equipment. Experience has shown that some ripping of hard zones may be required. In addition, large boulders may be encountered which may require splitting and/or blasting for removal. Some groundwater seepage may also be encountered. It is considered that excavations could be kept free of standing water using conventional pumping sumps.

Temporary excavation slopes should be designed by the geotechnical engineer. The feasibility of open cut would also depend upon the actual location of the proposed building with respect to existing buried services, sidewalks, structures, etc. and conventional shoring using shotcrete and tieback anchors may be required at areas where space is limited. Conventional shotcrete and tieback anchor underpinning at adjacent structures is also considered feasible and it should be designed by the Geotechnical Engineer.

7.6 Further Study

It is anticipated that plans for building project would be reviewed by the Geotechnical Engineer prior to final design. Project specific recommendations may be anticipated.

8.0 CLOSURE

Exp Services Inc. has prepared this report based on referenced information and our understanding of the project as described in this report.

The report was prepared for the exclusive use of our client, Musqueam Capital Corporation and their designated consultants and agents, and may not be used by other parties without the written consent of **exp** Services Inc.

We trust that this report will meet your present requirements. Please contact the undersigned should you have any questions or require further assistance.

Sincerely,

exp Services Inc.	**Reviewed by:**
Don Sargent, P.Eng. Senior Engineer	Evan Sykes, P.Eng. Senior Engineer

Enclosures:
Appendix A – Use & Interpretation of Study and Report
Appendix B – Test Hole Location Plan
Appendix C – Test Hole Logs

L:\2013 (starting at 0210575-A0)\0213751-A0 DWS Block F, Acadia & University Blvd, UBC\4.1 General Correspondence\Memos, Ltrs, Rpts\exp RE 2013 07 25 UBC Block 5 Prel Geotechnical Rpt.docx

Appendix A

Use & Interpretation of Study and Report

INTERPRETATION & USE OF STUDY AND REPORT

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering consulting practices in this area. No other warranty, expressed or implied, is made. Engineering studies and reports do not include environmental consulting unless specifically stated in the engineering report.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF THE REPORT

The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT. WE WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS “APPROVED USERS”. The contents of the Report remain our copyright property and we authorise only the Client and Approved Users to make copies of the Report 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 the Report, or any portion thereof, available to any party without our written permission. Any use which a third party makes of the Report, or any portion of the Report, are the sole responsibility of such third parties. We accept no responsibility for damages suffered by any third party resulting from unauthorised use of the Report.

5. INTERPRETATION OF THE REPORT

a. Nature and Exactness of Descriptions: Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations, or building envelope descriptions, utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarising such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b. Reliance on Provided information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.

c. To avoid misunderstandings, **exp** Services Inc. (**exp**) should be retained to work with the other design professionals to explain relevant engineering findings and to review their plans, drawings, and specifications relative to engineering issues pertaining to consulting services provided by **exp**. Further, **exp** should be retained to provide field reviews during the construction, consistent with building codes guidelines and generally accepted practices. Where applicable, the field services recommended for the project are the minimum necessary to ascertain that the Contractor’s work is being carried out in general conformity with **exp**’s recommendations. Any reduction from the level of services normally recommended will result in **exp** providing qualified opinions regarding adequacy of the work.

6.0 ALTERNATE REPORT FORMAT

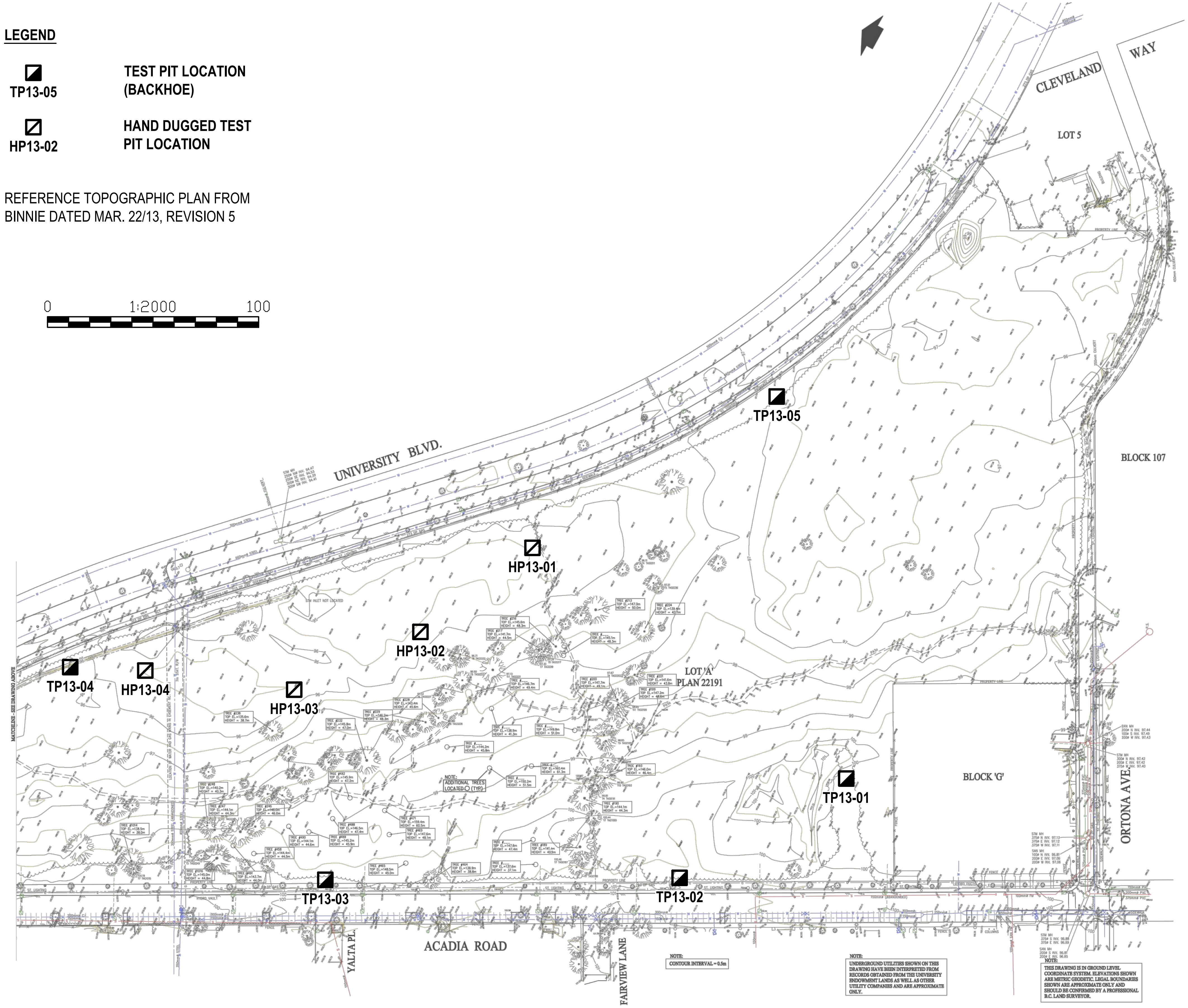
When **exp** submits both electronic file and hard copies of reports, drawings and other documents and deliverables (**exp**’s instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by **exp** shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancy, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by **exp** shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of **exp**’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except **exp**. The Client warrants that **exp**’s instruments of professional service will be used only and exactly as submitted by **exp**.

The Client recognizes and agrees that electronic files submitted by **exp** have been prepared and submitted using specific software and hardware systems. **Exp** makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

Appendix B

Test Hole Location Plan



LEGEND

◪ TP13-05	TEST PIT LOCATION (BACKHOE)
⧄ HP13-02	HAND DUGGED TEST PIT LOCATION

REFERENCE TOPOGRAPHIC PLAN FROM
BINNIE DATED MAR. 22/13, REVISION 5

0 1:2000 100

NOTE:
ADDITIONAL TREES LOCATED ○ (TYP.)

NOTE:
CONTOUR INTERVAL = 0.5m

NOTE:
UNDERGROUND UTILITIES SHOWN ON THIS DRAWING HAVE BEEN INTERPRETED FROM RECORDS OBTAINED FROM THE UNIVERSITY ENDOWMENT LANDS AS WELL AS OTHER UTILITY COMPANIES AND ARE APPROXIMATE ONLY.

NOTE:
THIS DRAWING IS IN GROUND LEVEL COORDINATE SYSTEM. ELEVATIONS SHOWN ARE METRIC GEODETIC. LEGAL BOUNDARIES SHOWN ARE APPROXIMATE ONLY AND SHOULD BE CONFIRMED BY A PROFESSIONAL B.C. LAND SURVEYOR.

exp Services Inc.
275–3001 Wayburne Drive
Burnaby, British Columbia V5G 4W3
Telephone: 604–874–1245
Fax: 604–874–2358
exp.com

DFTR. MG
DSGN. DGS
CHK. DWS

REVISIONS		
No.	DESCRIPTION	DATE

CLIENT MUSQUEAM CAPITAL CORP.
PROJECT BLOCK F, ACADIA AND UNIVERSITY BLVD.
UBC, VANCOUVER, B.C.
PROJECT NO. VAN-00213751-A0

TITLE: TEST HOLE LOCATION PLAN

DATE 2013-07-18
SCALE: 1:2000
DWG NO. FIGURE 1

Jul 25, 2013 – 9:35am L:\2013 (starting at 0210575-A0)\0213751-A0 DWS Block F, Acadia & University Blvd, UBC\4.25 CAD\213751 Testhole PLan.dwg

Appendix C

Test Hole Logs

HP13-01 to 13-04, inclusive
TP13-01 to 13-05, inclusive

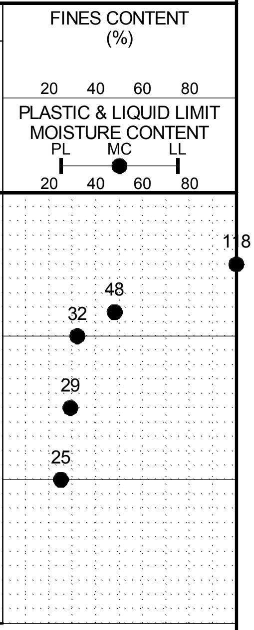
exp Services Inc

RECORD OF HAND PIT : HP13-01

CLIENT Musqueam Capital Corp.
PROJECT NUMBER VAN-00213751-A0
DRILLING DATE 17/7/13
DRILLING CONTRACTOR exp Services Inc.
DRILLING METHOD Shovel
LOGGED BY DGS **CHECKED BY**

PROJECT NAME Testholes and Percolation Tests
PROJECT LOCATION Block F, Acadia and University Blvd., UBC
BOREHOLE LOCATION N: 5457024 E: 483040
ELEVATION 95.70 m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AFTER DRILLING** ---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SAMPLES POCKET PEN. (TSF)
		PEAT, some organic silt, trace to some sand, roots and rootlets, amorphous dark brownish black, damp, (firm to stiff) (TOPSOIL)	95.50	S1	GB		
		SILTY SAND to SAND & SILT, occasional charcoal, greyish brown, damp, (compact to dense) sand is fine-grained	0.20 95.40	S2	GB		
		SILTY SAND to SAND, some silt, frequent roots and organics, seams of sand, seams of silt, light brown with rust stains, damp, (compact to dense)	0.30 95.19	S3 S4	GB GB		
		SAND, trace to some silt, light brown with rust stains, damp, (compact to dense) fine-grained -less silt with depth	0.51 94.79	S5	GB		
		Bottom of hole at 0.9m.	0.91				



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exp Services Inc

RECORD OF HAND PIT : HP13-02

PAGE 1 OF 3

CLIENT Musqueam Capital Corp.
PROJECT NUMBER VAN-00213751-A0
DRILLING DATE 17/7/13
DRILLING CONTRACTOR exp Services Inc.
DRILLING METHOD Shovel
LOGGED BY DGS **CHECKED BY**

PROJECT NAME Testholes and Percolation Tests
PROJECT LOCATION Block F, Acadia and University Blvd., UBC
BOREHOLE LOCATION N: 5456987 E: 482991
ELEVATION 95.40 m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AFTER DRILLING** ---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES				FINES CONTENT (%) 20 40 60 80
				NUMBER	TYPE	RECOVERY %	POCKET PEN. (TSF)	PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80
		PEAT, some organic silt, trace to some sand, roots and rootlets, dark brownish black, damp, (soft) (TOPSOIL)	95.25	S6	GB			338
		-grading to ORGANIC SILTY SAND, frequent roots and rootlets, dark brownish black, damp, (compact) fine-grained	0.15 95.10	S7	GB			56
		SAND, trace silt, some hard chunks, tan with rust stains, damp to wet, (dense)	0.30 94.89	S8	GB			32
		Bottom of hole at 0.5m.	0.51					

EXP TEST PIT/HAND AUGER *PHOTOS* 0213751-A0.GPJ EXP STD.GDT 30/7/13

(Continued Next Page)

RECORD OF HAND PIT : HP13-03

CLIENT Musqueam Capital Corp.
PROJECT NUMBER VAN-00213751-A0
DRILLING DATE 17/7/13
DRILLING CONTRACTOR exp Services Inc.
DRILLING METHOD Shovel
LOGGED BY DGS **CHECKED BY**

PROJECT NAME Testholes and Percolation Tests
PROJECT LOCATION Block F, Acadia and University Blvd., UBC
BOREHOLE LOCATION N: 5456961 E: 482935
ELEVATION 95.50 m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AFTER DRILLING** ---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SAMPLES POCKET PEN. (TSF)	FINES CONTENT (%) 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80
		SOD	95.45					
		PEAT, trace to some sand, rootlets, amorphous,black, damp, (soft to firm) slight plastic	0.05	S9	GB			168
		-becomes stiff to very stiff and brown	95.04	S10	GB			212
		SAND, trace silt, root remains, orangish ligh brown, damp to wet, (compact) fine-grained	0.46 94.69	S11	GB			30
		Bottom of hole at 0.8m.	0.81					

(Continued Next Page)

RECORD OF HAND PIT : HP13-04

exp Services Inc

CLIENT Musqueam Capital Corp.
PROJECT NUMBER VAN-00213751-A0
DRILLING DATE 17/7/13
DRILLING CONTRACTOR exp Services Inc.
DRILLING METHOD Shovel
LOGGED BY DGS **CHECKED BY**

PROJECT NAME Testholes and Percolation Tests
PROJECT LOCATION Block F, Acadia and University Blvd., UBC
BOREHOLE LOCATION N: 5456970 E: 482869
ELEVATION 95.50 m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AFTER DRILLING** ---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY %	POCKET PEN. (TSF)	FINES CONTENT (%) 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80
		ORGANIC SILT, trace to some sand, roots and rootlets, dark brownish black, damp, (soft) (TOPSOIL)	95.30	S12	GB			75
		SANDY SILT to SAND & SILT, rootlets and organics, brownish black, damp, (stiff) plastic	0.20 95.04	S13	GB			85
		-grades to SAND, trace to some gravel, trace to some silt, rootlets, light brown with rust stains, damp, (compact to dense) sand is fine-grained	0.46 94.84	S14	GB			25
		Bottom of hole at 0.7m.	0.66					

(Continued Next Page)

RECORD OF TEST PIT : TP13-01

exp Services Inc

CLIENT Musqueam Capital Corp.
PROJECT NUMBER VAN-00213751-A0
EXCAVATION DATE 18/7/13
EXCAVATION CONTRACTOR Backhoes Unlimited
EXCAVATION METHOD Rubber Tire Back-Hoe
LOGGED BY DGS **CHECKED BY**

PROJECT NAME Testholes and Percolation Tests
PROJECT LOCATION Block F, Acadia and University Blvd., UBC
TEST PIT LOCATION N: 5456922 E: 483180
ELEVATION 99.90 m
GROUND WATER LEVELS: ▽ **AT TIME OF EXCAVATION** 1.8m visible
▼ **AFTER EXCAVATION** ---

DEPTH (m)	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SAMPLES POCKET PEN. (TSF)	FINES CONTENT (%)
	SOD/TOPSOIL						
	SAND, some gravel to gravelly, trace silt, occasional cobbles, roots and organics, orange, dry, (dense) gravel is sub-angular to sub-rounded, sand is fine to medium grained	99.75 0.15	S1	GB			
	-becomes more gravelly and damp with depth		S2	GB			
1	SAND, trace to some gravel, tan, damp, (compact to dense) fine to medium grained	98.83 1.07	S3	GB			
	-becomes some gravel and well-graded by 1.5m		S4	GB			
	▽						
2	SANDY SILT, some gravel, light brownish grey with black gravel, damp, (very stiff) gravel is sub-angular to angular (TILL-LIKE)	98.07 1.83	S5	GB			9
			S6	GB			16
	Bottom of test pit at 2.5m.	97.41 2.49					

PLASTIC & LIQUID LIMIT MOISTURE CONTENT: PL, MC, LL (20, 40, 60, 80)

(Continued Next Page)

RECORD OF TEST PIT : TP13-02

exp Services Inc

CLIENT Musqueam Capital Corp.
PROJECT NUMBER VAN-00213751-A0
EXCAVATION DATE 18/7/13
EXCAVATION CONTRACTOR Backhoes Unlimited
EXCAVATION METHOD Rubber Tire Back-Hoe
LOGGED BY DGS **CHECKED BY**

PROJECT NAME Testholes and Percolation Tests
PROJECT LOCATION Block F, Acadia and University Blvd., UBC
TEST PIT LOCATION N: 5456878 E: 483106
ELEVATION 100.80 m
GROUND WATER LEVELS: ▽ **AT TIME OF EXCAVATION** 1.8m inferred
▼ **AFTER EXCAVATION** ---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SAMPLES POCKET PEN. (TSF)	FINES CONTENT (%) 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80
		SOD/TOPSOIL	100.65	S7	GB			13 ●
		SAND, trace silt, occasional gravel and rootlets, orange, dry, (compact) sand is fine-grained	0.15 99.89	S8	GB			
1		SAND, trace gravel, occasional cobbles, light brown with rust staining, dry, (compact to dense) well-graded	0.91 98.97	S9	GB			
	▽	SANDY SILT, some gravel, light brownish grey with black gravel, damp, (very stiff) gravel is sub-angular to angular (TILL-LIKE)	1.83					
2		-boulder at 2m		S10	GB			12 ●
		-becomes hard with less moisture @ 2.3m	98.41	S11	GB			13 ●
		Bottom of test pit at 2.4m.	2.39					

(Continued Next Page)

exp Services Inc

RECORD OF TEST PIT : TP13-03

CLIENT Musqueam Capital Corp.
PROJECT NAME Testholes and Percolation Tests
PROJECT NUMBER VAN-00213751-A0
PROJECT LOCATION Block F, Acadia and University Blvd., UBC
EXCAVATION DATE 18/7/13
TEST PIT LOCATION N: 5456877 E: 482949
EXCAVATION CONTRACTOR Backhoes Unlimited
ELEVATION 99.80 m
EXCAVATION METHOD Rubber Tire Back-Hoe
GROUND WATER LEVELS: ▽ **AT TIME OF EXCAVATION** 1.8m visible
LOGGED BY DGS **CHECKED BY**
▼ **AFTER EXCAVATION** ---

DEPTH (m)	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SAMPLES POCKET PEN. (TSF)	FINES CONTENT (%) 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80
	SOD/TOPSOIL						
	SILTY SAND, some gravel, seams of silt, pockets of till-like material, bottles, plastic bags, orangish brown, damp, (compact to dense) (FILL)	99.72 0.08	S12	GB			13
	-50mm layer of asphalt on north side @ 0.4m						
	SANDY SILT, organics and roots, dark brown, moist, (stiff) (POSSIBLE ORIGINAL TOPSOIL)	99.39 0.41	S13 S14	GB GB			33 24
1	SANDY SILT, organics and roots, orangish brown, damp, (stiff) sand is fine-grained	99.04 0.76	S15	GB			33
	SILTY SAND, trace organics, grey with black pockets, damp, (compact)	98.68 1.12	S16	GB			
2	SANDY SILT, some gravel, light brownish grey with black gravel, damp, (very stiff) gravel is sub-angular to angular (TILL-LIKE)	98.18 1.62	S17	GB			20
	-boulder @ 2m						
	-becomes hard with less moisture @ 2.2m		S18	GB			13
	Bottom of test pit at 2.3m.	97.46 2.34					

(Continued Next Page)

exp Services Inc

RECORD OF TEST PIT : TP13-04

CLIENT Musqueam Capital Corp.
PROJECT NAME Testholes and Percolation Tests
PROJECT NUMBER VAN-00213751-A0
PROJECT LOCATION Block F, Acadia and University Blvd., UBC
EXCAVATION DATE 18/7/13
TEST PIT LOCATION N: 5456971 E: 482835
EXCAVATION CONTRACTOR Backhoes Unlimited
ELEVATION 96.10 m
EXCAVATION METHOD Rubber Tire Back-Hoe
GROUND WATER LEVELS: ▽ **AT TIME OF EXCAVATION** 1.8m visible
LOGGED BY DGS **CHECKED BY**
▼ **AFTER EXCAVATION** ---

DEPTH (m)	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SAMPLES POCKET PEN. (TSF)	FINES CONTENT (%) 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80
	SOD/TOPSOIL/ROOTS	96.05					
	SILTY SAND to SANDY SILTY, some till-like material, plastic bags, dark brownish orange, dry, (compact to dense) (FILL)	0.05 95.85	S19	GB			23
	SILTY SAND, trace organics, black fleck, reddish orange, dry, (compact to dense) sand is fine-grained	0.25 95.59	S20	GB			40
	SAND, trace silt, occasional gravel, occasional hard chunks, light brown-tan with rust staining, moist, (dense) sand is fine to medium grained	0.51	S21	GB			
1			S22	GB			26
	-becomes some silt by 1.8m ▽	94.27					
	SANDY SILT, some gravel, light brownish grey with black gravel, damp, (very stiff) gravel is sub-angular to angular (TILL-LIKE)	1.83	S23	GB			12
2							
	-becomes grey and hard, less moisture by 2.1m	93.81	S24	GB			8
	Bottom of test pit at 2.3m.	2.29					

(Continued Next Page)

exp Services Inc

RECORD OF TEST PIT : TP13-05

CLIENT Musqueam Capital Corp.
PROJECT NAME Testholes and Percolation Tests
PROJECT NUMBER VAN-00213751-A0
PROJECT LOCATION Block F, Acadia and University Blvd., UBC
EXCAVATION DATE 18/7/13
TEST PIT LOCATION N: 5457091 E: 483149
EXCAVATION CONTRACTOR Backhoes Unlimited
ELEVATION 97.30 m
EXCAVATION METHOD Rubber Tire Back-Hoe
GROUND WATER LEVELS: ▽ **AT TIME OF EXCAVATION** ---
LOGGED BY DGS **CHECKED BY**
▼ **AFTER EXCAVATION** ---

DEPTH (m)	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SAMPLES POCKET PEN. (TSF)	FINES CONTENT (%) 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80
	SOD/TOPSOIL/ROOTS	97.22					
	SANDY SILT, some organics, trace gravel, brown, dry, (loose to compact) sand is fine-grained	0.08 97.00	S25	GB			
	SAND, trace silt, occasional gravel, orangish tan with dark brown spots, dry, (dense)	0.30	S26	GB			
1			S27	GB			6
		95.78	S28	GB			17
	SANDY SILT, some gravel, light brownish grey with black gravel, damp, (very stiff) gravel is sub-angular to angular (TILL-LIKE)	1.52					
	-becomes hard with less moisture @ 1.9m	95.32	S29	GB			14
	Bottom of test pit at 2.0m.	1.98					

(Continued Next Page)

January 21, 2015 Reference No. VAN-00213751-01

Musqueam Capital Corporation
6615 Salish Drive
Vancouver BC V6N 4C4

c/o Colliers International Consulting
19th Floor – 200 Granville Street
Vancouver, BC V6C 2R6
Email: gordon.easton@colliers.com

Attention: Gordon Easton, BA, M.E.S, MCIP

Re: Block F, Acadia and University Blvd., UBC
Acadia and Toronto Roads
Preliminary Geotechnical Report

Dear Sir:

1.0 INTRODUCTION

As requested, **exp** Services Inc. (**exp**) has completed a preliminary geotechnical report for the above-noted site.

The geotechnical work was performed in general accordance with **exp**'s proposal dated December 3, 2014. The purpose of the exploration was to provide a geotechnical report outlining the soil conditions encountered along the existing Acadia Road and Toronto Road, for road widening and utility upgrading design purposes.

Analysis of the soil or ground water with respect to environmental issues was beyond the scope of the geotechnical investigations. Appendix A contains our "Interpretation & Use of Study and Report" and forms an integral part of this report and must be included with any copies of this report.

2.0 PROPOSED DEVELOPMENTS AND SITE DESCRIPTION

The proposed site development would entail the following primary roadworks and servicing components along adjacent roadways, as follows:

a. Widening of Acadia Road adjacent to the site.
b. The upgrading of utilities along Acadia Road and Toronto Road, which will require excavation and restoration of roadway areas.

Preliminary geotechnical design is provided for the above components. In addition, new roadways, Road A and Road B, will be required within the proposed development site. However, the interior roadways are currently inaccessible to equipment needed for geotechnical exploration, thus, conceptual design of interior roads is provided.

For road design purposes, the road classification has been given as "Minor Collector Streets" for Acadia, Toronto and Road A, and "Local Street" for Road B.

The proposed development site is located at the southwest corner of the intersection of University Blvd. and Toronto Road, near UBC in Vancouver, BC. The site is bounded by Acadia Road to the west, Toronto Road to the north, University Blvd. to the east, and residential development, a church plus U-Hill School to the south. The site is triangular-shaped, and it has dimensions of about 520m along Acadia Road and University Blvd., 60m along Toronto Road, and 290m along the south side of the site.

