FUNCTIONAL SERVICING REPORT

Moco Subdivision

East Side of County Road 25,
South of Grand River
Town of Grand Valley
County of Dufferin

July 2015

Prepared For: **Moco Farms Ltd.**

CORTEL GROUP

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1.0 INTRODUCTION

Valdor Engineering Inc. has been retained by Moco Farms Ltd. to provide consulting engineering services for the proposed Moco Subdivision located on a 34.42 hectare parcel on the east side of County Road 25, south of the Grand River, in the Town of Grand Valley, County of Dufferin as illustrated in **Figure 1**.

The subject site has been identified for mixed-use, urban residential settlement and employment land use by the Town of Grand Valley Official Plan, last consolidated in February 2014. This Report's emphasis will be for lands located on the west side of Boyne Creek. A proposal for the development of lands east of Boyne Creek will be made at a later date.

1.1 Existing Conditions

The subject site is bounded to the north by an abandoned railway corridor and the settlement area of Grand Valley, to the east and south by existing agricultural lands, and to the west by County Road 25. The site is traversed by Boyne Creek, a tributary of the Grand River, which flows in a northerly direction beneath the abandoned railway corridor to the Grand River. The majority of the subject site is presently a vacant field and a small area within the environmental protection lands is tree covered. The geotechnical and topographical conditions of the site are summarized in the subsequent sections.

1.1.1 Geotechnical

A Geotechnical Investigation Report for the subject site was prepared by V.A. Wood Inc. and consisted of eleven (11) total boreholes with three ranging in depth from 9.6m to 12.6m and eight test pits at a depth of 5.0m. The investigation determined that the site is covered by a surficial deposit of topsoil ranging between 100mm and 250mm, underlain by a deposit of brown clay and silt ranging between 0.8m to 4.6m below grade.

With regards to groundwater, the report indicates that seven of the boreholes encountered cave-in at approximately 1.5m to 8.5m below grade with an examination of the soil samples yielding a moist to wet observation. The report indicates that provisions should be made for the control of any surface water run-off and minor groundwater seepage by pumping from local sumps. The Report recommends that a side slope of 1:1 be cut back or, supported using adequately braced sheeting for excavations exceeding 1.2m below grade.

A slope stability analysis was also undertaken as part of the Geotechnical Investigation along the west valley slope and Boyne Creek. The vegetated slope was considered to be stable and a minimum calculated factor of safety was considered to be satisfactory against the Conservation Authority standard set forth. The borehole, test pit logs and slope stability analysis are included in **Appendix "G"**.

1.1.2 Topography

The surface condition of the subject site can be generally described having gently to steeply sloped topography. Based on a recent topographic survey of the site, the west part of the property slopes from County Road 25 down in a easterly direction towards Boyne Creek. The east part of the property slopes in a westerly direction towards the creek, while the creek drains northwards. Based on an existing elevation of 473.21 m at County Road 25 and an existing elevation of 459.50 m at the edge of the environmental protection buffer, the differential of 13.71 m equates to an overall average slope of approximately 3.6% for the development area which is considered to be relatively moderate. The valley area of the site within the environmental protection block slopes downwards to Boyne Creek at varying slopes as high as approximately 2H:1V.

1.2 Proposed Development

The proposed development consists of a mix of lots for detached dwellings and mixed use development (commercial-residential). The lot frontages for the detached residential dwellings will range from 40 to 50 feet. Access for the subdivision will consist of a road network with two road connections off County Road 25. A block of land at the north end of the subject site has been established for a stormwater management facility to treat stormwater runoff. A block of land located within Town lands, north of the stormwater management block has been allocated for a local sanitary pumping station to convey wastewater flow to the Grand Valley Wastewater Pollution Control Plant (WPCP) further detailed within Section 3.0 of this Report. A community park will be located near the south end of the residential development. The remainder of the lands consist of an environmental protection area comprised of the valley surrounding Boyne Creek and a block to the east of the valley that will not be developed at this time. A reduced copy of the proposed Draft Plan of Subdivision is contained in **Figure 2**. The development statistics and the equivalent population data are summarized in **Table 1**.

Table 1. Development Statistics

Criteria:

Single Residential Dwelling Population Density* *value retrieved from RJB WPCP Capacity Analysis, Section 3.0 – May 27, 2015 (per Town Planner)	3.15	Persons / dwelling
Mixed Use Population Density** **value retrieved from similar developments within nearby municipalities	75	Persons / ha

Land Use	**Area** (Ha)	**Residential Units** (No.)	**Equivalent Population** (persons)
Residential Units	5.72	111	**350**
Mixed Use	6.17		**463**
SWM Pond	1.58		
Park	0.49		
Street ROW	2.40		
Other Lands Owned by Applicant	6.89		
Opens Space, Walkways & EP Lands	11.17		
TOTAL	**34.42**	**111**	**813**

1.3 Purpose of Report

This report has been prepared in support of the application for draft plan approval for the subject property. The primary intent of the report is to demonstrate the viability of water and wastewater servicing, storm drainage and stormwater management, grading as well as vehicular and pedestrian access for the proposed development with respect to applicable guidelines, policies and design criteria.

This report has been prepared based on a review of the topographic survey and background studies and a visit to the site. The conceptual design is documented on a series of large size functional servicing plans which are contained in a pocket at the rear of this report. This document provides guidance for detailed engineering design of the subdivision.

1.4 Approving Authorities

This report will be circulated for review, comment and approval to:

1. The Town of Grand Valley;
2. The County of Dufferin; and
3. The Grand River Conservation Authority (GRCA).

2.0 WATER SERVICING

The Town of Grand Valley retained R.J. Burnside & Associates Limited (RJB) to complete an update to the Water and Wastewater Master Servicing Plan. This Technical Memo completed in May 2014 reflects recent historical water demands and wastewater flows, incorporate amendments undertaken to the Town's Official Plan, and adds to a previous Memo completed by RJB in 2010 with regards to the water and wastewater infrastructure's ability to meet future demands.

The report outlines the existing water supply system consisting of 3 wells; Cooper Street Pumphouse wells (PW1 and PW2) and the Melody Lane Pumphouse well (PW3). PW1 and PW2 do not operate at the same time, limiting operating capacity. An elevated water tower with a storage capacity of 1,600m^3 and high water level of 519.3m located off County Road 25, north of Fife Road functions as part of the distribution system water storage and supplements the well supply during high demand periods. Based on the Memo's analysis of existing and future condition water service demands it was determined that the existing infrastructure would not be able to meet the future demand and that additional water supply, treatment and storage be implemented to meet the impending requirement. Of particular note is the Memo's recommendation to construct a new water tower, with similar capacity and storage to the existing tower, at the south end of the Town to accommodate the demand imposed on the system from the forthcoming southern developments where the subject site is located. This recommendation also adds that a Schedule B Class Environmental Assessment (EA) be undertaken to investigate the additional water capacity and storage requirements when the serviced population increases from 1,482 persons to 2,300 persons, or 3 to 5 years in advance of the need for the water supply, according to the Memo.

Further details with regards to the existing and future water supply and distribution can be found within the mentioned Technical Memo. The following is a summary of the water servicing requirements for the subject site.

2.1 Domestic Demand

The domestic water demand is to be calculated using the Town and Ministry of the Environment design standards which includes the following parameters:

Average Day Demand:	450 L/person/day
Maximum Day Factor:	2.75
Peak Hour Factor	4.13

A detailed tabulation of the domestic water demand calculation is detailed in **Table A1** and **Table A2** of **Appendix "A"**. The demands are summarized in **Table 2** below.

Table 2. Domestic Water & Fire Flow Demand

Land Use	**Equivalent Population** (Persons)	**Domestic Demand** (L/min)	**Maximum Day Demand** (L/min)	**Peak Hour Demand** (L/min)	**Fire Flow** (L/min)	**Maximum Day Plus Fire Flow** (L/min)	**Maximum Day Plus Fire Flow** (L/s)
Residential Units	**350**	109	301	452	6,000		
Mixed Use	**463**	145	398	598	-		
TOTAL	**813**	**254**	**699**	**1,050**	**6,000**	**6,699**	**113**

2.2 External Watermains

In accordance with the recommendations of the Technical Memo, a 300mm trunk watermain is proposed to be extended from its current terminus southerly from the existing WPCP along County Road 25 and across the frontage of the subject site. The proposed schematic extends the watermain to the southern entrance of the subject site which will facilitate the loop as required by the Town standards. This watermain is anticipated to connect to the proposed water storage tank which will be constructed at the south end of town, with an exact location of the facility to be determined after a Class EA stated in the Memo has been initiated. This system will feed a local distribution network which will provide water supply to the subject lands. The configuration of the water distribution system is illustrated on **Dwg. WM-1**.

2.3 Local Watermains & Service Connections

The local water distribution system within the subdivision will consist of watermains ranging in diameter from 150mm to 200mm. This water system will connect to the trunk watermain aforementioned in the preceding section.

In accordance with Town standards the individual detached dwellings are each to have separate water connections. Based on Ontario Building Code (OBC 2012) regulations (7.6.3.4.(1) and (5) and Table 7.6.3.4), the single residential unit dwellings will be serviced with 25mm diameter water connections. The size of service to be provided for the mixed use unit is to be determined during detailed design, as the details of the building to be constructed has not been yet established. Water meters shall be equipped as specified within Town standards.

2.4 Fire Protection

The fire flow required for the proposed detached dwelling units and commercial buildings was calculated using the criteria indicated in the *Water Supply for Public Fire Protection Manual*, 1999, by the Fire Underwriters Survey (FUS). The calculation incorporates various parameters such as coefficient for fire-resistant construction, an area reduction accounting for a fire-resistant (one hour rating) protection, a reduction for low-hazard occupancies, and a factor for neighbouring building proximity.

The calculation was completed to reflect the governing conditions which are the largest detached dwelling and the largest interior multi-use unit. Based on the calculations, the minimum fire suppression flow required for the residential units is 6,000 L/min. The calculation for minimum fire suppression flow for the mixed use unit is to be determined during detailed design, as the details of the building to be constructed has not been yet established. The detailed fire flow calculations are shown in **Table A-1** to **Table A-2** of **Appendix "A"**. In accordance with the Town standards, this flow must be a minimum fire flow of 79 L/s to the highest lot in the development with a minimum pressure of 140 KPa.

Fire hydrants will be provided along the private road such that a fire hydrant will be available approximately within 100m of one another and not be spaced exceeding 120m, as set out in the Town standards.

3.0 WASTEWATER SERVICING

The Town is currently serviced by the existing Grand Valley Wastewater Pollution Control Plant (WPCP) located at the east end of Industrial Road and just north of the subject site. This WPCP was commissioned in July 2011 with an average daily flow rating of 1,244m^3, designed for a population of 2,950 persons.

In addition to the Technical Memo composed by RJB as detailed in the previous section, a letter was completed to the Town by RJB in May 2015 updating the latter report's assessment of available capacity at the WPCP. The update also provided details on the population demands, wastewater flows and the capability of the WPCP to accommodate future planned developments. Both the 2014 Memo and 2015 Letter determined that the existing plant will need to be upgraded to manage future flow and capacity requirements. An Assimilative Capacity Study for the WPCP was completed in 2013 by XCG Environmental Engineers and Scientists (XCG) in conjunction with RJB, and concluded that a Class EA Study be undertaken to further examine the need to increase capacity for the future scenario at the WPCP facility. The XCG report findings were included as part of the 2014 Technical Memo conclusions.

The subject site was part of the study area considered and was partitioned into a separate sanitary drainage area (Area E2) within the 2014 Technical Memo. The proposed sanitary area E2 alongside adjacent future developments located east of the site (Area E1) were recommended to convey wastewater flow to a new local Sanitary Pumping Station (SPS-A), that would then relay the flow to the WPCP. Area E1 also includes the area of land located east of Boyne Creek known within the Draft Plan as Block 119 and within the 2014 Technical Memo as the Moco Employment Lands.

The Memo provides an assessment of the wastewater flows by formulating an estimate of the expected population to settle on these lands. The updated analysis within the Letter presents revised population density values and occupancy figures to determine the immediate demand on the existing system and the remaining capacity of the WPCP to meet those demands. Allocation for the remaining WPCP capacity was divided amongst 4 separate, impending developments with one of the developments identified as the subject site. Projected population and land use values were estimated for the Moco development to contain 7 residential lots and 15.3 ha of employment lands, yielding a total population allocation of 192 people to be serviced at the WPCP per the Letter.

A more detailed review of the baseline information against the proposed design yields variances between both datasets. These discrepancies are summarized as follows:

- Population Density: Population density unit rates differ between the Town Design Standards and the 2015 Letter. Utilizing the lower unit rates in the Letter as part of this design submission, the population of the subject development is estimated to be 813 persons within the proposed design, an increase of 621 persons from an initial estimate of 192 persons made within the Letter. As a result, an increase in wastewater allocation allotment at the existing WPCP is required for the Moco subdivision.
- Location of SPS-A: Analysis of the subject site's topography warrants that the SPS-A location be further examined in consideration of the proposed site plan and the routing overland stormwater flow via gravity drainage.
- Moco Employment Lands: A discrepancy for the land use estimate for the Employment Lands exists within the baseline information. The 2014 Memo allocates 2.4ha of land as the Employment Lands requiring wastewater servicing, whereas the 2015 Letter designates 15.3ha of Employment Lands to require WPCP allocation. The Moco Employment Lands presented as part of this submission is shown as Block 119 with an area of 6.89ha. Provided that a determination of "developable" land is still outstanding at the time of this Report, it is yet unknown to the exact amount of wastewater allocation required by Block 119.

A wastewater management strategy has been optimized for the Moco Subdivision that considers the points listed above, as well as the recommendations provided within the Technical Memo. This strategy includes placing SPS-A at the northeast corner of the subject site, north of the SWM Block within Town lands, to allow for gravity drainage of the local system to follow the general topography and allocate servicing for the future development of Block 119. Its location potentially facilitates wastewater servicing of the future Corseed Lands development, or Area E3 in the Memo, located northwest of the subject site. The subsequent sub-sections detail the wastewater servicing analysis for the subject site.

3.1 Wastewater Loading

The wastewater loading is to be calculated using the Town engineering design standards which include the following parameters:

Residential Average Daily Flow: 450 L/person/day

Peaking Factor: $K_H = 1 + \frac{14}{4 + \sqrt{P}}$

Where: K_H = Harmon Peaking Factor (Max. 4.0, Min. 2.75)
p = Population in thousands

Extraneous Flow, I: 0.20 L/ha/s (Infiltration)

Design Flow, Q_D = $Q_{RES} \times K_H + I$

Based on the above criteria the sewage flow calculations to be conveyed to SPS-A are provided for the Moco Subdivision and future Corseed Subdivisions in **Tables B1 and**

B2 contained in **Appendix "B"** and the total flow for each property is summarized in **Tables 3 and 4**.

Table 3. Wastewater Loading Summary Moco Subdivision

Land Use	**Area** (Ha)	**Equivalent Population** (Persons)	**Average Daily Flow** (L/s)	**Harmon Peaking Factor**	**Peak Daily Flow** (L/s)	**Infiltration Rate** (L/s)	**Total Flow** (L/s)
Residential Units	5.72	350	1.82	4.00	7.29	1.14	8.44
Mixed Use Units	6.17	463	2.41	3.99	9.62	1.23	10.86
TOTAL	**11.89**	**813**	**4.23**		**16.92**	**2.37**	**19.30**

Table 4. Wastewater Loading Summary Corseed Subdivision (Anticipated)

Land Use	**Area** (Ha)	**Equivalent Population** (Persons)	**Average Daily Flow** (L/s)	**Harmon Peaking Factor**	**Peak Daily Flow** (L/s)	**Infiltration Rate** (L/s)	**Total Flow** (L/s)
Residential Units	3.87	230	1.20	4.00	4.79	0.77	5.57
Mixed Use Units	1.35	102	0.53	4.00	2.13	0.27	2.40
TOTAL	**5.22**	**332**	**1.73**		**6.92**	**1.04**	**7.97**

3.2 External Sanitary Sewers

In accordance with the proposed initiatives stated within Section 3.0, it is being proposed to place SPS-A to the north of the SWM Block, within Town owned lands, northeast of the subject site that also contain the WPCP. The location of SPS-A was determined after an analysis of the existing topography of the area was undertaken to select a route which minimizes the depth of the gravity sanitary sewer network for the Moco Lands. Based on the preceding table, the total sanitary outflow of the subject site (19.3 L/s) is within the anticipated outflow allocation set forth within the 2014 RJB Technical Memo (28 L/s).

The proposed SPS-A location also considers the potential sanitary connections of the E1 and E3 lands (known as the Moco Employment and Corseed Subdivision lands, respectively) to the Pumping Station, and is illustrated within the drawings. The consideration of SPS-A to handle the wastewater flow of adjacent lands reduces the impact of increased flow within the existing infrastructure, notably for the Corseed Development which was recommended within the RJB Memo to ultimately convey its sanitary outflow to the existing Emma Street pumping station. Bypassing the Corseed wastewater flow to SPS-A provides increased capacity for future developments connecting to the existing infrastructure directed to Emma Street PS, notably for Areas E4 and E5 located north of the Corseed Lands.

Ultimately, regardless of the method sanitary outflow routing, consideration must be given to the variance between the estimates made within the baseline information and the proposed development plans set forth in this submission to determine the appropriate allocation at the existing WPCP. A future capacity analysis involving the Moco Employment Lands and the Corseed Development with respect to SPS-A would be required at a future date when the development plans for the adjacent lands become available to determine the feasibility of this schematic.

The preliminary layout of the sanitary sewers has been included on **Dwg. FSP-1** which includes sanitary obvert values to illustrate the depth of the sewer along the alignment. The contributing areas are delineated on **Dwg. SAN-1**.

3.3 Local Sanitary Sewers & Service Connections

The subject site will be serviced by a local sanitary system consisting of sewers which will discharge to SPS-A north of the SWM Block. The local sanitary drainage system will be by gravity and follow road grade slopes where possible. In accordance with standard practice and Town standards, manholes will be provided for maintenance access at a maximum spacing of 120m and private service connections will be provided as specified within Town Standards.

4.0 STORM CONVEYANCE SYSTEM

The subject site is located in the Boyne Creek watershed which is part of the larger Grand River watershed under the jurisdiction of the Grand River Conservation Authority (GRCA). Boyne Creek originates from the Luther Marsh Wildlife Management Area and generally flows in an easterly direction before discharging into the Grand River. Boyne Creek meets the Grand River approximately 235 km upstream of Lake Erie. A map illustrating the Grand River watershed is contained in **Appendix “C”**.

In accordance with Town standards, a major / minor system storm conveyance concept has been incorporated into the functional servicing design for the subject development. The following sections provide a brief summary of the storm drainage components:

4.1 Minor System Design

As per the Town engineering design criteria, the proposed development is to be serviced with a minor storm sewer system that is designed to convey runoff from the 5 year storm event. The rainfall intensity values, *I*, are calculated in accordance with the 1961-2007 rainfall intensity duration frequency (IDF) data for the Fergus Shand Dam weather station which was obtained from Environment Canada. Based on this data the rainfall intensity for the 5 and 100 year rainfall events is calculated as follows:

$$I_5 = \frac{1525.827}{(t+12.117)^{0.862}} \qquad I_{100} = \frac{4789.414}{(t+21.844)^{0.949}}$$

The peak flows are calculated using the following formula:

$Q = R \times A \times I \times 2.778$ where: Q = peak flow (L/s)
A = area in hectares (Ha)
I = rainfall intensity (mm/hr)
R = composite runoff coefficient
t = time of concentration (min)

The proposed storm sewer will discharge to Boyne Creek via the proposed SWM pond within the centre of the site as per the pre-development condition.

A schematic design of the minor system is illustrated in on **Dwg. FSP-1** and the catchment areas are delineated on **Dwg. STM-1**.

4.2 Major System Design

The major system will generally be comprised of an overland flow route along the municipal road network directing drainage to the proposed SWM pond and a safe outlet. This major system will convey flows which are in excess of the capacity of the minor storm sewer system. The major system flow route is illustrated in **Dwg STM-1**.

4.3 Foundation Drainage

In accordance with Town standards, storm service connections are to be provided to each unit. It is anticipated that the dwellings will have basements and will be serviced by direct gravity connections to the main line storm sewers on the respective roadway, as preferred by the Town.

4.4 Roof Drainage

It is anticipated that the proposed dwellings will have conventional peaked roof with eaves troughs and downspouts. As per standard practice the downspouts are to discharge to grade over splash pads, preferably towards sodded areas. Roof downspouts are not to be connected to the storm sewer.

4.5 Flood Plain

Existing flood estimation mapping was obtained from the Grand River Conservation Authority website. In order to better establish the limits of the existing floodplain within the subject property, a detailed hydraulic model was prepared using HEC-RAS based on surveyed cross sections completed along the watercourse. Peak flows were provided by the GRCA and were based on a previous study completed upstream of the site. The location of the existing floodplain is shown on **Figure 3** and **Figure 4**. The results of the hydraulic model are provided in **Appendix "D"**. All proposed development, grading and pond outlet structures will be located outside of the floodplain and the area regulated by the GRCA, except for rip-rap erosion protection associated with the SWM pond to be provided on the valley slope.

5.0 STORMWATER MANAGEMENT

5.1 Storm Drainage Areas

Based on the topographic survey and the proposed draft plan of subdivision, the following is a summary of the pre and post development drainage areas.

5.1.1 Pre-Development

A tributary of the Grand River (Boyne Creek) passes to the east of the proposed development before it flows beneath an abandoned railway corridor and into the Grand River. The overall site topography west of Boyne Creek generally falls easterly, while the site east of Boyne Creek generally falls westerly. The proposed SWM Pond will collect drainage from the proposed development and direct it to the outlet at Boyne Creek. Site elevations vary from 473.21 m adjacent County Road 25 to approximately 452.13 m adjacent Boyne Creek. The existing slopes range from approximately 0.6% to 50%.

The existing site land use is primarily agricultural with some wooded areas adjacent the creek. **Figure 3** shows the drainage patterns for existing conditions.

5.1.2 Post-Development

The subject site will be developed into a mixed-use development including medium-density residential, a SWM pond block and mixed-use (commercial-residential) areas. Drainage patterns will generally follow existing conditions, with all development area drainage to be directed through the proposed SWM facility before it discharges to Boyne Creek. **Figure 4** shows the details of the proposed drainage plan for the subject site.