The topography generally slopes down very gently toward the north and east. The current site is heavily forested with a mix of deciduous and coniferous trees and medium to thick undergrowth.

The topography adjacent to the site generally slopes down very gently and away from the site perimeters. The site is generally bounded by residential and urban developments.

3.0 GEOTECHNICAL SUBSURFACE CHARACTERIZATIONS

3.1 Fieldwork and Laboratory Testing

The geotechnical exploration for this project was conducted on December 23, 2014. The exploration consisted of the following:

- Six (6) machine auger drill holes to depths of 1.5 to 3m below existing ground surface (designated AH14-01 to AH14-06, inclusive).
- One (1) Dynamic Cone Penetration Test (DCPT) at AH14-01.

The DCPT consisted of driving a blunt 60° steel cone (38mm long, 64mm diameter, with a sleeve 133mm long) at the end of the drill rods using a 140 lb. drop (automatic trip) hammer, falling 750mm to drive the top end of the drill steel rods. The number of blows required to drive the cone in 300mm increments is recorded and shown on the test hole logs. The auger test holes were completed to depths of 1.5 to 3m, with the DCPT stopped at a depth of about 2m, in till-like soil.

The geotechnical exploration was carried out under the supervision of a geotechnical representative from **exp**, who located the test holes, logged the subsurface conditions and gathered soil samples for further classification and laboratory testing. The laboratory tests included natural moisture content on selected soil samples and two sieve tests. The test holes were backfilled with the drill cuttings upon completion.

The approximate test hole locations are shown on the attached Test Hole Location Plan, Figure 1 in Appendix B. Soil descriptions of each test pit including the moisture content test results are included in the test hole logs in Appendix C. The sieve analysis reports are shown in Appendix D.

3.2 Soil and Groundwater Conditions

The available test holes and nearby records generally encountered the following soil types:

UNIT FR	**FILL – SAND and GRAVEL**
	- Trace to some silt - Subangular particles, except in AH14-06 - Moisture contents 3 to 6%
UNIT F1	**FILL – SAND to SILT and SAND**
	- Encountered at 0.6 to 1.1m depth in AH14-03 - Encountered at 0.3 to 1.1m depth in AH14-04 - Moisture contents: 18 to 33%
UNIT A	**SAND, some silt**
	- Trace to some silt, trace to some gravel - Loose to compact - 0.7 to 1.5m thick in test holes - Moisture contents: 10 to 33%
UNIT B	**TILL-LIKE (SAND and SILT) SOILS**
	- Dense - Some gravel - Encountered at 1.6 to 1.8m depths in the test holes, except 0.3m depth in AH14-06

Groundwater

At the time of the drilling, slight groundwater seepage was encountered at depths of 0.8 to 1.5m, in two of six test holes (AH14-01 and AH14-02). The groundwater seepage is interpreted to be perched groundwater near the till-like soil surface. The perched water level may vary and fluctuate seasonally and in response to climatic conditions and local land use. Based on file information, the regional water table is anticipated to be at great depth in the order of about 60m below grade, at the bottom of the Quadra Sand.

It should be noted that the above subsurface conditions were encountered at the test hole locations only. The actual soil and groundwater conditions may vary between the test holes.

4.0 PRELIMINARY EVALUATION AND ANALYSIS

4.1 General

It is anticipated that proposed pavement areas along Acadia and Toronto Roads will generally be underlain by either one of the following:

- Existing roadway embankment, including sand and gravel fill and sand fill, Unit F soils;
- Natural Sand soils, e.g. Unit A Sand.
- Dense silt and sand till-like based on AH14-06 on Toronto Road.

The conditions within proposed widening areas are inferred based on site observations, testhole records, etc. The available exploration records provide information for the preliminary geotechnical design and proposed roadway widening and utility upgrade purposes, and additional exploration is recommended for final design purposes for Road A and Road B.

4.2 Pavement Outline

For reference, the Ministry of Transportation and Infrastructure minimum pavement structure for Type "A" and Type "B" roads on soil subgrades are as follows:

Type "A" Road (greater than 1,000,000 ESAL's)

- 100mm of Asphalt Pavement
- 300mm of Well Graded Base
- 300mm of Select Granular Sub-Base

Type "B" Road (100,000 to 1,000,000 ESAL's)

- 75mm of Asphalt Pavement
- 300mm of Well Graded Base
- 300mm of Select Granular Sub-Base

For reference, the City of Vancouver Street Restoration Manual, "Restoration of Cuts in Pavement" criteria are as follows:

Light Duty Asphalt Surfaced Roads, Section 2591

- 50mm up to 100mm thick, match existing Asphaltic Concrete Pavement
- 150mm, 19mm minus Crushed Granular Base
- 450mm, either 19mm minus Crushed Granular Base or 75mm minus Crushed Aggregate

Heavy Duty Asphalt Surfaced Roads, Section 2592, MF137-AE-3

- 50mm Asphaltic Concrete Surface Pavement
- 90mm Asphaltic Concrete Base Pavement
- 150mm, 19mm minus Crushed Granular Base
- 450mm, either 19mm minus Crushed Granular Base or 75mm minus Crushed Aggregate

4.3 Existing Materials

The testholes on Acadia Road encountered 75mm thick asphalt surfacing material, typically. The asphalt was 90mm thick in the one testhole on Toronto Road.

The testholes on Acadia Road encountered sand and gravel fill, subangular materials over native sand or sand fill, and in one testhole, sand and silt fill. The sand and gravel thickness varied from typically about 0.23m to 0.5m and 0.7m in two of five test holes. The sieve analysis report (Appendix D) done on sand and gravel fill show gradations compatible with MMCD Granular Base material gradation. Visually, the sand and gravel fill gravel particles were classified as sub-angular.

The test hole on Toronto Road encountered the sand and gravel fill, over dense silt and sand (till-like soil). The fill in the test hole on Toronto Road differed from that on Acadia, in that it was comprised of rounded particles.

At the time of the fieldwork, visual reconnaissance of existing pavements indicated the following:

- Numerous transverse cracks, occasional longitudinal cracks.
- Crack sealing.
- Occasional alligator cracked areas.

- Some wheel path rutting areas.

The pavement generally was in fair condition, with some localized poor condition areas.

4.4 Source Materials and Disposal

It is understood that granular materials could be available as follows:

- Granular fill from industry sources located in the vicinity of the site.
- Re-use of select materials, i.e., Sand and Gravel Fill, Unit FR, and pulverized pavements.

It is anticipated that significant stripping quantities may be placed outside the roadways, and on the proposed development site, provided materials can meet criteria for landscape fill purposes. Otherwise, suitable off-site disposal may be anticipated.

5.0 PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

5.1 General

The exploration testholes generally encountered granular fills over sand and some silt underlain by dense silt and sand, till-like soil at depth. Groundwater seepage was encountered in some of the test holes, however the water table may fluctuate due to the river levels and a seasonal, shallow perched water table may be anticipated where surficial water infiltration is “perched” on top of silty horizons.

Based on available information, construction of the proposed utility upgrades and pavements by conventional methods appears feasible.

5.2 Seismic Design Considerations

Based on the subsurface profile as mentioned above, the average properties of the top 30m are consistent with dense soils, which are considered to be generally non-liquefiable during the design earthquake events of the 2012 BCBC. As such, liquefaction induced ground displacement is expected to be minimal.

5.3 Utilities

Installation of the proposed utilities, such as, water and sewer lines, are anticipated on Acadia and Toronto Roads, and also on the proposed Roads A and B. The details of depth and pipe sizing are unavailable, presently. The following outlines preliminary advice, primarily for Acadia and Toronto Roads.

5.3.1 Excavation

The composition and consistency of the soils at the site are such that suitably equipped hydraulic excavators should be able to dig these materials.

The sidewalls of unsupported trench excavations should generally be cut vertical to about 1m depth and no steeper than 1H:1V (horizontal:vertical) below 1m depth. However, flatter cut slope gradients may be required for trench stability and worker safety purposes, if loose soils are prone to caving and sloughing or where significant zones of groundwater seepage are encountered. A Geotechnical Engineer should review the soils encountered periodically during excavation and to recommend flatter slopes, if required.

If open cut slopes are considered impractical or undesirable (e.g., depths greater than 1.2m), appropriate trench shoring/bracing methods should be employed such as standard trench boxes and/or sheeting, meeting the requirements of WorkSafeBC and other applicable authorities. The temporary shoring system should be the responsibility of the contractor, as per WorkSafeBC requirement including temporary works engineering.

As previously noted, perched water may be encountered. As such, some groundwater seepage should be assumed in the proposed trench excavation, and dewatering should be completed as necessary to allow pipe installation and backfill placement to occur in dry conditions. Based on the subsurface conditions encountered and local experience, it is probable that conventional sump pumping methods would be sufficient to handle possible seepage volumes. However, the dewatering method used would need to be selected in response to actual groundwater conditions encountered during construction. The design, operation, and maintenance of a dewatering system should be the responsibility of the contractor.

5.3.2 Pipe Subgrade and Bedding

The loose to compact sand or dense, till-like soil are the anticipated subgrades for pipe bedding. Unsuitable soil such as organic rich materials should be removed to expose anticipated subgrade.

Pipe bedding should be provided, consistent with Master Municipal Construction Documents (MMCD) Standards.

5.3.3 Trench Backfill

Backfilling of the utility trenches should be in general accordance with Master Municipal Construction Documents (MMCD) Section 02223 requirement and applicable Standard Specifications for the trench backfill.

Imported granular backfill should be comprised of free-draining, well graded sand and gravel meeting gradation specifications for either “Pit Run Gravel” or “Select Granular Subbase” per MMCD Section 02226 Items 2.3 and 2.8, respectively, or equivalent. The granular backfill should be placed in maximum 300mm lifts, with each lift compacted to achieve at least 95% Modified Proctor maximum dry density (ASTM D 1557).

The existing native soils, comprised of sand and till-like soil, are considered unsuitable for re-use as granular backfill. However, feasibility of reuse may be considered at the time of construction, if materials handling meet acceptance criteria for backfills.

5.4 Pavement Design Recommendations

5.4.1 Pavement Structure

The results of the new pavement structure design, incorporating the assumption and design parameters outlined above are summarized in Tables 1 and 2 below. Note that detailed design for Road B (Table 2) may consider a reduced subbase thickness, depending on details of subgrade and embankment materials anticipated.

Table 1.
Pavement Structure for (Minor Collector) Acadia Road, Toronto Road and Road A

Assumed Subgrade	**Pavement Structure**	
	Material Type	**Thickness**
Embankment Fill, Compact Sand and dense Silt and Sand	Asphalt Pavement	100mm
	19mm Granular Base	150mm
	19mm minus Granular Base or 75mm Crushed Granular Subbase	450mm
	Total Thickness:	**700mm**

Table 2.
Pavement Structure for Road B (Local Street)

Assumed Subgrade	**Pavement Structure**	
	Material Type	**Thickness**
Embankment Fill, Compact Sand and dense Silt and Sand	Asphalt Pavement	80mm
	19mm Granular Base	150mm
	19mm minus Granular Base or 75mm Crushed Granular Subbase	450mm
	Total Thickness:	**680mm**

The Hot Mix Asphalt surfacing should be placed in two equally thick lifts using MMCD Lower Course #1 for the bottom lift and Upper Course #1 for the top lift as per MMCD Section 02512. A tack cost should be applied between the lifts as per MMCD Section 02547. Superpave asphalt surfacing may be considered for heavy traffic areas, e.g. bus lanes, to provide improved rut resistance.

At new construction tie-ins to existing pavement, a sawcut joint should be planned to coincide within 150mm either side of the new lane edge or centre of the lane to avoid a construction joint along a wheelpath which can lead to raveling and joint failure.

5.4.2 Pavement Construction Materials, Placement and Construction

Gradations of the surficial 19mm minus Granular Base and the underlying Crushed Granular Subbase should be in compliance with MMCD. The base and subbase material should be compacted to at least 95% Modified proctor maximum dry density. The existing sand and gravel, Unit FR, material may be reused as subbase material.

Materials required to reinstate grade under the above-noted surfacing structure should be comprised of Select Granular Subbase (SGSB) or equivalent.

5.4.3 Estimated Stripping Depths

It is estimated that stripping depths may be in the order of about 0.1 to 0.3m to remove topsoils. Some additional excavation or stripping may be required to accommodate pavement sections.

5.4.4 Roadway Excavation and Drainage

It is estimated that it would be practical to use conventional excavation equipment to excavate soils encountered in testholes at the site. Based upon the testhole results, it is considered that excavations could be kept free of standing water using conventional pumping from sumps to facilitate excavation.

5.4.5 Existing Pavements

It is anticipated that the existing pavement section would be deficient for purposes of the traffic anticipated with the proposed site development. However, if traffic volume will be unchanged on a portion of Acadia Road, it may be feasible to retain the existing pavement.

If it will be desirable to upgrade the existing pavement, the new pavement section should be utilized as outlined above.

It is judged that asphalt overlay on the existing pavement would fail to achieve pavement design criteria. The repair of fair to poor pavement areas required for overlay purposes likely makes an overlay option impractical and costly.

6.0 GEOTECHNICAL REVIEWS, FURTHER STUDY

It is anticipated that plans for utilities and pavement would be reviewed by the Geotechnical Engineer prior to final design. Project specific recommendations may be anticipated.

Additional exploration is recommended within the proposed site for utility and road design and construction purposes.

7.0 CLOSURE

Exp Services Inc. has prepared this report based on referenced information and our understanding of the project as described in this report.

The report was prepared for the exclusive use of our client, Musqueam Capital Corporation and their designated consultants and agents, and may not be used by other parties without the written consent of **exp** Services Inc.

We trust that this report will meet your present requirements. Please contact the undersigned should you have any questions or require further assistance.

Sincerely,

exp Services Inc.

Don Sargent, P.Eng.
Senior Engineer

Reviewed by:

per

Ben Weiss, P.Eng.
Senior Engineer

Enclosures:
- Appendix A – Interpretation & Use of Study and Report
- Appendix B – Test Hole Location Plan
- Appendix C – Test Hole Logs
- Appendix D – Sieve Test Reports

Appendix A

Interpretation & Use of Study and Report

INTERPRETATION & USE OF STUDY AND REPORT

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering consulting practices in this area. No other warranty, expressed or implied, is made. Engineering studies and reports do not include environmental consulting unless specifically stated in the engineering report.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF THE REPORT

The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT. WE WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS “APPROVED USERS”. The contents of the Report remain our copyright property and we authorise only the Client and Approved Users to make copies of the Report 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 the Report, or any portion thereof, available to any party without our written permission. Any use which a third party makes of the Report, or any portion of the Report, are the sole responsibility of such third parties. We accept no responsibility for damages suffered by any third party resulting from unauthorised use of the Report.

5. INTERPRETATION OF THE REPORT

a. Nature and Exactness of Descriptions: Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations, or building envelope descriptions, utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarising such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b. Reliance on Provided information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.

c. To avoid misunderstandings, **exp** Services Inc. (**exp**) should be retained to work with the other design professionals to explain relevant engineering findings and to review their plans, drawings, and specifications relative to engineering issues pertaining to consulting services provided by **exp**. Further, **exp** should be retained to provide field reviews during the construction, consistent with building codes guidelines and generally accepted practices. Where applicable, the field services recommended for the project are the minimum necessary to ascertain that the Contractor’s work is being carried out in general conformity with **exp**’s recommendations. Any reduction from the level of services normally recommended will result in **exp** providing qualified opinions regarding adequacy of the work.

6.0 ALTERNATE REPORT FORMAT

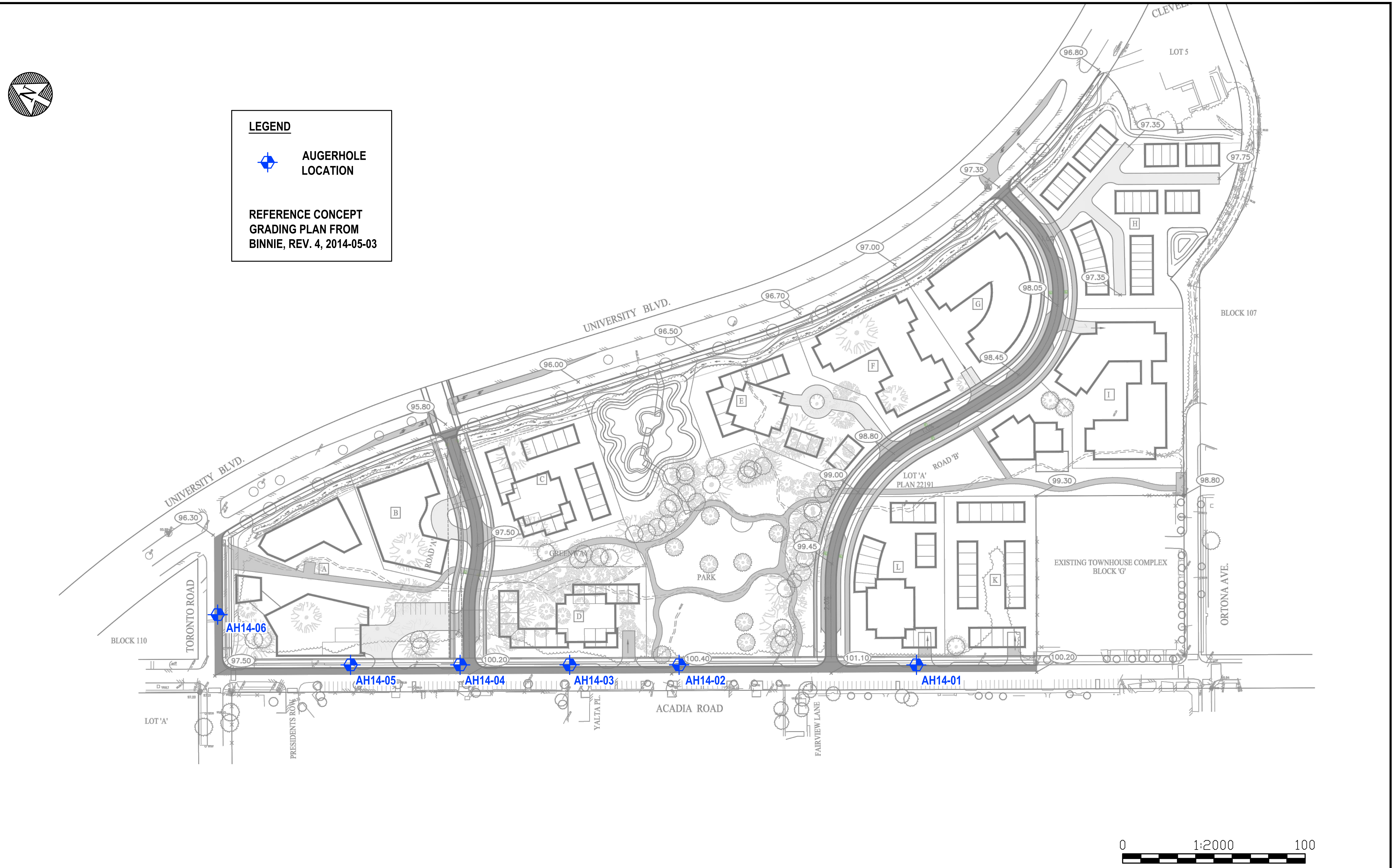
When **exp** submits both electronic file and hard copies of reports, drawings and other documents and deliverables (**exp**’s instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by **exp** shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancy, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by **exp** shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of **exp**’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except **exp**. The Client warrants that **exp**’s instruments of professional service will be used only and exactly as submitted by **exp**.

The Client recognizes and agrees that electronic files submitted by **exp** have been prepared and submitted using specific software and hardware systems. **Exp** makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

Appendix B

Test Hole Location Plan



LEGEND

⌖ AUGERHOLE LOCATION

REFERENCE CONCEPT GRADING PLAN FROM BINNIE, REV. 4, 2014-05-03

Jan 22, 2015 – 10:43am L:\2013 (starting at 0210575-A0)\0213751-01 DWS Block F, Acadia & University Blvd, UBC\Cad\213751-01 Testhole Plan.dwg

exp Services Inc.
275–3001 Wayburne Drive
Burnaby, British Columbia V5G 4W3
Telephone: 604–874–1245
Fax: 604–874–2358
exp.com

DFTR. MG
DSGN.
CHK. DWS

REVISIONS		
No.	DESCRIPTION	DATE

CLIENT Musqueam Capital Corp. c/o Colliers International
PROJECT Acadia and Toronto Roads - Geotechnical
Block F, Acadia Road and University Blvd., UBC
PROJECT NO. VAN-00213751-01

TITLE:
TESTHOLE LOCATION PLAN

DATE 2015-01-19
SCALE: 1:2000
DWG NO. FIGURE 1

Appendix C

Test Hole Logs

AH14-01o AH14-06, inclusive

RECORD OF AUGERHOLE : AH14-01

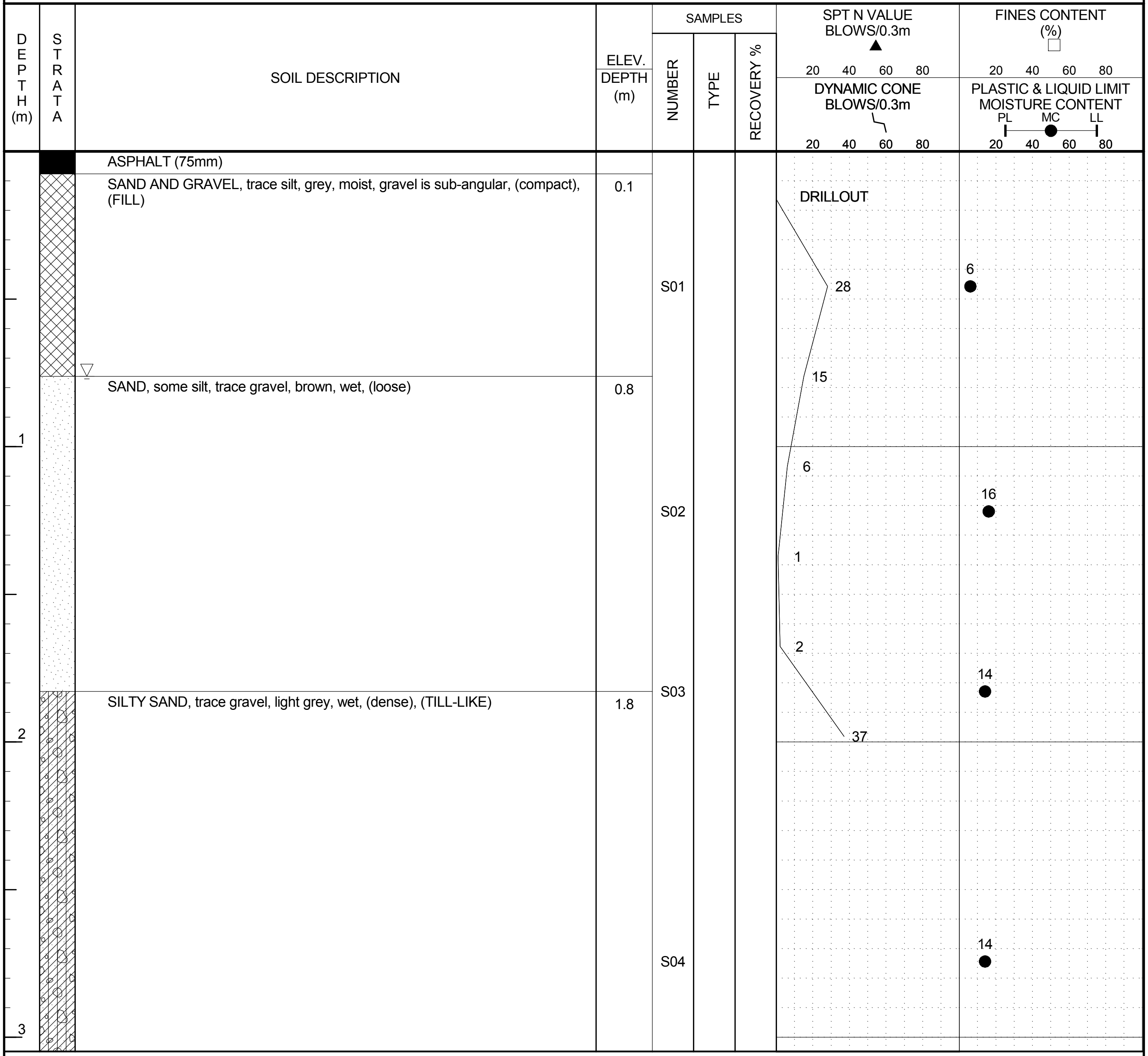
PAGE 1 OF 1

exp Services Inc

CLIENT Musqueam Capital Corp. c/o Colliers International
PROJECT NUMBER VAN-0213751-01
DRILLING DATE 2014-12-23 to 2014-12-23
DRILLING CONTRACTOR On Track Drilling Inc.
DRILLING METHOD Solid Stem Auger
LOGGED BY SCD **CHECKED BY** DWS

PROJECT NAME Acadia and Toronto Roads - Geotechnical
PROJECT LOCATION Block F, Acadia Road and University Blvd., UBC
AUGERHOLE LOCATION ZONE:10 N: 5456707 E: 482875
ELEVATION
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** 0.8m
▼ **AFTER DRILLING** ---

SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY %
ASPHALT (75mm)				
SAND AND GRAVEL, trace silt, grey, moist, gravel is sub-angular, (compact), (FILL)	0.1	S01		
SAND, some silt, trace gravel, brown, wet, (loose)	0.8	S02		
SILTY SAND, trace gravel, light grey, wet, (dense), (TILL-LIKE)	1.8	S03 S04		



Bottom of hole at 3.0m.

RECORD OF AUGERHOLE : AH14-02

CLIENT Musqueam Capital Corp. c/o Colliers International
PROJECT NUMBER VAN-0213751-01
DRILLING DATE 2014-12-23 to 2014-12-23
DRILLING CONTRACTOR On Track Drilling Inc.
DRILLING METHOD Solid Stem Auger
LOGGED BY SCD **CHECKED BY** DWS

PROJECT NAME Acadia and Toronto Roads - Geotechnical
PROJECT LOCATION Block F, Acadia Road and University Blvd., UBC
AUGERHOLE LOCATION ZONE:10 N: 5456796 E: 482829
ELEVATION
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AFTER DRILLING** ---

DEPTH (m)	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m ▲ / DYNAMIC CONE BLOWS/0.3m	FINES CONTENT (%) ☐ / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL
	ASPHALT (70mm)						
	SAND AND GRAVEL, trace silt, moist, grey, (compact), gravel is sub-angular, (FILL)	0.1	S05				5 ●
	SAND, trace silt, brown, moist, (loose)	0.3	S06				10 ●
1	SAND, some gravel, trace silt, grey, brown, moist, (loose)	0.8	S07				11 ●
2	SILT AND SAND, trace gravel, light grey, wet, (dense), (TILL-LIKE)	1.8	S08				12 ●
3			S09				13 ●

Bottom of hole at 3.0m.

RECORD OF AUGERHOLE : AH14-03

PAGE 1 OF 1

exp Services Inc

CLIENT Musqueam Capital Corp. c/o Colliers International
PROJECT NUMBER VAN-0213751-01
DRILLING DATE 2014-12-23 to 2014-12-23
DRILLING CONTRACTOR On Track Drilling Inc.
DRILLING METHOD Solid Stem Auger
LOGGED BY SCD **CHECKED BY** DWS

PROJECT NAME Acadia and Toronto Roads - Geotechnical
PROJECT LOCATION Block F, Acadia Road and University Blvd., UBC
AUGERHOLE LOCATION ZONE:10 N: 5456875 E: 482786
ELEVATION
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** 1.2m
▼ **AFTER DRILLING** ---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m ▲ 20 40 60 80 / DYNAMIC CONE BLOWS/0.3m 20 40 60 80	FINES CONTENT (%) ☐ 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC ● LL 20 40 60 80
		ASPHALT (75mm)						
		SAND AND GRAVEL, grey, moist, (compact), gravel is sub-angular, (FILL)	0.1	S10				3
1		SAND AND SILT, some gravel, grey, moist, (loose), (FILL)	0.6	S11				18
		SAND, some silt, trace organics, dark brown, moist, (firm)	1.1	S12				46
	▽	SAND, some silt, trace gravel, brown, wet, (loose)	1.2	S13				27
2		SILTY SAND, trace gravel, grey, moist, (dense), (TILL-LIKE)	1.7	S14				19
3				S15				13

Bottom of hole at 3.0m.

exp Services Inc

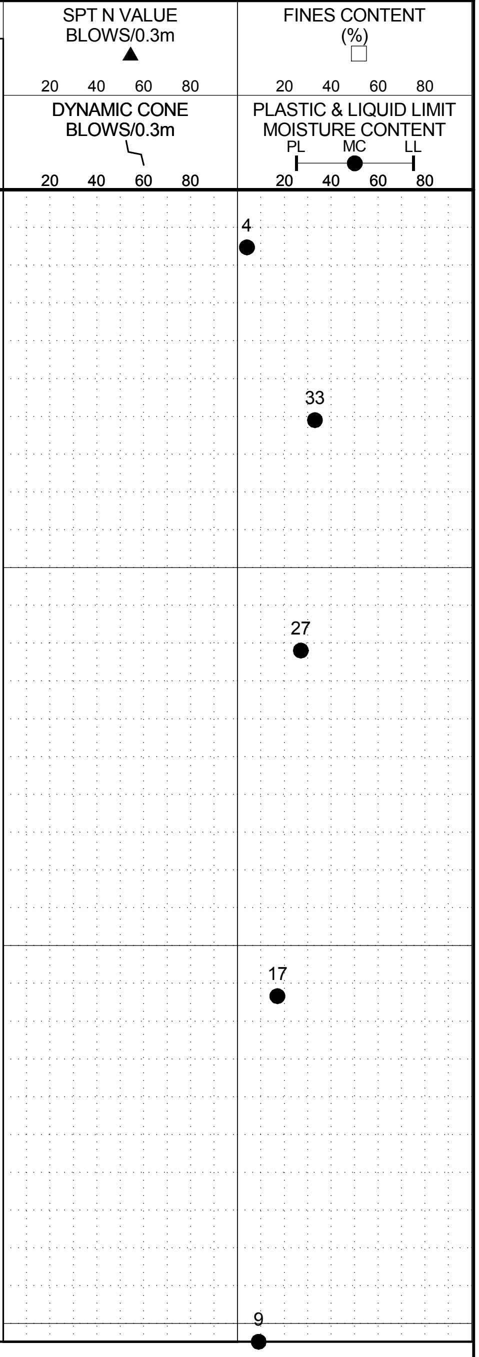
RECORD OF AUGERHOLE : AH14-04

PAGE 1 OF 1

CLIENT	Musqueam Capital Corp. c/o Colliers International	**PROJECT NAME**	Acadia and Toronto Roads - Geotechnical
PROJECT NUMBER	VAN-0213751-01	**PROJECT LOCATION**	Block F, Acadia Road and University Blvd., UBC
DRILLING DATE	2014-12-23 to 2014-12-23	**AUGERHOLE LOCATION**	ZONE:10 N: 5456928 E: 482758
DRILLING CONTRACTOR	On Track Drilling Inc.	**ELEVATION**	
DRILLING METHOD	Solid Stem Auger	**GROUND WATER LEVELS:** ▽ **AT TIME OF DRILLING**	---
LOGGED BY SCD	**CHECKED BY** DWS	▼ **AFTER DRILLING**	---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %
	■	ASPHALT (75mm)				
	▨	SAND AND GRAVEL, grey, moist, (compact), gravel is sub-angular, (FILL)	0.1	S16		
		SAND, some silt, mixed brown and dark brown pockets, moist, (compact), (FILL)	0.3	S17		
1		SAND, some silt, brown, moist, (compact)	1.1	S18		
2		SILT AND SAND, trace gravel, grey, moist, (dense), (TILL-LIKE)	1.8	S19		
3				S20		

Bottom of hole at 3.0m.



exp Services Inc

RECORD OF AUGERHOLE : AH14-05

PAGE 1 OF 1

CLIENT Musqueam Capital Corp. c/o Colliers International
PROJECT NUMBER VAN-0213751-01
DRILLING DATE 2014-12-23 to 2014-12-23
DRILLING CONTRACTOR On Track Drilling Inc.
DRILLING METHOD Solid Stem Auger
LOGGED BY SCD **CHECKED BY** DWS

PROJECT NAME Acadia and Toronto Roads - Geotechnical
PROJECT LOCATION Block F, Acadia Road and University Blvd., UBC
AUGERHOLE LOCATION ZONE:10 N: 5456980 E: 482729
ELEVATION
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** 1.5m
▼ **AFTER DRILLING** ---

SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m ▲ / DYNAMIC CONE BLOWS/0.3m	MOISTURE CONTENT ●
ASPHALT (75mm)						
SAND AND GRAVEL, trace silt, grey, moist, (compact), gravel is sub-angular, (FILL)	0.1	S21				6
SAND, trace gravel, some silt, brown, moist, (compact)	0.3	S22				14
SAND, trace gravel, trace silt, brown, moist, (compact) ▽	0.8	S23				8
SILTY SAND, trace gravel, grey, moist, (dense)	1.8	S24				10
SANDY SILT, trace gravel, grey, moist, (dense), (TILL-LIKE)	2.1	S25				17

Bottom of hole at 3.0m.

exp Services Inc

RECORD OF AUGERHOLE : AH14-06

PAGE 1 OF 1

CLIENT Musqueam Capital Corp. c/o Colliers International
PROJECT NUMBER VAN-0213751-01
DRILLING DATE 2014-12-23 to 2014-12-23
DRILLING CONTRACTOR On Track Drilling Inc.
DRILLING METHOD Solid Stem Auger
LOGGED BY SCD **CHECKED BY** DWS

PROJECT NAME Acadia and Toronto Roads - Geotechnical
PROJECT LOCATION Block F, Acadia Road and University Blvd., UBC
AUGERHOLE LOCATION ZONE:10 N: 5457059 E: 482723
ELEVATION
GROUND WATER LEVELS: ∇ **AT TIME OF DRILLING** ---
▼ **AFTER DRILLING** ---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m ▲ / DYNAMIC CONE BLOWS/0.3m (20 40 60 80)	FINES CONTENT (%) ☐ / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC ● LL (20 40 60 80)
		ASPHALT (90mm)						
		SAND AND GRAVEL, trace silt, grey, moist, (compact), gravel is rounded, (FILL)	0.1	S26				3
		SILT AND SAND, trace gravel, grey, dry, (dense), (TILL-LIKE)	0.3	S27				7
1				S28				7

-Refusal at 1.5m

Bottom of hole at 1.5m.

Appendix D

Sieve Test Reports

No. 1 to 2

exp Services Inc.
275-3001 Wayburne Drive
Burnaby, BC V5G 4W3
604-874-1245

Kamloops Branch
250-372-5321

CCIL
CERTIFIED TESTING
LABORATORY

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 002-13751
CLIENT MUSQUEAM CAPITAL CORP.
C.C. exp - DON SARGENT

TO
MUSQUEAM CAPITAL CORP.
6615 SALISH DRIVE
VANCOUVER, BC
V6N 4C4

ATTN: MR. JIM ROSS

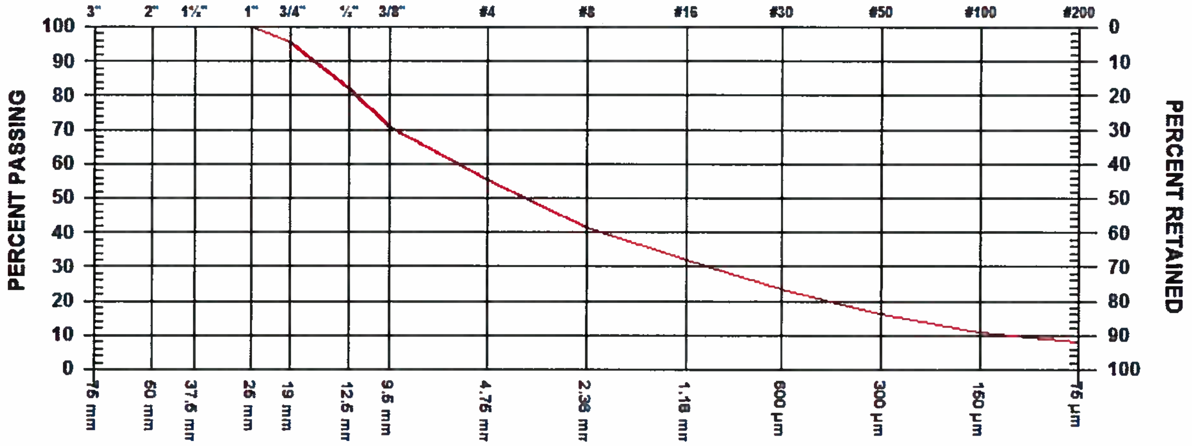
PROJECT BLOCK F, ACADIA & UNIVERSITY BLVD. UBC
GEOTECHNICAL VANCOUVER

CONTRACTOR

SIEVE TEST NO. 1 DATE RECEIVED Jan 19,2015 DATE TESTED Jan 19,2015 DATE SAMPLED Dec 23,2014

SUPPLIER SITE - DRILLING
SOURCE S1 & S5 COMBINED SAMPLE
SPECIFICATION
MATERIAL TYPE SAND AND GRAVEL, TRACE SILT

SAMPLED BY S. DALY
TESTED BY H. WU
TEST METHOD WASHED



GRAVEL SIZES			PERCENT PASSING	GRADATION LIMITS
3"	75	mm		
2"	50	mm		
1 1/2"	37.5	mm		
1"	25	mm	100.0	
3/4"	19	mm	95.3	
1/2"	12.5	mm	82.0	
3/8"	9.5	mm	70.9	

SAND SIZES AND FINES			PERCENT PASSING	GRADATION LIMITS
No. 4	4.75	mm	55.2	
No. 8	2.36	mm	41.5	
No. 16	1.18	mm	32.1	
No. 30	600	µm	23.5	
No. 50	300	µm	16.3	
No. 100	150	µm	10.9	
No. 200	75	µm	8.1	

COMMENTS
TEST METHOD: ASTM C136, C117.

Jan 20,2015 exp Services Inc. BRIAN GRAY, AScT PER.

exp Services Inc.
275-3001 Wayburne Drive
Burnaby, BC V5G 4W3
604-874-1245

Kamloops Branch
250-372-5321

CCIL
CERTIFIED TESTING
LABORATORY

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 002-13751
CLIENT MUSQUEAM CAPITAL CORP.
C.C. exp - DON SARGENT

TO
MUSQUEAM CAPITAL CORP.
6615 SALISH DRIVE
VANCOUVER, BC
V6N 4C4

ATTN: MR. JIM ROSS

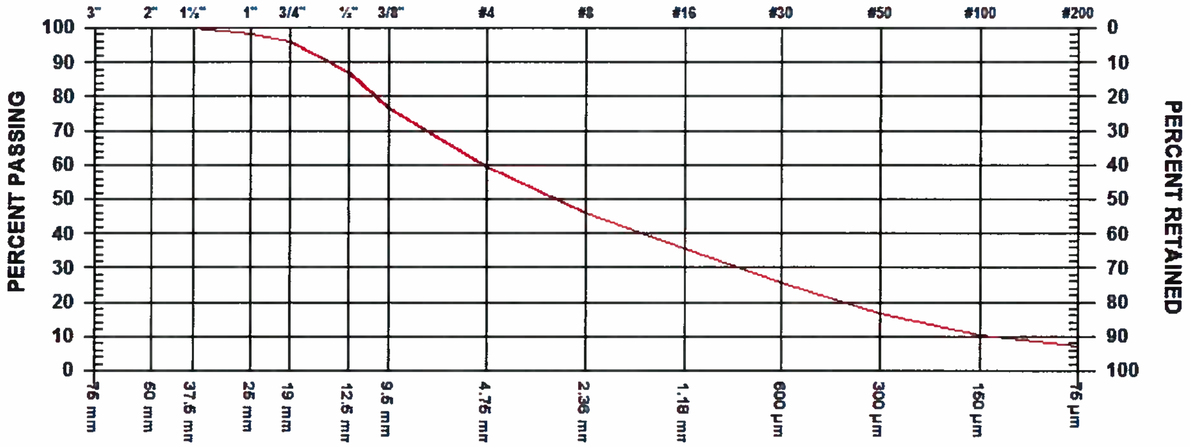
PROJECT BLOCK F, ACADIA & UNIVERSITY BLVD. UBC
GEOTECHNICAL VANCOUVER

CONTRACTOR

SIEVE TEST NO. 2 DATE RECEIVED Jan 19,2015 DATE TESTED Jan 19,2015 DATE SAMPLED Dec 23,2014

SUPPLIER SITE - DRILLING
SOURCE S16, S21, S10 COMBINED SAMPLE
SPECIFICATION
MATERIAL TYPE SAND AND GRAVEL, TRACE SILT

SAMPLED BY S. DALY
TESTED BY H. WU
TEST METHOD WASHED



GRAVEL SIZES			PERCENT PASSING	GRADATION LIMITS
3"	75	mm		
2"	50	mm		
1 1/2"	37.5	mm	100.0	
1"	25	mm	98.2	
3/4"	19	mm	95.9	
1/2"	12.5	mm	86.8	
3/8"	9.5	mm	76.6	

SAND SIZES AND FINES			PERCENT PASSING	GRADATION LIMITS
No. 4	4.75	mm	59.6	
No. 8	2.36	mm	46.1	
No. 16	1.18	mm	35.4	
No. 30	600	µm	25.5	
No. 50	300	µm	16.6	
No. 100	150	µm	10.2	
No. 200	75	µm	7.4	

COMMENTS
TEST METHOD: ASTM C136, C117.

Page 1 of 1 Jan 20,2015 exp Services Inc. BRIAN GRAY, AScT PER.

September 30, 2015 Reference No. VAN-00213751-A0

Musqueam Capital Corporation
6615 Salish Drive
Vancouver BC V6N 4C4

c/o Colliers International Consulting
19th Floor – 200 Granville Street
Vancouver, BC V6C 2R6 Email: gordon.easton@colliers.com

Attention: Gordon Easton, BA, M.E.S, MCIP

Re: Block F, Acadia and University Blvd., UBC
Geotechnical Percolation Test Report

Dear Sir:

1.0 INTRODUCTION

As requested, **exp** Services Inc. (**exp**) has completed a field percolation test memorandum for the above-noted site.

The field test work was performed in general accordance with **exp**'s proposal dated September 15, 2015. The purpose of the field percolation tests was to provide geotechnical input outlining the soil conditions encountered and the results of percolation tests done at defined locations. The **exp** Preliminary Geotechnical report dated July 25, 2013 contains logs of machine dug and hand dug pits plus results of one percolation test, at HP13-01. The test pit location plan by Binnie dated September 15, 2015 defined the location and depth of percolation tests. The following presents results of the percolation tests.

Analysis of the soil or groundwater with respect to environmental issues was beyond the scope of the geotechnical investigations. Appendix A contains our "Interpretation & Use of Study and Report" and forms an integral part of this report and must be included with any copies of this report.

2.0 PROPOSED DEVELOPMENT AND SITE DESCRIPTION

It is understood that a proposed wetland would be constructed in an area adjacent to University Blvd, about 200m east of Toronto Road. The proposed wetland is situated in a low lying area, covered by heavy brush at the time of the field work.

The site is located at the southwest corner of the intersection of University Blvd. and Toronto Road, near UBC in Vancouver, BC. The site is bounded by Acadia Road to the west, Toronto Road to the north, University Blvd. to the east and residential development, a church plus U-Hill School to the south. The site is triangular-shaped, and it has approximate dimensions of about 520m along Acadia Road and University Blvd., 60m on Toronto Road to 290m along the south side of the site.

The topography generally slopes down very gently toward the north and east. The current site is heavily forested with a mix of deciduous and coniferous trees, and medium to thick undergrowth.

The topography adjacent to the site generally slopes down very gently and away from the site perimeters. The site is generally bounded by residential and urban developments.

3.0 FIELD WORK AND LABORATORY TESTING

The recent percolation tests were conducted on September 17, 2015. The field percolation tests and laboratory testing consisted of the following:

- Five (5) hand dug pits to depths of 0.2 to 0.5m below existing ground surface (designated HP15-01a, 15-01b, HP15-02, HP15-03a, HP-03b)
- Two (2) sieve tests on selected samples.

The percolation test was done by measuring the time for water to infiltrate into the hand dug pit. The percolation tests were performed generally in accordance with the methodology given in the BC Ministry of Health's Sewerage System Standard Practice Manual V.3, 2014. On the day of the field work, the weather was mainly cloudy and rainy. As the test locations were covered by vegetation, considerable effort was required to clear a pathway to each test pit. Generally, the ground surface in the vicinity of test area was free of ponding water.

The geotechnical exploration and percolation testing was carried out by a geotechnical technician from **exp**, who located the test pits, logged the subsurface conditions and gathered soil samples for further classification and laboratory testing. The laboratory tests included natural moisture content on selected soil samples. The pits were backfilled with the excavated materials upon completion.

The approximate hand dug locations are shown on the attached Test Hole Location Plan, Figure 1 in Appendix B. Soil descriptions of each test pit including the moisture content test results are included in the test hole logs in Appendix C. Sieve test results are shown in Appendix D.

4.0 SOIL AND GROUNDWATER CONDITIONS

The 2015 test holes generally encountered soils as outlined below. No groundwater seepage was encountered.

UNIT A	**SILT to Organic SILT, PEAT**
UNIT A1	**Forest Detritus – thin**
UNIT A2	**PEAT to Organic Silt** - Dark brown to black - firm to stiff - Moisture content: 35% to 95% - Encountered to depths of 0.2 to 0.3m
UNIT A3	**SILT and SAND** - Some organics - Compact to stiff - Moisture contents: 32 to 38% - HP15-03b showed silty sand vs silt at HP15-01b and HP15-02

It should be noted that the above subsurface conditions were encountered at the test hole locations only. The actual soil and groundwater conditions may vary between the test holes.

5.0 PERCOLATION TEST RESULTS

Percolation Test

The summary of the percolation test results are shown in the following table.

Test Hole No.	Test Hole Depth (m)	Soil Unit	Percolation Rate minutes/25mm
HP15-01a	0.2	A2	12.2
HP15-01b	0.5	A3	29.4
HP15-02	0.5	A3	27.5
HP15-03a	0.2	A2	5
HP15-03b	0.5	A3	9.7
HP13-01 (2013)	0.17	A2	8.8

The percolation tests included pre-soaking the pit for four (4) hours prior to recording the percolation rates. The tests were repeated until the rates between two (2) consecutive trials were less than 2 minutes apart.

The sieve tests indicated fines contents of 21% to 61% for silty sand and silt soils, respectively. The percolation rate in HP15-02 for soil with 61% fines was slower than compared to the result at HP15-03b for a soil with 21% fines content.

Surface Water

The percolation test showed fair to good percolation rates, consistent with the silty materials encountered and an absence of ponding surface water. The presence of ponding surface water is expected to vary seasonally depending on several factors including the amount of precipitation (dry summers versus wet winters), and the amount of evaporation and evapotranspiration as well as subsurface infiltration characteristics.

6.0 CONCLUSIONS

The test holes done in 2015 encountered soils generally consistent with the Unit A soils encountered in some of the 2013 test holes shown in the **exp** Preliminary Geotechnical Report dated July 25, 2013. The reader should refer to the 2013 **exp** geotechnical report for additional information on subsurface conditions.

The percolation test results were consistent with the soil types encountered. For example, the percolation rates obtained in the organic rich soils were somewhat faster than the rates encountered in the silt and sand soils.

In the silt and sand soil, the faster percolation rate corresponded to lower fines content, as shown by comparing results for HP15-03b to the results in HP 15-01b and HP 15-02.

7.0 CLOSURE

Exp Services Inc. has prepared this report based on referenced information and our understanding of the project as described in this report.

The report was prepared for the exclusive use of our client, Musqueam Capital Corporation and their designated consultants and agents, and may not be used by other parties without the written consent of **exp** Services Inc.

We trust that this report will meet your present requirements. Please contact the undersigned should you have any questions or require further assistance.

Sincerely,

exp Services Inc.	**Reviewed by:**
Don Sargent, P.Eng. Senior Engineer	Ujjal Chakraborty, P.Eng. Geotechnical Engineer

Enclosures: Appendix A –Interpretation & Use of Study and Report
Appendix B – Test Hole Location Plan – Figure 1
Appendix C – Test Hole Logs
Appendix D – Sieve Test Results

L:\2013 (starting at 0210575-A0)\0213751-A0 DWS Block F, Acadia & University Blvd, UBC\4.1 General Correspondence\Memos, Ltrs, Rpts\exp RE 2015 09 30 UBC Block F Perc Test.docx

Appendix A

Interpretation & Use of Study and Report

INTERPRETATION & USE OF STUDY AND REPORT

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering consulting practices in this area. No other warranty, expressed or implied, is made. Engineering studies and reports do not include environmental consulting unless specifically stated in the engineering report.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF THE REPORT

The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT. WE WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS “APPROVED USERS”. The contents of the Report remain our copyright property and we authorise only the Client and Approved Users to make copies of the Report 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 the Report, or any portion thereof, available to any party without our written permission. Any use which a third party makes of the Report, or any portion of the Report, are the sole responsibility of such third parties. We accept no responsibility for damages suffered by any third party resulting from unauthorised use of the Report.

5. INTERPRETATION OF THE REPORT

a. Nature and Exactness of Descriptions: Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations, or building envelope descriptions, utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarising such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b. Reliance on Provided information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.

c. To avoid misunderstandings, **exp** Services Inc. (**exp**) should be retained to work with the other design professionals to explain relevant engineering findings and to review their plans, drawings, and specifications relative to engineering issues pertaining to consulting services provided by **exp**. Further, **exp** should be retained to provide field reviews during the construction, consistent with building codes guidelines and generally accepted practices. Where applicable, the field services recommended for the project are the minimum necessary to ascertain that the Contractor’s work is being carried out in general conformity with **exp**’s recommendations. Any reduction from the level of services normally recommended will result in **exp** providing qualified opinions regarding adequacy of the work.

6.0 ALTERNATE REPORT FORMAT

When **exp** submits both electronic file and hard copies of reports, drawings and other documents and deliverables (**exp**’s instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by **exp** shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancy, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by **exp** shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of **exp**’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except **exp**. The Client warrants that **exp**’s instruments of professional service will be used only and exactly as submitted by **exp**.