5.2 Stormwater Management Design Criteria

The proposed SWM facility shall be designed to provide the following levels of control as per the requirements of the Ministry of the Environment (MOE), Grand River Conservation Authority (GRCA) and Town of Grand Valley:

- **Quality control**: The permanent pool shall be sized to provide Normal (Level 2) treatment of stormwater runoff for the proposed development.
- **Erosion control**: Stormwater runoff from the 25 mm storm event shall be stored and released over a minimum 24 hour period.
- **Flood control**: Flood storage and control shall be provided to maintain peak outflows from the pond at or below pre-development levels for the critical of the 12 & 24-hour SCS, 1, 6 & 12-hour AES and the 3-hour Chicago storm distributions for the 2-yr through 100-yr design storm events.

5.3 Stormwater Management Pond Design

A SWM facility is proposed to serve the subject development area. This SWM facility will discharge through an outfall located near the northeast corner of the development area. The total service area for the SWM facility is approximately 16.4 ha. The proposed SWM pond is located at the northeast corner of the proposed development, to the west of Boyne Creek as illustrated in **Figure 4**.

Per the Town standards and MOE SWM pond criteria, the SWM pond design includes 5H:1V side slopes above and below the permanent pool level. This also meets the MOE requirement to provide a 5H:1V safety shelf for 3.0m on either side of the permanent pool elevation (NWL) of 464.50 m. A 5.0 m wide access road with maximum 10% slope has been provided to the bottom of the forebay and access to the facility is provided from the subdivision. The details of the proposed SWM Pond are provided in **Dwg. SWM-1**.

5.3.1 Quality Control

Various source controls, conveyance and end-of-pipe SWM facilities were considered to provide the appropriate level of stormwater quality control. Reduced lot grades, rear and side yard swales, and discharge of roof leaders to pervious surfaces will augment the control provided by the SWM facility and promote infiltration where possible. Based on a preliminary review of available controls, it appears that the primary and most effective option to provide water quality control for runoff from the contributing drainage areas is a SWM facility. The options reviewed are as follows:

- Roof Leader to Ponding Areas or Soakaway Pits (Lot Level): The Town design criteria do not address the use of ponding areas or soakaway pits in the rear yards. Roof leaders will discharge directly to pervious surfaces to encourage infiltration and filtration on the lots. Soakaway pits can be an effective means of improving infiltration of stormwater, but require a large area in comparison to typical residential rear yard dimensions. As a result, soakaway pits and ponding areas are not recommended.
- Grassed Swales (Conveyance): Rear and side yard swales will be incorporated into the grading plan. The swales will convey runoff to rear lot catch basins. The number of rear lot catch basins will be minimized in order to encourage infiltration via swales.
- Stormwater Management Facilities (End-of-Pipe): Based on discussions with the GRCA, SWM facilities are required to provide water quality, extended detention and flood control of stormwater runoff. Stormwater management facilities will be constructed within the Subject Property.
- Oil/Grit Separation Technologies (End-of-Pipe): These SWMF’s can be effective for smaller, high impervious sites where spill protection is desired and when area for a stormwater pond is unavailable. The construction of the stormwater pond will eliminate the need for any oil/grit separation units.

- Infiltration Trenches/Basins (End-of-Pipe): These SWMF's are most effective in areas with highly pervious soils and large areas.

In accordance with the GRCA requirements for development within the Boyne Creek watershed, a minimum of Normal (Level 2) water quality protection shall be provided by the proposed SWM facility.

The drainage area to the SWM pond consists of approximately 16.4 ha. The total assumed imperviousness of the drainage area tributary to the SWM pond is 75%. The required permanent pool volume for the SWM Pond is provided below.

SWM Pond Permanent Pool Volume Calculation

Volume required for catchment with 75% imperviousness:	136.7	m^3/ha
Less 40 m^3/ha of extended detention storage zone:	- 40.0	m^3/ha
Permanent Pool Volume Required:	96.7	m^3/ha

The permanent pool storage volume required for the Pond is 96.7 m^3/ha × 16.436 ha = 1,589 m^3.

In order to maintain a permanent pool of water in the pond and to prevent the mixing of surface water with ground water, a pond liner may be required. This will be confirmed at detailed design.

The normal water level of the permanent pool for the pond is set at an elevation of 463.50 m. The bottom of the pond is set at an elevation of 462.50 m and this provides 1.00 m depth of permanent pool for both the forebay and the main cell. The actual permanent pool storage volume provided is approximately 3,157 m^3 which is greater than the minimum required volume to meet the Normal (Level 2) quality control requirement (1,589 m^3). The required and provided quality control volume together with the elevation of the normal water level are summarized in **Table 5**.

The forebay have been sized based on MOE design criteria and supporting calculations are provided below.

Forebay Sizing Calculations

The proposed forebay is approximately 65 m in length and 23 m in width, on average. The resultant length-to-width ratio is therefore 2.8:1. Using the methodology provided in the Stormwater Management Planning and Design Manual, the recommended forebay length based on particulate settling is calculated using the following expression:

$$Dist = \sqrt{\frac{r \cdot Q_p}{V_s}} \qquad [1]$$

where: *Dist* is the forebay length (m)
r is the length-to-width ratio of the forebay (2.8:1 or r = 2.8)
Q_p is the pond's peak discharge (0.025 m^3/s, OTTHYMO modelling of 25 mm storm)
V_s is the settling velocity (0.0003 m/s for 150 µm particles)

Solving [1] gives:

$$Dist = \sqrt{\frac{2.8 \times 0.025}{0.0003}} = 15.3 \text{ m}$$

The recommended forebay length based on flow dispersion calculations is calculated using the following expression:

$$Dist = \frac{8 \cdot Q}{d \cdot V_f} \qquad [2]$$

where: *Dist* is the forebay length (m)
Q is the peak inlet flow (2.58 m^3/s, OTTHYMO modeling of 5-year storm)
d is the depth of the permanent pool in the forebay (1.00 m)
V_f is the desired velocity in the forebay (0.50 m/s)

Solving [2] gives:

$$Dist_w = \frac{8 \times 2.58}{1.00 \times 0.50} = 41.3 \text{ m}$$

The distance from the headwall to the forebay berm is 65 m; therefore, the proposed design satisfies the minimum forebay length recommendations.

The minimum recommended forebay bottom width is calculated as follows, based on the maximum distance from the calculations above:

$$Width = \frac{Dist}{8} = \frac{41.3}{8} = 5.2\text{m} \qquad [3]$$

The design proposes an average forebay bottom width of approximately 13 m, which satisfies this criterion.

5.3.2 Erosion Control

In accordance with the GRCA guidelines, erosion control shall typically be provided using an extended detention active storage zone sized to capture the runoff resulting from a 25 mm rainfall event and to release the runoff over a period of at least 24 hours. Based on calculations using the VO2 model, the required erosion volume for the SWM facility is 2,873 m^3 with a peak flow release rate of 0.029 m^3/s. The OTTHYMO model parameters and the results are included in **Appendix "D"**.

Based on the design for the SWM pond, the erosion control volume provided is 2,947 m^3 at an elevation of 464.10 m. This meets and/or exceeds the respective erosion volume requirement of 2,873 m^3 for the pond. The proposed extended detention depth is 0.60 m, which is less than the maximum recommended extended detention depth of 1.00 m.

The required detention time and release rate will be achieved using an orifice plate installed within the pond outlet control structure.

The extended detention active storage zone will capture the runoff volume resulting from a 25 mm rainfall event and release it over at least 47 hours, which exceeds the required 24-hour detention. A 4 hour, 25 mm Chicago distribution storm was used for this analysis. Based on the calculations below, the drawdown time for the proposed SWM Pond is approximately 47.2 hours with a 135 mm diameter orifice, which meets the minimum 24 hour release criteria. More detailed calculations will be provided at the detailed design stage.

Extended Detention Control Structure

Based on hydrologic modelling of this storm condition, the estimated runoff volume is 17.48 mm distributed over the 16.4 ha catchment area for a required capture volume of 2,873 m^3. The available volume in the extended detention storage zone, up to the elevation of 464.10 is approximately 2,947 m^3, which meets the volumetric criterion.

The extended detention function of the pond will be controlled with a 135 mm diameter orifice plate located in a control manhole to meet the drawdown time criterion of 24 hours (minimum).

The drawdown time can be calculated using the following expressions, from the *Stormwater Management Planning and Design Manual*:

$$t_d = \frac{0.66 \cdot C_2 \cdot h_1^{1.5} + 2 \cdot C_3 \cdot h_1^{0.5}}{2.75 \cdot A_o} \qquad [4]$$

where: t_d is the drawdown time (s)
h is the maximum water elevation above the orifice (0.60 m)
A_o is the cross-sectional area of the orifice (0.0143 m^2)
C_2 is the slope coefficient from area-depth linear regression (2642.8)
C_3 is the intercept from area-depth linear regression (4118.1)

The variable *h* is the maximum water elevation above the centroid of the orifice and is calculated as follows (invert of orifice set at normal water level):

$$h_1 = HWL_{25mm} - \left[NWL + \frac{D}{2} \right] = 464.10 - \left[463.50 + \frac{0.135}{2} \right] = 0.5325 \text{ m}$$

where: HWL_{25mm} is the high water level for the 25 mm rainfall (464.10 m)
NWL is the normal water level (463.50 m)
D is the diameter of the orifice (0.135 m)

Solving [4] yields:

$$t_d = \frac{0.66\times(2642.8)\times(0.5325)^{1.5} + 2\times(4118.1)\times(0.5325)^{0.5}}{2.75\times(0.0143)} = 170{,}069\ s = 47.2\ h$$

The orifice size, erosion control release rate, draw down time, extended detention volume and water level are summarized in **Table 5**.

5.3.3 Quantity Control

Per the GRCA and the Town's standards, the SWM facility shall be designed to control the post-development peak flow to pre-development levels for the 2-year through 100-year design storms and to safely convey the Regional flow. The overall drainage area to the proposed SWM facility is approximately 16.4 ha. The SWM facility will be sized to control post-development peak flows to pre-development levels up to and including the 100-yr storm using the VO2 model and the 12-hr SCS storm distribution. The 12-hour SCS storm distribution was determined to be critical based on a critical storm analysis completed for the proposed SWM Pond. The pre-development flow targets are provided in **Table 4**. The critical storm analysis is provided in **Table D.8** which is included in **Appendix "D"** together with the VO2 model schematic, catchments and pre-development flow calculations.

Post-development peak flows will be controlled to pre-development levels for the 2 through 100 year design storms. A Visual OTTHYMO model was created to simulate the design performance of the SWM Pond using the 12-hour SCS design storms created using the latest Fergus Shand Dam IDF data obtained from Environment Canada as specified in the Town of Grand Valley standards. An analysis of pond storage requirements based on the 12-hr & 24-hr SCS storms, the 1-hr, 6-hr and 12-hr AES storms and the 4-hour Chicago storm was completed to determine the critical storm duration (see **Table D.8**). Based on this analysis, the 12-hr SCS storm requires a larger storage volume for the 100-year return period event. Therefore, the 12-hr SCS storm distribution was determined to be the critical storm and was used to design the SWM facility. **Table 4** shows the VO2 simulation results for each development condition and **Table 5** shows the SWM facility performance characteristics for each return period event based on the preliminary rating curve. The rating curve includes quality and quantity control structures and an emergency spillway. The control structure design, including orifices and weirs, will be undertaken during the detailed design and will attempt to replicate the storage-discharge curve used in these preliminary analyses. The actual pond performance will also be finalized at the detailed design stage when the outlet structures are designed.

The SWM pond has been designed with a total active storage volume of 7,480 m^3 at an elevation of 464.80 m. The expected maximum storage required during 100 year storm conditions is approximately 7,173 m^3; therefore, the provided active storage for the pond is sufficient. As shown in **Table 4**, the peak discharge rates are equal to or less than the target release rates. The preliminary rating curve is presented in **Table D.1** which is included in **Appendix "D"** together with the output from the hydrologic modeling of the SWM pond.

Table 5. Summary of Storm Drainage Peak Flows

Return Period	**Existing Peak Flows** (m^3/s)	**Proposed Peak Flow** (m^3/s)
2 year SCS	0.566	0.342
5 year SCS	0.988	0.774
10 year SCS	1.287	1.061
25 year SCS	1.681	1.460
50 year SCS	1.978	1.672
100 year SCS	2.279	1.808

5.3.4 Thermal Mitigation Measures

Mitigation measures shall be incorporated into the SWM pond design to minimize thermal impacts to the receiving watercourse. These measures include a bottom draw pipe and a planting strategy to promote shading along the pond perimeter.

Bottom Draw Pipe

Instead of the common perforated riser configuration, a bottom draw pipe will be implemented for the extended detention component to discharge water from the deepest section of the pond where the water temperature is lowest. This outlet consists of a submerged intake headwall and a bottom draw pipe which discharges via an orifice plate in the quality control structure. Given that this pipe is sized for frequent rainfall events (25mm storm), it will provide the greatest benefit to the thermal regime of the receiving watercourse.

Planting Strategy

In accordance with the Town and GRCA requirements the SWM facility will be planted to provide a natural appearance and to provide environmental benefits. The landscape plan will specify shade producing species to minimize solar heating of the permanent pool during summer months. The forebay design provides additional pond perimeter where shade producing vegetation can be planted.

5.3.5 SWM Pond Inspection & Maintenance

The stormwater management facility should be inspected periodically to determine the frequency of maintenance activities. As such, maintenance activities will be performed on an as-required basis. During the first two years of operation, it is recommended that the stormwater management facility be inspected following significant storm events to determine if and when maintenance activities are required. Subsequently, inspections should be carried out twice per year. The following items should be considered when inspecting the pond:

- Sediment accumulation to determine cleanout requirements;
- Erosion of side slopes and outfall channel;
- Safety hazards;
- Hydraulic operation of the pond;
- Drawdown time following a rainfall event (extended drawdown time greater than 48 hours may indicate a blocked orifice or intake);
- Condition of terrestrial and aquatic vegetation;
- Trash accumulation near hydraulic structures; and
- Surface sheen indicating possible oil contamination.

Table 6: Stormwater Facility Performance Summary

Quality Control		
	Protection Level	Level 2 (Normal)
	Permanent Pool Required (m^3)	1,589
	Permanent Pool Provided (m^3)	3,157
	Normal Water Level, NWL (m)	463.50

Erosion Control		
25-mm 4-hour Chicago	Orifice Size (mm)	135
	Draw Down Time (hrs)	47.2
	Flow In (m^3/s)	1.07
	Flow Out (m^3/s)	0.025
	Storage Used (m^3)	2,632
	Pond W.S. Elevation (m)	**464.04**

Quantity Control		
2 Year Storm Event	Flow in (m^3/s)	1.82
	Flow Out (m^3/s)	0.34
	Storage Used (m^3)	3,467
	Pond W.S. Elevation (m)	**464.19**
5 Year Storm Event	Flow in (m^3/s)	2.58
	Flow Out (m^3/s)	0.77
	Storage Used (m^3)	4,310
	Pond W.S. Elevation (m)	**464.33**
10 Year Storm Event	Flow in (m^3/s)	3.27
	Flow Out (m^3/s)	1.06
	Storage Used (m^3)	5,060
	Pond W.S. Elevation (m)	**464.45**
25 Year Storm Event	Flow in (m^3/s)	4.01
	Flow Out (m^3/s)	1.46
	Storage Used (m^3)	5,921
	Pond W.S. Elevation (m)	**464.58**
50 Year Storm Event	Flow in (m^3/s)	4.55
	Flow Out (m^3/s)	1.67
	Storage Used (m^3)	6,516
	Pond W.S. Elevation (m)	**464.66**
100 Year Storm Event	Flow in (m^3/s)	5.11
	Flow Out (m^3/s)	1.81
	Storage Used (m^3)	7,173
	Pond W.S. Elevation (m)	**464.76**

5.4 Site Water Balance

In accordance with the requirements of the GRCA, a site water balance assessment was completed for the subject development area to determine the overall infiltration deficit under proposed conditions and to design infiltration facilities as part of an overall mitigation strategy to maintain pre-development infiltration volumes. Data for the assessment was obtained from soil mapping obtained from the Ontario Soil Survey mapping for Dufferin County, satellite imagery and the *Stormwater Management Planning and Design Manual* (Ministry of the Environment, March 2003). These documents provide information with respect to the soil types and soil infiltration rates. The following sections detail the methodology, volume calculations and proposed infiltration mitigation measures necessary to achieve a post-development site infiltration balance.

5.4.1 Methodology

The approach for estimating water balance volumes is based on the method described in the Stormwater Management Planning and Design Manual (MOE, 2003). The assessment was completed for the site using soils and land use information to calculate weighted evapotranspiration values. Weighted water surplus volumes were then calculated and a weighted infiltration factor was calculated. Surplus volumes were then split into runoff and infiltration components for existing and proposed conditions.

With regards to land use, the analysis reflects existing conditions which is described as agricultural. The proposed land use is residential and mixed-use (commercial-residential) with the pervious component being limited to the lawn areas.

The assumed hydrologic soil group (HSG) for the site was based on a review of soils mapping, which showed the predominant soil type within the subject development to be HSG “BC”. Under proposed conditions, it is assumed that existing soils will be used in the grading of the proposed development and therefore HSG “BC” soils were also assumed for the site under proposed conditions. The existing site soils were assumed to have a 15mm/hr percolation rate for the calculation of the infiltration trench maximum depth. It is recommended that a percolation rate be provided by the geotechnical consultant at detailed design to confirm the maximum allowable infiltration trench depth.

The water balance calculations including water holding capacity assessment, infiltration factor selection, rainfall analysis and evapotranspiration analysis are provided in **Table E.1** to **Table E.5** which are contained in **Appendix “E”**.

5.4.2 Existing Conditions Water Balance Volumes

The pre-development baseline site infiltration condition was calculated using the Toronto Pearson Airport Climate Normal 1971 – 2000 data from Environment Canada and the current land cover and land use pattern. Based on the MOE Infiltration Factor Method, the calculated infiltration factor for the site under existing conditions was 0.47. The calculations indicate that the existing annual surplus is

35,023 m^3 and the annual infiltration capacity is 16,461 m^3. The results of the annual water balance analysis for the existing condition are presented in the first row of **Table E.1**.

5.4.3 Post-Development Unmitigated Water Balance Volumes

Under post-development conditions and without implementing any infiltration mitigation measures, it is estimated that approximately 6,558 m^3 of water will infiltrate the ground. This represents 39.8% of the existing infiltration volume. The notable reduction in infiltration volume is the result of an increase in the impervious area associated with the proposed development. The results of the annual water balance analysis for the proposed condition, with no infiltration best management practices, are presented in the second row of **Table E.1**. Therefore, mitigation measures are necessary to achieve the site infiltration water balance.

5.4.4 Site Infiltration Mitigation Measures

In order to minimize the impact of development on the future water balance for the site, infiltration mitigation measures will be promoted and incorporated within the proposed development. These measures include basic and enhanced best management practices (BMPs) as follows:

Basic Best Management Practices

The following basic BMPs are to be implemented on the subject site:

- Roof down spouts of the dwellings will be directed to pervious lawn areas and grassed swales where feasible to promote infiltration;
- Where applicable, grassed swales will be constructed along side and rear lot lines;
- For lots abutting the existing valley to the east, all roof drainage and rear yard drainage is to sheet flow across the buffer, where possible, to encourage infiltration; and
- Where possible, the fine grading of lots will be completed with an extra depth of topsoil to encourage infiltration and absorption.

Under proposed conditions with the implementation of the above infiltration BMP's, approximately 8,214 m^3 of water will infiltrate the ground which equates to approximately 49.9% of the pre-development infiltration volume. It is assumed that each of the approximately 100 proposed lots has an average roof area of 150 m^2, which will need to be confirmed at detailed design. The third row of **Table E.1** provides the summary of the calculations for the post-development condition with basic infiltration BMP's.

Enhanced Best Management Practices

In an effort to better match the existing infiltration volumes, enhanced infiltration BMP's in the form of infiltration trenches is required. These measures will serve to further promote the infiltration of runoff from the proposed development.

Through the implementation of the proposed infiltration trenches, the annual infiltration capacity can increase by 8,538 m^3, which represents 51.9% of existing infiltration capacity. As a result, the post-development infiltration volumes for the site will be 16,752 m^3, which is 101.8% of the pre-development volume. The areas directed to the infiltration trenches will include the rear yard areas of the adjacent lots as well as the roof areas, which will drain overland. Based on the water balance calculations completed, a minimum area of 3.40 ha including rear yard and roof areas will need to be directed to the proposed infiltration trenches to achieve the required annual infiltration volume. It will also need to be confirmed that the seasonal high groundwater level is a minimum of 1.0 m below the bottom of the proposed infiltration trenches.

Table E.6 provides a summary of the infiltration trench sizing. It is recommended that infiltration trenches be designed with a provision for over-flow. If there are challenges meeting the required infiltration trench length at detailed design, then the design of the proposed SWM Pond could be modified to incorporate a proposed infiltration trench at the pond outlet (subject to approval by the Geotechnical Engineer). Specific sizing details for the proposed infiltration trenches will also be provided at detailed design.

6.0 VEHICULAR & PEDESTRIAN ACCESS

The layout of the proposed subdivision has been developed with consideration for efficient and safe access and circulation of both vehicular and pedestrian traffic.

6.1 Municipal Roads

The subject site has frontage on County Road 25 which is county road under the jurisdiction of the County of Dufferin. This road consists of a rural cross section having two lanes with gravel shoulders and road site ditches. The vehicular access to the subdivision will be facilitated by two connections being the north and south intersections of Street ‘A’ with County Road 25.

The municipal roads will have an 8.0m pavement, crowned with 2% cross fall and edged with concrete curb and gutter. The longitudinal slope of the road will generally be 0.5% with some length of road ranging up to 3.0% slope. A copy of a typical road cross section is included in **Appendix “F”**.

Based on the recommendations contained in the Geotechnical Investigation Report for the site, the recommended minimum pavement structure for the proposed roads is as follows:

Municipal Roads

Material	Compacted Depth
Asphalt Concrete	90mm
Granular "A"	175mm
Granular "B"	350mm

6.2 Driveways/Parking

Units will likely require parking by way of driveways or surface parking lots for the mixed use units. The recommended pavement structure for passenger car parking is as follows:

Passenger Car Parking

Material	Compacted Depth
Asphalt Concrete	50mm
Granular "A"	150mm
Granular "B"	300mm

The slope of driveways and parking is to be within the range of 2.0% to 6.0% in accordance with Town criteria.

6.3 Sidewalks, Walkways & Trails

Internal pedestrian access will be provided by standard 1.5m wide concrete sidewalks to safely guide residents through the subdivision for access to the proposed units and the adjacent existing road allowances. Sidewalks will be generally be constructed on one side of each road.

The configuration of the proposed sidewalks are illustrated on **Dwg. SWK-1**.

7.0 GRADING

As is typical will all subdivisions, earthmoving is required, to varying degrees, in order to achieve the municipal design criteria and accommodate the development form.

7.1 Grading Criteria

The subject site is to be graded in accordance with the Town grading criterion which dictates that road grades are to range from 0.5% to 8.0% and that sodded yard areas are to range from 2.0% to 4.0%. For large grade differentials, a maximum slope 4H : 1V can be used for sodded embankments. In areas where space is limited, retaining walls can be utilized to accommodate grade differentials, however, their use should be minimized.

7.2 Preliminary Design

Based on the topographic survey, the proposed subdivision configuration and the Township's criteria, a preliminary grading design has been prepared. The preliminary grading design, considered the following factors:

- Achieve the Town's lot grading criteria.
- Meet the Town's vertical road design parameters.
- Minimize the requirement for retaining walls.
- Match existing grades along the adjacent properties and road allowances.
- Grading along existing road allowances is to have consideration for their future urbanization and grades are to be established to accommodate future boulevard slopes in the range of 2 to 4%.
- Provide an overland flow route to direct drainage to a safe outlet.
- Provide sufficient cover over the sanitary sewer.

An analysis of the earthworks will be conducted using digital terrain modelling software at the detailed design stage to optimize the cut and fill volumes in an effort to achieve a balance. Based on the preliminary design, no significant difficulties are anticipated in achieving the municipal grading design standards.

7.3 Permitting

A review of the Regulation Mapping indicates that the subject site is located within an area that is regulated by the ORCA. A grading permit is therefore required from their office under Ontario Regulation 166/06 prior to commencing topsoil stripping and earthworks. The permit application should be submitted in conjunction with the detailed design at the subdivision engineering stage.

In addition, a clearance letter from the Ministry of Tourism, Culture and Sport (MTSC) is required prior to commencing topsoil stripping and earthworks. In this regard and as per standard practice for subdivisions, an investigation is to be conducted by a licensed archaeologist and a report is to be submitted to the MTSC for approval. Such investigations typically consists of background research and a visual inspection of the lands after it has been ploughed and weathered by two rainfall events which will assist in exposing any archaeological resources that may be present.

8.0 EROSION & SEDIMENT CONTROL DURING CONSTRUCTION

Construction activity, especially operations involving the handling of earthen material, dramatically increases the availability of particulate matter for erosion and transport by surface drainage. In order to mitigate the adverse environmental impacts caused by the release of silt-laden stormwater runoff into receiving watercourses, measures for erosion and sediment control are required for construction sites. This is an extremely important component of land development that plays a large role in the protection of downstream watercourses and aquatic habitat. It is of particular concern for this site given the proximity of the site to a watercourse.

The impact of construction on the environment is recognized by the Greater Golden Horseshoe Area Conservation Authorities. In December 2006 they released their document titled Erosion & Sediment Control Guidelines for Urban Construction (ESC Guideline). This document provides guidance for the preparation of effective erosion and sediment control plans.

Control measures must be selected that are appropriate for the erosion potential of the site and it is important that they be implemented and modified on a staged basis to reflect the site activities. Furthermore, their effectiveness decreases with sediment loading and therefore inspection and maintenance is required. The selection, implementation, inspection and maintenance of the control features are summarized as follows:

8.1 Control Measures

On relatively large sites, measures for erosion and sediment control typically include the use of sediment control basins, silt fencing, a mud mat and sediment traps. The following is a description of the sediment controls to be implemented on the subject site:

- **Temporary Sediment Control Basins** are commonly used to clarify silt-laden stormwater runoff by promoting sedimentation of the suspended particles in the runoff through long detention times. The proposed SWM pond will be utilized as temporary sediment control basins during construction. The basin is to be sized in accordance with the ESC Guideline based on a required storage volume of 250 m^3 per hectare of disturbed area (125 m^3/ha of permanent pool and 125 m^3/ha of active storage). The basin's outlet is to have a Hickenbottom riser and a minimum 75mm diameter orifice plate sized to provide a drawdown time in the order of 48 hours.
- **Silt Fences** are to be installed adjacent to all property limits subject to drainage from the development area prior to topsoil stripping and in other locations, such as at the bases of topsoil stockpiles. It is recommended that earthworks not extend immediately adjacent to the silt fence and instead 1m to 2m vegetated buffer be maintained for additional protection. The silt fences are to be constructed with 150 x 150mm wire farm fence fabric to properly support the geotextile. Heavy duty silt fence is recommended to be installed adjacent the valley and watercourse to the east of the development area, consisting of two rows of fence with a row of staked straw bales between.
- **Mud Mat** is to be installed at the construction entrance prior to commencing earthworks to minimize the tracking of mud onto municipal roads.
- **Sediment Traps** are to be installed at all catchbasin locations once the storm sewer system has been constructed to prevent silt laden runoff from entering.
- **Rock Check Dams** are to be constructed in swales and ditches to reduce velocities and trap sediment.
- **Erosion Protection** in the form of a level spreader or vegetative buffers are be provided immediately downstream pond outlets to ensure that sediment is not released and / or created as a result of the concentrated discharge.

A set of Erosion and Sediment Control Plans are to be prepared at the detailed engineering design stage to reflect the various construction stages. Details of typical erosion and sediment control measures are included in **Appendix "H"**.

8.2 Construction Sequencing

The following is a summary of the scheduling of construction activities and the related implementation of sediment controls:

Stage 1 – Subdivision Earthworks

1. Construct mud mat for temporary construction access.
2. Install primary silt fencing around the limits of grading and secondary silt fencing along the south limit of the work area adjacent the existing wetland.
3. Install temporary swales and rock check dams.
4. Excavate and construct the temporary sediment basins including installation of hickenbottom drain and spillway and connect to temporary swales.
5. Strip any remaining topsoil, stockpile where indicated and install silt fence around the perimeter.
6. Rough grade the site by placing cut material in fill areas and spreading and compacting of imported fill. Maintain the mud mat to minimize the tracking of silt onto the municipal road and provide street sweeping as necessary.

Stage 2 – Subdivision Servicing & Road Construction

1. Install underground servicing, covering the end of the pipe at the end of each work day to ensure that silt does not enter the storm sewer.
2. Construct roads, install sediment controls on catchbasins and install temporary hickenbottom drains at low point of lot blocks.

Stage 3 – House Construction

1. Construct houses and maintain all sediment controls including regular street sweeping and catchbasin cleaning.
2. Stabilize all lot surfaces as soon as possible after completion of the houses.
3. Remove silt fencing on a phased basis as areas are stabilized.

8.3 ESC Inspection & Maintenance

In order to ensure that the erosion and sediment control measures operate effectively, they are to be regularly monitored and they will require periodic cleaning (e.g., removal of accumulated silt), maintenance and/or re-construction.

Inspections of all of the erosion and sediment controls on the construction site should be undertaken with the following frequency:

- On a weekly basis
- After every rainfall event
- After significant snow melt events
- Prior to forecasted rainfall events

If damaged control measures are found they should be repaired and/or replaced within 48 hours. Site inspection staff and construction managers should refer to the Erosion and Sediment Control Inspection Guide (2008) prepared by the Greater Golden Horseshoe Area Conservation Authorities. This Inspection Guide provides information related to the inspection reporting, problem response and proper installation techniques.

9.0 UTILITIES

While some external upgrades may be necessary by the utility providers, it is anticipated that utilities such as hydro, natural gas, cable television, and telephone service will be available to service the subject development. As per standard practice in subdivisions, utilities will be installed underground. Co-ordination with the local hydro authority and the various utility companies will be undertaken at the detailed engineering design stage to determine appropriate locations for pedestals, transformers and street lights.

It is recommended that the utility installation be in the form of a joint trench as outlined in the Town's Design Standards. The process of joint trenching allows all of the utility companies to co-ordinate the placement of their lines in a common trench excavated by a single utility contractor. Joint trenching maximizes the efficiency of the available area in the utility corridor and provides for a safe installation. A detail of the typical utility corridor location is included in the road cross-section details within **Appendix "F"**.

10.0 SUMMARY

Based on the analysis contained herein, the proposed residential subdivision can be adequately serviced with full municipal services (watermain, wastewater and storm) in accordance with the standards of the Town of Grand Valley, the County of Dufferin and the Grand River Conservation Authority design criteria and consists of the following:

Water

- The existing water supply system in the Town of Grand Valley consists of 3 wells with an elevated water tower located off County Road 25, north of Fife Road functioning as part of the water distribution system and supplementing the well supply during high demand periods.
- The existing water infrastructure is not able to meet the future demand and that an additional water tower at the south end of the Town to accommodate the demand be investigated by Class EA study to determine the ability to meet the impending requirement.
- A trunk watermain is proposed to be extended from its current terminus southerly from the existing WPCP along County Road 25 and across the frontage to the southern entrance of the subject site, facilitating a loop per Town standards.
- A local water distribution system will be constructed along the roads to provide domestic supply and fire protection for the proposed dwellings. This local system will connect to the trunk watermain. Based on the Ontario Building Code (OBC 2012) requirements, the water service connections for the individual townhouse units are to be 25mm diameter.

Waste Water

- The Town is currently serviced by the existing Grand Valley Wastewater Pollution Control Plant (WPCP) located at the east end of Industrial Road. A 2013 Capacity Study completed for the WPCP concluded that a Class EA Study be undertaken to further examine the need to increase capacity to accommodate the impending developments.
- Variances in the data between baseline reports completed for this area and the proposed development presented as part of this Report has necessitated revisions to the wastewater strategy, which includes inserting the proposed Sanitary Pumping Station (SPS-A) north of the subject site, within Town Lands, to convey flow to the WPCP. The capacity allocation specified by the latest dataset indicates discrepancies between the estimated and proposed allocation requirements.
- A sanitary sewer system will be constructed along the roads to provide service to the proposed dwellings. This local system will connect to SPS-A and ultimately outlet to the WPCP. In accordance with Town standards, the dwellings will be serviced with individual sanitary connections.

Storm Drainage

- The subject site is located in the Boyne Creek subwatershed. Boyne Creek drains to the Grand River which discharges to Lake Erie.

- In accordance with Town criteria, the subject site will be serviced by minor system comprised of a municipal storm sewer sized for the 5 year storm event. This storm sewer will outlet to Boyne Creek within the centre of the subject site as per the pre-development condition.
- The major system will be comprised of an overland flow route which will convey runoff from rainfall events in excess of the capacity of the municipal storm sewer to a safe outlet.
- The flood plain of Boyne Creek is contained entirely within the valley lands and therefore the proposed residential lots and the stormwater management pond are outside the Regulatory flood plain.

Stormwater Management

- A stormwater management facility will be constructed to service the subject property. This facility has been designed as a wet pond to provide a minimum of Normal (Level 2) water quality treatment, extended detention for erosion control and flood control using the calculated pre-development flow targets up to and including the 100 year storm event. The wet pond consists of a sediment forebay and a main cell separated by a forebay berm.
- Thermal mitigation measures are to be incorporated in the design of the pond including bottom draw pipe and a planting strategy to provide shading around the pond perimeter.
- A site water balance assessment has been undertaken to ensure that pre-development infiltration volumes are maintained. Based on the analysis it was determined that mitigation measures are required in the form of infiltration trenches.

Vehicular & Pedestrian Access

- Vehicular access to the subject site will be provided by two road connections to County Road 25.
- The proposed local roads will be constructed to urban standards having an 8.0m pavement width within a 20m wide road allowance.
- Pedestrian access will be provided by 1.5m wide concrete sidewalks which are to be generally located on one side of each road.

Grading

- As is typical with subdivision projects, earthmoving will be required to achieve the proposed subdivision grading necessary to meet the criteria of the Town. A detailed analysis of the earthworks will be conducted at the detailed design stage to optimize the cut and fill volumes. Based on the preliminary design, no significant difficulties are anticipated in achieving the municipal grading design standards.
- Since the subject site is located in an area which regulated by the ORCA, a permit will be required from their office prior to commencing earthworks. In addition, an archaeological clearance letter will be required from the Ministry of Tourism, Culture and Sport.

Erosion & Sediment Control During Construction

- Erosion and sediment control (ESC) measures are to be implemented during construction to prevent silt laden runoff downstream in accordance with the Erosion & Sediment Control Guidelines for Urban Construction (December 2006). The ESC plans are to be prepared at the detailed engineering design stage and are to reflect the various construction stages.

Subdivision Engineering Design

- Detailed design for the proposed development is to be prepared at the subdivision engineering stage. This detailed design is to include servicing and grading plans as well as a stormwater management report based on the criteria established in this Functional Servicing Report.

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- Fire Underwriters Survey, **Water Supply for Public Fire Protection**, 1999.
- Ministry of Municipal Affairs & Housing, **Ontario Building Code**, 2012.

Respectfully Submitted,
VALDOR ENGINEERING INC.

Ary Rezvanifar, P.Eng. Design Engineer	**Peter Zourntos,** P.Eng., C.Eng. Principal
Oliver Beaudin, Jr.Eng Water Resources Analyst	**Bill Coffey**, M.Sc., P.Eng. Head of Water Resources

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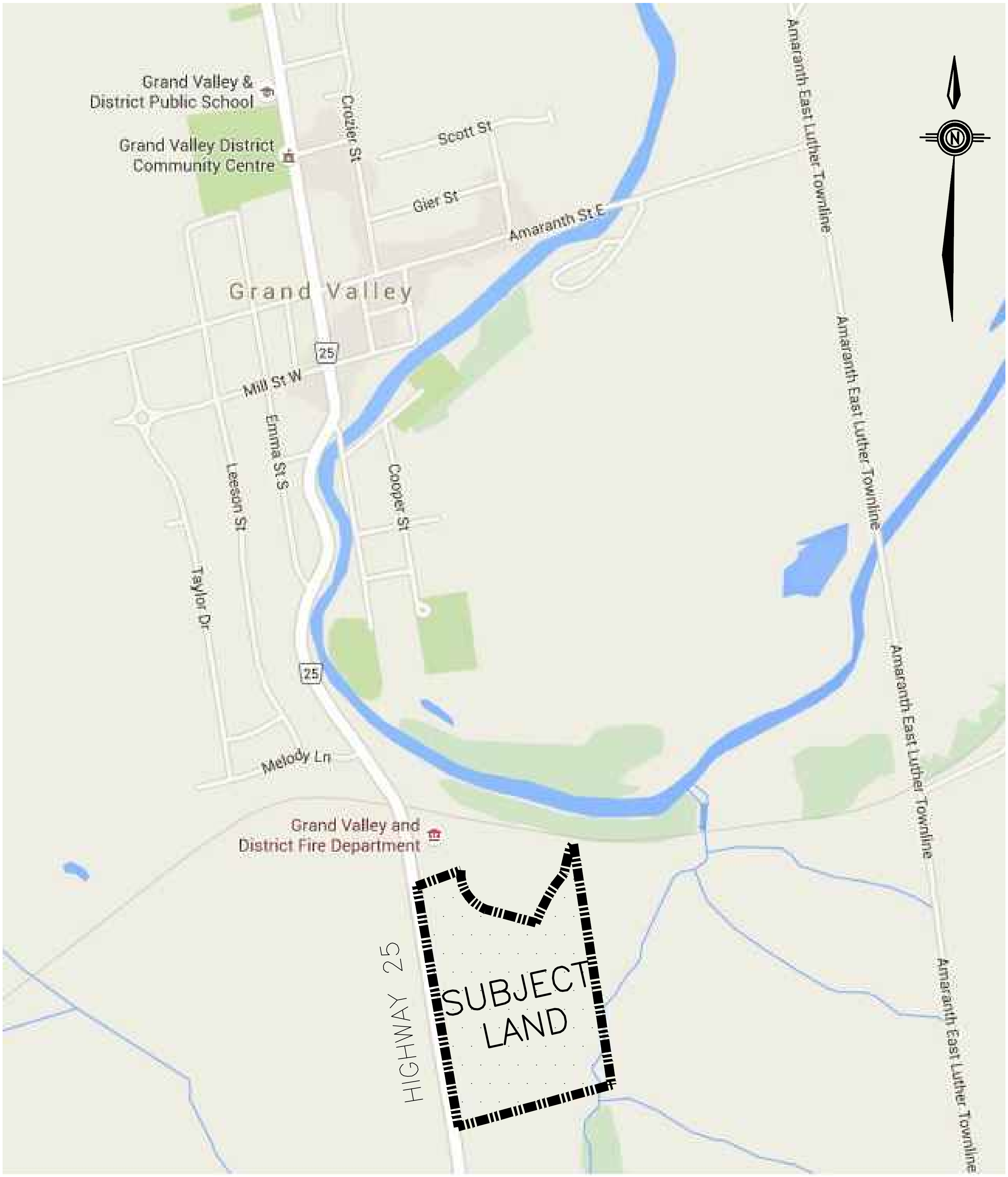

MOCO FARMS SUBDIVISION

LOCATION MAP

VALDOR ENGINEERING INC.
Consulting Engineers - Project Managers
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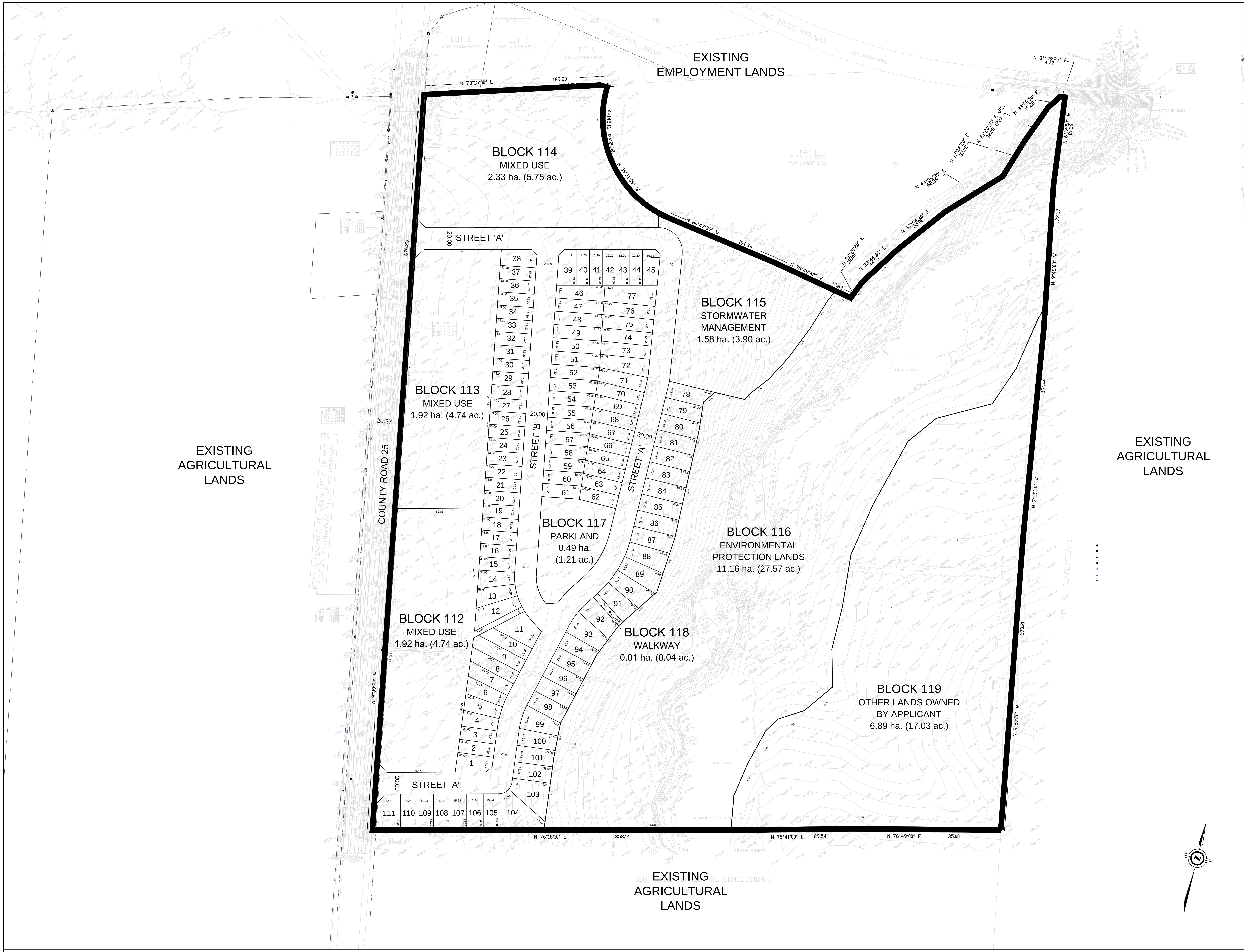
E-MAIL: info@valdor-engineering.com
www.valdor-engineering.com

SCALE	N.T.S.	PROJECT	14119
DATE	JULY 2015	DRAWN BY	R.T.