The Client recognizes and agrees that electronic files submitted by **exp** have been prepared and submitted using specific software and hardware systems. **Exp** makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

Appendix B

Test Hole Location Plan

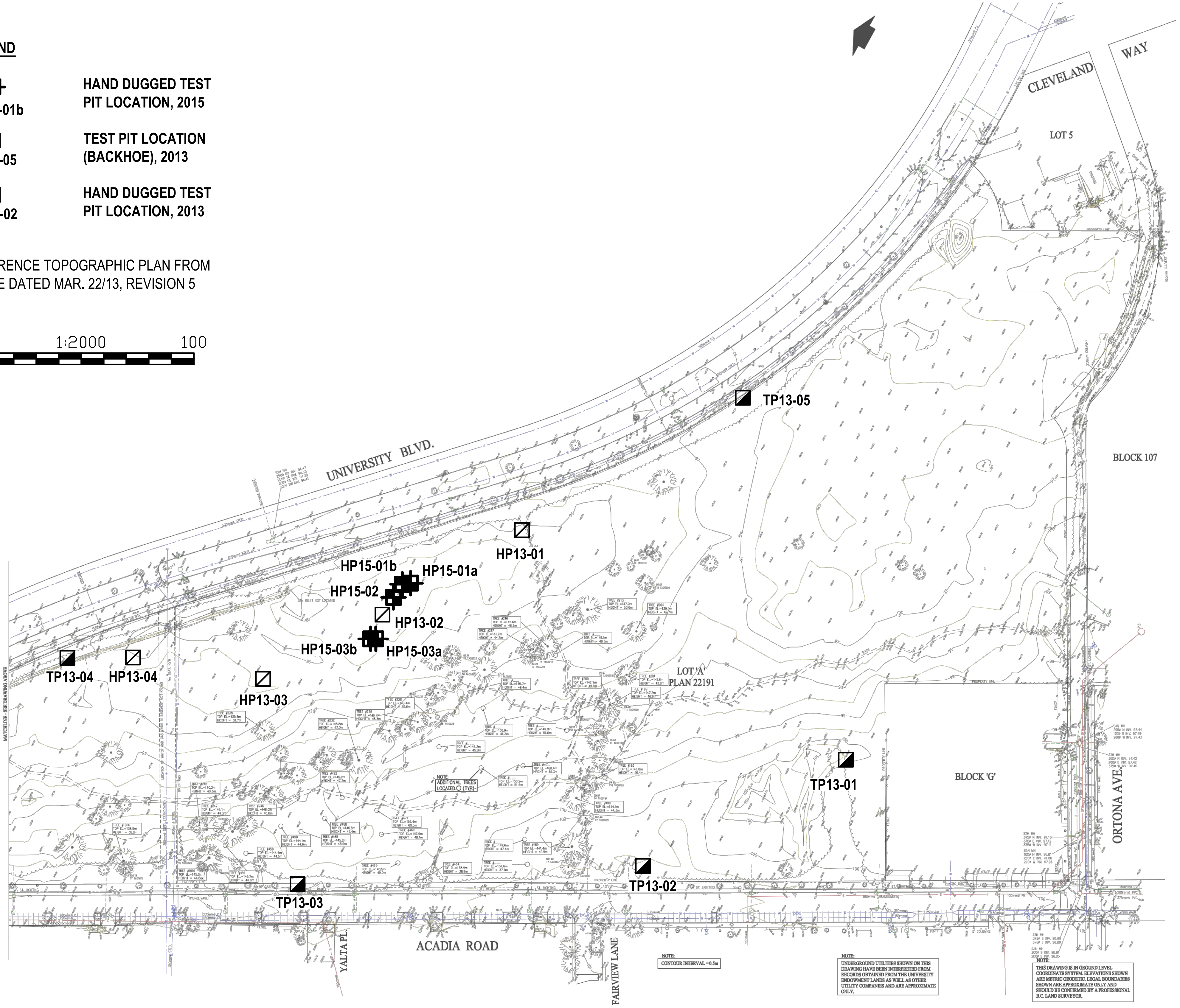
Figure 1

LEGEND

⊞ HP15-01b	HAND DUGGED TEST PIT LOCATION, 2015
◪ TP13-05	TEST PIT LOCATION (BACKHOE), 2013
▨ HP13-02	HAND DUGGED TEST PIT LOCATION, 2013

REFERENCE TOPOGRAPHIC PLAN FROM
BINNIE DATED MAR. 22/13, REVISION 5

0 1:2000 100



exp Services Inc.
275–3001 Wayburne Drive
Burnaby, British Columbia V5G 4W3
Telephone: 604–874–1245
Fax: 604–874–2358
exp.com

DFTR. MG
DSGN. DGS
CHK. DWS

REVISIONS

No.	DESCRIPTION	DATE

CLIENT
MUSQUEAM CAPITAL CORP.

PROJECT
BLOCK F, ACADIA AND UNIVERSITY BLVD.
UBC, VANCOUVER, B.C.

PROJECT NO. VAN-00213751-A0

TITLE:
TEST HOLE LOCATION PLAN

DATE 2013-07-18
SCALE: 1:2000
DWG NO. FIGURE 1

Sep 30, 2015 – 10:39am L:\2013 (starting at 0210575-A0)\0213751-A0 DWS Block F, Acadia & University Blvd, UBC\4.25 CAD\213751 Testhole PLan rev1.dwg

Appendix C

Test Hole Logs

HP15-01a, HP15-01b
HP15-02
HP15-03a, HP15-03b

exp Services Inc

RECORD OF HAND PIT : HP15-01a

PAGE 1 OF 1

PROJECT NUMBER VAN-00213751-A0
PROJECT NAME Testholes and Percolation Tests
DRILLING DATE 2015-09-17
DRILLING CONTRACTOR exp Services Inc.
DRILLING METHOD Hand Pit
EQUIPMENT TYPE Shovel
LOGGED BY DGS **CHECKED BY**

CLIENT Musqueam Capital Corp.
PROJECT LOCATION Block F, Acadia and University Blvd., UBC
BOREHOLE LOCATION N: 5456902 E: 482928
ELEVATION
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** ---
▽ **AFTER DRILLING** ---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	TESTS POCKET PEN. (kPa)	SPT N VALUE BLOWS/0.3m ▲ 20 40 60 80 / DYNAMIC CONE BLOWS/0.3m 20 40 60 80	FINES CONTENT (%) ☐ 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80
		FOREST DETRITUS							
0.1		PEAT, some sand, trace roots and rootlets, black, moist, (firm to stiff)	0.0	S1					95 ●

Bottom of hole at 0.2m.

EXP GEO W/P.P. 0213751-A0.GPJ EXP STD.GDT 30/9/15

exp Services Inc

RECORD OF HAND PIT : HP15-01b

PROJECT NUMBER VAN-00213751-A0
PROJECT NAME Testholes and Percolation Tests
DRILLING DATE 2015-09-17
DRILLING CONTRACTOR exp Services Inc.
DRILLING METHOD Hand Pit
EQUIPMENT TYPE Shovel
LOGGED BY DGS **CHECKED BY**

CLIENT Musqueam Capital Corp.
PROJECT LOCATION Block F, Acadia and University Blvd., UBC
BOREHOLE LOCATION N: 5456905 E: 482926
ELEVATION
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** ---
▼ **AFTER DRILLING** ---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES			TESTS	SPT N VALUE BLOWS/0.3m ▲ 20 40 60 80 DYNAMIC CONE BLOWS/0.3m 20 40 60 80	FINES CONTENT (%) ☐ 20 40 60 80 PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80
				NUMBER	TYPE	RECOVERY %	POCKET PEN. (kPa)		
		FOREST DETRITUS							
		PEAT, some sand, trace roots and rootlets, black, moist, (firm to stiff)	0.0						
		SILT, some sand to sandy, trace clay, light brown with rust seams, moist, (stiff to very stiff)	0.2	S2					38 ●

Bottom of hole at 0.5m.

exp Services Inc

RECORD OF HAND PIT : HP15-02

PAGE 1 OF 1

PROJECT NUMBER VAN-00213751-A0

PROJECT NAME Testholes and Percolation Tests

DRILLING DATE 2015-09-17

DRILLING CONTRACTOR exp Services Inc.

DRILLING METHOD Hand Pit

EQUIPMENT TYPE Shovel

LOGGED BY DGS **CHECKED BY**

CLIENT Musqueam Capital Corp.

PROJECT LOCATION Block F, Acadia and University Blvd., UBC

BOREHOLE LOCATION N: 5456906 E: 482919

ELEVATION

GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---

▼ **AT END OF DRILLING** ---

▽ **AFTER DRILLING** ---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES			TESTS	SPT N VALUE BLOWS/0.3m ▲ 20 40 60 80 DYNAMIC CONE BLOWS/0.3m 20 40 60 80	FINES CONTENT (%) ☐ 20 40 60 80 PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80
				NUMBER	TYPE	RECOVERY %	POCKET PEN. (kPa)		
		FOREST DETRITUS							
		PEAT, some sand, trace roots and rootlets, black, moist, (firm to stiff)	0.0						
		SILT, some sand to sandy, trace clay, light brown with rust seams, moist, (stiff to very stiff)	0.3	S3					32 ●

Bottom of hole at 0.5m.

exp Services Inc

RECORD OF HAND PIT : HP15-03a

PAGE 1 OF 1

PROJECT NUMBER VAN-00213751-A0
PROJECT NAME Testholes and Percolation Tests
DRILLING DATE 2015-09-17
DRILLING CONTRACTOR exp Services Inc.
DRILLING METHOD Hand Pit
EQUIPMENT TYPE Shovel
LOGGED BY DGS **CHECKED BY**

CLIENT Musqueam Capital Corp.
PROJECT LOCATION Block F, Acadia and University Blvd., UBC
BOREHOLE LOCATION N: 5456905 E: 482899
ELEVATION
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** ---
▼ **AFTER DRILLING** ---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	TESTS POCKET PEN. (kPa)	SPT N VALUE BLOWS/0.3m ▲ 20 40 60 80 / DYNAMIC CONE BLOWS/0.3m 20 40 60 80	FINES CONTENT (%) ☐ 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80
0.1		FOREST DETRITUS							
		ORGANIC SILT, some sand, trace roots and rootlets, black, moist, (firm to stiff)	0.1	S4					34 ●

Bottom of hole at 0.2m.

EXP GEO W/P.P. 0213751-A0.GPJ EXP STD.GDT 30/9/15

exp Services Inc

RECORD OF HAND PIT : HP15-03b

PROJECT NUMBER VAN-00213751-A0
PROJECT NAME Testholes and Percolation Tests
DRILLING DATE 2015-09-17
DRILLING CONTRACTOR exp Services Inc.
DRILLING METHOD Hand Pit
EQUIPMENT TYPE Shovel
LOGGED BY DGS **CHECKED BY**

CLIENT Musqueam Capital Corp.
PROJECT LOCATION Block F, Acadia and University Blvd., UBC
BOREHOLE LOCATION N: 5456907 E: 482898
ELEVATION
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** ---
▽ **AFTER DRILLING** ---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	TESTS POCKET PEN. (kPa)	SPT N VALUE BLOWS/0.3m ▲ 20 40 60 80 DYNAMIC CONE BLOWS/0.3m 20 40 60 80	FINES CONTENT (%) ☐ 20 40 60 80 PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80
		FOREST DETRITUS							
		ORGANIC SILT, some sand, trace roots and rootlets, black, moist, (firm to stiff)	0.2						
		SANDY SILT to SILTY SAND, trace clay, light brown with grey and rust pockets, damp, (compact to dense)	0.3	S5					35 ●

Bottom of hole at 0.5m.

Appendix D

Sieve Test Results

Sieve Tests No. 3 & 4

exp Services Inc.
275-3001 Wayburne Drive
Burnaby, BC V5G 4W3
604-874-1245

Kamloops Branch
250-372-5321

CERTIFIED BY CCIL
CERTIFIED TESTING
LABORATORY

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 002-13751
CLIENT MUSQUEAM CAPITAL CORP.
C.C. exp - DON SARGENT

TO exp - DON SARGENT

ATTN: DON SARGENT

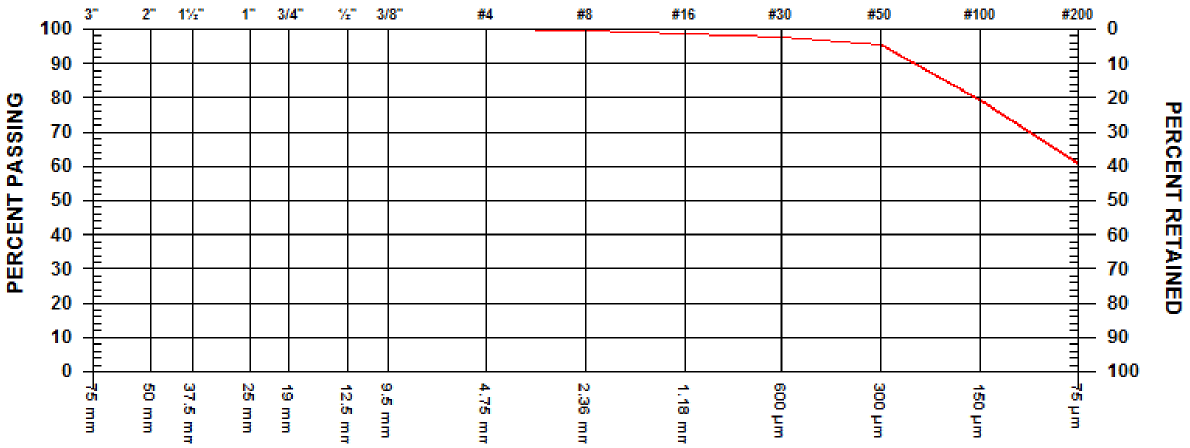
PROJECT BLOCK F, ACADIA & UNIVERSITY BLVD. UBC
GEOTECHNICAL VANCOUVER

CONTRACTOR

SIEVE TEST NO. 3
DATE RECEIVED Sep 17,2015
DATE TESTED Sep 21,2015
DATE SAMPLED Sep 17,2015

SUPPLIER SITE
SOURCE S3
SPECIFICATION
MATERIAL TYPE SILT AND SAND

SAMPLED BY D. SILVEIRA
TESTED BY H. WU
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm		
2"	50 mm		
1 1/2"	37.5 mm		
1"	25 mm		
3/4"	19 mm		
1/2"	12.5 mm		
3/8"	9.5 mm		

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	100.0	
No. 8	2.36 mm	99.7	
No. 16	1.18 mm	98.8	
No. 30	600 µm	97.6	
No. 50	300 µm	95.3	
No. 100	150 µm	79.4	
No. 200	75 µm	60.7	

COMMENTS
TEST METHOD: ASTM C136, C117.

Page 1 of 1 Sep 24,2015 exp Services Inc. KEVIN BOWYER, CTech PER.

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CERTIFIED BY CCIL
CERTIFIED TESTING
LABORATORY

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 002-13751
CLIENT MUSQUEAM CAPITAL CORP.
C.C. exp - DON SARGENT

TO
exp - DON SARGENT

ATTN: DON SARGENT

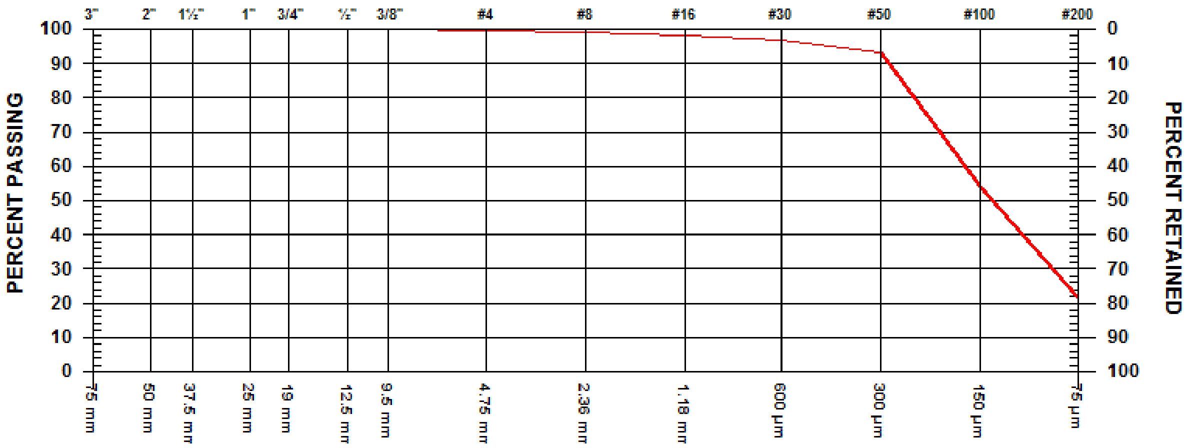
PROJECT BLOCK F, ACADIA & UNIVERSITY BLVD. GEOTECHNICAL UBC VANCOUVER

CONTRACTOR

SIEVE TEST NO. 4 DATE RECEIVED Sep 17,2015 DATE TESTED Sep 21,2015 DATE SAMPLED Sep 17,2015

SUPPLIER SITE
SOURCE S5
SPECIFICATION
MATERIAL TYPE SILTY SAND, TRACE GRAVEL

SAMPLED BY D. SILVEIRA
TESTED BY H. WU
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm		
2"	50 mm		
1 1/2"	37.5 mm		
1"	25 mm		
3/4"	19 mm		
1/2"	12.5 mm		
3/8"	9.5 mm	100.0	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	99.6	
No. 8	2.36 mm	99.0	
No. 16	1.18 mm	98.2	
No. 30	600 µm	97.0	
No. 50	300 µm	93.3	
No. 100	150 µm	54.1	
No. 200	75 µm	21.6	

COMMENTS
TEST METHOD: ASTM C136, C117.

Page 1 of 1 Sep 24,2015 exp Services Inc. KEVIN BOWYER, CTech PER.

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of test results is provided only on written request.

APPENDIX D – SITE PLAN

MUSQUEAM CAPITAL CORPORATION • ROSITCH HEMPILL ARCHITECTS • PWL PARTNERSHIP LANDSCAPE ARCHITECTS INC.

BLOCK F • UNIVERSITY ENDOWMENT LANDS

Site Plan

Sept 28, 2015

APPENDIX E – URBAN SYSTEMS IMPACT ASSESSMENT

12-125-04

2353 - 13353 Commerce Parkway, Richmond, BC V6V 3A1
Telephone: 604-273-8700 Fax: 604-273-8752

URBANSYSTEMS.

MEMORANDUM

date: December 8, 2010
to: Steve Butt
cc:
from: Amie Dawe, Simpson Hong
file #: 0721.0056.01
subject: **UEL BLOCK F DEVELOPMENT - IMPACT TO SANITARY AND STORM INFRASTRUCTURE**

1.0 INTRODUCTION

This memo summarizes the capacity analysis modeling results of the University Endowment Land's (UEL) sanitary and storm systems under the loading of the proposed Block F development. It is supplemental to the **UEL Sanitary and Storm Systems – Model Generation and Capacity Analysis** project, and should be read in conjunction with the report.

1.1 Background

Block F refers to a site located within the UEL that was acquired by the Musqueam First Nation in 2008. The land is approximately 8.7 hectares in size and lies west of the UBC Golf Course. It is bordered by University Boulevard to the north and Acadia Road to the south. It has been identified for potential redevelopment, and is planned to house multi-family residential units and several commercial operations, including a hotel. Figure 1 illustrates the location of Block F within the University Endowment Lands.

The proposed development of Block F would create a significant new demand on the UEL sanitary, storm and combined systems. As such, a complete analysis has been performed to determine the extents of the impact the development could have.

2.0 SERVICING STRATEGY

The following sections outline the potential servicing strategies for sanitary and storm utilities for the Block F development.

2.1 Sanitary System

There are many options for handling the potential sanitary flows generated by the Block F development. However, the most convenient and cost effective way would be to convey flows to the north catchment of the UEL system, utilizing the existing sanitary infrastructure located on Acadia Road, as shown on Figure 2. This is the preferred servicing option for sanitary sewerage.

BRITISH COLUMBIA

Ministry of Community Services

UNIVERSITY ENDOWMENT LANDS

Legend

Project No: 0721.0056.01
Date: November, 2010

Block F Overview

Figure 1

URBANSYSTEMS.

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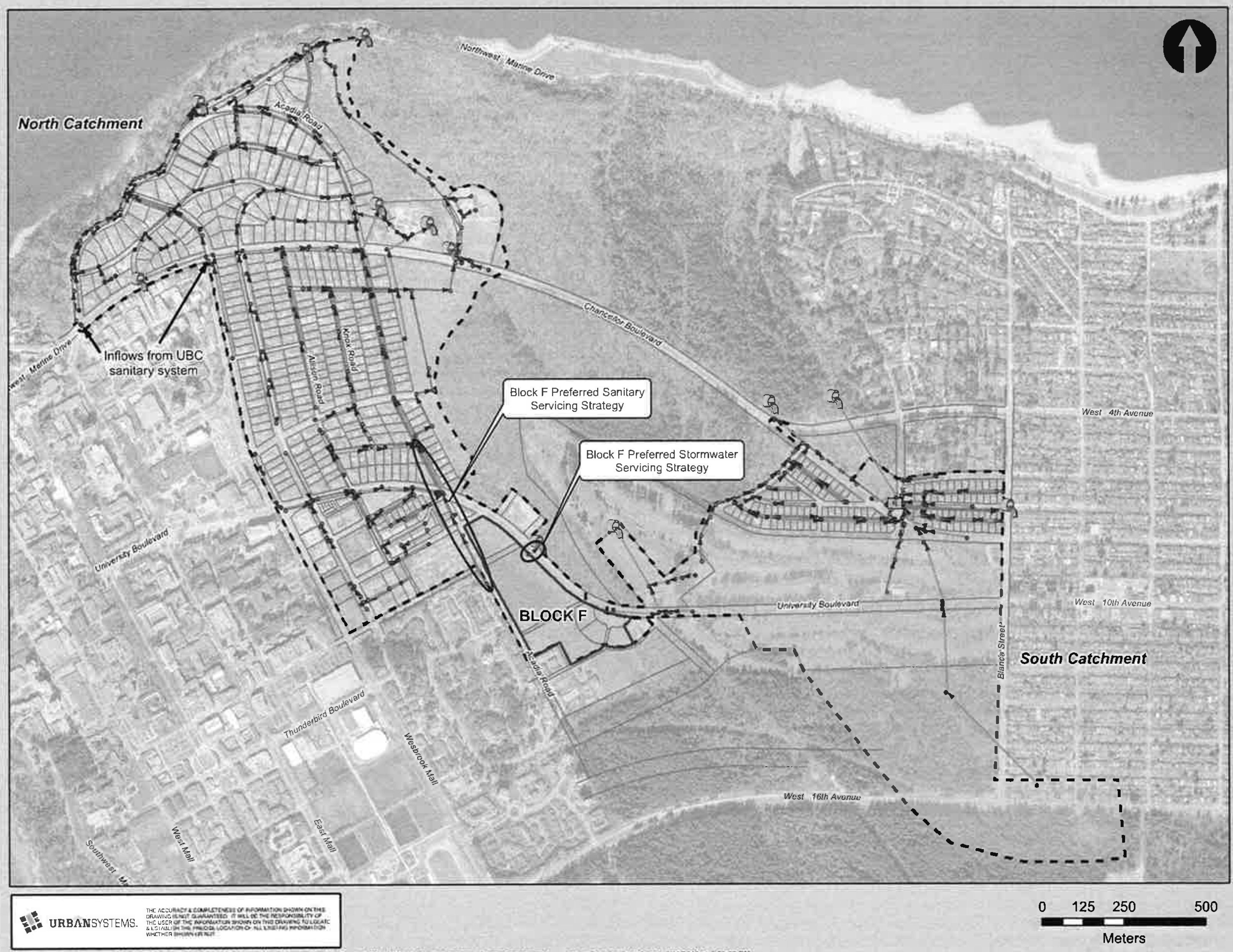

BRITISH COLUMBIA

Ministry of Community Services

UNIVERSITY ENDOWMENT LANDS

Legend

- Drummond Drive Pump Station

Storm Infrastructure

- ● Storm Node
- → Storm Conduit
- Storm Outfall

Sanitary Infrastructure

- ● Sanitary Node
- → Sanitary Conduit
- Sanitary Outfall

Combined Infrastructure

- ● Combined Node
- → Combined Conduit
- Combined Outfall

Project No: 0721.0056.01
Date: November, 2010

Block F Impact: UEL Sanitary & Storm Systems

Figure 2

URBANSYSTEMS.

U:\Projects_VAN\0721\0056\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\BlockF_Figure2_Block F Impact - Sanitary and Storm System.mxd Last revised by: bpaols on 16/11/2010 at 4:56:22 PM

2.2 Storm System

Existing stormwater runoff in the vicinity of Block F currently drains to a gulley via a culvert that crosses University Boulevard. This runoff eventually makes its way to English Bay. Based on topography, the preferred discharge point for site runoff is the existing culvert. This is shown on Figure 2.

3.0 SCOPE AND METHODOLOGY

3.1 Scope

The scope of work for analysis of the Block F development includes:

- Add the Block F sanitary and storm demands to the existing PCSWMM model;
- Assess the performance of the existing system with Block F loading;
- Identify anticipated system deficiencies;
- Revise recommended upgrades as outlined in the **UEL Sanitary and Storm Systems – Model Generation and Capacity Analysis** project report.

3.2 Model

Minimal changes were made to the existing physical model. The sanitary system remained the same, several storm sewer upgrades (as recommended in the initial analysis) were implemented, and one new storm catchment was created to represent the Block F development.

Properties of the new catchment were prescribed in a manner consistent with the previous MDP, and are outlined in Appendix A of the **UEL Sanitary and Storm Systems – Model Generation and Capacity Analysis** report. The percent impervious area of Block F was determined using the potential land use plan in the **Collier's International Report – Block F: Development Rationale**; it was estimated to be 70%.

4.0 POPULATION ESTIMATE

The population of the potential Block F development was estimated based on information provided by Colliers International Consultants, and was estimated as follows:

- 1500 residential units at 2.5 persons per unit for a total of 3750 persons
- 125 room suite hotel at 1 equivalent person per suite for a total of 125 persons
- 25,000 ft^2 of retail with an equivalent population of 2 persons/1,000 ft^2 of commercial space for a total of 50 persons

The resulting calculated populations used to load the sanitary system are summarized in the table below.