FIGURE 1



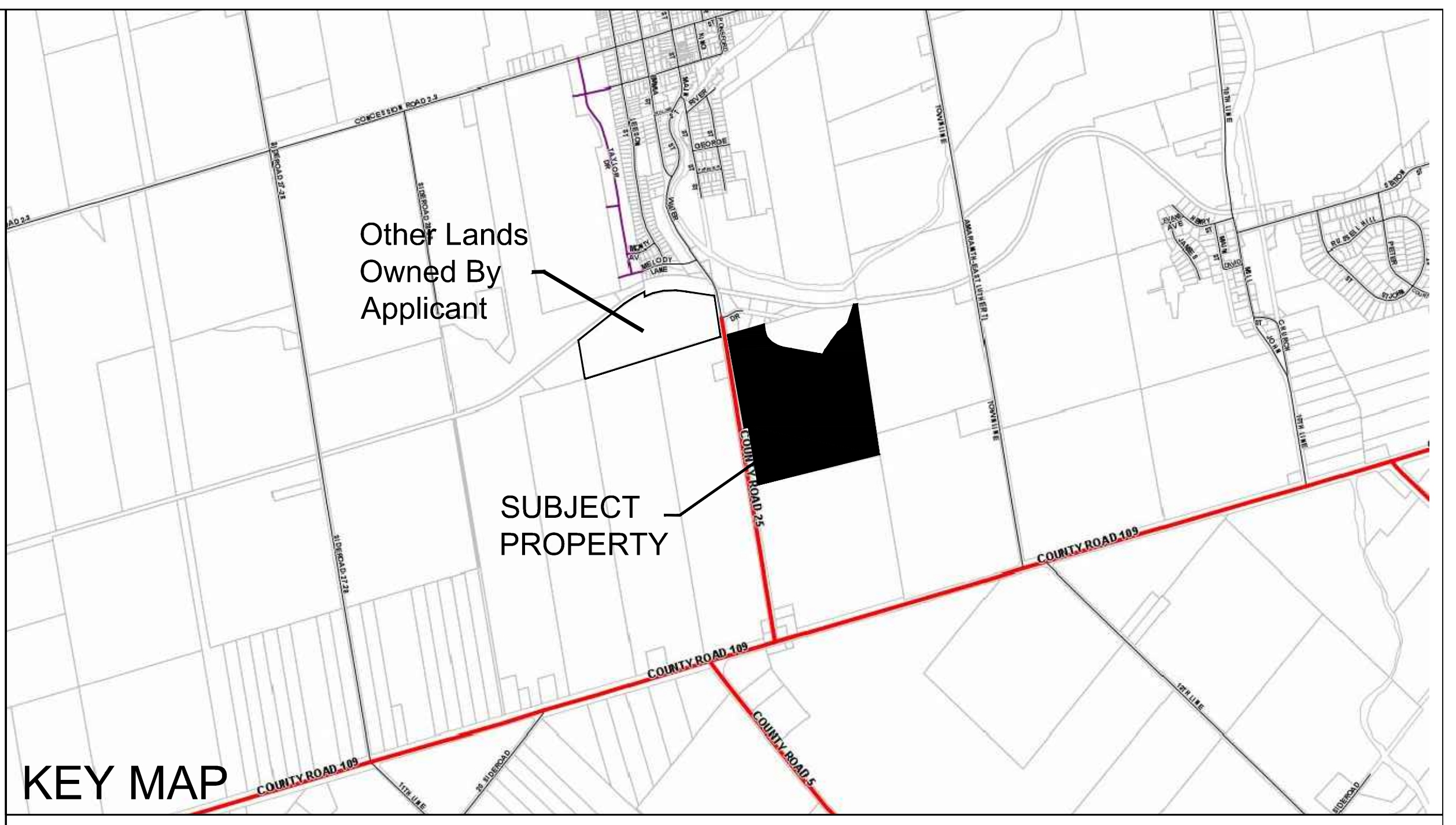


FIGURE 2: DRAFT PLAN

DRAFT PLAN OF SUBDIVISION

PART OF NORTH HALF OF LOT 31,
CONCESSION 1
FORMERLY IN THE TOWNSHIP OF EAST LUTHER
NOW IN THE
TOWNSHIP OF EAST LUTHER - GRAND VALLEY
COUNTY OF DUFFERIN
2015

0 m 150 m

OWNER'S CERTIFICATE

I HEREBY AUTHORIZE INNOVATIVE PLANNING SOLUTIONS TO PREPARE THIS DRAFT PLAN OF SUBDIVISION AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION FOR APPROVAL.

DATE

TOWERHILL DEVELOPMENTS

SURVEYOR'S CERTIFICATE

I CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED AND THEIR RELATIONSHIP TO ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN.

DATE

PIER DE ROSA, O.L.S

ADDITIONAL INFORMATION REQUIRED UNDER SECTION 51(17) OF THE PLANNING ACT

a) SHOWN ON PLAN
b) SHOWN ON PLAN
c) SEE KEY PLAN
d) RESIDENTIAL, MIXED USE, PARKLAND, ENVIRONMENTAL PROTECTION, STORMWATER MANAGEMENT
e) SHOWN ON PLAN
f) SHOWN ON PLAN
g) SHOWN ON PLAN
h) MUNICIPAL WATER
i) GUELPH LOAM
j) SHOWN ON PLAN
k) ALL MUNICIPAL SERVICES
l) NONE

LAND USE STATISTICS

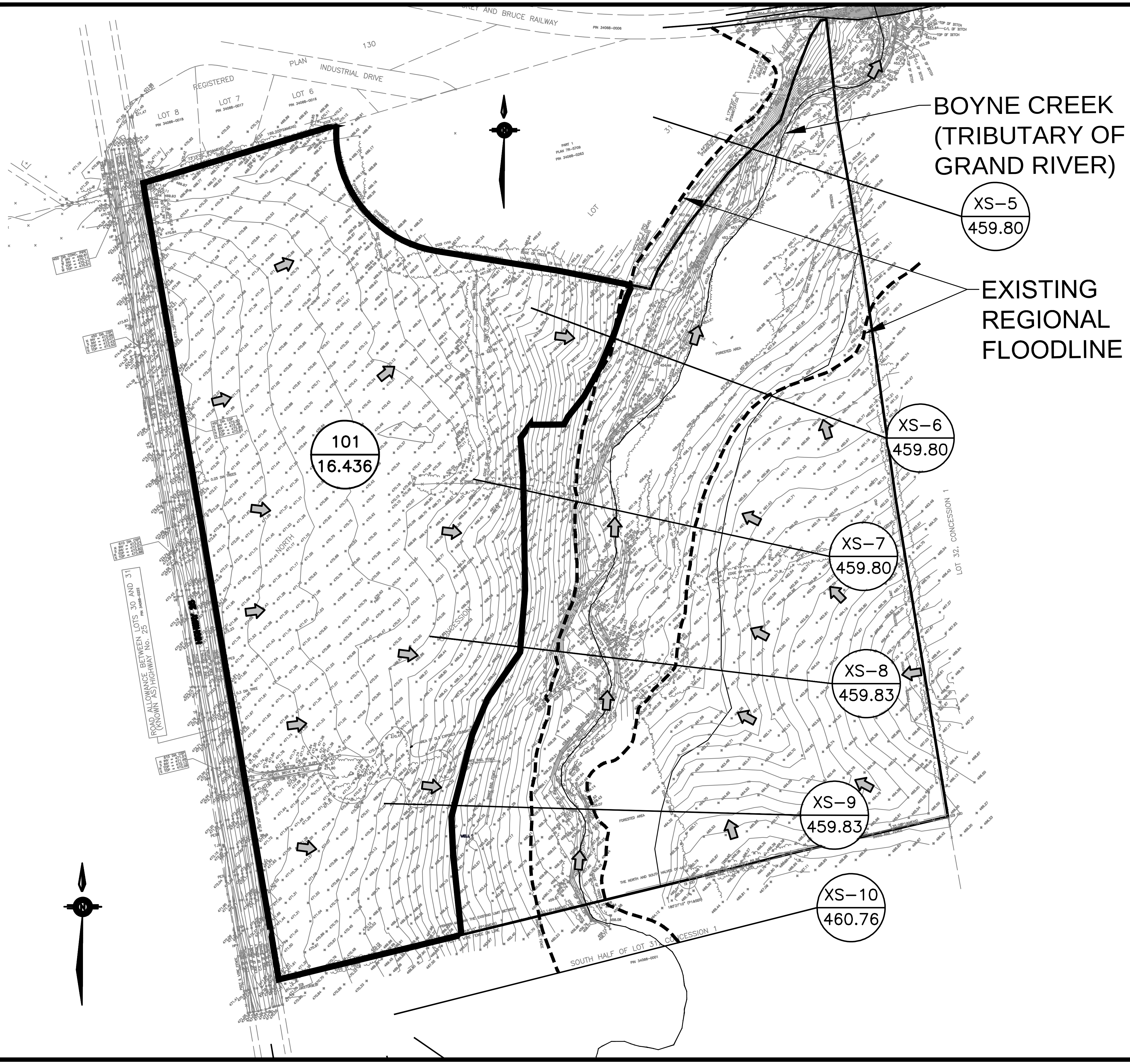
Land Use	Lot / Block No.	Area (ha.)	Units
RESIDENTIAL UNITS (40')	1-77	3.70	77
RESIDENTIAL UNITS (50')	78-111	2.02	34
MIXED USE	112-114	6.17	
PARKLAND	117	0.49	
STORMWATER MANAGEMENT	115	1.58	
ENVIRONMENTAL PROTECTION LANDS	116	11.16	
OTHER LANDS OWNED BY APPLICANT	119	6.89	
WALKWAY	118	0.01	
0.3 m RESERVE			
20.0 m R.O.W		2.4	
TOTAL		34.42	111

MOCO FARMS- DRAFT PLAN OF SUBDIVISION

TOWN OF GRAND VALLEY

INNOVATIVE PLANNING SOLUTIONS
PLANNERS ● PROJECT MANAGERS ● LAND DEVELOPMENT
150 DUNLOP STREET EAST, SUITE 201, BARRIE, ONTARIO L4M1B2
TEL: (705) 812-3281 FAX: (705) 812-3438
EMAIL: INFO@IPSCONSULTINGINC.COM

FILE NAME: 10-301 MOCO - 010615.dwg
DATE: JANUARY 06, 2015
PROJECT: 10-301 CORTEL GRAND VALLEY



LEGEND

202 — CATCHMENT ID
1.580 — AREA (HA)

▬ DRAINAGE BOUNDARY

⇨ OVERLAND FLOW DIRECTION

— HEC–RAS CROSS–SECTION

XS–5 — HEC–RAS CROSS–SECTION ID
459.80 — REGIONAL WSE (m)

PROJECT

MOCO SUBDIVISION,
TOWN OF GRAND VALLEY

TITLE

EXISTING STORM DRAINAGE PLAN

VALDOR ENGINEERING INC.
Consulting Engineers - Project Managers
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TEL (905)264-0054, FAX (905)264-0069
E-MAIL: info@valdor-engineering.com
www.valdor-engineering.com

PREPARED BY D.B.	CKD. BY B.C.
SCALE NTS	DATE JULY 2015
PROJECT 14119	FIGURE 3

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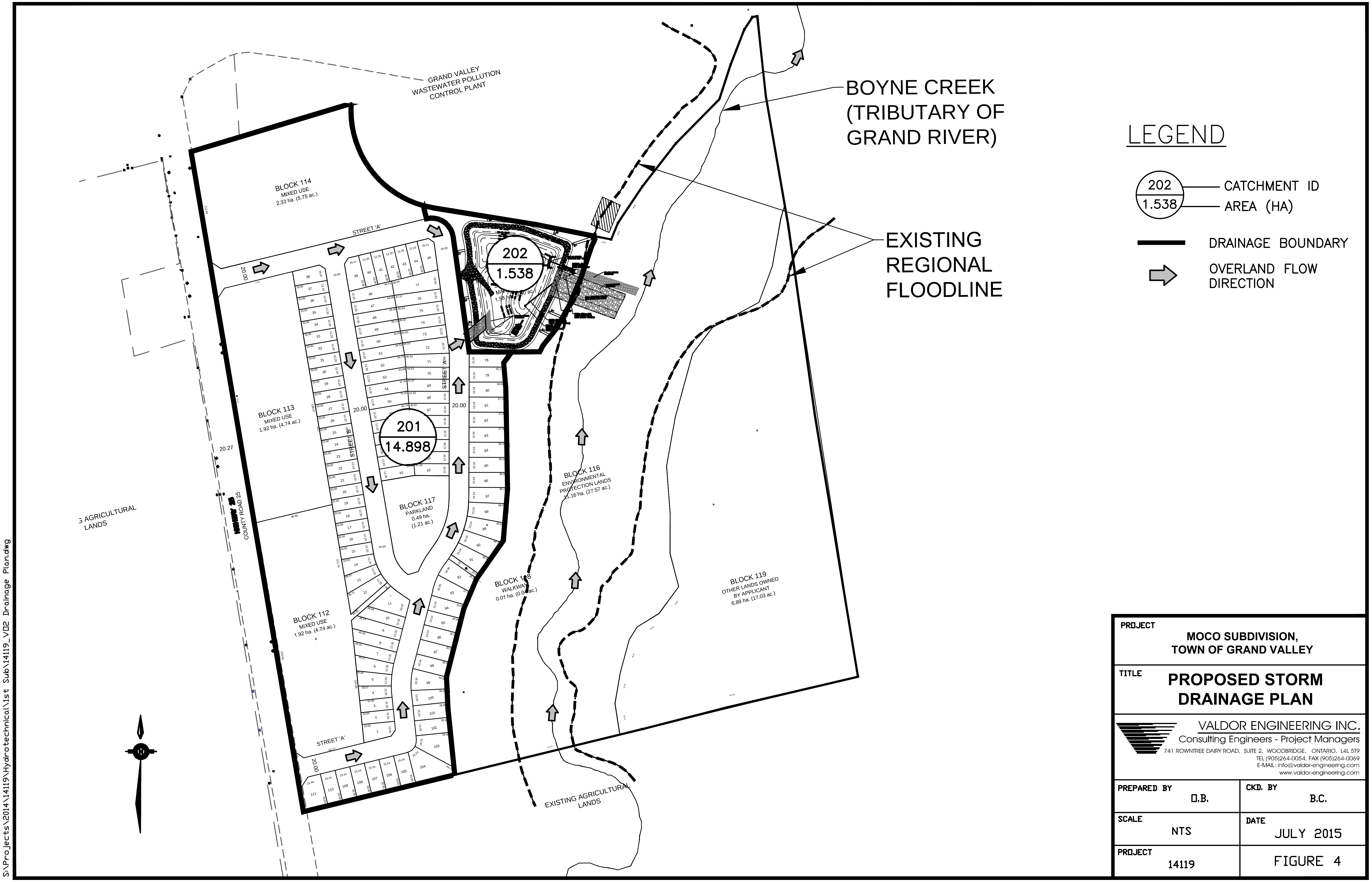

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PROJECT

MOCO SUBDIVISION,
TOWN OF GRAND VALLEY

TITLE

PROPOSED STORM DRAINAGE PLAN

VALDOR ENGINEERING INC.
Consulting Engineers - Project Managers
741 ROWNTREE DAIRY ROAD, SUITE 2, WOODBRIDGE, ONTARIO, L4L 5T9
TEL (905)264-0054, FAX (905)264-0069
E-MAIL: info@valdor-engineering.com
www.valdor-engineering.com

PREPARED BY D.B.	CKD. BY B.C.
SCALE NTS	DATE JULY 2015
PROJECT 14119	FIGURE 4

APPENDIX “A”

Water Demand Calculations & Details

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www.valdor-engineering.com

TABLE A1: DOMESTIC WATER CONSUMPTION DEMAND CALCULATION

Project Name: **Moco Subdivision, Town of Grand Valley**
File: 14119
Date: July 2015

Conditions:

Average Day Demand	450	L/person/day
Maximum Day Factor	2.75	
Peak Hour Factor	4.13	

Consumption Demand:

	Equivalent Population (persons)	Domestic Demand (L/min)	Maximum Day Demand (L/min)	Peak Hour Demand (L/min)
Residential Units	350	109	301	452
Mixed Use	463	145	398	598
Total	**813**	**254**	**699**	**1,050**

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www.valdor-engineering.com

TABLE A2: REQUIRED FIRE FLOW CALCULATION

In accordance to Water Supply for Public Fire Protection, Fire Underwriters Survey 1999

Project Name: **Moco Subdivision**
File: 14119
Date: July 2015

Notes: **DETACHED DWELLING**
Assume:
- 3,500 sq.ft total floor area
- interior unit for max exposure

Type of Construction - Ordinary Construction
$C =$ 1.0

Total Floor Area: 325 sq.m
$A =$ 325 sq.m
(Total Floor Area includes all storeys, but excludes basements at least 50 percent below grade)

$F = 220\ C\ \sqrt{A}$
$F =$ 3,966 L/min
$F =$ 4,000 (to nearest 1,000 Lmin)

Occupancy Factor

		Charge
Type:	Limited Combustible	-15%
	$f_1 =$	-15%

$F' = F \text{ x } (1+f_1)$
$F' =$ 3,400 L/min

Sprinkler Credit

			Charge
NFPA 13 Sprinkler Standard:	NO		0%
Standard Water Supply:	NO		0%
Fully Supervised System:	NO		0%
Total Charge to Fire Flow:		$f_2 =$	0%

Exposure Factor			Charge	
Side 1 - Distance to Building (m):	0 to 3m		25%	
Side 2 - Distance to Building (m):	0 to 3m		25%	
Side 3 - Distance to Building (m):	3.1 to 10m		20%	
Side 4 - Distance to Building (m):	3.1 to 10m		20%	
		$f_3 =$	75%	(maximum of 75%)

$F'' = F' + F' \text{ x} f_2 + F' \text{ x} f_3$
$F'' =$ 5,950 L/min

REQUIRED FIRE FLOW
$F'' =$ **6,000** **L/min** (to nearest 1,000 L/min)

APPENDIX “B”

Wastewater Calculations & Details

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www.valdor-engineering.com

TABLE B1: SEWAGE FLOW CALCULATIONS

Project Name: **Moco Subdivision, Town of Grand Valley**
File: 14119
Date: July 2015

Conditions:

Average Daily Flow: 450 L/person/day

Residential Peaking Factor: $K_H = 1 + \frac{14}{4+\sqrt{P}}$ where K_H = Harmon Peaking Factor
(max. 4.0, min. 2.75)
p = population in thousands

Extraneous Flow (I): 0.20 L/ha/s. (infiltration)

Design Flow (Q_D): Q x K_H $+ I$

Consumption Demand:

Land Use	Area (ha.)	Equivalent Population (persons)	Average Daily Flow (L/s)	Harmon Peaking Factor	Peak Daily Flow (L/s)	Extraneous Flow (L/s)	Total Flow (L/s)
Residential Units	5.72	350	1.82	4.00	7.29	1.14	8.44
Mixed Use Units	6.17	463	2.41	3.99	9.62	1.23	10.86
Total	**11.89**	**813**	**4.23**		**16.92**	**2.37**	**19.30**

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www.valdor-engineering.com

TABLE B2: SEWAGE FLOW CALCULATIONS

Project Name: **Corseed Subdivision, Town of Grand Valley**
File: 14119
Date: July 2015

Conditions:

Average Daily Flow: 450 L/person/day

Residential Peaking Factor: $K_H = 1 + \frac{14}{4 + \sqrt{P}}$ where K_H = Harmon Peaking Factor
(max. 4.0, min. 2.75)
p = population in thousands

Extraneous Flow (I): 0.20 L/ha/s. (infiltration)

Design Flow (Q_D): Q x $K_H + I$

Consumption Demand:

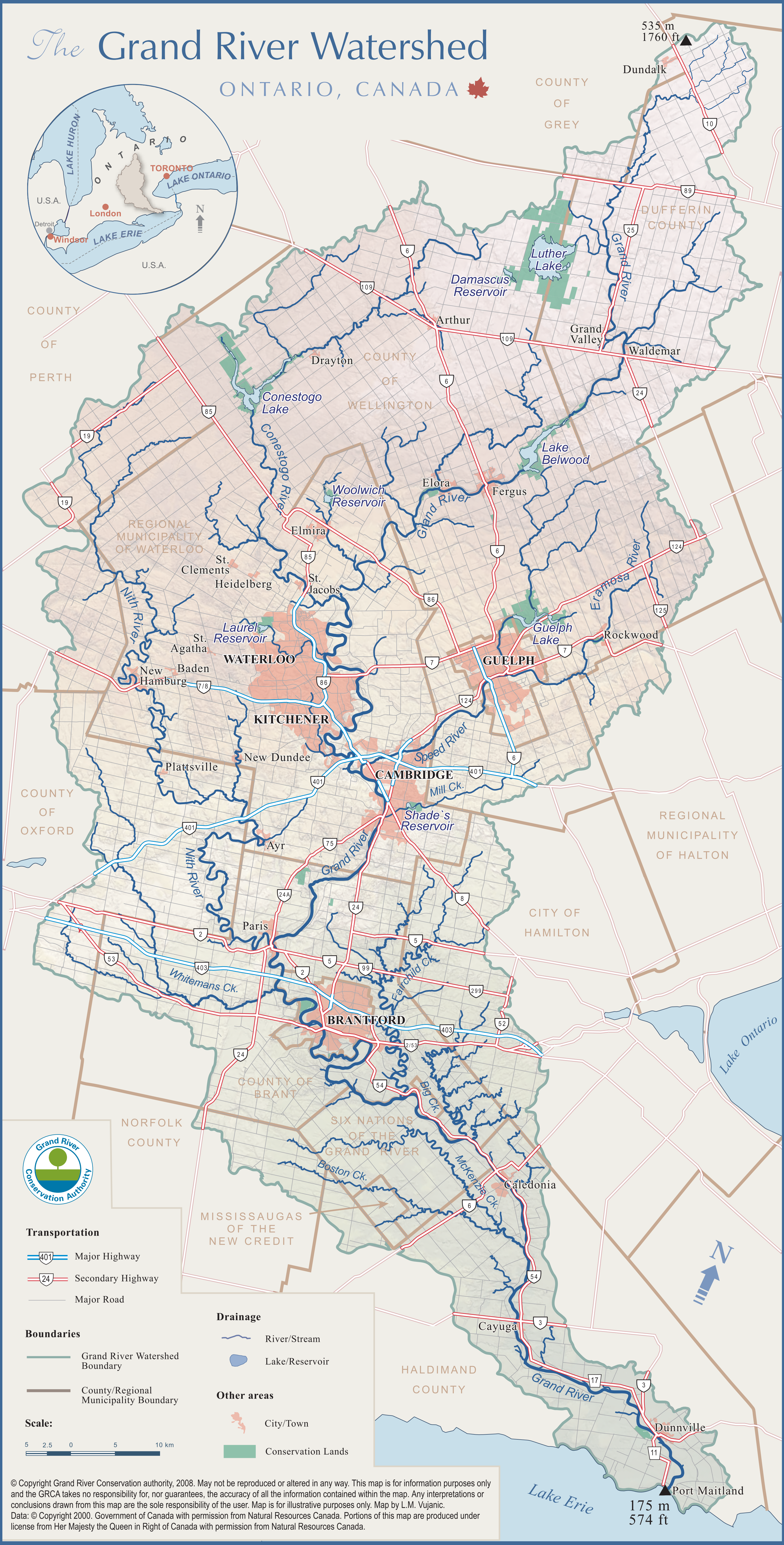
Land Use	Area (ha.)	Equivalent Population (persons)	Average Daily Flow (L/s)	Harmon Peaking Factor	Peak Daily Flow (L/s)	Extraneous Flow (L/s)	Total Flow (L/s)
Residential Units	3.87	230	1.20	4.00	4.79	0.77	5.57
Mixed Use Units	1.35	102	0.53	4.00	2.13	0.27	2.40
Total	**5.22**	**332**	**1.73**		**6.92**	**1.04**	**7.97**

APPENDIX “C”

Storm Drainage Details

The Grand River Watershed

ONTARIO, CANADA



Transportation

401 Major Highway

24 Secondary Highway

Major Road

Boundaries

Grand River Watershed Boundary

County/Regional Municipality Boundary

Scale:

5 2.5 0 5 10 km

Drainage

River/Stream

Lake/Reservoir

Other areas

City/Town

🟩 Conservation Lands

Consultant:

VALDOR ENGINEERING INC.
741 Rowntree Dairy Road, Suite 2, Woodbridge, Ontario, L4L 5T9
Tel: 905-264-0054 Fax: 905-264-0069 info@valdor-engineering.com

Town of Grand Valley
Engineering and Public Works Department
STORM SEWER DESIGN SHEET

Project Name: Moco Subdivision
Project No: 14119

Design: A. Rezvanifar, P.Eng.
Checked: P.Zourntos, P.Eng
Approved: P.Zourntos, P.Eng
Date: 1-Jul-15

Street	FROM MH	TO MH	A (ha)	R	A x R	Accum. A x R	Tc (min)	5 Year I (mm/hr)	5yr Design Flow Qd (m^3/s)	Size of Pipe (mm)	Grade (%)	Nominal Capacity Qc (m^3/s)	Full Flow Velocity (m/s)	Length (m)	Time in Sect. (min)	Total Time (min)	Qd / Qc	Remarks
OUTLET PIPE TO POND																		
DRAINAGE AREA TO OUTLET PIPE MH	DRAINAGE AREA 201 MH	POND HEADWALL							2.580	1200	0.50	2.757	2.46	33.9	0.23	0.23	94%	
(5-YEAR FLOW PROVIDED BY OTTHYMO MODEL)																		

No.	REVISION	DATE	AUTH
3			
2			
1			

Town of Grand Valley
Engineering and Public Works Department

STORM SEWER DESIGN SHEET

SCALE:	N.T.S.		DATE: July 2015
DRAWN BY:	--		DWG. No.

APPENDIX “D”

Stormwater Management Calculations

Table D.1
CONCEPTUAL STAGE-STORAGE TABLE

Project Name: Moco Subdivision
Municipality: Town of Grand Valley
Project No.: 14119
Date: July 2015

Stage Storage Curve						Outlet Structure										
Elevation (m)	Sec Area (m^{2})	Avg Area (m^{2})	Sec Volume (m^{3})	Cumulative Volume (m^{3})	Volume Above NWL (m^{3})		Stage Active (m)	Discharge m^{3}/s								**Comments:**
								Orifice 1	Orifice 2 (DICB.1)	Orifice 3 (DICB.2)	Orifice 4 (Box)	Orifice 5 (DICB.3)	Orifice 6 (DICB.4)	Spillway	Total Flow	
						Invert Elevation(m)		463.50	463.00	463.00	464.10	463.00	463.00	464.80		
						Diameter(mm)/Length(m)		135	315	315	1.00	300	250	13.00		
						Box Orifice Height (m)		-	-	-	0.50	-	-			
						Orifice Area (m^{2})		0.0143	0.0779	0.0779	0.500	0.0707	0.0491	-		
																Spillway Design: $Q=1.67xLxH^{1.5}$
																Orifice Eq'n: $Q = 0.6A(2gH)^{0.5}$
462.50	**2,196**	**-**	**-**	**0**		**Bottom of Pond**										**Bottom of Pond**
463.50	**4,118**	**3,157**	**3,157**	**3,157**	**0**	**Permanent Pool**	0.00	0.000							**0.000**	**Permanent Pool Provided**
464.10	**5,704**	**4,911**	**2,947**	**6,103**	**2,947**	**Extended Detention**	0.60	0.028	0.000	0.000	0.000				**0.028**	**Extended Detention Provided**
464.25	6,053	5,878	882	6,985	3,828	**2-year Storage**	0.75	0.031	0.216	0.216	0.097	0.000			**0.561**	**2-year Storage Provided**
464.40	6,402	6,228	934	7,919	4,762	**5-year Storage**	0.90	0.035	0.231	0.231	0.274	0.210			**0.981**	**5-year Storage Provided**
464.50	**6,635**	**6,519**	**652**	**8,571**	**5,414**	**10-year Storage**	1.00	0.037	0.240	0.240	0.422	0.218	0.000		**1.157**	**10-year Storage Provided**
464.60	6,803	6,719	672	9,243	6,086	**25-year Storage**	1.10	0.039	0.249	0.249	0.664	0.226	0.158		**1.585**	**25-year Storage Provided**
464.70	6,971	6,887	689	9,932	6,775	**50-year Storage**	1.20	0.040	0.257	0.257	0.786	0.234	0.164		**1.739**	**50-year Storage Provided**
464.80	**7,139**	**7,055**	**706**	**10,637**	**7,480**	**100-year Storage**	1.30	0.042	0.265	0.265	0.891	0.241	0.169	0.000	**1.875**	**100-year Storage Provided**
465.50	**8,372**	**7,756**	**5,429**	**16,066**	**12,909**	**Top of Berm**	2.00	0.053	0.317	0.317	1.425	0.288	0.201	12.715	**15.316**	**Top of Berm**

VALDOR ENGINEERING INC.
Project: Moco Subdivision
File: 14119
Date: July 2015

Table D.2: Existing VO2 Model Parameters

Subcatchment	**Area (ha)**	**DT (min)**	**CN Number**	**IA (mm)**	**Tp (hr)**
101	16.436	5	85	7.0	0.36
Total	**16.436**				

VALDOR ENGINEERING INC.
Project: Moco Subdivision
File: 14119
Date: July 2015

Table D.3: Proposed VO2 Model Parameters

Subcatchment	**Area (ha)**	**DT (min)**	**TIMP**	**XIMP**	**CN**	**IA (mm)**
201	14.898	5	0.75	0.70	68	5.0
202	1.538	5	0.50	0.50	68	5.0
Total	**16.436**					

VALDOR ENGINEERING INC.
Project: Moco Subdivision
File: 14119
Date: July 2015

Table D.4: Calculation of CN Values, Initial Abstractions and Runoff Coefficients

Watershed	Area (ha)	Land Use and Land Cover		CN	Area Weighted CN	IA (mm)	Area Weighted IA (mm)	C-Value	Area Weighted C-Value
		Type	Area (ha)						
101	**16.436**	Row Crops (HSG 'BC')	16.436	85	**85**	**7**	**7.0**	0.35	**0.350**

VALDOR ENGINEERING INC.
Project: Moco Subdivision
File: 14119
Date: July 2015

Table D.5: Calculation of Time to Peak

Subcatchment	C Runoff Coefficient (Area Weighted)	L(m) Catchment Length	Highest Elevation (m)	Lowest Elevation (m)	S(%) Catchment Slope	T_c (min)	T_p (hr)
101	0.35	393	472.85	459.50	3.40	32.5	0.36

Note:

1) T_p calculation is based on Airport Method

$$T_c = {3.26\times(1.1-C)\times L^{0.5}} \big/ {S_w^{\,0.3}} \qquad T_P = 0.67T_c$$

Moco Subdivision
SWM Facility (Wet Pond)
Town of Grand Valley
Project No.: 14119
Date: July 2015

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www.valdor-engineering.com

TABLE D.6: SWM FACILITY SIZING FOR WATER QUALITY CONTROL

Source: Stormwater Management Planning and Design Manual (Table 3.2),
Ministry of the Environment, Ontario, March 2003

Protection Level	SWMP Type	Storage Volume (m^3/ha) for Impervious Level			
		35%	**55%**	**70%**	**85%**
Level 1	*Infiltration*	25	30	35	40
	Wetlands [2]	80	105	120	140
	Wet Pond [2]	140	190	225	250
	Hybrid Wet Pond/Wetland [4]	110	150	175	195
Level 2	*Infiltration*	20	20	25	30
	Wetlands	60	70	80	90
	Wet Pond	90	110	130	150
	Hybrid Wet Pond/Wetland	75	90	105	120
Level 3	*Infiltration*	20	20	20	20
	Wetlands	60	60	60	60
	Wet Pond	60	75	85	95
	Hybrid Wet Pond/Wetland	60	70	75	80
	Dry Pond	90	150	200	240

1. Table 3.2 was based on specific design parameters (depth, length to width ratio) for each type of end-of-pipe stormwater management facility. The values of these parameters are provided in Appendix I of the Manual. All values in Table 4.1 are based on a 24 hour detention.
2. For wetlands, wet ponds and hybrid ponds, all of the storage, except 40 m^3/ha, in Table 3.2 represents the permanent pool volume. The 40 m^3/ha represents the extended detention storage.
3. For hybrid ponds, 50% to 60% of the permanent pool volume shall be contained in deeper portions of the facility.

PERMANENT POOL CALCULATOR

SWMP Type:	WET POND	(IN - infiltration, WET - wetlands, WP - wet pond, HYB - hybrid wet pond/wetland, DP - dry pond)
Protection Level:	2	(1 - 80% TSS, 2 - 70% TSS, 3 - 60% TSS)
Average Imperviousness:	75.0 %	
Volume Level:	96.7 m^3/ha	Excluding Extended Detention
Area:	16.436 ha	
Total Required Volume:	**1,589** m^3	

VALDOR ENGINEERING INC.
Project: Moco Subdivision
File: 14119
Date: July 2015

Table D.7: Permanent Pool and Extended Detention Requirements

Event	Area (ha)	R.V. (mm)	Required Ext. Det. Volume (m^3)	Provided Ext. Det. Volume (m^3)
25mm 4-hour Chicago Storm	16.436	17.48	2,873	2,947

VALDOR ENGINEERING INC.
Project: Moco Subdivision
File: 14119
Date: July 2015

Table D.8: Critical Storm Analysis

Return Period	Storage Volume Required (m^3)					
	12-hour SCS	24-hour SCS	1-hour AES	6-hour AES	12-hour AES	3-hour Chicago
2-year	3,273	**3,545**	2,858	3,180	3,235	3,071
5-year	4,093	**4,389**	3,838	3,799	3,830	3,836
10-year	4,887	**5,100**	4,498	4,318	4,221	4,449
25-year	5,687	**5,886**	5,333	4,969	4,696	5,285
50-year	6,273	**6,373**	5,972	5,479	5,027	5,848
100-year	**6,891**	6,793	6,636	6,021	5,345	6,441
Note	****	****				

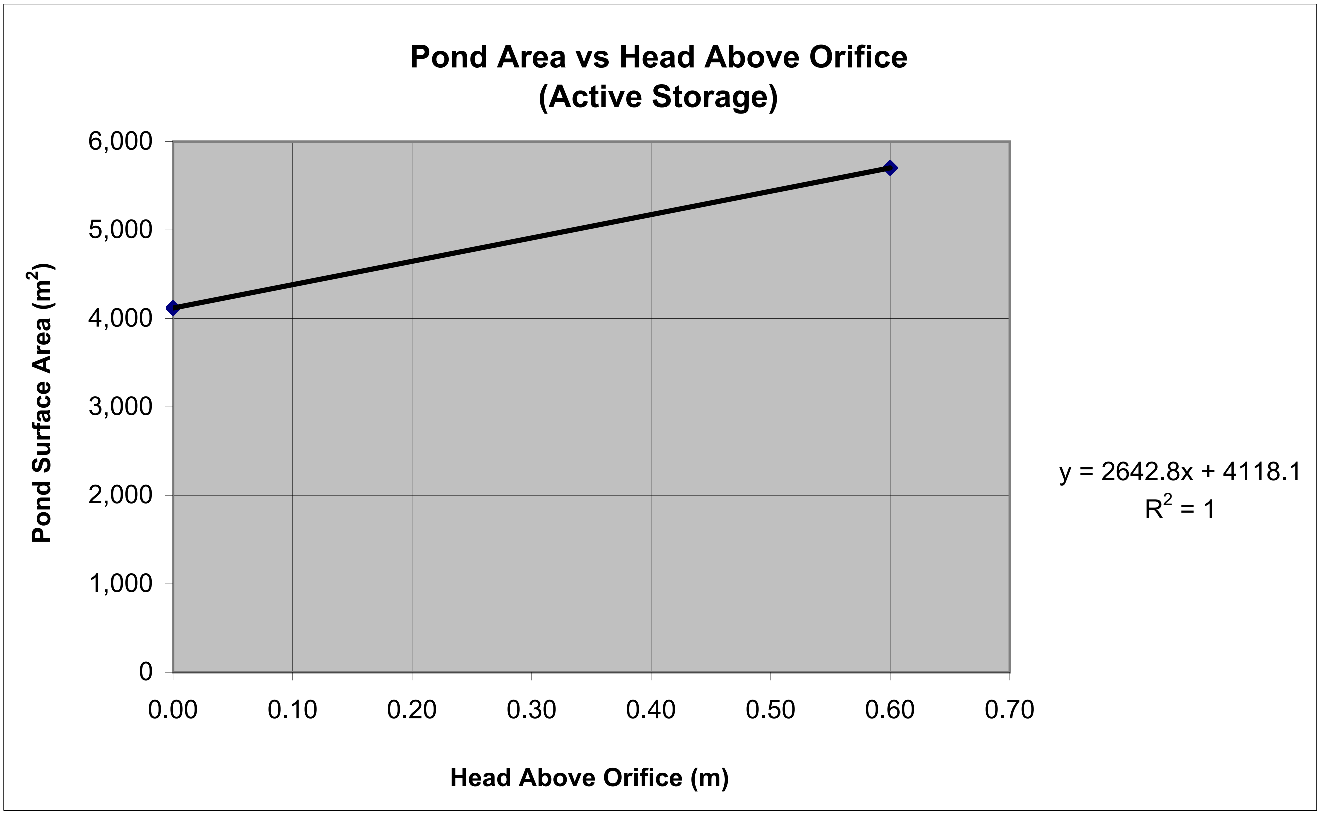
Table D.9: SWM Facility Operation - Extended Detention Erosion Control Drawdown Time

Project Name: Moco Subdivision
Municipality: Town of Grand Valley
Project No.: 14119
Date: July 2014

Extended Detention - SWM Pond

Orifice Sizing		
Orifice Size	135	mm
Orifice Invert	463.50	m
Orifice Area	0.0143139	sq. m
$EDL_{erosion}$	464.10	m
NWL	463.50	m
C_2	2642.8	
C_3	4118.1	
h	0.5325	m
Drawdown Time	47.2	hr

$y = mx + b$
$C_2 = m$
$C_3 = b$



VALDOR ENGINEERING INC.
File: 14119
Project: Moco Subdivision
Date: July 2015

TABLE D.10: TOTAL CAPTURE CALCULATIONS (SWM POND)

INPUT DESIGN PARAMETERS

Inlet Location: = DICB.1/2

Total Flows to be captured: = **0.216** m^3/s

Number of Catchbasins required: = 1

(Q)Total Flow to be captured per inlet: = 0.216 m^3/s

(C) Orifice Coefficient: = 0.60

(g) Acceleration due to gravity: = 9.81 m/s^2

(H) Headwater Elevation: = 464.25 m

(T) Tailwater or Grate Elevation: = 464.10 m

(P) Percentage of area lost due to grate: = 15 %

Assume 15% for Ditch Inlet OPSD 403.010 and Pyramidal Inlet Grate (StepCon)
Assume 25% for Heavy Duty Roadway Super Catchbasin Grating (Stepcon)
Assume 70% for "Herringbone" Street CB OPSD 400.010
Assume 60% for "Square" Street CB OPSD 400.100

(F) Factor of safety against potential blockage: = 2.0

REQUIRED GRATE AREA - Based on One Single Grate

$$\text{(A) Grate Area required} = \frac{Q}{C \times (2 \times g \times H)^{\wedge}.5} \times F \;/\; (100- P)$$

A = 0.495 m^2

PROPOSED GRATE AREA - Based on One Single Grate

Grate #1		**Grate #2**	
L (length) =	1.200 m	L (length) =	0.000 m
W (Width) =	0.600 m	W (Width) =	0.000 m

Total Area =	**0.720**	**m^2**

VALDOR ENGINEERING INC.

File: 14119
Project: Moco Subdivision
Date: July 2015

Table D.11: Total Capture Inlet Calculation (Weir Equation)

Pond DICB Capacity Calculation

Inlet Location:	=	DICB.1/2	
Number of Catchbasins required:	=	1	
(C) Weir Coefficient:	=	1.67	
(E) Weir Elevation	=	464.10	m
Water Surface Elevation (WSEL)	=	464.25	m
(H) Head (Depth of water over Weir):	=	0.15	m
Catchbasin Length	=	1.2	m
Catchbasin Width	=	0.6	m
Open Area Between Pyramidal Grate Bars	=	85%	
(L) Weir Length:	=	3.1	m

(Q) Flow Captured = C x L x H^(1.5)

Q = 0.297 m^3/s

TABLE D.12: TOTAL CAPTURE CALCULATIONS (SWM POND)

INPUT DESIGN PARAMETERS

Inlet Location: = DICB.3

Total Flows to be captured: = **0.210** m^3/s

Number of Catchbasins required: = 1

(Q)Total Flow to be captured per inlet: = 0.210 m^3/s

(C) Orifice Coefficient: = 0.60

(g) Acceleration due to gravity: = 9.81 m/s^2

(H) Headwater Elevation: = 464.40 m

(T) Tailwater or Grate Elevation: = 464.25 m

(P) Percentage of area lost due to grate: = 15 %

Assume 15% for Ditch Inlet OPSD 403.010 and Pyramidal Inlet Grate (StepCon)
Assume 25% for Heavy Duty Roadway Super Catchbasin Grating (Stepcon)
Assume 70% for "Herringbone" Street CB OPSD 400.010
Assume 60% for "Square" Street CB OPSD 400.100

(F) Factor of safety against potential blockage: = 2.0

REQUIRED GRATE AREA - Based on One Single Grate

$$(A)\ \text{Grate Area required} = \frac{Q}{C \times (2 \times g \times H)^{\wedge}.5} \times F \;/\; (100-P)$$

A = 0.480 m^2

PROPOSED GRATE AREA - Based on One Single Grate

Grate #1		**Grate #2**	
L (length) =	1.200 m	L (length) =	0.000 m
W (Width) =	0.600 m	W (Width) =	0.000 m

Total Area = **0.720** **m^2**

VALDOR ENGINEERING INC.

File: 14119
Project: Moco Subdivision
Date: July 2015

Table D.13: Total Capture Inlet Calculation (Weir Equation)

Pond DICB Capacity Calculation

Inlet Location: = DICB.3

Number of Catchbasins required: = 1

(C) Weir Coefficient: = 1.67

(E) Weir Elevation = 464.25 m

Water Surface Elevation (WSEL) = 464.40 m

(H) Head (Depth of water over Weir): = 0.15 m

Catchbasin Length = 1.2 m

Catchbasin Width = 0.6 m

Open Area Between Pyramidal Grate Bars = 85%

(L) Weir Length: = 3.1 m

(Q) Flow Captured = C x L x H^(1.5)

Q = 0.297 m^3/s

VALDOR ENGINEERING INC.
File: 14119
Project: Moco Subdivision
Date: July 2015

TABLE D.14: TOTAL CAPTURE CALCULATIONS (SWM POND)

INPUT DESIGN PARAMETERS

Inlet Location: = DICB.4

Total Flows to be captured: = **0.158** m^3/s

Number of Catchbasins required: = 1

(Q)Total Flow to be captured per inlet: = 0.158 m^3/s

(C) Orifice Coefficient: = 0.60

(g) Acceleration due to gravity: = 9.81 m/s^2

(H) Headwater Elevation: = 464.60 m

(T) Tailwater or Grate Elevation: = 464.50 m

(P) Percentage of area lost due to grate: = 15 %

- Assume 15% for Ditch Inlet OPSD 403.010 and Pyramidal Inlet Grate (StepCon)
- Assume 25% for Heavy Duty Roadway Super Catchbasin Grating (Stepcon)
- Assume 70% for "Herringbone" Street CB OPSD 400.010
- Assume 60% for "Square" Street CB OPSD 400.100

(F) Factor of safety against potential blockage: = 2.0

REQUIRED GRATE AREA - Based on One Single Grate

$$\text{(A) Grate Area required} = \frac{Q}{C \text{ x } (2 \text{ x } g \text{ x } H)\text{^}.5} \text{ x } F \ / \ (100- P)$$

A = 0.444 m^2

PROPOSED GRATE AREA - Based on One Single Grate

Grate #1		**Grate #2**	
L (length) =	1.200 m	L (length) =	0.000 m
W (Width) =	0.600 m	W (Width) =	0.000 m

Total Area = **0.720** **m^2**

VALDOR ENGINEERING INC.