Table 4.1 – Block F and UEL Equivalent Populations

Catchment	Equivalent Populations			
	Residential	Commercial	Institutional	Total
Block F	3750	50	125	**3925**
North	3631	541	91	**4263**
South	357	0	61	**418**
UEL Total	**7738**	**591**	**277**	**8606**

5.0 DEMANDS AND LOADING

5.1 Sanitary Demands

Resulting sanitary demands are summarized in the table below.

Table 5.1 – Block F and UEL Sanitary System Loads

Catchment	Area (hectares)	Total Equivalent Population	Average Dry Flow (L/s)	I & I (L/s)
UEL – Block F	10.84	3750	20.67	1.41
UEL – North	113.86	4263	22.45	14.80
UEL – South	38.63	418	2.20	5.02
UBC (Inflows)	n/a	n/a	79.9	32.5
UEL Total	**163.33**	**9056**	**125.22**	**53.73**

A more detailed table showing the equivalent population, average sanitary demand, I&I and corresponding flow pattern for each loaded sanitary node in the UEL system is attached for reference.

5.2 Storm Loads

Storm system loads were based on the same design storms specified in the **UEL Sanitary and Storm Systems – Model Generation and Capacity Analysis** report.

6.0 SYSTEM EVALUATION

6.1 System Performance Targets

The same procedure and performance targets used to assess the existing system were also used to assess the system under Block F loading.

6.2 Demand Scenarios

The following scenarios were modeled:

- Future system (Existing + Block F) under Peak Wet Weather Flows (under 5 year design storm applied to storm and combined portions of the system)
- Future system (Existing + Block F) under Peak Wet Weather Flows (under 100 year design storm applied to storm and combined portions of the system)

7.0 RESULTS

The following table summarizes the resulting system performance. As noted previously, the analysis was completed with the future system in place, which assumes that all recommended upgrades as outlined in the **UEL Sanitary and Storm Systems – Model Generation and Capacity Analysis** have been completed.

Table 7.1 – System Performance Summary, Post Suggested Existing Upgrades

Conduits (Pipes)	Total in System	Limited Capacity	Insufficient Capacity
Storm	145	40	1
Combined	54	9	0
Sanitary	157	4	4

As shown in the table above, potential loading from Block F places a higher demand on the sanitary system, surpassing the capacity of the existing system, even after completing the recommended upgrades. The single underperforming component of the storm system is the existing culvert receiving overland flows from the Block F development; the magnitude of flooding, during a critical storm event, predicted at this location is around 10 m^3. Figure 3 and Figure 4 show the locations of the underperforming pipes identified above.

BRITISH COLUMBIA

Ministry of Community Services

UNIVERSITY ENDOWMENT LANDS

Legend

- PS Drummond Drive Pump Station

Sanitary Infrastructure

- ● Sanitary Node
- → Sanitary Conduit
- Sanitary Outfall

Combined Infrastructure

- ● Combined Node
- → Combined Conduit
- Combined Outfall
- ☐ Block F Sanitary Catchments

Deficiencies

- ▨ Limited sanitary conduit
- ■ Flooding sanitary conduit

Project No: 0721.0056.01
Date: November, 2010

Block F Impact: Resulting UEL Sanitary System Deficiencies

Figure 3

URBANSYSTEMS.

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0 125 250 500
Meters

British Columbia

Ministry of Community Services

UNIVERSITY ENDOWMENT LANDS

Legend

☐ Block F Storm Catchments

Storm Infrastructure

- ● Storm Node
- → Storm Conduit
- Storm Outfall

Combined Infrastructure

- ● Combined Node
- → Combined Conduit
- Combined Outfall

Deficiencies

- ▨ Surcharging storm/combined conduit
- ■ Deficient storm/combined conduit

Project No: 0721.0056.01
Date: November, 2010

Block F Impact: Resulting UEL Storm System Deficiencies

Figure 4

URBANSYSTEMS.

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8.0 RECOMMENDED UPGRADES

8.1 Methodology

The culvert upgrade and sanitary upgrades were applied to the system under the 5 year - 1 hour storm event, and then additional upgrades were modeled under the 5 year - 30 min storm event. For insufficient infrastructure in the system, capacity issues were addressed by examining the model flow results. Sections of pipe were upgraded in one of two ways:

- An increase in pipe diameter (one size at a time),
- or by a logical reconfiguration of pipe inlets at critical junctions and splits to redirect flows within the system to routes with greater available capacity.

8.2 Recommendations

Table 8.1 below lists options of recommended upgrades to ensure satisfactory performance of the existing UEL system, in consideration of potential flows from development of Block F. Figure 5 highlights the location of the suggested upgrades listed below.

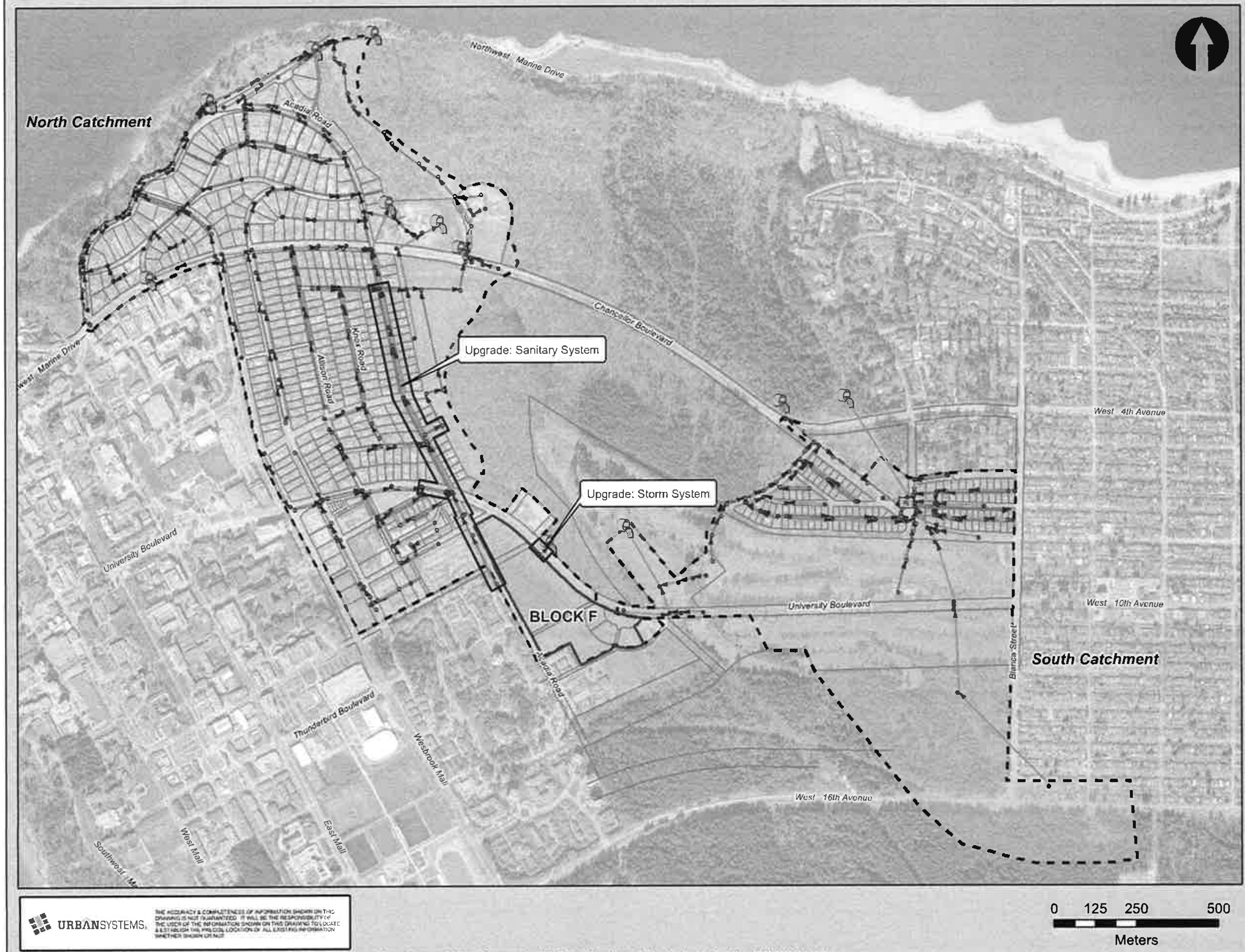
Table 8.1 – Recommended Upgrade Options

Conduit Type	Road	Limits		Existing Size (mm)	Proposed Size (mm)
		From	To		
Storm	University Boulevard	South Side	North Side	150	525
Sanitary	Acadia Road	Fairview Lane	Toronto Road	150	250
			Wycliffe Road	200	250
	Acadia Road Bypass	College High Road	n/a	200	250
	University Boulevard	Acadia Road	E of Allison Road	200	200‡
Combined	n/a	n/a	n/a	n/a	n/a

‡ indicates conduit reconfiguration for downstream network protection

8.2.1 Storm Upgrades

It is relevant to note the location of the proposed culvert upgrade that would potentially convey stormwater runoff from the Block F development. The culvert flows directly underneath University Boulevard, which is a major roadway providing access to UBC. As there are limited roads accessing the University, it is imperative for these roadways to maintain an acceptable level of performance. In the event of a 1 in 100 year storm, an overland flow path will likely form across University Boulevard. Due to the high level of serviceability required from the road, this outcome is not desirable.



BRITISH COLUMBIA

Ministry of Community Services

UNIVERSITY ENDOWMENT LANDS

Legend

- ▨ Drummond Drive Pump Station

Storm Infrastructure

- ● Storm Node
- → Storm Conduit
- Storm Outfall

Sanitary Infrastructure

- ○ Sanitary Node
- → Sanitary Conduit
- Sanitary Outfall

Combined Infrastructure

- ● Combined Node
- → Combined Conduit
- Combined Outfall

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Date: November, 2010

Block F Impact: Additional Recommended UEL System Upgrades

Figure 5

URBANSYSTEMS.

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The UEL may wish to consider more conservative upgrades and may see it fit to size the culvert underneath the road to convey both the 1 in 5 year and 1 in 100 year storm events. The following table illustrates the necessary upgrades required for the culvert to accommodate the 1 in 5 year and 1 in 100 year storm events. More detailed calculations are attached for reference.

Table 8.2 – Potential Culvert Upgrades

Design Storm	Required Culvert Diameter (mm)
Existing Culvert Size	250
1:5 Year Storm	525
1:100 Year Storm	675

Due to the additional flows that would be generated from the Block F development, it is also recommended a comprehensive analysis of the downstream conveyance capacity, erosion potential and bank stability be undertaken, if the development proceeds.

8.2.2 Sanitary Upgrades

As noted previously, the preferred conveyance of sanitary flows from Block F is towards the north catchment, particularly through to the Acadia Road Bypass. This option has been identified as the most convenient and cost-effective, as the Acadia Bypass currently has surplus conveyance capacity.

The network reconfigurations identified in Table 8.1, above, both involve raising pipe inlets to redirect the additional sanitary flows that would be generated by the Block F development. The first network reconfiguration would reroute the Block F sanitary flows from Acadia Road to the Acadia Bypass. The second suggested network reconfiguration is just upstream, and would also cut off sanitary flows from the Block F development. This second reconfiguration serves to remove the flow split, protecting the remaining branch of the sanitary system. Details of the manhole reconfigurations are attached for reference.

Table 8.3 summarizes the anticipated system performance after the suggested upgrades are implemented.

Table 8.3 – System Performance Summary, Post Block F Suggested Upgrades

Conduits (Pipes)	Total in System	Limited Capacity	Insufficient Capacity
Storm	145	40	0
Combined	54	9	0
Sanitary	157	1	0

9.0 COST ESTIMATE

The estimated cost of the upgrades recommended above, are presented below:

Table 9.1 – Cost Estimate Summary

Conduit Type	Road	Size Upgrades (mm)	Estimated Cost
Storm	University Boulevard	250 → 525	$58,000
Sanitary	Acadia Road, Acadia Road Bypass and University Boulevard	150 → 250 200 → 250 Inlet reconfiguration	$1,376,000

It is estimated that the additional recommended upgrades, for maintaining satisfactory system performance after the potential development of Block F, would cost a total of approximately **$1,434,000** (exclusive of HST). Detailed cost estimates are attached for reference.

Additional information has been attached to the end of this memorandum for reference purposes. We trust that this report meets your needs and expectations. Should you have any questions or concerns, or wish to discuss any matters in detail, please call the undersigned at 604-273-8700.

URBAN SYSTEMS LTD.

Amie Dawe, EIT
Project Engineer

Simpson Hong, P.Eng.
Project Reviewer

/AD

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Loaded Sanitary Nodes

BLOCK F

Loading Node	Contributing Catchment Area (ha)	Population Calculations						Equivalent Populations						Average Sanitary Flow (L/s)				Diurnal Curve	**I&I (L/s)**
		Single Family Units	Equivalent Population	Multi-family Population	Commercial Floor Space (ft^2)	Institutional Equivalent Population	Total Equivalent Population	Residential		Commercial		Institutional		Residential	Commercial	Institutional	**Total (L/s)**		
								Eq. Pop.	% Total	Eq. Pop.	% Total	Eq. Pop.	% Total						
CLH227	0.5973	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.078**
CLH229	0.9387	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	**0.045**	R	**0.122**
CLH231	0.6789	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	**0.045**	R	**0.088**
CLH239	0.7471	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	**0.045**	R	**0.097**
CLH276	0.9279	4	4.60	0	0	0	11.500	11.5	100%	0	0%	0	0%	0.0606	-	-	**0.061**	R	**0.121**
CMH201	0.7464	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.097**
CMH203	0.2084	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.027**
CMH204	0.3833	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.050**
CMH206	0.6845	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.089**
CMH209	0.5215	1	1.15	0	0	0	2.875	2.875	100%	0	0%	0	0%	0.0151	-	-	**0.015**	R	**0.068**
CMH210	1.4116	4	4.60	0	0	0	11.500	11.5	100%	0	0%	0	0%	0.0606	-	-	**0.061**	R	**0.184**
CMH212	0.8992	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.117**
CMH214	0.6599	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.086**
CMH215	1.1662	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	**0.045**	R	**0.152**
CMH218	0.7445	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.097**
CMH219	0.6279	1	1.15	0	0	0	2.875	2.875	100%	0	0%	0	0%	0.0151	-	-	**0.015**	R	**0.082**
CMH225	0.7407	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	**0.045**	R	**0.096**
CMH226	0.1656	1	1.15	0	0	0	2.875	2.875	100%	0	0%	0	0%	0.0151	-	-	**0.015**	R	**0.022**
CMH228	0.5874	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.076**
CMH230	0.5684	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	**0.045**	R	**0.074**
CMH232	0.4507	1	1.15	0	0	0	2.875	2.875	100%	0	0%	0	0%	0.0151	-	-	**0.015**	R	**0.059**
CMH237	1.4496	6	6.90	0	0	0	17.250	17.25	100%	0	0%	0	0%	0.0908	-	-	**0.091**	R	**0.188**
CMH238	0.5302	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.069**
CMH266	1.3999	4	4.60	0	0	0	11.500	11.5	100%	0	0%	0	0%	0.0606	-	-	**0.061**	R	**0.182**
CMH267	1.0122	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.132**
CMH268	0.6492	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.084**
CMH269	0.9155	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	**0.045**	R	**0.119**
CMH270	0.9621	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	**0.045**	R	**0.125**
CMH271	1.0600	4	4.60	0	0	0	11.500	11.5	100%	0	0%	0	0%	0.0606	-	-	**0.061**	R	**0.138**
CMH273	0.7487	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.097**
CMH274	0.5619	3	3.00	0	0	0	7.500	7.5	100%	0	0%	0	0%	0.0395	-	-	**0.039**	R	**0.073**
CMH275	1.3066	5	5.75	0	0	0	14.375	14.375	100%	0	0%	0	0%	0.0757	-	-	**0.076**	R	**0.170**
CMH277	1.0759	2	2.00	0	0	0	5.000	5	100%	0	0%	0	0%	0.0263	-	-	**0.026**	R	**0.140**
CMH279	4.5458	1	0.00	0	0	6	6.400	0	0%	0	0%	6	100%	-	-	0.0337	**0.034**	I	**0.591**
CMH281	0.5183	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.067**
CMH282	1.0482	4	4.60	0	0	0	11.500	11.5	100%	0	0%	0	0%	0.0606	-	-	**0.061**	R	**0.136**
CMH283	0.5226	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.068**
CMH284	0.4692	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.061**
CMH285	0.6723	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	**0.045**	R	**0.087**
CO2	3.2146	1	0.00	0	0	56	56.000	0	0%	0	0%	56	100%	-	-	0.2949	**0.295**	I	**0.418**
DRUMMOND_P S	1.1457	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.149**
SLH104A	0.6549	4	4.60	0	0	0	11.500	11.5	100%	0	0%	0	0%	0.0606	-	-	**0.061**	R	**0.085**
SLH129	1.8522	9	10.35	0	0	0	25.875	25.875	100%	0	0%	0	0%	0.1363	-	-	**0.136**	R	**0.241**
SLH131	2.8225	18	20.70	0	0	0	51.750	51.75	100%	0	0%	0	0%	0.2725	-	-	**0.273**	R	**0.367**
SLH137	2.7535	13	14.95	0	0	0	37.375	37.375	100%	0	0%	0	0%	0.1968	-	-	**0.197**	R	**0.358**
SLH144	0.8030	1	0.00	92	0	0	230.000	230	100%	0	0%	0	0%	1.2112	-	-	**1.211**	R	**0.104**
SLH150	1.5102	3	0.00	30	0	0	75.000	75	100%	0	0%	0	0%	0.3950	-	-	**0.395**	R	**0.196**
SLH245	0.5111	1	1.15	0	0	0	2.875	2.875	100%	0	0%	0	0%	0.0151	-	-	**0.015**	R	**0.066**

Loading Node	Contributing Catchment Area (ha)	Population Calculations						Equivalent Populations						Average Sanitary Flow (L/s)			Total (L/s)	Diurnal Curve	I&I (L/s)
		Single Family Units	Equivalent Population	Multi-family Population	Commercial Floor Space (ft^2)	Institutional Equivalent Population	Total Equivalent Population	Residential		Commercial		Institutional		Residential	Commercial	Institultional			
								Eq. Pop.	% Total	Eq. Pop.	% Total	Eq. Pop.	% Total						
SLH35	0.6541	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	0.030	R	0.085
SMH101	6.0445	1	0.00	0	0	61	60.800	0	0%	0	0%	61	100%	-	-	0.3202	0.320	I	0.786
SMH102	1.3327	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	0.000	-	0.173
SMH103	0.9186	4	4.60	0	0	0	11.500	11.5	100%	0	0%	0	0%	0.0606	-	-	0.061	R	0.119
SMH104	0.7845	5	5.75	0	0	0	14.375	14.375	100%	0	0%	0	0%	0.0757	-	-	0.076	R	0.102
SMH105	0.8606	5	5.75	0	0	0	14.375	14.375	100%	0	0%	0	0%	0.0757	-	-	0.076	R	0.112
SMH106	1.5228	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	0.000	-	0.198
SMH109	1.3186	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	0.000	-	0.171
SMH110	1.6651	9	10.35	0	0	0	25.875	25.875	100%	0	0%	0	0%	0.1363	-	-	0.136	R	0.216
SMH111B	0.7917	5	5.75	0	0	0	14.375	14.375	100%	0	0%	0	0%	0.0757	-	-	0.076	R	0.103
SMH112	0.1853	1	1.15	0	0	0	2.875	2.875	100%	0	0%	0	0%	0.0151	-	-	0.015	R	0.024
SMH113	5.2027	9	9.20	0	0	5	28.000	23	82%	0	0%	5	18%	0.1211	-	0.0047	0.147	R	0.676
SMH114	0.5613	3	0.00	147	0	0	367.500	367.5	100%	0	0%	0	0%	1.9353	-	-	1.935	R	0.073
SMH116	0.3623	1	0.00	40	0	0	100.000	100	100%	0	0%	0	0%	0.5266	-	-	0.527	R	0.047
SMH117	**10.8392**				**25000**	**125**	**3750.000**	**3750**	**96%**	**50**	**1%**	**125**	**3%**	**19.7483**	**0.0034**	**0.0210**	**20.670**	**R**	**1.409**
SMH119	0.1765	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	0.000	-	0.023
SMH120	2.1820	14	16.10	0	0	0	40.250	40.25	100%	0	0%	0	0%	0.2120	-	-	0.212	R	0.284
SMH121	1.9669	10	11.50	0	0	0	28.750	28.75	100%	0	0%	0	0%	0.1514	-	-	0.151	R	0.256
SMH122	0.6159	4	4.60	0	0	0	11.500	11.5	100%	0	0%	0	0%	0.0606	-	-	0.061	R	0.080
SMH123	0.4613	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	0.045	R	0.060
SMH124	0.9238	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	0.045	R	0.120
SMH125	0.6157	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	0.030	R	0.080
SMH126	2.5120	14	16.10	0	0	0	40.250	40.25	100%	0	0%	0	0%	0.2120	-	-	0.212	R	0.327
SMH127	1.8016	9	10.35	0	0	0	25.875	25.875	100%	0	0%	0	0%	0.1363	-	-	0.136	R	0.234
SMH128	1.8932	10	11.50	0	0	0	28.750	28.75	100%	0	0%	0	0%	0.1514	-	-	0.151	R	0.246
SMH130	1.9025	12	13.80	0	0	0	34.500	34.5	100%	0	0%	0	0%	0.1817	-	-	0.182	R	0.247
SMH132	1.6482	11	12.65	0	0	0	31.625	31.625	100%	0	0%	0	0%	0.1665	-	-	0.167	R	0.214
SMH133	1.4242	10	11.50	0	0	0	28.750	28.75	100%	0	0%	0	0%	0.1514	-	-	0.151	R	0.185
SMH134	1.0683	6	6.90	0	0	0	17.250	17.25	100%	0	0%	0	0%	0.0908	-	-	0.091	R	0.139
SMH135	0.8211	4	4.60	0	0	0	11.500	11.5	100%	0	0%	0	0%	0.0606	-	-	0.061	R	0.107
SMH136	0.6933	4	4.60	0	0	0	11.500	11.5	100%	0	0%	0	0%	0.0606	-	-	0.061	R	0.090
SMH138A	0.5963	2	0.00	0	34405	0	68.810	0	0%	68.81	100%	0	0%	-	0.3624	-	0.362	C	0.078
SMH140	0.3540	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	0.000	-	0.046
SMH141	1.3548	2	0.00	0	158859	0	317.718	0	0%	317.718	100%	0	0%	-	1.6732	-	1.673	C	0.176
SMH142	2.1672	3	0.00	202	0	19	524.000	505	96%	0	0%	19	4%	2.6594	-	0.0036	2.759	R	0.282
SMH146	1.3564	7	8.05	0	0	0	20.125	20.125	100%	0	0%	0	0%	0.1060	-	-	0.106	R	0.176
SMH147	0.5441	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	0.045	R	0.071
SMH148A	0.9295	5	5.75	0	0	0	14.375	14.375	100%	0	0%	0	0%	0.0757	-	-	0.076	R	0.121
SMH149	1.0654	1	0.00	108	77187	0	424.374	270	64%	154.374	36%	0	0%	0.9046	0.2957	-	2.235	split	0.138
SMH151	0.7983	4	4.60	0	0	0	11.500	11.5	100%	0	0%	0	0%	0.0606	-	-	0.061	R	0.104
SMH152	0.6537	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	0.045	R	0.085
SMH154	1.1614	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	0.000	-	0.151
SMH155	0.4234	1	0.00	39	0	0	97.500	97.5	100%	0	0%	0	0%	0.5135	-	-	0.513	R	0.055
SMH156	0.6132	2	0.00	49	0	0	122.500	122.5	100%	0	0%	0	0%	0.6451	-	-	0.645	R	0.080
SMH157	2.9356	1	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	0.000	-	0.382
SMH158	1.1791	1	0.00	110	0	0	275.000	275	100%	0	0%	0	0%	1.4482	-	-	1.448	R	0.153
SMH159	1.3451	4	0.00	260	0	0	650.000	650	100%	0	0%	0	0%	3.4230	-	-	3.423	R	0.175
SMH221	0.2905	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	0.000	-	0.038
SMH236	0.4375	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	0.000	-	0.057
SMH240	0.0672	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	0.000	-	0.009
SMH241	0.9778	3	3.45	0	0	0	8.625	8.625	100%	0	0%	0	0%	0.0454	-	-	0.045	R	0.127
SMH242	1.3014	4	4.60	0	0	0	11.500	11.5	100%	0	0%	0	0%	0.0606	-	-	0.061	R	0.169