File: 14119
Project: Moco Subdivision
Date: July 2015

Table D.15: Total Capture Inlet Calculation (Weir Equation)

Pond DICB Capacity Calculation

Inlet Location:	=	DICB.4	
Number of Catchbasins required:	=	1	
(C) Weir Coefficient:	=	1.67	
(E) Weir Elevation	=	464.50	m
Water Surface Elevation (WSEL)	=	464.60	m
(H) Head (Depth of water over Weir):	=	0.10	m
Catchbasin Length	=	1.2	m
Catchbasin Width	=	0.6	m
Open Area Between Pyramidal Grate Bars	=	85%	
(L) Weir Length:	=	3.1	m

(Q) Flow Captured = C x L x H^(1.5)

Q = 0.162 m^3/s

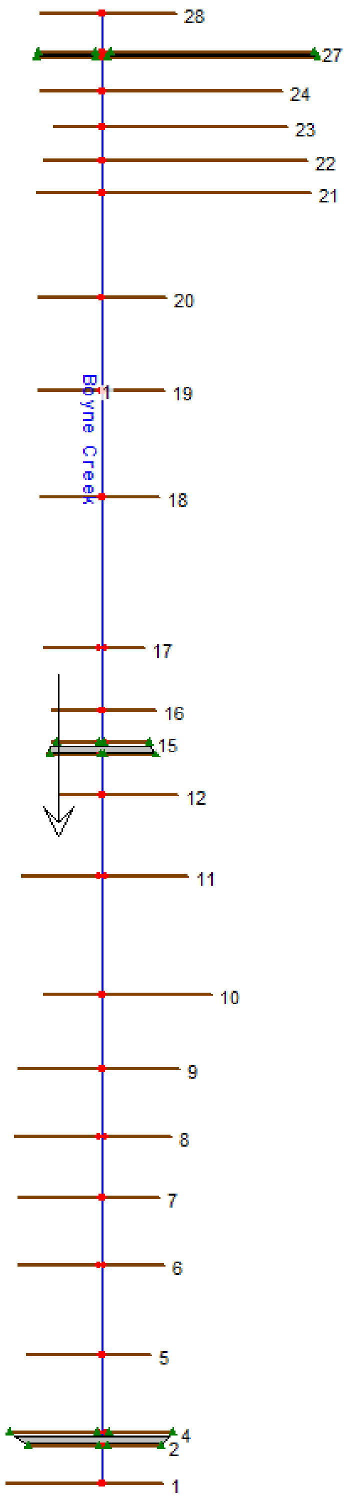


Figure D.1: HEC-RAS Model Schematic

Table D.16

Valdor Engineering Inc.
File: 14119
Date: July, 2015

HEC-RAS Output
Existing Condition

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	28	Regulatory	71.30	465.66	468.97		469.02	0.00	1.49	145.99	124.41	0.27
1	27	Regulatory	73.90	465.29	468.95	468.37	468.96	0.00	0.86	421.32	528.84	0.15
1	26		Bridge									
1	25	Regulatory	74.30	465.55	468.00	468.00	468.17	0.00	2.50	132.50	394.50	0.52
1	24	Regulatory	76.50	464.94	467.32		467.37	0.00	1.93	183.74	360.47	0.42
1	23	Regulatory	78.90	464.62	467.02	467.02	467.16	0.00	2.80	146.75	443.58	0.6
1	22	Regulatory	79.50	464.53	466.83		466.86	0.00	1.42	252.21	460.72	0.3
1	21	Regulatory	80.10	464.03	466.81		466.82	0.00	1.02	332.79	422.24	0.2
1	20	Regulatory	82.00	463.67	466.62		466.66	0.00	1.82	173.61	192.67	0.34
1	19	Regulatory	83.70	463.09	465.57	465.57	466.12	0.01	4.15	45.49	45.67	0.87
1	18	Regulatory	85.70	462.39	465.17		465.26	0.00	2.06	102.59	68.91	0.4
1	17	Regulatory	88.40	461.82	464.97		465.04	0.00	1.38	124.25	78.31	0.25
1	16	Regulatory	91.30	461.06	464.83		464.94	0.00	2.25	107.03	56.78	0.37
1	15	Regulatory	92.70	459.58	464.77	461.64	464.89	0.00	1.58	75.35	123.42	0.23
1	14		Culvert									
1	13	Regulatory	93.30	459.62	462.51	462.29	463.63	0.01	4.71	20.24	27.90	0.89
1	12	Regulatory	95.20	459.93	462.53		462.77	0.00	2.93	77.63	62.77	0.59
1	11	Regulatory	98.90	459.44	461.49	461.49	461.97	0.01	3.47	55.34	72.38	0.81
1	10	Regulatory	99.50	458.26	460.76		460.89	0.00	2.55	112.84	104.33	0.54
1	9	Regulatory	99.90	457.24	459.63	459.62	460.21	0.01	4.19	52.36	47.13	0.88
1	8	Regulatory	100.20	456.56	459.83		459.88	0.00	1.30	163.31	98.90	0.24
1	7	Regulatory	100.50	455.70	459.80		459.83	0.00	1.14	226.07	102.70	0.18
1	6	Regulatory	100.9	454.22	459.8		459.81	0.000078	0.77	349.83	137.79	0.11
1	5	Regulatory	101.3	452.53	459.8		459.8	0.000018	0.44	708.05	206.5	0.05
1	4	Regulatory	101.7	450.67	459.76	452.78	459.79	0.000049	0.86	299.73	342.34	0.09
1	3		Culvert									
1	2	Regulatory	101.8	450.65	454.1		454.38	0.001633	2.59	54.69	95.52	0.45
1	1	Regulatory	102	449.23	454.23	452.29	454.23	0.000038	0.5	699.43	308.1	0.07