Loading Node	Contributing Catchment Area (ha)	Population Calculations						Equivalent Populations						Average Sanitary Flow (L/s)				Diurnal Curve	**I&I (L/s)**
		Single Family Units	Equivalent Population	Multi-family Population	Commercial Floor Space (ft^2)	Institutional Equivalent Population	Total Equivalent Population	Residential		Commercial		Institutional		Residential	Commercial	Institultional	**Total (L/s)**		
								Eq. Pop.	% Total	Eq. Pop.	% Total	Eq. Pop.	% Total						
SMH244	0.7077	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.092**
SMH291	2.4969	5	5.75	0	0	0	14.375	14.375	100%	0	0%	0	0%	0.0757	-	-	**0.076**	R	**0.325**
SMH403	0.4112	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.053**
SMH732	0.1346	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.017**
SMH733	0.4379	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.057**
SMH737	0.6029	8	9.20	0	0	0	23.000	23	100%	0	0%	0	0%	0.1211	-	-	**0.121**	R	**0.078**
SMH738	1.7022	19	21.85	0	0	0	54.625	54.625	100%	0	0%	0	0%	0.2877	-	-	**0.288**	R	**0.221**
SMH740	0.2761	1	1.15	0	0	0	2.875	2.875	100%	0	0%	0	0%	0.0151	-	-	**0.015**	R	**0.036**
SMH741	0.1920	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.025**
SMH742	0.4728	6	6.90	0	0	0	17.250	17.25	100%	0	0%	0	0%	0.0908	-	-	**0.091**	R	**0.061**
SMH743	1.5316	18	20.70	0	0	0	51.750	51.75	100%	0	0%	0	0%	0.2725	-	-	**0.273**	R	**0.199**
SMH767	7.0169	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.912**
SMH769	0.3045	2	2.30	0	0	0	5.750	5.75	100%	0	0%	0	0%	0.0303	-	-	**0.030**	R	**0.040**
SMH771	0.4790	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.062**
SMH772	0.4088	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.053**
SMH773	0.1848	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.024**
SMH774	0.1177	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.015**
SMH775	0.0795	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.010**
SMH776	0.0845	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.011**
SMH777	0.0588	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.008**
SMH778	0.1996	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.026**
SMH779	0.0301	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.004**
SMH780	1.0893	5	5.75	0	0	0	14.375	14.375	100%	0	0%	0	0%	0.0757	-	-	**0.076**	R	**0.142**
SMH781	1.4053	5	5.75	0	0	0	14.375	14.375	100%	0	0%	0	0%	0.0757	-	-	**0.076**	R	**0.183**
SMH783	0.8301	7	8.05	0	0	0	20.125	20.125	100%	0	0%	0	0%	0.1060	-	-	**0.106**	R	**0.108**
SMH784	3.2600	12	13.80	0	0	0	34.500	34.5	100%	0	0%	0	0%	0.1817	-	-	**0.182**	R	**0.424**
SMH785	2.7212	14	16.10	0	0	0	40.250	40.25	100%	0	0%	0	0%	0.2120	-	-	**0.212**	R	**0.354**
SMH786	0.0382	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.005**
SMH787	0.8996	7	8.05	0	0	0	20.125	20.125	100%	0	0%	0	0%	0.1060	-	-	**0.106**	R	**0.117**
SMH788	0.9344	10	11.50	0	0	0	28.750	28.75	100%	0	0%	0	0%	0.1514	-	-	**0.151**	R	**0.121**
SMH789	0.9802	8	9.20	0	0	0	23.000	23	100%	0	0%	0	0%	0.1211	-	-	**0.121**	R	**0.127**
SMH801	7.3866	1	0.00	0	0	5	5.000	0	0%	0	0%	5	100%	-	-	0.0263	**0.026**	I	**0.960**
SMH803	0.1673	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.022**
SMH809	0.3047	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.040**
SMH810	0.1665	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.022**
SMH812	0.1150	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.015**
SMH98	1.6301	0	0.00	0	0	0	0.000	0	0%	0	0%	0	0%	-	-	-	**0.000**	-	**0.212**
						TOTAL	**8430.35**	**7737.25**	92%	**590.90**	7%	**277.20**	3%	**40.229**	**2.335**	**0.704**	**45.318**		**21.233**

UEL + Block F Sanitary and Storm Systems Analysis

MODEL RESULTS

System	Conduit Name	Storm Scenarios	
		5 Year	
		30 min	1 hr
STORM	CHANNEL-1	No surcharging	No surcharging
	CHANNEL-2	No surcharging	No surcharging
	CHANNEL-3	No surcharging	No surcharging
	CULJUNC6-JUNC7	Flooding	Flooding
	CULVERT_1	No surcharging	No surcharging
	CULVERT_2	No surcharging	No surcharging
	D100-222	Surcharged	No surcharging
	D102-100	Surcharged	No surcharging
	D102-109	Surcharged	No surcharging
	D103-102	Surcharged	Surcharged
	D104-103	Surcharged	No surcharging
	D105-104	Surcharged	No surcharging
	D106-140	Surcharged	Surcharged
	D107-106	No surcharging	No surcharging
	D108-107	No surcharging	No surcharging
	D109-114	Surcharged	Surcharged
	D110-109	Surcharged	No surcharging
	D111-110	No surcharging	No surcharging
	D112-111	Surcharged	No surcharging
	D113-112	Surcharged	Surcharged
	D114-118	Surcharged	Surcharged
	D115-114	Surcharged	No surcharging
	D116-115	Surcharged	No surcharging
	D117-116	No surcharging	No surcharging
	D118-119	No surcharging	No surcharging
	D119-120	No surcharging	No surcharging
	D120-WEIR	No surcharging	No surcharging
	D121-128	No surcharging	No surcharging
	D122-121	No surcharging	No surcharging
	D123-122	Surcharged	No surcharging
	D124-123	No surcharging	No surcharging
	D125-124	No surcharging	No surcharging
	D126-125	Surcharged	No surcharging
	D127-120	No surcharging	No surcharging
	D128-127	No surcharging	No surcharging
	D128-163	No surcharging	No surcharging
	D129-128	Surcharged	Surcharged
	D130-129	No surcharging	No surcharging
	D131-130	Surcharged	Surcharged
	D132-131	Surcharged	Surcharged
	D133-132	Surcharged	Surcharged
	D134-132	Surcharged	Surcharged
	D135-134	No surcharging	No surcharging
	D136-135	Surcharged	Surcharged
	D137-133	Surcharged	Surcharged
	D138-137	No surcharging	No surcharging
	D139-138	No surcharging	No surcharging
	D140-139	Surcharged	Surcharged
	D141-140	No surcharging	No surcharging
	D142-X4	No surcharging	No surcharging
	D143-142	No surcharging	No surcharging
	D144-181	No surcharging	No surcharging
	D146-139	Surcharged	Surcharged
	D147-137	Surcharged	Surcharged

System	Conduit Name	Storm Scenarios	
		5 Year	
		30 min	1 hr
STORM	D148-X2	No surcharging	No surcharging
	D149-148	No surcharging	No surcharging
	D150-149	No surcharging	No surcharging
	D151-150	No surcharging	No surcharging
	D152-149	No surcharging	No surcharging
	D161-OUT1	No surcharging	No surcharging
	D162-161	No surcharging	No surcharging
	D163-162	Surcharged	No surcharging
	D164-163	No surcharging	No surcharging
	D181-143	No surcharging	No surcharging
	D222-223	Surcharged	Surcharged
	D249-248	No surcharging	No surcharging
	D250-249	No surcharging	No surcharging
	D251-250	No surcharging	No surcharging
	D252-250	Surcharged	No surcharging
	D253-252	Surcharged	Surcharged
	D254-253	No surcharging	No surcharging
	D255-254	No surcharging	No surcharging
	D256-252	No surcharging	No surcharging
	D257-256	No surcharging	No surcharging
	D258-257	No surcharging	No surcharging
	D259-258	No surcharging	No surcharging
	D260-253	Surcharged	No surcharging
	D261-260	No surcharging	No surcharging
	D262-261	No surcharging	No surcharging
	D700-701	No surcharging	No surcharging
	D701-702	No surcharging	No surcharging
	D702-719	No surcharging	No surcharging
	D703-702	No surcharging	No surcharging
	D704-703	No surcharging	No surcharging
	D705-702	No surcharging	No surcharging
	D705B-704	No surcharging	No surcharging
	D707-705	No surcharging	No surcharging
	D708-705	Surcharged	No surcharging
	D709-708	No surcharging	No surcharging
	D712-703	No surcharging	No surcharging
	D716-712	No surcharging	No surcharging
	D717-716	No surcharging	No surcharging
	D718-717	No surcharging	No surcharging
	D719-OUT2	No surcharging	No surcharging
	D720-708	No surcharging	No surcharging
	D721-720	No surcharging	No surcharging
	D722-721	No surcharging	No surcharging
	D724-720	No surcharging	No surcharging
	D725-724	No surcharging	No surcharging
	D746-X5	No surcharging	No surcharging
	D747-746	No surcharging	No surcharging
	D748-747	No surcharging	No surcharging
	D749-748	No surcharging	No surcharging
	D750-749	No surcharging	No surcharging
	D751-750	No surcharging	No surcharging
	D752-751	No surcharging	No surcharging
	D753-701	No surcharging	No surcharging
	D754-753	No surcharging	No surcharging
	D755-754	Surcharged	No surcharging
	D756-755	No surcharging	No surcharging
	D760-749	Surcharged	Surcharged
	D761-760	No surcharging	No surcharging

System	Conduit Name	Storm Scenarios	
		5 Year	
		30 min	1 hr
STORM	D765-719	No surcharging	No surcharging
	D768-747	No surcharging	No surcharging
	D769-768	No surcharging	No surcharging
	D-CO-121	No surcharging	No surcharging
	D-DLH1-113	Surcharged	No surcharging
	DDMH153-DMH154	No surcharging	No surcharging
	DDMH154-DMH155	No surcharging	No surcharging
	DDMH155-	Surcharged	Surcharged
	DDMH400-DMH401	No surcharging	No surcharging
	DDMH401-DMH404	Surcharged	Surcharged
	DDMH402-DMH401	Surcharged	Surcharged
	DDMH403-DMH401	No surcharging	Surcharged
	DDMH404-dmh408	No surcharging	No surcharging
	DDMH405-DMH404	Surcharged	Surcharged
	DDMH406-DMH405	No surcharging	No surcharging
	DDMH407-DMH406	No surcharging	No surcharging
	DDMH409-DMH403	No surcharging	No surcharging
	DDMH779-DMH781	No surcharging	No surcharging
	DDMH780-DMH781	No surcharging	No surcharging
	DDMH781-DMH782	No surcharging	No surcharging
	DDMH782-DMH155	No surcharging	No surcharging
	DDMH783-DMH155	No surcharging	No surcharging
	DDMH784-DMH153	No surcharging	No surcharging
	DDMH785-DMH784	No surcharging	No surcharging
	DMHN3-DMH128	No surcharging	No surcharging
	DSLH1-136	Surcharged	No surcharging
	DSLH2-136	No surcharging	No surcharging
	DX1-144	No surcharging	No surcharging
	DX2-147	No surcharging	No surcharging
	DX3-141	No surcharging	No surcharging
	DX4-X3	No surcharging	No surcharging
	DX5-OUT3	No surcharging	No surcharging
	L18	No surcharging	No surcharging
COMBINED	C000-206	Surcharged	Surcharged
	C205-206	No surcharging	No surcharging
	C206-OUT	No surcharging	No surcharging
	C207-206	No surcharging	No surcharging
	C208-000	No surcharging	No surcharging
	C208-207	No surcharging	No surcharging
	C209-208	Surcharged	No surcharging
	C210-209	No surcharging	No surcharging
	C211-210	No surcharging	No surcharging
	C212-211	No surcharging	No surcharging
	C213-212	No surcharging	No surcharging
	C214-213	No surcharging	No surcharging
	C216-215	No surcharging	No surcharging
	C217-216	No surcharging	No surcharging
	C218-217	No surcharging	No surcharging
	C219-218	No surcharging	No surcharging
	C225-218	No surcharging	No surcharging
	C226-225	No surcharging	No surcharging
	C227-226	No surcharging	No surcharging
	C228-232	No surcharging	No surcharging
	C229-228	Surcharged	No surcharging
	C230-228	No surcharging	No surcharging
	C231-230	No surcharging	No surcharging
	C232-212	Surcharged	No surcharging

System	Conduit Name	Storm Scenarios	
		5 Year	
		30 min	1 hr
COMBINED	C237-232	No surcharging	No surcharging
	C238-232	Surcharged	Surcharged
	C239-238	No surcharging	No surcharging
	C265-205	No surcharging	No surcharging
	C266-265	Surcharged	Surcharged
	C267-266	Surcharged	Surcharged
	C268-267	Surcharged	No surcharging
	C269-268	No surcharging	No surcharging
	C270-269	No surcharging	No surcharging
	C271-270	No surcharging	No surcharging
	C272-271	No surcharging	No surcharging
	C273-272	No surcharging	No surcharging
	C277-272	No surcharging	No surcharging
	C281-271	No surcharging	No surcharging
	C282-281	No surcharging	No surcharging
	C283-282	No surcharging	No surcharging
	C284-283	No surcharging	No surcharging
	C285-284	No surcharging	No surcharging
	CCLH276-CMH275	No surcharging	No surcharging
	CCMH201-CMH200(OF)	No surcharging	No surcharging
	CCMH202-CMH201	No surcharging	No surcharging
	CCMH203-CMH202	No surcharging	No surcharging
	CCMH204-CMH203	No surcharging	No surcharging
	CCMH206-CMH204	No surcharging	No surcharging
	CCMH274-CMH277	No surcharging	No surcharging
	CCMH275-CMH273	No surcharging	No surcharging
	CCMH279-CMH274	No surcharging	No surcharging
	D215-214	No surcharging	No surcharging
	DR215-214	No surcharging	No surcharging
	SSMH263-CMH266	Surcharged	Surcharged
SANITARY	1	Sufficient	Sufficient
	JUNC1-SMH770	Sufficient	Sufficient
	SCMH207-CMH	Sufficient	Sufficient
	SCO2-SMH401	Sufficient	Sufficient
	SMH782-JUNC1	Sufficient	Sufficient
	SSLH104A-SMH104	Sufficient	Sufficient
	SSLH129-SMH128	Sufficient	Sufficient
	SSLH131-SMH130	Sufficient	Sufficient
	SSLH137-SMH138	Sufficient	Sufficient
	SSLH144-SMH143	Sufficient	Sufficient
	SSLH150-SMH149	Sufficient	Sufficient
	SSLH245-SMH244	Sufficient	Sufficient
	SSLH35-SMH242	Sufficient	Sufficient
	SSMH100-SMH99	Sufficient	Sufficient
	SSMH101-SMH100	Sufficient	Sufficient
	SSMH102-SMH101	Sufficient	Sufficient
	SSMH103-SMH102	Sufficient	Sufficient
	SSMH103-SMH119	Sufficient	Sufficient
	SSMH104-SMH103	Sufficient	Sufficient
	SSMH105-SMH124	Sufficient	Sufficient
	SSMH106-SMH102	Sufficient	Sufficient
	SSMH107-SMH106	Sufficient	Sufficient
	SSMH108-SMH107	Sufficient	Sufficient
	SSMH109-SMH108	Sufficient	Sufficient
	SSMH110-SMH109	Sufficient	Sufficient
	SSMH111A-SMH111	Sufficient	Sufficient
	SSMH111B-SMH111A	Sufficient	Sufficient

System	Conduit Name	Storm Scenarios	
		5 Year	
		30 min	1 hr
SANITARY	SSMH111-SMH121	Insufficient	Insufficient
	SSMH112-SMH110	Sufficient	Sufficient
	SSMH112-SMH111	Sufficient	Sufficient
	SSMH113-SMH112	Sufficient	Sufficient
	SSMH114-SMH113	Sufficient	Sufficient
	SSMH115-SMH114	Insufficient	Insufficient
	SSMH116-SMH115	Limited	Limited
	SSMH117-SMH116	Insufficient	Insufficient
	SSMH119-CMH273	Sufficient	Sufficient
	SSMH120-SMH103	Limited	Limited
	SSMH121-SMH120	Limited	Limited
	SSMH122-SMH119	Sufficient	Sufficient
	SSMH123-SMH122	Sufficient	Sufficient
	SSMH124-SMH123	Sufficient	Sufficient
	SSMH125-CMH285	Sufficient	Sufficient
	SSMH125-SMH124	Sufficient	Sufficient
	SSMH126-SMH125	Sufficient	Sufficient
	SSMH127-SMH126	Sufficient	Sufficient
	SSMH128-SMH127	Sufficient	Sufficient
	SSMH130-SMH105	Sufficient	Sufficient
	SSMH132-SMH104	Sufficient	Sufficient
	SSMH133-SMH132	Sufficient	Sufficient
	SSMH134-SMH133	Sufficient	Sufficient
	SSMH135-SMH134	Sufficient	Sufficient
	SSMH136-SMH135	Sufficient	Sufficient
	SSMH138A-SMH148A	Sufficient	Sufficient
	SSMH138-SMH138A	Sufficient	Sufficient
	SSMH139-SMH138	Sufficient	Sufficient
	SSMH140A-SMH139	Sufficient	Sufficient
	SSMH140-SMH139	Sufficient	Sufficient
	SSMH141-SMH140A	Sufficient	Sufficient
	SSMH142A-SMH142	Sufficient	Sufficient
	SSMH142-SMH141	Sufficient	Sufficient
	SSMH143-SMH142A	Sufficient	Sufficient
	SSMH146-SMH147	Sufficient	Sufficient
	SSMH147A-SMH147	Sufficient	Sufficient
	SSMH147-SMH111B	Sufficient	Sufficient
	SSMH148A-SMH147A	Sufficient	Sufficient
	SSMH148-SMH148A	Sufficient	Sufficient
	SSMH149-SMH148	Sufficient	Sufficient
	SSMH151-SMH148	Limited	Limited
	SSMH152-SMH113	Sufficient	Sufficient
	SSMH152-SMH151	Insufficient	Insufficient
	SSMH153-SMH113	Sufficient	Sufficient
	SSMH154-SMH161	Sufficient	Sufficient
	SSMH155-SMH157	Sufficient	Sufficient
	SSMH156-SMH155	Sufficient	Sufficient
	SSMH157-SMH158	Sufficient	Sufficient
	SSMH158-SMH149	Sufficient	Sufficient
	SSMH159-SMH160	Sufficient	Sufficient
	SSMH160-SMH143	Sufficient	Sufficient
	SSMH161-SMH153	Sufficient	Sufficient
	SSMH221-SMH830	Sufficient	Sufficient
	SSMH233-SMH808	Sufficient	Sufficient
	SSMH234-SMH233	Sufficient	Sufficient
	SSMH235-SMH234	Sufficient	Sufficient
	SSMH236-SMH235	Sufficient	Sufficient
	SSMH240-SMH262	Sufficient	Sufficient

System	Conduit Name	Storm Scenarios	
		5 Year	
		30 min	1 hr
SANITARY	SSMH241-SMH240	Sufficient	Sufficient
	SSMH242-SMH241	Sufficient	Sufficient
	SSMH244-SMH240	Sufficient	Sufficient
	SSMH262-SMH806	Sufficient	Sufficient
	SSMH290-CMH203	Sufficient	Sufficient
	SSMH291-SMH290	Sufficient	Sufficient
	SSMH401-SMH402	Sufficient	Sufficient
	SSMH402-SMH403	Sufficient	Sufficient
	SSMH403-SMH778	Sufficient	Sufficient
	SSMH731-DRUMMOND_PS	Sufficient	Sufficient
	SSMH732-SMH731	Sufficient	Sufficient
	SSMH733-SMH732	Sufficient	Sufficient
	SSMH736-SMH731	Sufficient	Sufficient
	SSMH737-SMH736	Sufficient	Sufficient
	SSMH738-SMH737	Sufficient	Sufficient
	SSMH740-DRUMMOND_PS	Sufficient	Sufficient
	SSMH741-SMH740	Sufficient	Sufficient
	SSMH742-SMH741	Sufficient	Sufficient
	SSMH743-SMH742	Sufficient	Sufficient
	SSMH767-SMH768	Sufficient	Sufficient
	SSMH768-SMH769	Sufficient	Sufficient
	SSMH769-JUNC1	Sufficient	Sufficient
	SSMH770-DRUMMOND_PS	Sufficient	Sufficient
	SSMH771-SMH770	Sufficient	Sufficient
	SSMH772-SMH771	Sufficient	Sufficient
	SSMH773-SMH772	Sufficient	Sufficient
	SSMH774-SMH773	Sufficient	Sufficient
	SSMH775-SMH774	Sufficient	Sufficient
	SSMH776-SMH775	Sufficient	Sufficient
	SSMH777-SMH776	Sufficient	Sufficient
	SSMH778-SMH777	Sufficient	Sufficient
	SSMH779-SMH778	Sufficient	Sufficient
	SSMH780-SMH779	Sufficient	Sufficient
	SSMH781-SMH780	Sufficient	Sufficient
	SSMH783-SMH782	Sufficient	Sufficient
	SSMH784-SMH783	Sufficient	Sufficient
	SSMH785-SMH784	Sufficient	Sufficient
	SSMH786-SMH776	Sufficient	Sufficient
	SSMH787-SMH786	Sufficient	Sufficient
	SSMH788-SMH774	Sufficient	Sufficient
	SSMH789-SMH788	Sufficient	Sufficient
	SSMH801-SMH767	Sufficient	Sufficient
	SSMH802-SMH803	Sufficient	Sufficient
	SSMH803-SMH804	Sufficient	Sufficient
	SSMH804-SMH805	Sufficient	Sufficient
	SSMH805-SMH810	Sufficient	Sufficient
	SSMH806-SMH263	Sufficient	Sufficient
	SSMH807-CMH207	Sufficient	Sufficient
	SSMH808-CMH213	Sufficient	Sufficient
	SSMH808-SMH809	Sufficient	Sufficient
	SSMH809-SMH814	Sufficient	Sufficient
	SSMH810-SMH811	Sufficient	Sufficient
	SSMH811-SMH812	Sufficient	Sufficient
	SSMH812-SMH813	Sufficient	Sufficient
	SSMH813-SMH809	Sufficient	Sufficient
	SSMH814-SMH816	Sufficient	Sufficient
	SSMH815-SMH818	Sufficient	Sufficient
	SSMH816-SMH817	Sufficient	Sufficient

System	Conduit Name	Storm Scenarios	
		5 Year	
		30 min	1 hr
SANITARY	SSMH817-SMH815	Sufficient	Sufficient
	SSMH818-SMH807	Sufficient	Sufficient
	SSMH830-SMH802	Sufficient	Sufficient
	SSMH88-SMH98	Sufficient	Sufficient
	SSMH90-CMH201	Sufficient	Sufficient
	SSMH91-SMH90	Sufficient	Sufficient
	SSMH92-SMH91	Sufficient	Sufficient
	SSMH93-SMH92	Sufficient	Sufficient
	SSMH94-SMH93	Sufficient	Sufficient
	SSMH95-SMH94	Sufficient	Sufficient
	SSMH96-SMH95	Sufficient	Sufficient
	SSMH97-SMH96	Sufficient	Sufficient
	SSMH98-SMH97	Sufficient	Sufficient
	SSMH99-SMH98	Sufficient	Sufficient

Additional Recommended Upgrades for the UEL Sanitary and Storm Systems

BLOCK F

STORM & COMBINED

Storm	Manhole	Downstream Conduit	Original Diam (m)	Upgrade Diam (m) 1st Run	Upgrade Diam (m) 2nd Run
Insufficient Conduits	JUNC 6	CULJUNCC6-JUNC7	250	300	**375**

**See additional calculations on culvert sizing*

TOTAL STORM PIPE UPGRADES: 1

SANITARY

Manhole	Downstream Conduit	Original Diam (m)	Upgrade Diam (m) 1st Run	Upgrade Diam (m) 2nd Run
SMH117	SSMH117-SMH116	150	200	**250**
SMH116	SSMH116-SMH115	150	200	**250**
SMH115	SSMH115-SMH114	150	200	**250**
SMH114	SSMH114-SMH113	200		**250**
SMH113	SSMH113-SMH112	200		**250**
SMH112	SSMH112-SMH110	200		**250**
SMH110	SSMH110-SMH109	200		**250**
SMH111	SSMH111-SMH121	200	Reconfig *	**250**
SMH121	SSMH121-SMH120	200		**250**
SMH120	SSMH120-SMH103	200		**250**
SMH113	SSMH152-SMH113	200	Reconfig **	*
SMH151	SSMH152-SMH151	200		
SMH151	SSMH151-SMH148	200		

**Reconfigure pipe network:*
- 2 flows entering inlet node: (SSMH111A-SMH111) & (SSMH112-SMH111)
- Raise inlet of SSMH112-SMH111 to redirect upstream flow to bypass
-SSMH112-SMH111 inlet raised 0.2m from 83.931424 to 84.131424

***Reconfig pipe network:*
- Unnecessary flow split at SMH113
- Raise SSMH152-SMH113 at SMH113 to redirect flow to SSMH113-SMH112
- SSMH152-SMH113 inlet raised from 87.934424 to 88.134424

TOTAL SAN PIPE UPGRADES: 11

Model Run Result

Sufficient
Insufficient

URBANSYSTEMS.

Block F Impact on UEL Existing Sanitary and Storm Systems Analysis

Additional Recommended System Upgrades

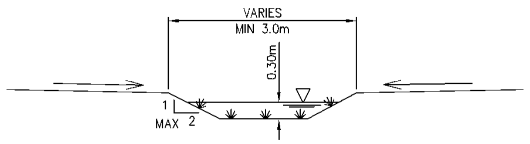
COST ESTIMATE

Item	Description	Unit	Quantity	Unit Price	Total
Storm:	Upgrade existing storm culvert underneath University Blvd				
1	**Storm Culvert**				
1.01	525mm dia. culvert remove and replace (includes pavement restoration)	m	42	$1,000.00	$42,328.39
	Subtotal Storm Culvert				$42,328.39
	Engineering and Contingency (35%)				$15,000.00
	STORM TOTAL				**$58,000.00**
Sanitary:	Upgrade existing sanitary sewer main along and around Acadia Road				
1	**Sanitary Sewer (Acadia Road)**				
1.01	250mm dia. sewermain remove and replace, depth greater than 2 metres (includes pavement restoration)	m	801	$900.00	$720,706.71
1.02	250mm dia. sewermain remove and replace (includes pavement restoration)	m	164	$800.00	$131,163.01
2	**Sanitary Sewer (Acadia Road Bypass)**				
2.01	250mm dia. sanitary bypass remove and replace, depth greater than 2 metres	m	89	$900.00	$79,959.86
3	**Sanitary Sewer (University Blvd)**				
3.01	200mm dia. sewermain reconfiguration, depth greater than 2m (includes pavement restoration)	m	97	$900.00	$87,029.33
	Subtotal Sanitary Sewer				$1,018,858.91
	Engineering and Contingency (35%)				$357,000.00
	SANITARY TOTAL				**$1,376,000.00**
				BUDGET TOTAL	**$1,434,000.00**
				BUDGET TOTAL with 12% HST	**$1,606,080.00**

Notes:
1. Costs for pipe works include mains, appurtenances, tie-ins, service connections, manholes, traffic management, etc.
2. Cost of sewer main installation includes full pavement restoration where specified above.
3. Restoration based on 2m wide trench.
4. Costs do not include any permit, RoW or land acquisition costs.

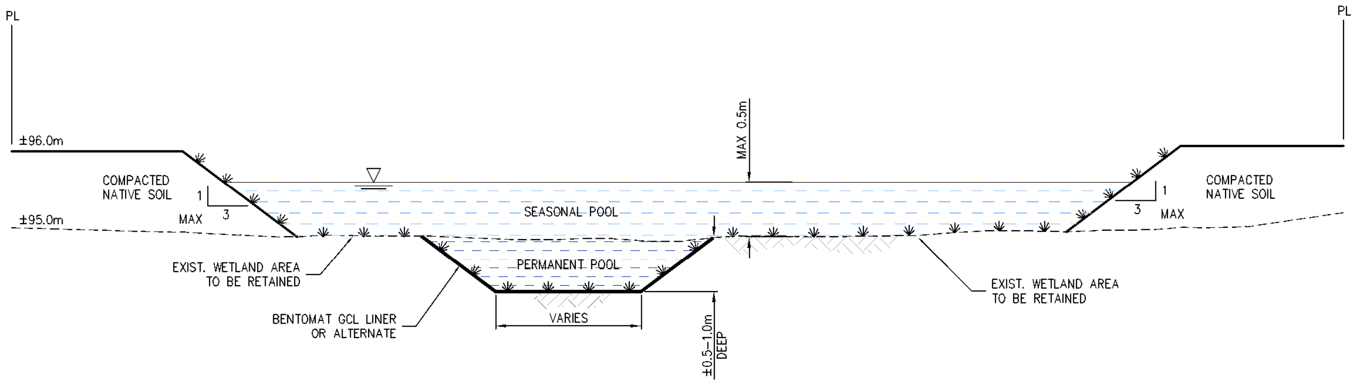
November 2010

APPENDIX F – STORMWATER MANAGEMENT DRAWING



BIOSWALE TYPICAL SECTION

N.T.S.



CONSTRUCTED WETLAND TYPICAL SECTION

N.T.S.

LEGEND

🟨	BUILDING ROOF
🟩	PERMEABLE SURFACES (EXTENSIVE / LIMITED TREE CANOPY)
◩	IMPERMEABLE SURFACES
🟦	CONSTRUCTED WETLAND (SEASONAL / PERMANENT POOL)

STORMWATER MANAGEMENT NOTES:

- THE LARGE DETENTION POND HAS SUFFICIENT STORAGE TO MEET THE REQUIREMENTS OF THE PROPOSED DEVELOPMENT. ADDITIONAL STORAGE AVAILABLE FROM BIO–SWALES WILL BE CONSIDERED AS CONTINGENCY.
- HARD SURFACE RUNOFF (EG. ROADS) WILL BE ROUTED THROUGH A TREATMENT MANHOLE PRIOR TO ENTERING THE DETENTION POND.

CATCHMENT B PARCELS H, I, AND J EACH REQUIRE A MINIMUM OF 49m³ ONSITE DETENTION AND MIN. 117m² OF INFILTRATION AREA. STORM RUNOFF TO BE DISCHARGED TO EXISTING DITCH ALONG ORTONA ROAD.

STORMCEPTOR OIL/GRIT INTERCEPTOR.

BIOSWALE (TYP.) SEE DWG CSP–XS AND SECTION ON THIS SHEET FOR DETIALS

CONSTRUCTED WETLAND
CATCHMENT 'A' COLLECTION POINT
AVAILABLE DETENTION VOLUME ≈ 900m³
FLOW CONTROL MANHOLE AT OUTLET TO RESTRICT FLOW TO THE PRE–DEVELOPMENT EVENT

UPGRADE EXISTING STORM SEWER SEE DRAWING CSP–2

STORMCEPTOR OIL/GRIT INTERCEPTOR.

BIOSWALE (TYP.)

GREENWAY

PROPOSED STORM SEWER (TYP.). SEE DRAWING CSP–2 FOR DETAILS

COST OF ROADWORKS FRONTING BLOCK G TO BE SHARED BETWEEN DEVELOPER AND UEL

BENCHMARK:
MONUMENT UEL #28
CVD28GVRD DATUM
EL. 91.709M

SITE SCALE FACTOR: 0.9996

SURVEYED BY:
R.F. BINNIE & ASSOCIATES

CIVIC ADDRESS:

LEGAL DESCRIPTION:
LOT 'A'
PLAN 22191
DL140
NEW WESTMINSTER DISTRICT

SCALE:
0 1:1000 50m

10/21/15	7	ISSUED FOR COORDINATION
08/27/15	6	REVISED PER AECOM RESUBMISSION REVIEW
04/30/15	5	REZONING SUBMISSION
02/28/14	4	RE–ISSUED FOR REZONING SUBMISSION
10/02/13	3	RE–ISSUED FOR REZONING SUBMISSION
08/26/13	2	ISSUED FOR REZONING SUBMISSION
06/25/13	1	ISSUED FOR INFORMATION ONLY
ISSUED: M/D/Y	REVISION	DESCRIPTION

PROJECT:

BLOCK F
MUSQUEAM
DEVELOPMENT

CLIENT:
COLLIERS INTERNATIONAL

CONSULTANT:
BINNIE
Your Challenges. Our Solutions. Build with Binnie.

R.F. BINNIE & ASSOCIATES LTD.
205 - 4946 Canada Way,
Burnaby, BC V5G 4H7
TEL 604 420 1721
BINNIE.com

DATE: 6/20/13
DRAWN:
DESIGN:
CHECKED: CHECKED
SCALE: 1:1000m
SEAL:

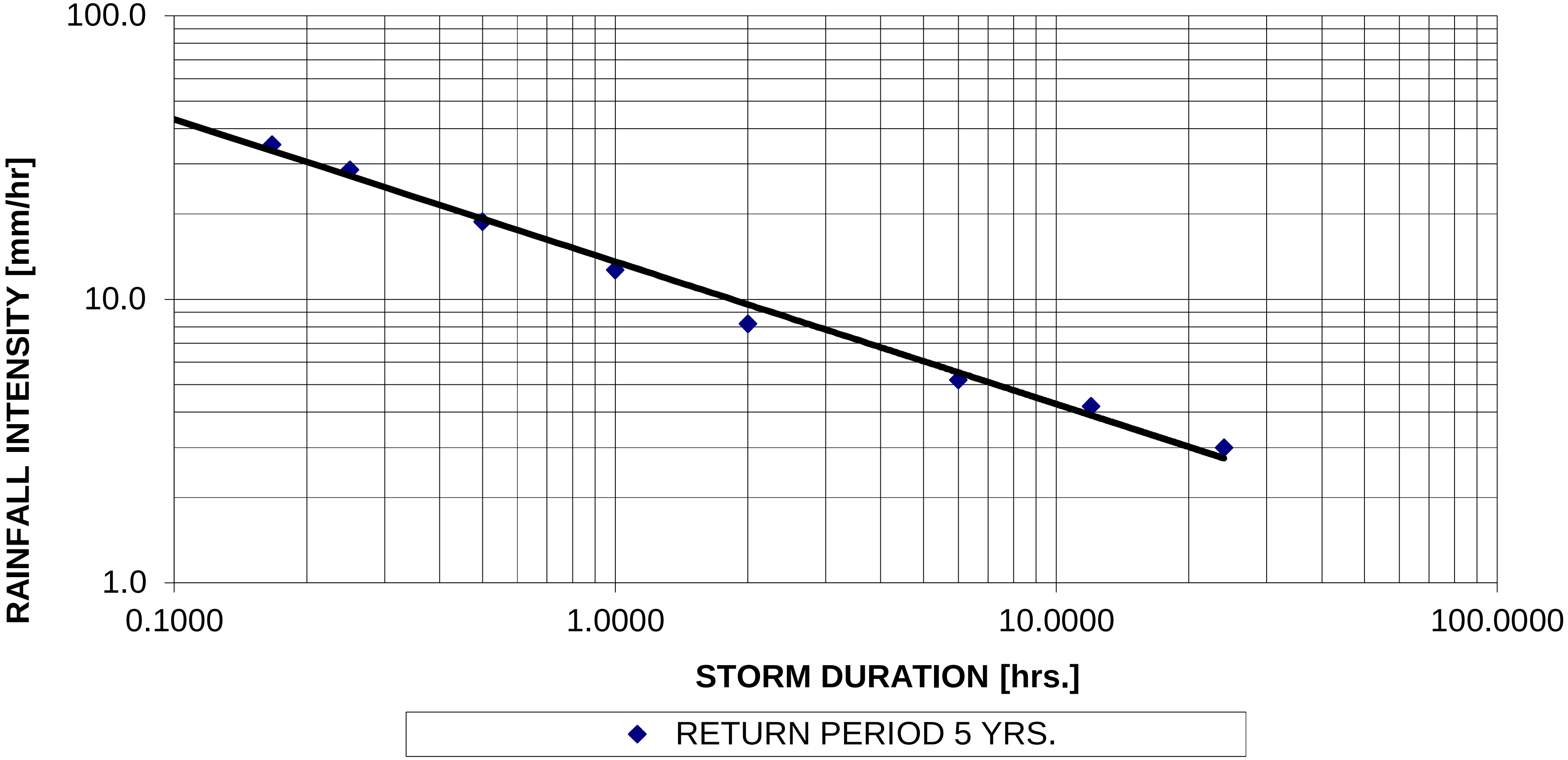
SHEET TITLE:

CONCEPTUAL
STORMWATER
MANAGEMENT PLAN

DRAWING NO.: SWMP-1
REV. 7
RFB JOB No. 12–125
SHEET 9 OF 10

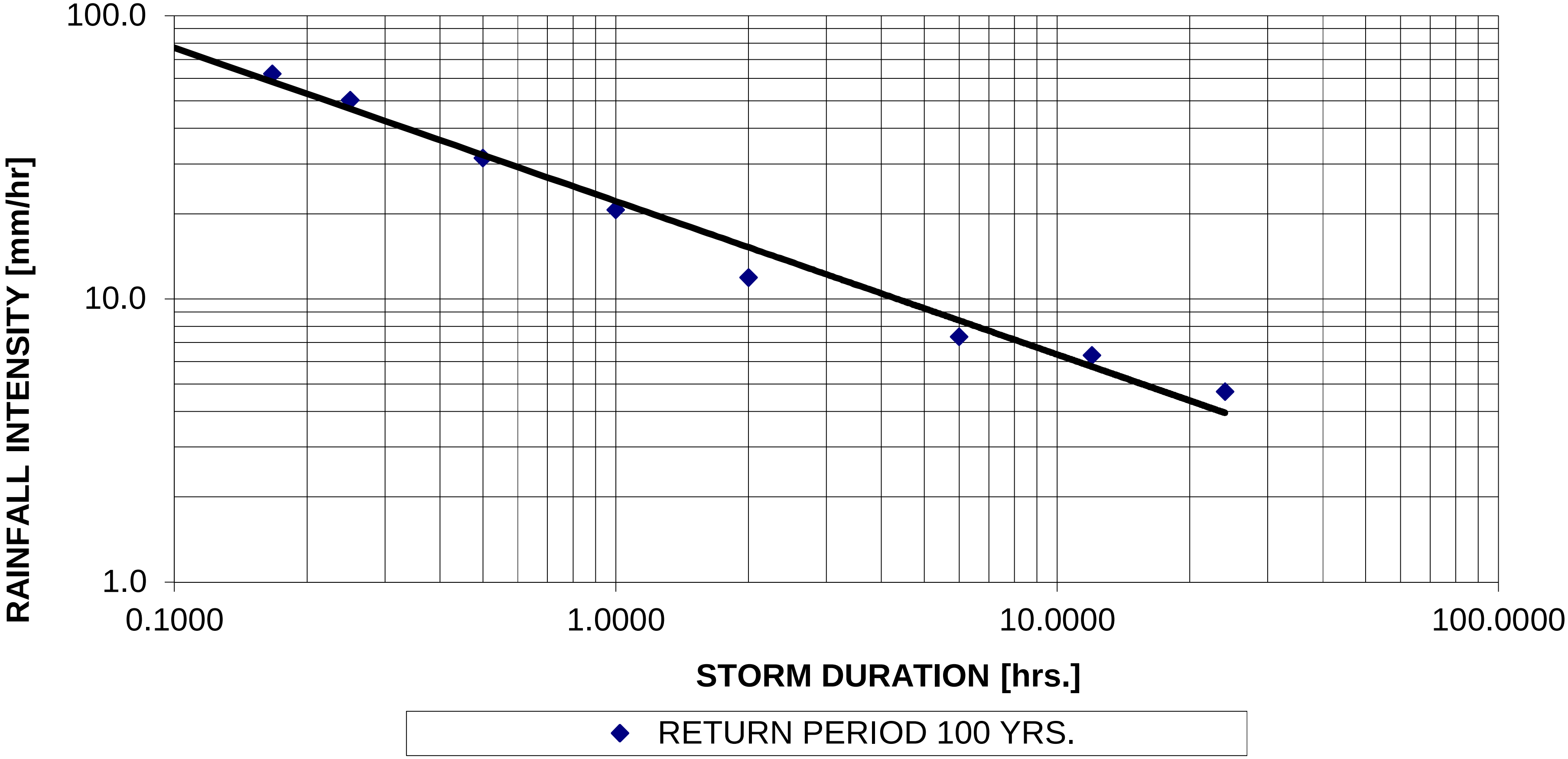
APPENDIX G – UBC RAINFALL DATA

INTENSITY DURATION FREQUENCY CURVE
for
Musqueam - Block F



INTENSITY DURATION FREQUENCY CURVE
for
Musqueam - Block F

$y = 22.134x^{-0.542}$



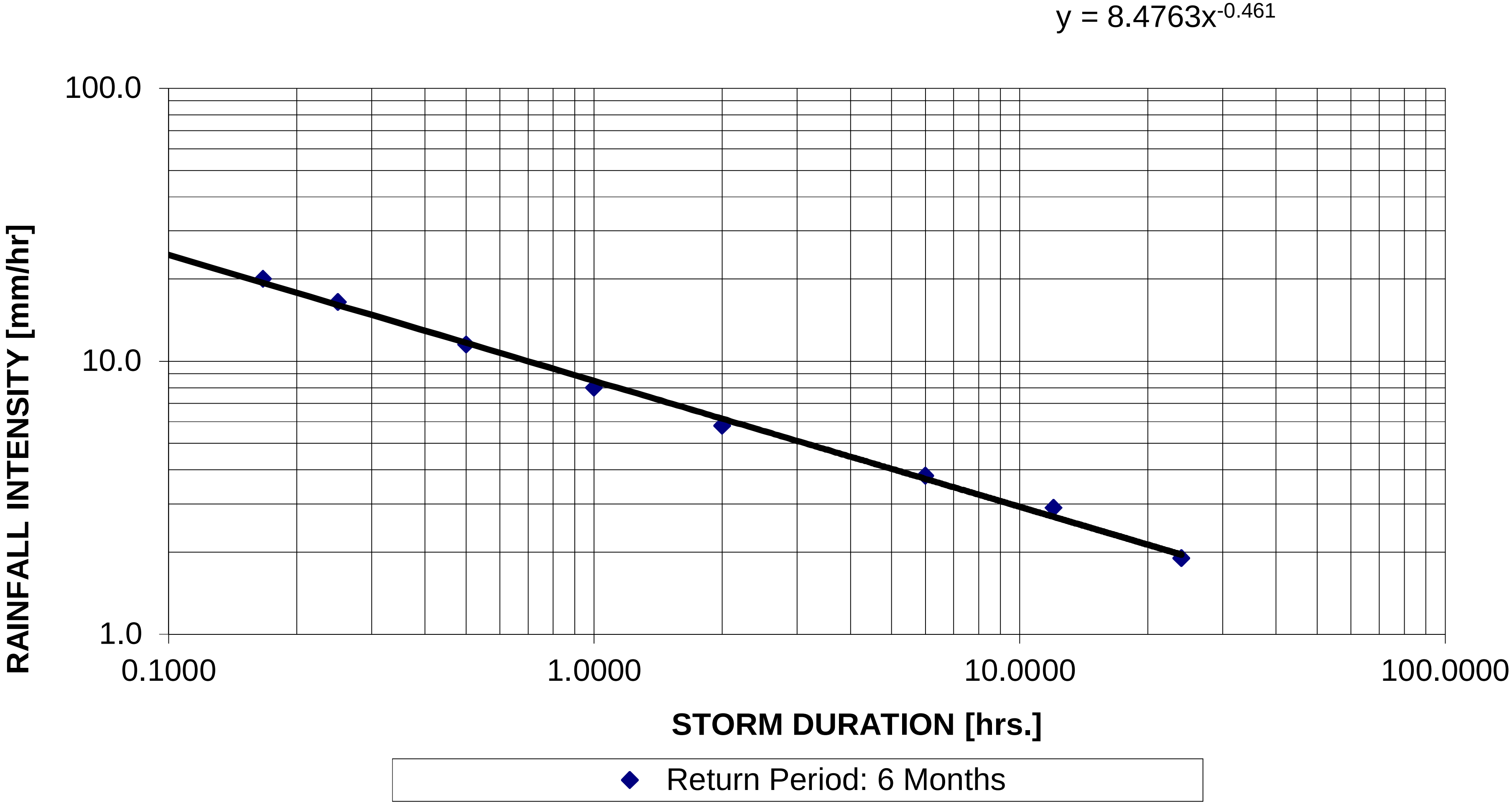
R.F. Binnie & Associates Ltd.
205 – 4946 Canada Way
Burnaby, BC   V5G 4H7
Tel: 604-420-1721 Fax: 604-420-4743

Rainfall Data Extrapolation

Project Name:	**Block F Musqueam Development**	**Project #:**	**12-125**
Description:	**UBC IDF Curb Extrapolation for 1:6-month Storm Data**	**Date:**	**11-Aug-15**

Storm Duration	Return Period							
	100 Years	50 Years	25 Years	10 Years	5 Years	2 Years	Equation	**6 months**
5	90.8	81.4	72.0	59.3	49.3	34.1	$I = 31.674(R)^{0.2424}$	**26.8**
10	62.4	56.3	50.1	41.7	35.1	25.2	$I = 23.377(R)^{0.2254}$	**20.0**
15	50.3	45.4	40.5	33.9	28.6	20.7	$I = 19.226(R)^{0.2206}$	**16.5**
30	31.5	28.6	25.8	21.9	18.8	14.2	$I = 13.204(R)^{0.1985}$	**11.5**
60	20.6	18.8	17.0	14.6	12.7	9.8	$I = 9.1336(R)^{0.1852}$	**8.0**
12	11.9	11.1	10.2	9.1	8.2	6.8	$I =6.4079(R)^{0.1401}$	**5.8**
360	7.4	6.9	6.4	5.7	5.2	4.4	$I = 4.1402(R)^{0.1307}$	**3.8**
720	6.3	5.8	5.3	4.7	4.2	3.4	$I = 3.1962(R)^{0.153}$	**2.9**
1440	4.7	4.3	3.9	3.4	3.0	2.3	$I = 2.1697R)^{0.1759}$	**1.9**

INTENSITY DURATION FREQUENCY CURVE
for
Musqueam - Block F



APPENDIX H – TIME OF CONCENTRATION CALCULATIONS

Time of Concentration Calculations

Catchment “A”

Area = 7.6 ha

T_{c5} (Pre) = $T_i + T_t$

Where : T_i = Overland Flow Time, $T_i = \dfrac{(3.26(1.1-C)L^{0.5})}{S^{0.33}}$

Where : C = 0.1 (1:5-year, Woodlands) [MMCD]

C = 0.3 (1:100-year, Woodlands) [MMCD]

C = 0.8 (1:5-year, post-development runoff coefficient)

C = 0.85 (1:100-year, post-development runoff coefficient)

L = 300m

S ≈ 1.5-2.0%

T_t = Concentrated Flow Time

1:6-month Storm

$$T_i = \frac{(3.26(1.1-0.1)250m^{0.5})}{1.5\%^{0.33}}$$

*in the absence of 1:6-month C values, the T_c calculations use the C value of the next closest storm event

Ti = 45 min, Tt = 0 min

Tc_6 (Pre) = 45 min + 0 min

Tc_6 (Pre) = 45 min

$$T_i = \frac{(3.26(1.1-0.8)250m^{0.5})}{2.0\%^{0.33}}$$

Ti = 12 min, Tt = 0 min

Tc_6 (Post) = 12 min + 0 min

Tc_6 (Post) = 12 min

1:5-year Storm

$$T_i = \frac{(3.26(1.1-0.1)250m^{0.5})}{1.5\%^{0.33}}$$

Ti = 45 min, Tt = 0 min $\quad$ Tc_5 (Pre) = 45 min + 0 min

Tc_5 (Pre) = 45 min

$$T_i = \frac{(3.26(1.1-0.8)250m^{0.5})}{2.0\%^{0.33}}$$

Ti = 12 min, Tt = 0 min $\quad$ Tc_5 (Post) = 12 min + 0 min

Tc_5 (Post) = 12 min

1:100-year Storm

$$T_i = \frac{(3.26(1.1-0.3)250m^{0.5})}{1.5\%^{0.33}}$$

Ti = 36 min, Tt = 0 min $\quad$ Tc_{100} (Pre) = 36 min + 0 min

Tc_{100} (Pre) = 36 min

$$T_i = \frac{(3.26(1.1-0.85)250m^{0.5})}{2.0\%^{0.33}}$$

Ti = 10 min, Tt = 0 min $\quad$ Tc_{100} (Post) = 10 min + 0 min

Tc_{100} (Post) = 10 min

Catchment "B"

Area = 1.2 ha

T_{c5} (Pre) = $T_i + T_t$

Where : T_i = Overland Flow Time, $T_i = \dfrac{(3.26(1.1 - C)L^{0.5})}{S^{0.33}}$

Where :
C = 0.1 (1:5-year, Woodlands) [MMCD]
C = 0.3 (1:100-year, Woodlands) [MMCD]
C = 0.8 (1:5-year, post-development runoff coefficient)
C = 0.85 (1:100-year, post-development runoff coefficient)
L = 120m
S ≈ 1.5-2.0%

T_t = Concentrated Flow Time

1:6-month Storm

$$T_i = \frac{(3.26(1.1 - 0.1)120m^{0.5})}{1.5\%^{0.33}}$$

*in the absence of 1:6-month C values, the T_c calculations use the C value of the next closest storm event

Ti = 31 min, Tt = 0 min

Tc_5 (Pre) = 31 min + 0 min

$$\boxed{\textbf{Tc}_5\textbf{ (Pre) = 31 min}}$$

$$T_i = \frac{(3.26(1.1 - 0.8)120m^{0.5})}{2.0\%^{0.33}}$$

Ti = 8.5 min, Tt = 0 min

Tc_5 (Post) = 8.5 min + 0 min

$$\boxed{\textbf{Tc}_5\textbf{ (Post) = 8.5 min}}$$

1:5-year Storm

$$T_i = \frac{(3.26(1.1-0.1)120m^{0.5})}{1.5\%^{0.33}}$$

Ti = 31 min, Tt = 0 min $\quad$ Tc_5 (Pre) = 31 min + 0 min

$$\boxed{\mathbf{Tc_5\ (Pre) = 31\ min}}$$

$$T_i = \frac{(3.26(1.1-0.8)120m^{0.5})}{2.0\%^{0.33}}$$

Ti = 8.5 min, Tt = 0 min $\quad$ Tc_5 (Post) = 8.5 min + 0 min

$$\boxed{\mathbf{Tc_5\ (Post) = 8.5\ min}}$$

1:100-year Storm

$$T_i = \frac{(3.26(1.1-0.3)120m^{0.5})}{1.5\%^{0.33}}$$

Ti = 25 min, Tt = 0 min $\quad$ Tc_{100} (Pre) = 25 min + 0 min

$$\boxed{\mathbf{Tc_{100}\ (Pre) = 25\ min}}$$

$$T_i = \frac{(3.26(1.1-0.85)120m^{0.5})}{2.0\%^{0.33}}$$

Ti = 7 min, Tt = 0 min $\quad$ Tc_{100} (Post) = 7 min + 0 min

$$\boxed{\mathbf{Tc_{100}\ (Post) = 7\ min}}$$

APPENDIX I – RATIONAL METHOD CALCULATIONS

Rational Method Calculations

CATCHMENT A

Rainfall Intensity

$$I = AT^{B}$$

Where: I = rainfall intensity (mm/h)

A = Constant obtained when rainfall data was plotted on attached IDF curves

T = Time of Concentration (hours)