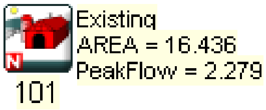


Figure D.2: VO2 Model Schematic – Existing Condition

```
==========================================================================================
===============
       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I      SS   U   U  AAAAA  L
         V  V   I       SS  U   U  A   A  L
          VV    I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM, Version 2.0
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O   Licensed To: Valdor Engineering
        OOO     T      T    H   H    Y    M   M   OOO                 VO2-0156

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                   *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files\Visual OTTHYMO v2.0\voin.dat
  Output  filename: S:\Projects\2014\14119\HYDROT~1\1STSUB~2\VO2\14119\FSR-Preliminary SCS -
Existing.out
  Summary filename: S:\Projects\2014\14119\HYDROT~1\1STSUB~2\VO2\14119\FSR-Preliminary SCS -
Existing.sum


DATE: 7/10/2015                           TIME: 3:46:21 PM

USER:


COMMENTS: Existing Conditions VO2 Model Output

------------------------------------------------------------------------------------------
---------------
  ****************************
  ** SIMULATION NUMBER:   1 **  25mm 4-hour Chicago Storm
  ****************************


--------------------
|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              25mmchi.stm
| Ptotal= 25.02 mm |    Comments: 25mm CHICAGO Storm
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .17    2.17 |  1.17    6.20 |  2.17    5.62 |  3.17    2.95
                  .33    2.38 |  1.33   12.18 |  2.33    4.80 |  3.33    2.76
                  .50    2.66 |  1.50   41.67 |  2.50    4.21 |  3.50    2.62
                  .67    3.03 |  1.67   15.28 |  2.67    3.78 |  3.67    2.47
                  .83    3.58 |  1.83    9.22 |  2.83    3.45 |  3.83    2.35
                 1.00    4.47 |  2.00    6.88 |  3.00    3.18 |  4.00    2.23

------------------------------------------------------------------------------


--------------------
| CALIB            |
| NASHYD    (0101) |   Area    (ha)=  16.44   Curve Number   (CN)= 85.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   7.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.
```

```
                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083    2.17 | 1.083    6.20 | 2.083    5.62 |  3.08    2.95
                 .167    2.17 | 1.167    6.20 | 2.167    5.62 |  3.17    2.95
                 .250    2.38 | 1.250   12.18 | 2.250    4.80 |  3.25    2.76
                 .333    2.38 | 1.333   12.18 | 2.333    4.80 |  3.33    2.76
                 .417    2.66 | 1.417   41.67 | 2.417    4.21 |  3.42    2.62
                 .500    2.66 | 1.500   41.67 | 2.500    4.21 |  3.50    2.62
                 .583    3.03 | 1.583   15.28 | 2.583    3.78 |  3.58    2.47
                 .667    3.03 | 1.667   15.28 | 2.667    3.78 |  3.67    2.47
                 .750    3.58 | 1.750    9.22 | 2.750    3.45 |  3.75    2.35
                 .833    3.58 | 1.833    9.22 | 2.833    3.45 |  3.83    2.35
                 .917    4.47 | 1.917    6.88 | 2.917    3.18 |  3.92    2.23
                1.000    4.47 | 2.000    6.88 | 3.000    3.18 |  4.00    2.23

     Unit Hyd Qpeak  (cms)=   1.744

     PEAK FLOW       (cms)=    .124 (i)
     TIME TO PEAK    (hrs)=   2.083
     RUNOFF VOLUME    (mm)=   5.168
     TOTAL RAINFALL   (mm)=  25.023
     RUNOFF COEFFICIENT   =    .207

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   2 **  2-year 12-hour SCS Storm
  ****************************


--------------------
|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              2Y12HSCS.STM
| Ptotal= 44.81 mm |    Comments: 2yr/12hr Fergus Shand Dam 2007 SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .25     .00 |  3.50    1.79 |  6.75    8.06 | 10.00    1.57
                  .50    1.12 |  3.75    1.79 |  7.00    3.58 | 10.25    1.57
                  .75    1.12 |  4.00    1.79 |  7.25    3.58 | 10.50     .90
                 1.00    1.12 |  4.25    1.79 |  7.50    2.69 | 10.75     .90
                 1.25    1.12 |  4.50    2.69 |  7.75    2.69 | 11.00     .90
                 1.50    1.12 |  4.75    2.69 |  8.00    2.69 | 11.25     .90
                 1.75    1.12 |  5.00    3.58 |  8.25    2.69 | 11.50     .90
                 2.00    1.12 |  5.25    3.58 |  8.50    1.57 | 11.75     .90
                 2.25    1.12 |  5.50    5.38 |  8.75    1.57 | 12.00     .90
                 2.50    1.34 |  5.75    5.38 |  9.00    1.57 | 12.25     .90
                 2.75    1.34 |  6.00   21.50 |  9.25    1.57 |
                 3.00    1.34 |  6.25   59.14 |  9.50    1.57 |
                 3.25    1.34 |  6.50    8.06 |  9.75    1.57 |

------------------------------------------------------------------------------

--------------------
| CALIB            |
| NASHYD    (0101) |   Area    (ha)=  16.44   Curve Number   (CN)= 85.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   7.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
```

```
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                .083     .00 | 3.167    1.34 | 6.250   59.14 |  9.33    1.57
                .167     .00 | 3.250    1.34 | 6.333    8.06 |  9.42    1.57
                .250     .00 | 3.333    1.79 | 6.417    8.06 |  9.50    1.57
                .333    1.12 | 3.417    1.79 | 6.500    8.06 |  9.58    1.57
                .417    1.12 | 3.500    1.79 | 6.583    8.06 |  9.67    1.57
                .500    1.12 | 3.583    1.79 | 6.667    8.06 |  9.75    1.57
                .583    1.12 | 3.667    1.79 | 6.750    8.06 |  9.83    1.57
                .667    1.12 | 3.750    1.79 | 6.833    3.58 |  9.92    1.57
                .750    1.12 | 3.833    1.79 | 6.917    3.58 | 10.00    1.57
                .833    1.12 | 3.917    1.79 | 7.000    3.58 | 10.08    1.57
                .917    1.12 | 4.000    1.79 | 7.083    3.58 | 10.17    1.57
               1.000    1.12 | 4.083    1.79 | 7.167    3.58 | 10.25    1.57
               1.083    1.12 | 4.167    1.79 | 7.250    3.58 | 10.33     .90
               1.167    1.12 | 4.250    1.79 | 7.333    2.69 | 10.42     .90
               1.250    1.12 | 4.333    2.69 | 7.417    2.69 | 10.50     .90
               1.333    1.12 | 4.417    2.69 | 7.500    2.69 | 10.58     .90
               1.417    1.12 | 4.500    2.69 | 7.583    2.69 | 10.67     .90
               1.500    1.12 | 4.583    2.69 | 7.667    2.69 | 10.75     .90
               1.583    1.12 | 4.667    2.69 | 7.750    2.69 | 10.83     .90
               1.667    1.12 | 4.750    2.69 | 7.833    2.69 | 10.92     .90
               1.750    1.12 | 4.833    3.58 | 7.917    2.69 | 11.00     .90
               1.833    1.12 | 4.917    3.58 | 8.000    2.69 | 11.08     .90
               1.917    1.12 | 5.000    3.58 | 8.083    2.69 | 11.17     .90
               2.000    1.12 | 5.083    3.58 | 8.167    2.69 | 11.25     .90
               2.083    1.12 | 5.167    3.58 | 8.250    2.69 | 11.33     .90
               2.167    1.12 | 5.250    3.58 | 8.333    1.57 | 11.42     .90
               2.250    1.12 | 5.333    5.38 | 8.417    1.57 | 11.50     .90
               2.333    1.34 | 5.417    5.38 | 8.500    1.57 | 11.58     .90
               2.417    1.34 | 5.500    5.38 | 8.583    1.57 | 11.67     .90
               2.500    1.34 | 5.583    5.38 | 8.667    1.57 | 11.75     .90
               2.583    1.34 | 5.667    5.38 | 8.750    1.57 | 11.83     .90
               2.667    1.34 | 5.750    5.38 | 8.833    1.57 | 11.92     .90
               2.750    1.34 | 5.833   21.50 | 8.917    1.57 | 12.00     .90
               2.833    1.34 | 5.917   21.50 | 9.000    1.57 | 12.08     .90
               2.917    1.34 | 6.000   21.50 | 9.083    1.57 | 12.17     .90
               3.000    1.34 | 6.083   59.14 | 9.167    1.57 | 12.25     .90
               3.083    1.34 | 6.167   59.14 | 9.250    1.57 |

     Unit Hyd Qpeak  (cms)=   1.744

     PEAK FLOW       (cms)=    .566 (i)
     TIME TO PEAK    (hrs)=   6.500
     RUNOFF VOLUME    (mm)=  17.294
     TOTAL RAINFALL   (mm)=  44.805
     RUNOFF COEFFICIENT   =    .386

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
  ***************************
  ** SIMULATION NUMBER:   3 **  5-year 12-hour SCS Storm
  ***************************


--------------------
|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              5Y12HSCS.STM
| Ptotal= 61.00 mm |    Comments: 5yr/12hr Fergus Shand Dam 2007 SCS
--------------------
                TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .25     .00 |  3.50    2.44 |  6.75   10.98 | 10.00    2.14
                 .50    1.52 |  3.75    2.44 |  7.00    4.88 | 10.25    2.14
                 .75    1.52 |  4.00    2.44 |  7.25    4.88 | 10.50    1.22
                1.00    1.52 |  4.25    2.44 |  7.50    3.66 | 10.75    1.22
                1.25    1.52 |  4.50    3.66 |  7.75    3.66 | 11.00    1.22
                1.50    1.52 |  4.75    3.66 |  8.00    3.66 | 11.25    1.22
                1.75    1.52 |  5.00    4.88 |  8.25    3.66 | 11.50    1.22
                2.00    1.52 |  5.25    4.88 |  8.50    2.14 | 11.75    1.22
                2.25    1.52 |  5.50    7.32 |  8.75    2.14 | 12.00    1.22
                2.50    1.83 |  5.75    7.32 |  9.00    2.14 | 12.25    1.22
                2.75    1.83 |  6.00   29.28 |  9.25    2.14 |
                3.00    1.83 |  6.25   80.52 |  9.50    2.14 |
                3.25    1.83 |  6.50   10.98 |  9.75    2.14 |

-------------------------------------------------------------------------------

--------------------
| CALIB            |
| NASHYD    (0101) |   Area    (ha)=  16.44   Curve Number   (CN)= 85.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   7.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                .083     .00 | 3.167    1.83 | 6.250   80.52 |  9.33    2.14
                .167     .00 | 3.250    1.83 | 6.333   10.98 |  9.42    2.14
                .250     .00 | 3.333    2.44 | 6.417   10.98 |  9.50    2.14
                .333    1.52 | 3.417    2.44 | 6.500   10.98 |  9.58    2.14
                .417    1.52 | 3.500    2.44 | 6.583   10.98 |  9.67    2.14
                .500    1.52 | 3.583    2.44 | 6.667   10.98 |  9.75    2.14
                .583    1.52 | 3.667    2.44 | 6.750   10.98 |  9.83    2.14
                .667    1.52 | 3.750    2.44 | 6.833    4.88 |  9.92    2.14
                .750    1.52 | 3.833    2.44 | 6.917    4.88 | 10.00    2.14
                .833    1.52 | 3.917    2.44 | 7.000    4.88 | 10.08    2.14
                .917    1.52 | 4.000    2.44 | 7.083    4.88 | 10.17    2.14
               1.000    1.52 | 4.083    2.44 | 7.167    4.88 | 10.25    2.14
               1.083    1.52 | 4.167    2.44 | 7.250    4.88 | 10.33    1.22
               1.167    1.52 | 4.250    2.44 | 7.333    3.66 | 10.42    1.22
               1.250    1.52 | 4.333    3.66 | 7.417    3.66 | 10.50    1.22
               1.333    1.52 | 4.417    3.66 | 7.500    3.66 | 10.58    1.22
               1.417    1.52 | 4.500    3.66 | 7.583    3.66 | 10.67    1.22
               1.500    1.52 | 4.583    3.66 | 7.667    3.66 | 10.75    1.22
               1.583    1.52 | 4.667    3.66 | 7.750    3.66 | 10.83    1.22
               1.667    1.52 | 4.750    3.66 | 7.833    3.66 | 10.92    1.22
               1.750    1.52 | 4.833    4.88 | 7.917    3.66 | 11.00    1.22
               1.833    1.52 | 4.917    4.88 | 8.000    3.66 | 11.08    1.22
               1.917    1.52 | 5.000    4.88 | 8.083    3.66 | 11.17    1.22
               2.000    1.52 | 5.083    4.88 | 8.167    3.66 | 11.25    1.22
               2.083    1.52 | 5.167    4.88 | 8.250    3.66 | 11.33    1.22
               2.167    1.52 | 5.250    4.88 | 8.333    2.14 | 11.42    1.22
               2.250    1.52 | 5.333    7.32 | 8.417    2.14 | 11.50    1.22
               2.333    1.83 | 5.417    7.32 | 8.500    2.14 | 11.58    1.22
               2.417    1.83 | 5.500    7.32 | 8.583    2.14 | 11.67    1.22
               2.500    1.83 | 5.583    7.32 | 8.667    2.14 | 11.75    1.22
               2.583    1.83 | 5.667    7.32 | 8.750    2.14 | 11.83    1.22
               2.667    1.83 | 5.750    7.32 | 8.833    2.14 | 11.92    1.22
               2.750    1.83 | 5.833   29.28 | 8.917    2.14 | 12.00    1.22
               2.833    1.83 | 5.917   29.28 | 9.000    2.14 | 12.08    1.22
               2.917    1.83 | 6.000   29.28 | 9.083    2.14 | 12.17    1.22
               3.000    1.83 | 6.083   80.52 | 9.167    2.14 | 12.25    1.22
               3.083    1.83 | 6.167   80.52 | 9.250    2.14 |

     Unit Hyd Qpeak  (cms)=   1.744

     PEAK FLOW       (cms)=    .988 (i)
     TIME TO PEAK    (hrs)=   6.500
     RUNOFF VOLUME    (mm)=  29.501
     TOTAL RAINFALL   (mm)=  61.000
     RUNOFF COEFFICIENT   =    .484

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
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  ** SIMULATION NUMBER:   4 **  10-year 12-hour SCS Storm

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|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              10Y12HSCS.STM
| Ptotal= 71.69 mm |    Comments: 10yr/12hr Fergus Shand Dam 2007 SCS
--------------------
                TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .25     .00 |  3.50    2.87 |  6.75   12.91 | 10.00    2.51
                 .50    1.79 |  3.75    2.87 |  7.00    5.74 | 10.25    2.51
                 .75    1.79 |  4.00    2.87 |  7.25    5.74 | 10.50    1.43
                1.00    1.79 |  4.25    2.87 |  7.50    4.30 | 10.75    1.43
                1.25    1.79 |  4.50    4.30 |  7.75    4.30 | 11.00    1.43
                1.50    1.79 |  4.75    4.30 |  8.00    4.30 | 11.25    1.43
                1.75    1.79 |  5.00    5.74 |  8.25    4.30 | 11.50    1.43
                2.00    1.79 |  5.25    5.74 |  8.50    2.51 | 11.75    1.43
                2.25    1.79 |  5.50    8.60 |  8.75    2.51 | 12.00    1.43
                2.50    2.15 |  5.75    8.60 |  9.00    2.51 | 12.25    1.43
                2.75    2.15 |  6.00   34.42 |  9.25    2.51 |
                3.00    2.15 |  6.25   94.64 |  9.50    2.51 |
                3.25    2.15 |  6.50   12.91 |  9.75    2.51 |

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| CALIB            |
| NASHYD    (0101) |   Area    (ha)=  16.44   Curve Number   (CN)= 85.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   7.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                .083     .00 | 3.167    2.15 | 6.250   94.64 |  9.33    2.51
                .167     .00 | 3.250    2.15 | 6.333   12.91 |  9.42    2.51
                .250     .00 | 3.333    2.87 | 6.417   12.91 |  9.50    2.51
                .333    1.79 | 3.417    2.87 | 6.500   12.91 |  9.58    2.51
                .417    1.79 | 3.500    2.87 | 6.583   12.91 |  9.67    2.51
                .500    1.79 | 3.583    2.87 | 6.667   12.91 |  9.75    2.51
                .583    1.79 | 3.667    2.87 | 6.750   12.91 |  9.83    2.51
                .667    1.79 | 3.750    2.87 | 6.833    5.74 |  9.92    2.51
                .750    1.79 | 3.833    2.87 | 6.917    5.74 | 10.00    2.51
                .833    1.79 | 3.917    2.87 | 7.000    5.74 | 10.08    2.51
                .917    1.79 | 4.000    2.87 | 7.083    5.74 | 10.17    2.51
               1.000    1.79 | 4.083    2.87 | 7.167    5.74 | 10.25    2.51
               1.083    1.79 | 4.167    2.87 | 7.250    5.74 | 10.33    1.43
               1.167    1.79 | 4.250    2.87 | 7.333    4.30 | 10.42    1.43
               1.250    1.79 | 4.333    4.30 | 7.417    4.30 | 10.50    1.43
               1.333    1.79 | 4.417    4.30 | 7.500    4.30 | 10.58    1.43
               1.417    1.79 | 4.500    4.30 | 7.583    4.30 | 10.67    1.43
               1.500    1.79 | 4.583    4.30 | 7.667    4.30 | 10.75    1.43
               1.583    1.79 | 4.667    4.30 | 7.750    4.30 | 10.83    1.43
               1.667    1.79 | 4.750    4.30 | 7.833    4.30 | 10.92    1.43
               1.750    1.79 | 4.833    5.74 | 7.917    4.30 | 11.00    1.43
               1.833    1.79 | 4.917    5.74 | 8.000    4.30 | 11.08    1.43
               1.917    1.79 | 5.000    5.74 | 8.083    4.30 | 11.17    1.43
               2.000    1.79 | 5.083    5.74 | 8.167    4.30 | 11.25    1.43
               2.083    1.79 | 5.167    5.74 | 8.250    4.30 | 11.33    1.43
               2.167    1.79 | 5.250    5.74 | 8.333    2.51 | 11.42    1.43
               2.250    1.79 | 5.333    8.60 | 8.417    2.51 | 11.50    1.43
               2.333    2.15 | 5.417    8.60 | 8.500    2.51 | 11.58    1.43
               2.417    2.15 | 5.500    8.60 | 8.583    2.51 | 11.67    1.43
               2.500    2.15 | 5.583    8.60 | 8.667    2.51 | 11.75    1.43
               2.583    2.15 | 5.667    8.60 | 8.750    2.51 | 11.83    1.43
               2.667    2.15 | 5.750    8.60 | 8.833    2.51 | 11.92    1.43
               2.750    2.15 | 5.833   34.42 | 8.917    2.51 | 12.00    1.43
               2.833    2.15 | 5.917   34.42 | 9.000    2.51 | 12.08    1.43
               2.917    2.15 | 6.000   34.42 | 9.083    2.51 | 12.17    1.43
               3.000    2.15 | 6.083   94.64 | 9.167    2.51 | 12.25    1.43
               3.083    2.15 | 6.167   94.64 | 9.250    2.51 |

    Unit Hyd Qpeak  (cms)=   1.744

    PEAK FLOW      (cms)=   1.287 (i)
    TIME TO PEAK   (hrs)=   6.500
    RUNOFF VOLUME    (mm)=  38.205
    TOTAL RAINFALL   (mm)=  71.690
    RUNOFF COEFFICIENT   =    .533

    (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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  ** SIMULATION NUMBER:   5 **  25-year 12-hour SCS Storm

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|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              25Y12HSCS.STM
| Ptotal= 85.31 mm |    Comments: 25yr/12hr Fergus Shand Dam 2007 SCS
--------------------
                TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .25     .00 |  3.50    3.41 |  6.75   15.35 | 10.00    2.99
                 .50    2.13 |  3.75    3.41 |  7.00    6.82 | 10.25    2.99
                 .75    2.13 |  4.00    3.41 |  7.25    6.82 | 10.50    1.71
                1.00    2.13 |  4.25    3.41 |  7.50    5.12 | 10.75    1.71
                1.25    2.13 |  4.50    5.12 |  7.75    5.12 | 11.00    1.71
                1.50    2.13 |  4.75    5.12 |  8.00    5.12 | 11.25    1.71
                1.75    2.13 |  5.00    6.82 |  8.25    5.12 | 11.50    1.71
                2.00    2.13 |  5.25    6.82 |  8.50    2.99 | 11.75    1.71
                2.25    2.13 |  5.50   10.24 |  8.75    2.99 | 12.00    1.71
                2.50    2.56 |  5.75   10.24 |  9.00    2.99 | 12.25    1.71
                2.75    2.56 |  6.00   40.94 |  9.25    2.99 |
                3.00    2.56 |  6.25  112.60 |  9.50    2.99 |
                3.25    2.56 |  6.50   15.35 |  9.75    2.99 |

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| CALIB            |
| NASHYD    (0101) |   Area    (ha)=  16.44   Curve Number   (CN)= 85.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   7.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                .083     .00 | 3.167    2.56 | 6.250  112.60 |  9.33    2.99
                .167     .00 | 3.250    2.56 | 6.333   15.35 |  9.42    2.99
                .250     .00 | 3.333    3.41 | 6.417   15.35 |  9.50    2.99
                .333    2.13 | 3.417    3.41 | 6.500   15.35 |  9.58    2.99
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                 .417    2.13 | 3.500    3.41 | 6.583   15.35 |  9.67    2.99
                 .500    2.13 | 3.583    3.41 | 6.667   15.35 |  9.75    2.99
                 .583    2.13 | 3.667    3.41 | 6.750   15.35 |  9.83    2.99
                 .667    2.13 | 3.750    3.41 | 6.833    6.82 |  9.92    2.99
                 .750    2.13 | 3.833    3.41 | 6.917    6.82 | 10.00    2.99
                 .833    2.13 | 3.917    3.41 | 7.000    6.82 | 10.08    2.99
                 .917    2.13 | 4.000    3.41 | 7.083    6.82 | 10.17    2.99
                1.000    2.13 | 4.083    3.41 | 7.167    6.82 | 10.25    2.99
                1.083    2.13 | 4.167    3.41 | 7.250    6.82 | 10.33    1.71
                1.167    2.13 | 4.250    3.41 | 7.333    5.12 | 10.42    1.71
                1.250    2.13 | 4.333    5.12 | 7.417    5.12 | 10.50    1.71
                1.333    2.13 | 4.417    5.12 | 7.500    5.12 | 10.58    1.71
                1.417    2.13 | 4.500    5.12 | 7.583    5.12 | 10.67    1.71
                1.500    2.13 | 4.583    5.12 | 7.667    5.12 | 10.75    1.71
                1.583    2.13 | 4.667    5.12 | 7.750    5.12 | 10.83    1.71
                1.667    2.13 | 4.750    5.12 | 7.833    5.12 | 10.92    1.71
                1.750    2.13 | 4.833    6.82 | 7.917    5.12 | 11.00    1.71
                1.833    2.13 | 4.917    6.82 | 8.000    5.12 | 11.08    1.71
                1.917    2.13 | 5.000    6.82 | 8.083    5.12 | 11.17    1.71
                2.000    2.13 | 5.083    6.82 | 8.167    5.12 | 11.25    1.71
                2.083    2.13 | 5.167    6.82 | 8.250    5.12 | 11.33    1.71
                2.167    2.13 | 5.250    6.82 | 8.333    2.99 | 11.42    1.71
                2.250    2.13 | 5.333   10.24 | 8.417    2.99 | 11.50    1.71
                2.333    2.56 | 5.417   10.24 | 8.500    2.99 | 11.58    1.71
                2.417    2.56 | 5.500   10.24 | 8.583    2.99 | 11.67    1.71
                2.500    2.56 | 5.583   10.24 | 8.667    2.99 | 11.75    1.71
                2.583    2.56 | 5.667   10.24 | 8.750    2.99 | 11.83    1.71
                2.667    2.56 | 5.750   10.24 | 8.833    2.99 | 11.92    1.71
                2.750    2.56 | 5.833   40.94 | 8.917    2.99 | 12.00    1.71
                2.833    2.56 | 5.917   40.94 | 9.000    2.99 | 12.08    1.71
                2.917    2.56 | 6.000   40.94 | 9.083    2.99 | 12.17    1.71
                3.000    2.56 | 6.083  112.60 | 9.167    2.99 | 12.25    1.71
                3.083    2.56 | 6.167  112.60 | 9.250    2.99 |

     Unit Hyd Qpeak  (cms)=   1.744

     PEAK FLOW       (cms)=   1.681 (i)
     TIME TO PEAK    (hrs)=   6.500
     RUNOFF VOLUME    (mm)=  49.794
     TOTAL RAINFALL   (mm)=  85.310
     RUNOFF COEFFICIENT   =    .584

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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  ** SIMULATION NUMBER:   6 **  50-year 12-hour SCS Storm
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|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              50Y12HSCS.STM
| Ptotal= 95.31 mm |    Comments: 50yr/12hr Fergus Shand Dam 2007 SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .25     .00 |  3.50    3.81 |  6.75   17.15 | 10.00    3.34
                  .50    2.38 |  3.75    3.81 |  7.00    7.62 | 10.25    3.34
                  .75    2.38 |  4.00    3.81 |  7.25    7.62 | 10.50    1.91
                 1.00    2.38 |  4.25    3.81 |  7.50    5.72 | 10.75    1.91
                 1.25    2.38 |  4.50    5.72 |  7.75    5.72 | 11.00    1.91
                 1.50    2.38 |  4.75    5.72 |  8.00    5.72 | 11.25    1.91
                 1.75    2.38 |  5.00    7.62 |  8.25    5.72 | 11.50    1.91
                 2.00    2.38 |  5.25    7.62 |  8.50    3.34 | 11.75    1.91
                 2.25    2.38 |  5.50   11.44 |  8.75    3.34 | 12.00    1.91
                 2.50    2.86 |  5.75   11.44 |  9.00    3.34 | 12.25    1.91
                 2.75    2.86 |  6.00   45.74 |  9.25    3.34 |
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                 3.00    2.86 |  6.25  125.80 |  9.50    3.34 |
                 3.25    2.86 |  6.50   17.15 |  9.75    3.34 |

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| CALIB            |
| NASHYD    (0101) |   Area    (ha)=  16.44   Curve Number   (CN)= 85.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   7.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083     .00 | 3.167    2.86 | 6.250  125.80 |  9.33    3.34
                 .167     .00 | 3.250    2.86 | 6.333   17.15 |  9.42    3.34
                 .250     .00 | 3.333    3.81 | 6.417   17.15 |  9.50    3.34
                 .333    2.38 | 3.417    3.81 | 6.500   17.15 |  9.58    3.34
                 .417    2.38 | 3.500    3.81 | 6.583   17.15 |  9.67    3.34
                 .500    2.38 | 3.583    3.81 | 6.667   17.15 |  9.75    3.34
                 .583    2.38 | 3.667    3.81 | 6.750   17.15 |  9.83    3.34
                 .667    2.38 | 3.750    3.81 | 6.833    7.62 |  9.92    3.34
                 .750    2.38 | 3.833    3.81 | 6.917    7.62 | 10.00    3.34
                 .833    2.38 | 3.917    3.81 | 7.000    7.62 | 10.08    3.34
                 .917    2.38 | 4.000    3.81 | 7.083    7.62 | 10.17    3.34
                1.000    2.38 | 4.083    3.81 | 7.167    7.62 | 10.25    3.34
                1.083    2.38 | 4.167    3.81 | 7.250    7.62 | 10.33    1.91
                1.167    2.38 | 4.250    3.81 | 7.333    5.72 | 10.42    1.91
                1.250    2.38 | 4.333    5.72 | 7.417    5.72 | 10.50    1.91
                1.333    2.38 | 4.417    5.72 | 7.500    5.72 | 10.58    1.91
                1.417    2.38 | 4.500    5.72 | 7.583    5.72 | 10.67    1.91
                1.500    2.38 | 4.583    5.72 | 7.667    5.72 | 10.75    1.91
                1.583    2.38 | 4.667    5.72 | 7.750    5.72 | 10.83    1.91
                1.667    2.38 | 4.750    5.72 | 7.833    5.72 | 10.92    1.91
                1.750    2.38 | 4.833    7.62 | 7.917    5.72 | 11.00    1.91
                1.833    2.38 | 4.917    7.62 | 8.000    5.72 | 11.08    1.91
                1.917    2.38 | 5.000    7.62 | 8.083    5.72 | 11.17    1.91
                2.000    2.38 | 5.083    7.62 | 8.167    5.72 | 11.25    1.91
                2.083    2.38 | 5.167    7.62 | 8.250    5.72 | 11.33    1.91
                2.167    2.38 | 5.250    7.62 | 8.333    3.34 | 11.42    1.91
                2.250    2.38 | 5.333   11.44 | 8.417    3.34 | 11.50    1.91
                2.333    2.86 | 5.417   11.44 | 8.500    3.34 | 11.58    1.91
                2.417    2.86 | 5.500   11.44 | 8.583    3.34 | 11.67    1.91
                2.500    2.86 | 5.583   11.44 | 8.667    3.34 | 11.75    1.91
                2.583    2.86 | 5.667   11.44 | 8.750    3.34 | 11.83    1.91
                2.667    2.86 | 5.750   11.44 | 8.833    3.34 | 11.92    1.91
                2.750    2.86 | 5.833   45.74 | 8.917    3.34 | 12.00    1.91
                2.833    2.86 | 5.917   45.74 | 9.000    3.34 | 12.08    1.91
                2.917    2.86 | 6.000   45.74 | 9.083    3.34 | 12.17    1.91
                3.000    2.86 | 6.083  125.80 | 9.167    3.34 | 12.25    1.91
                3.083    2.86 | 6.167  125.80 | 9.250    3.34 |

     Unit Hyd Qpeak  (cms)=   1.744

     PEAK FLOW       (cms)=   1.978 (i)
     TIME TO PEAK    (hrs)=   6.500
     RUNOFF VOLUME    (mm)=  58.566
     TOTAL RAINFALL   (mm)=  95.310
     RUNOFF COEFFICIENT   =    .614

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
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  ** SIMULATION NUMBER:   7 **  100-year 12-hour SCS Storm
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|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              100Y12HSCS.STM
| Ptotal=105.31 mm |    Comments: 100yr/12hr Fergus Shand Dam 2007 SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .25     .00 |  3.50    4.21 |  6.75   18.95 | 10.00    3.69
                  .50    2.63 |  3.75    4.21 |  7.00    8.42 | 10.25    3.69
                  .75    2.63 |  4.00    4.21 |  7.25    8.42 | 10.50    2.11
                 1.00    2.63 |  4.25    4.21 |  7.50    6.32 | 10.75    2.11
                 1.25    2.63 |  4.50    6.32 |  7.75    6.32 | 11.00    2.11
                 1.50    2.63 |  4.75    6.32 |  8.00    6.32 | 11.25    2.11
                 1.75    2.63 |  5.00    8.42 |  8.25    6.32 | 11.50    2.11
                 2.00    2.63 |  5.25    8.42 |  8.50    3.69 | 11.75    2.11
                 2.25    2.63 |  5.50   12.64 |  8.75    3.69 | 12.00    2.11
                 2.50    3.16 |  5.75   12.64 |  9.00    3.69 | 12.25    2.11
                 2.75    3.16 |  6.00   50.54 |  9.25    3.69 |
                 3.00    3.16 |  6.25  139.00 |  9.50    3.69 |
                 3.25    3.16 |  6.50   18.95 |  9.75    3.69 |

------------------------------------------------------------------------------

--------------------
| CALIB            |
| NASHYD    (0101) |   Area    (ha)=  16.44   Curve Number   (CN)= 85.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   7.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=    .36

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083     .00 | 3.167    3.16 | 6.250  139.00 |  9.33    3.69
                 .167     .00 | 3.250    3.16 | 6.333   18.95 |  9.42    3.69
                 .250     .00 | 3.333    4.21 | 6.417   18.95 |  9.50    3.69
                 .333    2.63 | 3.417    4.21 | 6.500   18.95 |  9.58    3.69
                 .417    2.63 | 3.500    4.21 | 6.583   18.95 |  9.67    3.69
                 .500    2.63 | 3.583    4.21 | 6.667   18.95 |  9.75    3.69
                 .583    2.63 | 3.667    4.21 | 6.750   18.95 |  9.83    3.69
                 .667    2.63 | 3.750    4.21 | 6.833    8.42 |  9.92    3.69
                 .750    2.63 | 3.833    4.21 | 6.917    8.42 | 10.00    3.69
                 .833    2.63 | 3.917    4.21 | 7.000    8.42 | 10.08    3.69
                 .917    2.63 | 4.000    4.21 | 7.083    8.42 | 10.17    3.69
                1.000    2.63 | 4.083    4.21 | 7.167    8.42 | 10.25    3.69
                1.083    2.63 | 4.167    4.21 | 7.250    8.42 | 10.33    2.11
                1.167    2.63 | 4.250    4.21 | 7.333    6.32 | 10.42    2.11
                1.250    2.63 | 4.333    6.32 | 7.417    6.32 | 10.50    2.11
                1.333    2.63 | 4.417    6.32 | 7.500    6.32 | 10.58    2.11
                1.417    2.63 | 4.500    6.32 | 7.583    6.32 | 10.67    2.11
                1.500    2.63 | 4.583    6.32 | 7.667    6.32 | 10.75    2.11
                1.583    2.63 | 4.667    6.32 | 7.750    6.32 | 10.83    2.11
                1.667    2.63 | 4.750    6.32 | 7.833    6.32 | 10.92    2.11
                1.750    2.63 | 4.833    8.42 | 7.917    6.32 | 11.00    2.11
                1.833    2.63 | 4.917    8.42 | 8.000    6.32 | 11.08    2.11
                1.917    2.63 | 5.000    8.42 | 8.083    6.32 | 11.17    2.11
                2.000    2.63 | 5.083    8.42 | 8.167    6.32 | 11.25    2.11
                2.083    2.63 | 5.167    8.42 | 8.250    6.32 | 11.33    2.11
                2.167    2.63 | 5.250    8.42 | 8.333    3.69 | 11.42    2.11
```

```
                2.250    2.63 | 5.333   12.64 | 8.417    3.69 | 11.50    2.11
                2.333    3.16 | 5.417   12.64 | 8.500    3.69 | 11.58    2.11
                2.417    3.16 | 5.500   12.64 | 8.583    3.69 | 11.67    2.11
                2.500    3.16 | 5.583   12.64 | 8.667    3.69 | 11.75    2.11
                2.583    3.16 | 5.667   12.64 | 8.750    3.69 | 11.83    2.11
                2.667    3.16 | 5.750   12.64 | 8.833    3.69 | 11.92    2.11
                2.750    3.16 | 5.833   50.54 | 8.917    3.69 | 12.00    2.11
                2.833    3.16 | 5.917   50.54 | 9.000    3.69 | 12.08    2.11
                2.917    3.16 | 6.000   50.54 | 9.083    3.69 | 12.17    2.11
                3.000    3.16 | 6.083  139.00 | 9.167    3.69 | 12.25    2.11
                3.083    3.16 | 6.167  139.00 | 9.250    3.69 |

     Unit Hyd Qpeak  (cms)=   1.744

     PEAK FLOW       (cms)=   2.279 (i)
     TIME TO PEAK    (hrs)=   6.500
     RUNOFF VOLUME    (mm)=  67.511
     TOTAL RAINFALL   (mm)= 105.310
     RUNOFF COEFFICIENT   =    .641

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

------------------------------------------------------------------------------

 FINISH
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```

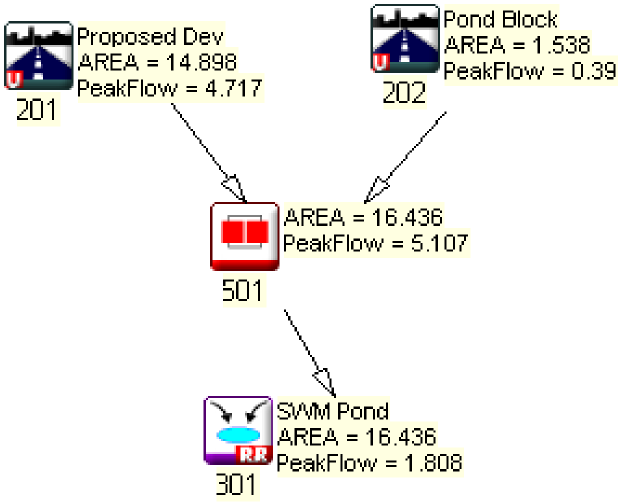

Figure D.3: VO2 Model Schematic – Proposed Condition

```
==============================================================================================
===============

      V    V   I    SSSSS  U   U    A    L
      V    V   I    SS     U   U   A A   L
       V  V    I     SS    U   U  AAAAA  L
       V  V    I      SS   U   U  A   A  L
        VV     I    SSSSS  UUUUU  A   A  LLLLL

       OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM, Version 2.0
      O   O    T      T    H   H   Y Y   MM MM  O   O
      O   O    T      T    H   H    Y    M   M  O   O   Licensed To: Valdor Engineering
       OOO     T      T    H   H    Y    M   M   OOO                VO2-0156

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                   *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files\Visual OTTHYMO v2.0\voin.dat
  Output  filename: S:\Projects\2014\14119\HYDROT~1\1STSUB~2\VO2\14119\FSR-Preliminary SCS -
Proposed.out
  Summary filename: S:\Projects\2014\14119\HYDROT~1\1STSUB~2\VO2\14119\FSR-Preliminary SCS -
Proposed.sum


DATE: 7/10/2015                           TIME: 3:50:57 PM

USER:


COMMENTS: Proposed Conditions VO2 Model Output


----------------------------------------------------------------------------------------------
---------------
  ****************************
  ** SIMULATION NUMBER:   1 **  25mm 4-hour Chicago Storm
  ****************************


--------------------
|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              25mmchi.stm
| Ptotal= 25.02 mm |    Comments: 25mm CHICAGO Storm
--------------------
                TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .17    2.17 |  1.17    6.20 |  2.17    5.62 |  3.17    2.95
                 .33    2.38 |  1.33   12.18 |  2.33    4.80 |  3.33    2.76
                 .50    2.66 |  1.50   41.67 |  2.50    4.21 |  3.50    2.62
                 .67    3.03 |  1.67   15.28 |  2.67    3.78 |  3.67    2.47
                 .83    3.58 |  1.83    9.22 |  2.83    3.45 |  3.83    2.35
                1.00    4.47 |  2.00    6.88 |  3.00    3.18 |  4.00    2.23

-------------------------------------------------------------------------------

--------------------
| CALIB            |
| STANDHYD  (0202) |   Area    (ha)=   1.54
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .77          .77
```

```
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     101.30        40.00
     Mannings n          =        .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                .083    2.17 | 1.083    6.20 | 2.083    5.62 |  3.08    2.95
                .167    2.17 | 1.167    6.20 | 2.167    5.62 |  3.17    2.95
                .250    2.38 | 1.250   12.18 | 2.250    4.80 |  3.25    2.76
                .333    2.38 | 1.333   12.18 | 2.333    4.80 |  3.33    2.76
                .417    2.66 | 1.417   41.67 | 2.417    4.21 |  3.42    2.62
                .500    2.66 | 1.500   41.67 | 2.500    4.21 |  3.50    2.62
                .583    3.03 | 1.583   15.28 | 2.583    3.78 |  3.58    2.47
                .667    3.03 | 1.667   15.28 | 2.667    3.78 |  3.67    2.47
                .750    3.58 | 1.750    9.22 | 2.750    3.45 |  3.75    2.35
                .833    3.58 | 1.833    9.22 | 2.833    3.45 |  3.83    2.35
                .917    4.47 | 1.917    6.88 | 2.917    3.18 |  3.92    2.23
               1.000    4.47 | 2.000    6.88 | 3.000    3.18 |  4.00    2.23

     Max.Eff.Inten.(mm/hr)=      41.67         2.08
                over (min)        5.00        40.00
     Storage Coeff.  (min)=       3.65 (ii)   36.89 (ii)
     Unit Hyd. Tpeak (min)=       5.00        40.00
     Unit Hyd. peak  (cms)=        .25          .03
                                                          *TOTALS*
     PEAK FLOW      (cms)=        .08          .00          .085 (iii)
     TIME TO PEAK    (hrs)=       1.50         2.42          1.50
     RUNOFF VOLUME    (mm)=      24.02         2.87         13.43
     TOTAL RAINFALL   (mm)=      25.02        25.02         25.02
     RUNOFF COEFFICIENT   =        .96          .11           .54