B = Exponent generated by plotting rainfall data onto attached IDF curves

I_{6A} (Pre) = AT_c^B = 8.48 $(0.75)^{-0.461}$

I_{6A} (Pre) = 9.7 mm/hr

I_{6A} (Post) = AT_c^B = 8.48 $(0.2)^{-0.461}$

I_{6A} (Post) = 17.8 mm/hr

I_{5A} (Pre) = AT_c^B = 13.57 $(0.75)^{-0.502}$

I_{5A} (Pre) = 15.7 mm/hr

I_{5A} (Post) = AT_c^B = 13.57 $(0.2)^{-0.502}$

I_{5A} (Post) = 30.4 mm/hr

I_{100A} (Pre) = AT_c^B = 22.13 $(0.60)^{-0.542}$

I_{100A} (Pre) = 29.2 mm/hr

I_{100A} (Post) = AT_c^B = 22.13 $(0.167)^{-0.542}$

I_{100A} (Post) = 58.4 mm/hr

Rational Method

$Q = RAIN$

Where: Q = runoff flow (m^3/s)

R = Runoff Coefficient

A = Catchment Area, 7.6 ha

I = Rainfall Intensity @ Tc (mm/h)

N = Conversion factor (1/360)

$$Q_{6A}(Pre) = 0.1 \times 7.6ha \times 9.7\, {}^{mm}/_{h} \times \frac{1}{360} = 0.0204\frac{m^3}{s}$$

$$= \mathbf{20.4}\, {}^{\boldsymbol{L}}/_{\boldsymbol{s}}$$

$$Q_{6A}(Post) = 0.8 \times 7.6ha \times 17.8\, {}^{mm}/_{h} \times \frac{1}{360} = 0.3006\frac{m^3}{s}$$

$$= \mathbf{300.6}\, {}^{\boldsymbol{L}}/_{\boldsymbol{s}}$$

$$Q_{5A}(Pre) = 0.1 \times 7.6ha \times 15.7\, {}^{mm}/_{h} \times \frac{1}{360} = 0.0331\frac{m^3}{s}$$

$$= \mathbf{33.1}\, {}^{\boldsymbol{L}}/_{\boldsymbol{s}}$$

$$Q_{5A}(Post) = 0.8 \times 7.6ha \times 30.4\, {}^{mm}/_{h} \times \frac{1}{360} = 0.5134\frac{m^3}{s}$$

$$= \mathbf{513.4}\, {}^{\boldsymbol{L}}/_{\boldsymbol{s}}$$

$$Q_{100A}(Pre) = 0.3 \times 7.6ha \times 29.2\, {}^{mm}/_{h} \times \frac{1}{360} = 0.1849\frac{m^3}{s}$$

$$= \mathbf{184.9}\, {}^{\boldsymbol{L}}/_{\boldsymbol{s}}$$

$$Q_{100A}(Post) = 0.85 \times 7.6ha \times 58.4\, {}^{mm}/_{h} \times \frac{1}{360} = 1.048\frac{m^3}{s}$$

$$= \mathbf{1048}\, {}^{\boldsymbol{L}}/_{\boldsymbol{s}}$$

*See the attached spreadsheet for detention requirements

CATCHMENT B

Rainfall Intensity

$I = AT^{B}$

Where: I = rainfall intensity (mm/h)

A = Constant obtained when rainfall data was plotted on attached IDF curves

T = Time of Concentration (hours)

B = Exponent generated by plotting rainfall data onto attached IDF curves

I_{6B} (Pre) = AT_c^B = 8.48 $(0.52)^{-0.461}$

I_{6B} (Pre) = 11.5 mm/hr

I_{6B} (Post) = AT_c^B = 8.48 $(0.14)^{-0.461}$

I_{6B} (Post) = 21.0 mm/hr

I_{5B} (Pre) = AT_c^B = 13.57 $(0.52)^{-0.502}$

I_{5B} (Pre) = 18.8 mm/hr

I_{5B} (Post) = AT_c^B = 13.57 $(0.14)^{-0.502}$

I_{5B} (Post) = 36.4 mm/hr

I_{100B} (Pre) = AT_c^B = 22.13 $(0.42)^{-0.542}$

I_{100B} (Pre) = 35.4 mm/hr

I_{100B} (Post) = AT_c^B = 22.13 $(0.12)^{-0.542}$

I_{100B} (Post) = 69.8 mm/hr

Rational Method

$Q = RAIN$

Where: Q = runoff flow (m^3/s)

R = Runoff Coefficient

A = Catchment Area, 1.2 ha

I = Rainfall Intensity (mm/h)

N = Conversion factor (1/360)

$$Q_{6B}(Pre) = 0.1 \times 1.2ha \times 11.5\,{}^{mm}\!/_{h} \times \frac{1}{360} = \; 0.0038\,\frac{m^3}{s}$$

$$= \mathbf{3.8}\,{}^{\boldsymbol{L}}\!/_{\boldsymbol{s}}$$

$$Q_{6B}(Post) = 0.8 \times 1.2ha \times 21.0\,{}^{mm}\!/_{h} \times \frac{1}{360} = \; 0.056\,\frac{m^3}{s}$$

$$= \mathbf{56.0}\,{}^{\boldsymbol{L}}\!/_{\boldsymbol{s}}$$

$$Q_{5B}(Pre) = 0.1 \times 1.2ha \times 18.8\,{}^{mm}\!/_{h} \times \frac{1}{360} = \; 0.0063\,\frac{m^3}{s}$$

$$= \mathbf{6.3}\,{}^{\boldsymbol{L}}\!/_{\boldsymbol{s}}$$

$$Q_{5B}(Post) = 0.8 \times 1.2ha \times 36.4\,{}^{mm}\!/_{h} \times \frac{1}{360} = \; 0.0944\,\frac{m^3}{s}$$

$$= \mathbf{94.4}\,{}^{\boldsymbol{L}}\!/_{\boldsymbol{s}}$$

$$Q_{100B}(Pre) = 0.3 \times 1.2ha \times 35.4\,{}^{mm}\!/_{h} \times \frac{1}{360} = \; 0.0354\,\frac{m^3}{s}$$

$$= \mathbf{35.4}\,{}^{\boldsymbol{L}}\!/_{\boldsymbol{s}}$$

$$Q_{100B}(Post) = 0.85 \times 1.2ha \times 69.8\,{}^{mm}\!/_{h} \times \frac{1}{360} = \; 0.1978\,\frac{m^3}{s}$$

$$= \mathbf{197.8}\,{}^{\boldsymbol{L}}\!/_{\boldsymbol{s}}$$

*See the attached spreadsheet for detention requirements

APPENDIX J – DFO DETENTION CRITERIA CALCULATIONS

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Calculations

Project Name: **Block F Development** **Project #:** **12-125**
Description: **DFO Detention Requirements - Catchment A** **Date:** **27-Oct-15**

DFO Detention Requirements:

1. Reduce post-development *flows* to pre-development rates for the 5-year and 6-month, 24-hour precipitation event
2. Limit post-development runoff *volumes* to pre-development levels for the 6-month and 5-year 24-hour storm events

Criteria 1
1:6-MONTH RETURN

Pre-Development Runoff Rate - 1:6month Q_6 = 0.0204 m^3/s
Maximum Release Rate (equal to Q_6) Q_{allow} = 0.0204 m^3/s

(from Rational Method Calculations)

INFILTRATION

Infiltration Rate: 1.13 mm/min
Infiltration Flow (unlined pond bottom + swales) 38.4 L/s
Infiltration Flow (Factor of Safety = 2) Q_i= 0.0192 m^3/s

(From Geotech report)

Includes un-lined* portion of wetlands + area of bio swales

POST DEVELOPMENT - 6 MONTH RETURN

Runoff Coefficient R_{AVG} = 0.80
Catchment Area A = 7.6 ha
Time of Concentration Tc = 12 minutes

Hyd No.	Duration, Tr (minutes)	Rainfall Intensity, I (mm/h)	Peak Flow, Q_p (m^3/s)	Inflow Runoff Volume (m^3)	Release Rate $=Q_{allow}+Q_i$ (m^3/s)	Required Storage Volume (m^3)
1	8	21.5	0.363	174.0	0.0396	155.02
2	10	19.4	0.327	196.3	0.0396	172.68
3	15	16.1	0.271	244.2	0.0396	209.10
4	20	14.1	0.238	285.2	0.0396	238.48
5	30	11.7	0.197	354.8	0.0396	284.86
6	40	10.2	0.173	414.4	0.0396	321.0
7	60	8.5	0.143	515.6	0.0396	375.4
8	120	6.2	0.104	749.1	0.0396	467.8
9	180	5.1	0.086	932.1	0.0396	***509.3***
10	360	3.7	0.063	1354.3	0.0396	506.2
11	480	3.3	0.055	1581.5	0.0396	449.5
12	600	2.9	0.050	1783.6	0.0396	367.5
13	720	2.7	0.046	1967.8	0.0396	267.5
14	1200	2.1	0.036	2591.5	0.0396	-
15	1440	2.0	0.033	2859.1	0.0396	-

Calculations

Project Name:	**Block F Development**	**Project #:**	**12-125**
Description:	**DFO Detention Requirements - Catchment A**	**Date:**	**27-Oct-15**

1:5 YEAR RETURN

Pre-Development Runoff Rate - 1:5year $Q_5 =$ 0.0331 m^3/s
Maximum Release Rate (equal to Q_5) $Q_{allow} =$ 0.0331 m^3/s

(from Rational Method Calculations)

INFILTRATION

Infiltration Rate: 1.13 mm/min

Infiltration Flow (unlined pond bottom + swales) 38.4 L/s

Infiltration Flow (Factor of Safety = 2) Q_i= 0.0192 m^3/s

(From Geotech report)

Includes un-lined* portion of wetlands + area of bio swales

POST DEVELOPMENT - 5 YEAR RETURN

Runoff Coefficient $R_{AVG} =$ 0.80
Catchment Area A = 7.6 ha
Time of Concentration Tc = 12 minutes

Hyd No.	Duration, Tr (minutes)	Rainfall Intensity, I (mm/h)	Peak Flow, Q_p (m^3/s)	Inflow Runoff Volume (m^3)	Release Rate $=Q_{allow}+Q_i$ (m^3/s)	Required Storage Volume (m^3)
1	8	37.3	0.630	302.5	0.0523	276.22
2	10	33.4	0.563	338.0	0.0523	305.68
3	15	27.2	0.460	413.7	0.0523	366.02
4	20	23.6	0.398	477.4	0.0523	414.38
5	30	19.2	0.325	584.2	0.0523	490.37
6	40	16.6	0.281	674.2	0.0523	549.4
7	60	13.6	0.229	825.1	0.0523	638.3
8	120	9.6	0.162	1165.2	0.0523	791.9
9	180	7.8	0.132	1425.9	0.0523	865.7
10	360	5.5	0.093	2013.7	0.0523	***891.7***
11	480	4.8	0.081	2323.9	0.0523	826.9
12	600	4.3	0.072	2597.1	0.0523	724.9
13	720	3.9	0.066	2843.9	0.0523	596.4
14	1200	3.0	0.051	3667.7	0.0523	-
15	1440	2.8	0.046	4016.3	0.0523	-

Calculations

Project Name:	**Block F Development**	**Project #:**	**12-125**
Description:	**DFO Detention Requirements - Catchment A**	**Date:**	**27-Oct-15**

Criteria 2

Q=RAIN

Q= Flow Rate
R= Runoff Coefficient (As specified in Time of Concentration Calculations)
A= Catchment Area
I= Rainfall intensity for specified storm (see extrapolation calculations for 1:6-month Storm)
N= 1/360

1:6-month 24-Hour Pre-development Runoff Volume

$$Q = (0.1) \times (7.6ha) \times \left(1.9\,{}^{mm}/_{h}\right) \times \frac{1}{360} = 0.00401\,{}^{m^3}/_{s}$$

$$V_{6pre} = Qt = 0.00401\,{}^{m^3}/_{s} \times 24h \times \frac{3600s}{h} = \mathbf{346.6m^3}$$

1:6-month 24-Hour Post-development Runoff Volume

$$Q = (0.8) \times (7.6ha) \times \left(1.9\,{}^{mm}/_{h}\right) \times \frac{1}{360} = 0.0321\,{}^{m^3}/_{s}$$

$$V_{6post} = Qt = 0.0321\,{}^{m^3}/_{s} \times 24h \times \frac{3600s}{h} = \mathbf{2773.4m^3}$$

$$V_{6retain} = V_{6post} - V_{6pre} = \mathbf{2426.8m^3}$$

1:5-Year 24-Hour Pre-development Runoff Volume

$$Q = (0.1) \times (7.6ha) \times \left(2.8\,{}^{mm}/_{h}\right) \times \frac{1}{360} = 0.00591\,{}^{m^3}/_{s}$$

$$V_{5pre} = Qt = 0.00591\,{}^{m^3}/_{s} \times 24h \times \frac{3600s}{h} = \mathbf{510.7m^3}$$

1:5-Year 24-Hour Post-development Runoff Volume

$$Q = (0.8) \times (7.6ha) \times \left(2.8\,{}^{mm}/_{h}\right) \times \frac{1}{360} = 0.0473\,{}^{m^3}/_{s}$$

$$V_{5post} = Qt = 0.0473\,{}^{m^3}/_{s} \times 24h \times \frac{3600s}{h} = \mathbf{4085.8m^3}$$

$$\boxed{V_{5retain} = V_{5post} - V_{5pre} = \mathbf{3575.1m^3}}$$

larger of the two volumes

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Calculations

Project Name:	**Block F Development**	**Project #:**	**12-125**
Description:	**DFO Detention Requirements - Catchment A**	**Date:**	**27-Oct-15**

Stormwater Retention

Parkland Pervious Area =	12600	m^2	Area of Park
Infiltration Rate =	1.13	mm/min	
Infiltration Capacity =	20442.24	m^3	(24-hour period)
Volume Available for Capture =	**832.33**	**m^3**	total rainfall on park in 24hr period
Wetland & Swale Area =	2046	m^2	Includes un-lined* portions of wetlands + area of bio swales
Infiltration Rate =	1.13	mm/min	
Infiltration Capacity =	**3319.4**	**m^3**	(24-hour period)
Volume Available for Capture =	4188.1	m^3	total rainfall directed to wetlands in 24hr period
Total Rainfall Capture	**4151.8**	**m^3**	sum of the above

✔ Capture Target Achieved

* Assumes a maximum 20% of pond area to be lined. Actual lining extents TBD

Calculations

Project Name: **Block F Development** **Project #:** **12-125**
Description: **DFO Detention Requirements - Catchment B** **Date:** **27-Oct-15**

DFO Detention Requirements:

1. Reduce post-development *flows* to pre-development rates for the 5-year and 6-month, 24-hour precipitation event
2. Limit post-development runoff *volumes* to pre-development levels for the 6-month and 5-year 24-hour storm events

Criteria 1
1:6-MONTH RETURN

Pre-Development Runoff Rate - 1:6month Q_6 = 0.0038 m^3/s (from Rational Method Calculations)
Maximum Release Rate (equal to Q_6) Q_{allow} = 0.0038 m^3/s

INFILTRATION

Infiltration Rate: 1.13 mm/min (From Geotech report)
Infiltration Flow (350m^2 infiltration area) 6.57 L/s
Infiltration Flow (Factor of Safety = 2) Q_i= 0.0033 m^3/s

POST DEVELOPMENT - 6 MONTH RETURN

Runoff Coefficient R_{AVG} = 0.80
Catchment Area A = 1.2 ha
Time of Concentration Tc = 12 minutes

Hyd No.	Duration, Tr (minutes)	Rainfall Intensity, I (mm/h)	Peak Flow, Q_p (m^3/s)	Inflow Runoff Volume (m^3)	Release Rate $=Q_{allow}+Q_i$ (m^3/s)	Required Storage Volume (m^3)
1	8	21.5	0.057	27.5	0.0071	24.08
2	10	19.4	0.052	31.0	0.0071	26.77
3	15	16.1	0.043	38.6	0.0071	32.29
4	20	14.1	0.038	45.0	0.0071	36.69
5	30	11.7	0.031	56.0	0.0071	43.54
6	40	10.2	0.027	65.4	0.0071	48.8
7	60	8.5	0.023	81.4	0.0071	56.4
8	120	6.2	0.016	118.3	0.0071	68.0
9	180	5.1	0.014	147.2	0.0071	***71.7***
10	360	3.7	0.010	213.8	0.0071	62.3
11	480	3.3	0.009	249.7	0.0071	47.4
12	600	2.9	0.008	281.6	0.0071	28.5
13	720	2.7	0.007	310.7	0.0071	6.8
14	1200	2.1	0.006	409.2	0.0071	-
15	1440	2.0	0.005	451.4	0.0071	-

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Calculations

Project Name:	**Block F Development**	**Project #:**	**12-125**
Description:	**DFO Detention Requirements - Catchment B**	**Date:**	**27-Oct-15**

1:5 YEAR RETURN

Pre-Development Runoff Rate - 1:5year Q_5 = 0.0063 m^3/s (from Rational Method Calculations)
Maximum Release Rate (equal to Q_5) Q_{allow} = 0.0063 m^3/s

INFILTRATION

Infiltration Rate: 1.13 mm/min (From Geotech report)
Infiltration Flow (350m^2 infiltration area) 6.57 L/s
Infiltration Flow (Factor of Safety = 2) Q_i= 0.0033 m^3/s

POST DEVELOPMENT - 5 YEAR RETURN

Runoff Coefficient R_{AVG} = 0.80
Catchment Area A = 1.2 ha
Time of Concentration Tc = 12 minutes

Hyd No.	Duration, Tr (minutes)	Rainfall Intensity, I (mm/h)	Peak Flow, Q_p (m^3/s)	Inflow Runoff Volume (m^3)	Release Rate $=Q_{allow}+Q_i$ (m^3/s)	Required Storage Volume (m^3)
1	8	37.3	0.100	47.8	0.0096	42.91
2	10	33.4	0.089	53.4	0.0096	47.42
3	15	27.2	0.073	65.3	0.0096	56.57
4	20	23.6	0.063	75.4	0.0096	63.82
5	30	19.2	0.051	92.2	0.0096	75.06
6	40	16.6	0.044	106.5	0.0096	83.6
7	60	13.6	0.036	130.3	0.0096	96.1
8	120	9.6	0.026	184.0	0.0096	115.7
9	180	7.8	0.021	225.1	0.0096	***122.6***
10	360	5.5	0.015	318.0	0.0096	112.6
11	480	4.8	0.013	366.9	0.0096	92.9
12	600	4.3	0.011	410.1	0.0096	67.3
13	720	3.9	0.010	449.0	0.0096	37.5
14	1200	3.0	0.008	579.1	0.0096	-
15	1440	2.8	0.007	634.2	0.0096	-

Calculations

Project Name:	**Block F Development**	**Project #:**	**12-125**
Description:	**DFO Detention Requirements - Catchment B**	**Date:**	**27-Oct-15**

Criteria 2

Q=RAIN

Q= Flow Rate
R= Runoff Coefficient (As specified in Time of Concentration Calculations)
A= Catchment Area
I= Rainfall intensity for specified storm (see extrapolation calculations for 1:6-month Storm)
N= 1/360

1:6-month 24-Hour Pre-development Runoff Volume

$$Q = (0.1) \times (1.2ha) \times \left(1.9\,{}^{mm}\!/_{h}\right) \times \frac{1}{360} = 0.0006\,{}^{m^3}\!/_{s}$$

$$V_{6pre} = Qt = 0.0006\,{}^{m^3}\!/_{s} \times 24h \times \frac{3600s}{h} = \mathbf{51.8m^3}$$

1:6-month 24-Hour Post-development Runoff Volume

$$Q = (0.8) \times (1.2ha) \times \left(1.9\,{}^{mm}\!/_{h}\right) \times \frac{1}{360} = 0.005\,{}^{m^3}\!/_{s}$$

$$V_{6post} = Qt = 0.005\,{}^{m^3}\!/_{s} \times 24h \times \frac{3600s}{h} = \mathbf{437.8m^3}$$

$$V_{6retain} = V_{6post} - V_{6pre} = \mathbf{386.0m^3}$$

1:5-Year 24-Hour Pre-development Runoff Volume

$$Q = (0.1) \times (1.2ha) \times \left(2.8\,{}^{mm}\!/_{h}\right) \times \frac{1}{360} = 0.000933\,{}^{m^3}\!/_{s}$$

$$V_{5pre} = Qt = 0.000933\,{}^{m^3}\!/_{s} \times 24h \times \frac{3600s}{h} = \mathbf{80.6m^3}$$

1:5-Year 24-Hour Post-development Runoff Volume

$$Q = (0.8) \times (1.2ha) \times \left(2.8\,{}^{mm}\!/_{h}\right) \times \frac{1}{360} = 0.0075\,{}^{m^3}\!/_{s}$$

$$V_{5post} = Qt = 0.0075\,{}^{m^3}\!/_{s} \times 24h \times \frac{3600s}{h} = \mathbf{645.1m^3}$$

$$\boxed{V_{5retain} = V_{5post} - V_{5pre} = \mathbf{567.4m^3}}$$

larger of the two volumes

Calculations

Project Name:	**Block F Development**	**Project #:**	**12-125**
Description:	**DFO Detention Requirements - Catchment B**	**Date:**	**27-Oct-15**

Stormwater Retention

Infiltration Area =	350	m^2	
Infiltration Rate =	1.13	mm/min	
Infiltration Capacity =	**567.8**	**m^3**	(24-hour period)
Volume Available for Capture =	645.1	m^3	total rainfall directed to ponds in 24hr period
Total Rainfall Capture	**567.8**	**m^3**	

✓ Capture Target Achieved

APPENDIX K – UEL DETENTION CRITERIA CALCULATIONS

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Calculations

Project Name:	**Block F Development**	**Project #:**	**12-125**
Description:	**UEL Detention Requirements - Catchment A**	**Date:**	**27-Oct-15**

UEL Detention Requirements:

1. Restrict the 100-year post-development runoff rate to that of the pre-developed condition

1:100 YEAR RETURN

Pre-Development Runoff Rate - 1:100-year Q_{100} = 0.1849 m^3/s (from Rational Method Calculations)

Maximum Release Rate (equal to Q_{100}) Q_{allow} = 0.1849 m^3/s

INFILTRATION

Infiltration Rate: 1.13 mm/min (From Geotech report)

Infiltration Flow 38.4 L/s

Infiltration Flow (Factor of Safety = 2) Q_i= 0.0192 m^3/s

Includes un-lined* portion of wetlands + area of bio swales

POST DEVELOPMENT - 100-YEAR RETURN

Runoff Coefficient R_{AVG} = 0.85

Catchment Area A = 7.6 ha

Time of Concentration Tc = 10 minutes

Hyd No.	Duration, Tr (minutes)	Rainfall Intensity, I (mm/h)	Peak Flow, Q_p (m^3/s)	Inflow Runoff Volume (m^3)	Release Rate $=Q_{allow}+Q_i$ (m^3/s)	Required Storage Volume (m^3)
1	8	66.0	1.184	568.1	0.2041	470.14
2	10	58.4	1.049	629.2	0.2041	508.14
3	15	46.9	0.842	757.7	0.2041	578.24
4	20	40.1	0.720	864.4	0.2041	626.22
5	30	32.2	0.578	1040.7	0.2041	684.40
6	40	27.6	0.495	1187.3	0.2041	712.2
7	60	22.1	0.397	1429.6	0.2041	***715.7***
8	120	15.2	0.273	1963.7	0.2041	529.4
9	180	12.2	0.219	2364.5	0.2041	206.6
10	360	8.4	0.150	3247.9	0.2041	-
11	480	7.2	0.129	3705.3	0.2041	-
12	600	6.4	0.114	4104.1	0.2041	-
13	720	5.8	0.103	4461.5	0.2041	-
14	1200	4.4	0.078	5637.5	0.2041	-
15	1440	4.0	0.071	6128.5	0.2041	-

Calculations

Project Name:	**Block F Development**	**Project #:**	**12-125**
Description:	**UEL Detention Requirements - Catchment B**	**Date:**	**6-Oct-15**

UEL Detention Requirements:

1. Restrict the 100-year post-development runoff rate to that of the pre-developed condition

1:100 YEAR RETURN

Pre-Development Runoff Rate - 1:100-year Q_{100} = 0.0354 m^3/s (from Rational Method Calculations)

Maximum Release Rate (equal to Q_{100}) Q_{allow} = 0.0354 m^3/s

INFILTRATION

Infiltration Rate: 1.13 mm/min (From Geotech report)

Infiltration Flow (350m^2 pond bottom) 6.6 L/s

Infiltration Flow (Factor of Safety = 2) Q_i= 0.0033 m^3/s

POST DEVELOPMENT - 100-YEAR RETURN

Runoff Coefficient R_{AVG} = 0.85

Catchment Area A = 1.2 ha

Time of Concentration Tc = 7 minutes

Hyd No.	Duration, Tr (minutes)	Rainfall Intensity, I (mm/h)	Peak Flow, Q_p (m^3/s)	Inflow Runoff Volume (m^3)	Release Rate =Q_{allow}+Q_i (m^3/s)	Required Storage Volume (m^3)
1	8	66.0	0.187	89.7	0.0387	71.13
2	10	58.4	0.166	99.4	0.0387	76.36
3	15	46.9	0.133	119.6	0.0387	85.49
4	20	40.1	0.114	136.5	0.0387	91.14
5	30	32.2	0.091	164.3	0.0387	96.45
6	40	27.6	0.078	187.5	0.0387	***97.0***
7	60	22.1	0.063	225.7	0.0387	89.8
8	120	15.2	0.043	310.1	0.0387	37.1
9	180	12.2	0.035	373.3	0.0387	-
10	360	8.4	0.024	512.8	0.0387	-
11	480	7.2	0.020	585.1	0.0387	-
12	600	6.4	0.018	648.0	0.0387	-
13	720	5.8	0.016	704.4	0.0387	-
14	1200	4.4	0.012	890.1	0.0387	-
15	1440	4.0	0.011	967.7	0.0387	-