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0201) |   Area    (ha)=  14.90
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      11.17         3.72
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     315.20        40.00
     Mannings n          =        .013         .250

     Max.Eff.Inten.(mm/hr)=      41.67         3.50
                over (min)        5.00        35.00
     Storage Coeff.  (min)=       7.22 (ii)   34.20 (ii)
     Unit Hyd. Tpeak (min)=       5.00        35.00
     Unit Hyd. peak  (cms)=        .17          .03
                                                          *TOTALS*
     PEAK FLOW      (cms)=        .98          .02          .984 (iii)
     TIME TO PEAK    (hrs)=       1.50         2.25          1.50
     RUNOFF VOLUME    (mm)=      24.02         3.61         17.90
     TOTAL RAINFALL   (mm)=      25.02        25.02         25.02
     RUNOFF COEFFICIENT   =        .96          .14           .72
```

```
       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0501) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0202):     1.54    .085     1.50    13.43
        + ID2= 2 (0201):    14.90    .984     1.50    17.90
          ===============================================
          ID = 3 (0501):    16.44   1.069     1.50    17.48

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR (0301) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          .0000      .0000    |   1.5850      .6086
                          .0280      .2947    |   1.7390      .6775
                          .5610      .3828    |   1.8750      .7480
                          .9810      .4762    |  15.3160     1.2909
                         1.1570      .5414    |    .0000      .0000

                               AREA     QPEAK     TPEAK       R.V.
                               (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (0501)     16.44      1.07      1.50      17.48
     OUTFLOW: ID= 1 (0301)     16.44       .02      4.17      17.32

                 PEAK   FLOW   REDUCTION [Qout/Qin](%)=  2.34
                 TIME SHIFT OF PEAK FLOW         (min)=160.00
                 MAXIMUM  STORAGE   USED       (ha.m.)=  .2632

-------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   2 **  2-year 12-hour SCS Storm
  ****************************


--------------------
|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              2Y12HSCS.STM
| Ptotal= 44.81 mm |    Comments: 2yr/12hr Fergus Shand Dam 2007 SCS
--------------------
                TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .25     .00 |  3.50    1.79 |  6.75    8.06 | 10.00    1.57
                 .50    1.12 |  3.75    1.79 |  7.00    3.58 | 10.25    1.57
                 .75    1.12 |  4.00    1.79 |  7.25    3.58 | 10.50     .90
                1.00    1.12 |  4.25    1.79 |  7.50    2.69 | 10.75     .90
                1.25    1.12 |  4.50    2.69 |  7.75    2.69 | 11.00     .90
                1.50    1.12 |  4.75    2.69 |  8.00    2.69 | 11.25     .90
                1.75    1.12 |  5.00    3.58 |  8.25    2.69 | 11.50     .90
                2.00    1.12 |  5.25    3.58 |  8.50    1.57 | 11.75     .90
                2.25    1.12 |  5.50    5.38 |  8.75    1.57 | 12.00     .90
                2.50    1.34 |  5.75    5.38 |  9.00    1.57 | 12.25     .90
                2.75    1.34 |  6.00   21.50 |  9.25    1.57 |
                3.00    1.34 |  6.25   59.14 |  9.50    1.57 |
                3.25    1.34 |  6.50    8.06 |  9.75    1.57 |

-------------------------------------------------------------------------------
```

```
--------------------
| CALIB            |
| STANDHYD  (0202) |   Area    (ha)=   1.54
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .77          .77
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     101.30        40.00
     Mannings n          =        .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                   TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                    hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                   .083     .00 | 3.167    1.34 | 6.250   59.14 |  9.33    1.57
                   .167     .00 | 3.250    1.34 | 6.333    8.06 |  9.42    1.57
                   .250     .00 | 3.333    1.79 | 6.417    8.06 |  9.50    1.57
                   .333    1.12 | 3.417    1.79 | 6.500    8.06 |  9.58    1.57
                   .417    1.12 | 3.500    1.79 | 6.583    8.06 |  9.67    1.57
                   .500    1.12 | 3.583    1.79 | 6.667    8.06 |  9.75    1.57
                   .583    1.12 | 3.667    1.79 | 6.750    8.06 |  9.83    1.57
                   .667    1.12 | 3.750    1.79 | 6.833    3.58 |  9.92    1.57
                   .750    1.12 | 3.833    1.79 | 6.917    3.58 | 10.00    1.57
                   .833    1.12 | 3.917    1.79 | 7.000    3.58 | 10.08    1.57
                   .917    1.12 | 4.000    1.79 | 7.083    3.58 | 10.17    1.57
                  1.000    1.12 | 4.083    1.79 | 7.167    3.58 | 10.25    1.57
                  1.083    1.12 | 4.167    1.79 | 7.250    3.58 | 10.33     .90
                  1.167    1.12 | 4.250    1.79 | 7.333    2.69 | 10.42     .90
                  1.250    1.12 | 4.333    2.69 | 7.417    2.69 | 10.50     .90
                  1.333    1.12 | 4.417    2.69 | 7.500    2.69 | 10.58     .90
                  1.417    1.12 | 4.500    2.69 | 7.583    2.69 | 10.67     .90
                  1.500    1.12 | 4.583    2.69 | 7.667    2.69 | 10.75     .90
                  1.583    1.12 | 4.667    2.69 | 7.750    2.69 | 10.83     .90
                  1.667    1.12 | 4.750    2.69 | 7.833    2.69 | 10.92     .90
                  1.750    1.12 | 4.833    3.58 | 7.917    2.69 | 11.00     .90
                  1.833    1.12 | 4.917    3.58 | 8.000    2.69 | 11.08     .90
                  1.917    1.12 | 5.000    3.58 | 8.083    2.69 | 11.17     .90
                  2.000    1.12 | 5.083    3.58 | 8.167    2.69 | 11.25     .90
                  2.083    1.12 | 5.167    3.58 | 8.250    2.69 | 11.33     .90
                  2.167    1.12 | 5.250    3.58 | 8.333    1.57 | 11.42     .90
                  2.250    1.12 | 5.333    5.38 | 8.417    1.57 | 11.50     .90
                  2.333    1.34 | 5.417    5.38 | 8.500    1.57 | 11.58     .90
                  2.417    1.34 | 5.500    5.38 | 8.583    1.57 | 11.67     .90
                  2.500    1.34 | 5.583    5.38 | 8.667    1.57 | 11.75     .90
                  2.583    1.34 | 5.667    5.38 | 8.750    1.57 | 11.83     .90
                  2.667    1.34 | 5.750    5.38 | 8.833    1.57 | 11.92     .90
                  2.750    1.34 | 5.833   21.50 | 8.917    1.57 | 12.00     .90
                  2.833    1.34 | 5.917   21.50 | 9.000    1.57 | 12.08     .90
                  2.917    1.34 | 6.000   21.50 | 9.083    1.57 | 12.17     .90
                  3.000    1.34 | 6.083   59.14 | 9.167    1.57 | 12.25     .90
                  3.083    1.34 | 6.167   59.14 | 9.250    1.57 |

     Max.Eff.Inten.(mm/hr)=      59.14        12.07
                over (min)       5.00        20.00
     Storage Coeff.  (min)=       3.18 (ii)   19.62 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=        .27          .06
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .13          .02          .136 (iii)
     TIME TO PEAK    (hrs)=       6.25         6.50          6.25
     RUNOFF VOLUME    (mm)=      43.80         9.94         26.87
     TOTAL RAINFALL   (mm)=      44.80        44.80         44.80
     RUNOFF COEFFICIENT   =        .98          .22           .60

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
```

```
       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0201) |   Area    (ha)=  14.90
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      11.17         3.72
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     315.20        40.00
     Mannings n          =        .013         .250

     Max.Eff.Inten.(mm/hr)=      59.14        21.39
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       6.28 (ii)   19.36 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=        .19          .06
                                                          *TOTALS*
     PEAK FLOW       (cms)=       1.61          .11         1.683 (iii)
     TIME TO PEAK    (hrs)=       6.25         6.42          6.25
     RUNOFF VOLUME    (mm)=      43.80        11.78         34.20
     TOTAL RAINFALL   (mm)=      44.80        44.80         44.80
     RUNOFF COEFFICIENT   =        .98          .26           .76


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD   (0501) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0202):     1.54    .136     6.25    26.87
        + ID2= 2 (0201):    14.90   1.683     6.25    34.20
          ==================================================
          ID = 3 (0501):    16.44   1.819     6.25    33.51

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR (0301) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          .0000      .0000    |  1.5850      .6086
                          .0280      .2947    |  1.7390      .6775
                          .5610      .3828    |  1.8750      .7480
                          .9810      .4762    | 15.3160     1.2909
                         1.1570      .5414    |   .0000      .0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (0501)     16.44      1.82      6.25      33.51
     OUTFLOW: ID= 1 (0301)     16.44       .34      6.75      33.35

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 18.81
```

```
                    TIME SHIFT OF PEAK FLOW        (min)= 30.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=  .3467

-------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   3 **  5-year 12-hour SCS Storm
  ****************************


--------------------
|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              5Y12HSCS.STM
| Ptotal= 61.00 mm |    Comments: 5yr/12hr Fergus Shand Dam 2007 SCS
--------------------
                TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .25     .00 |  3.50    2.44 |  6.75   10.98 | 10.00    2.14
                 .50    1.52 |  3.75    2.44 |  7.00    4.88 | 10.25    2.14
                 .75    1.52 |  4.00    2.44 |  7.25    4.88 | 10.50    1.22
                1.00    1.52 |  4.25    2.44 |  7.50    3.66 | 10.75    1.22
                1.25    1.52 |  4.50    3.66 |  7.75    3.66 | 11.00    1.22
                1.50    1.52 |  4.75    3.66 |  8.00    3.66 | 11.25    1.22
                1.75    1.52 |  5.00    4.88 |  8.25    3.66 | 11.50    1.22
                2.00    1.52 |  5.25    4.88 |  8.50    2.14 | 11.75    1.22
                2.25    1.52 |  5.50    7.32 |  8.75    2.14 | 12.00    1.22
                2.50    1.83 |  5.75    7.32 |  9.00    2.14 | 12.25    1.22
                2.75    1.83 |  6.00   29.28 |  9.25    2.14 |
                3.00    1.83 |  6.25   80.52 |  9.50    2.14 |
                3.25    1.83 |  6.50   10.98 |  9.75    2.14 |

-------------------------------------------------------------------------------

--------------------
| CALIB            |
| STANDHYD  (0202) |   Area    (ha)=   1.54
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .77          .77
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     101.30        40.00
     Mannings n          =        .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                         ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                .083     .00 | 3.167    1.83 | 6.250   80.52 |  9.33    2.14
                .167     .00 | 3.250    1.83 | 6.333   10.98 |  9.42    2.14
                .250     .00 | 3.333    2.44 | 6.417   10.98 |  9.50    2.14
                .333    1.52 | 3.417    2.44 | 6.500   10.98 |  9.58    2.14
                .417    1.52 | 3.500    2.44 | 6.583   10.98 |  9.67    2.14
                .500    1.52 | 3.583    2.44 | 6.667   10.98 |  9.75    2.14
                .583    1.52 | 3.667    2.44 | 6.750   10.98 |  9.83    2.14
                .667    1.52 | 3.750    2.44 | 6.833    4.88 |  9.92    2.14
                .750    1.52 | 3.833    2.44 | 6.917    4.88 | 10.00    2.14
                .833    1.52 | 3.917    2.44 | 7.000    4.88 | 10.08    2.14
                .917    1.52 | 4.000    2.44 | 7.083    4.88 | 10.17    2.14
               1.000    1.52 | 4.083    2.44 | 7.167    4.88 | 10.25    2.14
               1.083    1.52 | 4.167    2.44 | 7.250    4.88 | 10.33    1.22
               1.167    1.52 | 4.250    2.44 | 7.333    3.66 | 10.42    1.22
               1.250    1.52 | 4.333    3.66 | 7.417    3.66 | 10.50    1.22
               1.333    1.52 | 4.417    3.66 | 7.500    3.66 | 10.58    1.22
               1.417    1.52 | 4.500    3.66 | 7.583    3.66 | 10.67    1.22
               1.500    1.52 | 4.583    3.66 | 7.667    3.66 | 10.75    1.22
```

```
                1.583    1.52 | 4.667    3.66 | 7.750    3.66 | 10.83    1.22
                1.667    1.52 | 4.750    3.66 | 7.833    3.66 | 10.92    1.22
                1.750    1.52 | 4.833    4.88 | 7.917    3.66 | 11.00    1.22
                1.833    1.52 | 4.917    4.88 | 8.000    3.66 | 11.08    1.22
                1.917    1.52 | 5.000    4.88 | 8.083    3.66 | 11.17    1.22
                2.000    1.52 | 5.083    4.88 | 8.167    3.66 | 11.25    1.22
                2.083    1.52 | 5.167    4.88 | 8.250    3.66 | 11.33    1.22
                2.167    1.52 | 5.250    4.88 | 8.333    2.14 | 11.42    1.22
                2.250    1.52 | 5.333    7.32 | 8.417    2.14 | 11.50    1.22
                2.333    1.83 | 5.417    7.32 | 8.500    2.14 | 11.58    1.22
                2.417    1.83 | 5.500    7.32 | 8.583    2.14 | 11.67    1.22
                2.500    1.83 | 5.583    7.32 | 8.667    2.14 | 11.75    1.22
                2.583    1.83 | 5.667    7.32 | 8.750    2.14 | 11.83    1.22
                2.667    1.83 | 5.750    7.32 | 8.833    2.14 | 11.92    1.22
                2.750    1.83 | 5.833   29.28 | 8.917    2.14 | 12.00    1.22
                2.833    1.83 | 5.917   29.28 | 9.000    2.14 | 12.08    1.22
                2.917    1.83 | 6.000   29.28 | 9.083    2.14 | 12.17    1.22
                3.000    1.83 | 6.083   80.52 | 9.167    2.14 | 12.25    1.22
                3.083    1.83 | 6.167   80.52 | 9.250    2.14 |

     Max.Eff.Inten.(mm/hr)=      80.52        27.14
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.81 (ii)   14.70 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=        .28          .08
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .17          .04           .201 (iii)
     TIME TO PEAK    (hrs)=       6.25         6.33           6.25
     RUNOFF VOLUME    (mm)=      60.00        17.87          38.93
     TOTAL RAINFALL   (mm)=      61.00        61.00          61.00
     RUNOFF COEFFICIENT   =        .98          .29            .64

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0201) |   Area    (ha)=  14.90
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      11.17         3.72
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     315.20        40.00
     Mannings n          =        .013         .250

     Max.Eff.Inten.(mm/hr)=      80.52        37.81
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       5.55 (ii)   15.96 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=        .20          .07
                                                           *TOTALS*
     PEAK FLOW       (cms)=       2.23          .22          2.380 (iii)
     TIME TO PEAK    (hrs)=       6.25         6.42           6.25
     RUNOFF VOLUME    (mm)=      60.00        20.65          48.19
     TOTAL RAINFALL   (mm)=      61.00        61.00          61.00
     RUNOFF COEFFICIENT   =        .98          .34            .79


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
```

```
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (0501) |
|   1 +  2 =  3    |        AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
           ID1= 1 (0202):     1.54     .201     6.25    38.93
         + ID2= 2 (0201):    14.90    2.380     6.25    48.19
           =================================================
           ID = 3 (0501):    16.44    2.580     6.25    47.33

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR (0301) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          .0000      .0000    |   1.5850      .6086
                          .0280      .2947    |   1.7390      .6775
                          .5610      .3828    |   1.8750      .7480
                          .9810      .4762    |  15.3160     1.2909
                         1.1570      .5414    |    .0000      .0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (0501)     16.44      2.58      6.25      47.33
     OUTFLOW: ID= 1 (0301)     16.44       .77      6.50      47.16

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 29.98
                   TIME SHIFT OF PEAK FLOW        (min)= 15.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  .4310

-------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   4 **  10-year 12-hour SCS Storm
  ****************************


--------------------
|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              10Y12HSCS.STM
| Ptotal= 71.69 mm |    Comments: 10yr/12hr Fergus Shand Dam 2007 SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .25     .00 |  3.50    2.87 |  6.75   12.91 | 10.00    2.51
                  .50    1.79 |  3.75    2.87 |  7.00    5.74 | 10.25    2.51
                  .75    1.79 |  4.00    2.87 |  7.25    5.74 | 10.50    1.43
                 1.00    1.79 |  4.25    2.87 |  7.50    4.30 | 10.75    1.43
                 1.25    1.79 |  4.50    4.30 |  7.75    4.30 | 11.00    1.43
                 1.50    1.79 |  4.75    4.30 |  8.00    4.30 | 11.25    1.43
                 1.75    1.79 |  5.00    5.74 |  8.25    4.30 | 11.50    1.43
                 2.00    1.79 |  5.25    5.74 |  8.50    2.51 | 11.75    1.43
                 2.25    1.79 |  5.50    8.60 |  8.75    2.51 | 12.00    1.43
                 2.50    2.15 |  5.75    8.60 |  9.00    2.51 | 12.25    1.43
                 2.75    2.15 |  6.00   34.42 |  9.25    2.51 |
                 3.00    2.15 |  6.25   94.64 |  9.50    2.51 |
                 3.25    2.15 |  6.50   12.91 |  9.75    2.51 |

-------------------------------------------------------------------------------

--------------------
| CALIB            |
| STANDHYD  (0202) |   Area    (ha)=   1.54
```

```
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .77          .77
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     101.30        40.00
     Mannings n           =       .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083     .00 | 3.167    2.15 | 6.250   94.64 |  9.33    2.51
                 .167     .00 | 3.250    2.15 | 6.333   12.91 |  9.42    2.51
                 .250     .00 | 3.333    2.87 | 6.417   12.91 |  9.50    2.51
                 .333    1.79 | 3.417    2.87 | 6.500   12.91 |  9.58    2.51
                 .417    1.79 | 3.500    2.87 | 6.583   12.91 |  9.67    2.51
                 .500    1.79 | 3.583    2.87 | 6.667   12.91 |  9.75    2.51
                 .583    1.79 | 3.667    2.87 | 6.750   12.91 |  9.83    2.51
                 .667    1.79 | 3.750    2.87 | 6.833    5.74 |  9.92    2.51
                 .750    1.79 | 3.833    2.87 | 6.917    5.74 | 10.00    2.51
                 .833    1.79 | 3.917    2.87 | 7.000    5.74 | 10.08    2.51
                 .917    1.79 | 4.000    2.87 | 7.083    5.74 | 10.17    2.51
                1.000    1.79 | 4.083    2.87 | 7.167    5.74 | 10.25    2.51
                1.083    1.79 | 4.167    2.87 | 7.250    5.74 | 10.33    1.43
                1.167    1.79 | 4.250    2.87 | 7.333    4.30 | 10.42    1.43
                1.250    1.79 | 4.333    4.30 | 7.417    4.30 | 10.50    1.43
                1.333    1.79 | 4.417    4.30 | 7.500    4.30 | 10.58    1.43
                1.417    1.79 | 4.500    4.30 | 7.583    4.30 | 10.67    1.43
                1.500    1.79 | 4.583    4.30 | 7.667    4.30 | 10.75    1.43
                1.583    1.79 | 4.667    4.30 | 7.750    4.30 | 10.83    1.43
                1.667    1.79 | 4.750    4.30 | 7.833    4.30 | 10.92    1.43
                1.750    1.79 | 4.833    5.74 | 7.917    4.30 | 11.00    1.43
                1.833    1.79 | 4.917    5.74 | 8.000    4.30 | 11.08    1.43
                1.917    1.79 | 5.000    5.74 | 8.083    4.30 | 11.17    1.43
                2.000    1.79 | 5.083    5.74 | 8.167    4.30 | 11.25    1.43
                2.083    1.79 | 5.167    5.74 | 8.250    4.30 | 11.33    1.43
                2.167    1.79 | 5.250    5.74 | 8.333    2.51 | 11.42    1.43
                2.250    1.79 | 5.333    8.60 | 8.417    2.51 | 11.50    1.43
                2.333    2.15 | 5.417    8.60 | 8.500    2.51 | 11.58    1.43
                2.417    2.15 | 5.500    8.60 | 8.583    2.51 | 11.67    1.43
                2.500    2.15 | 5.583    8.60 | 8.667    2.51 | 11.75    1.43
                2.583    2.15 | 5.667    8.60 | 8.750    2.51 | 11.83    1.43
                2.667    2.15 | 5.750    8.60 | 8.833    2.51 | 11.92    1.43
                2.750    2.15 | 5.833   34.42 | 8.917    2.51 | 12.00    1.43
                2.833    2.15 | 5.917   34.42 | 9.000    2.51 | 12.08    1.43
                2.917    2.15 | 6.000   34.42 | 9.083    2.51 | 12.17    1.43
                3.000    2.15 | 6.083   94.64 | 9.167    2.51 | 12.25    1.43
                3.083    2.15 | 6.167   94.64 | 9.250    2.51 |

     Max.Eff.Inten.(mm/hr)=      94.64        36.44
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.63 (ii)   13.20 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=        .29          .08
                                                         *TOTALS*
     PEAK FLOW      (cms)=         .20          .05          .244 (iii)
     TIME TO PEAK    (hrs)=       6.25         6.33          6.25
     RUNOFF VOLUME    (mm)=      70.69        23.88         47.28
     TOTAL RAINFALL   (mm)=      71.69        71.69         71.69
     RUNOFF COEFFICIENT   =        .99          .33           .66

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
```

```
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD  (0201) |   Area    (ha)=  14.90
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      11.17         3.72
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     315.20        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=      94.64        53.98
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       5.20 (ii)    9.98 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .21          .11
                                                         *TOTALS*
     PEAK FLOW      (cms)=        2.64          .39         3.031 (iii)
     TIME TO PEAK    (hrs)=       6.25         6.25          6.25
     RUNOFF VOLUME    (mm)=      70.69        27.28         57.67
     TOTAL RAINFALL   (mm)=      71.69        71.69         71.69
     RUNOFF COEFFICIENT   =        .99          .38           .80


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------


--------------------
| ADD HYD   (0501) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0202):     1.54    .244     6.25    47.28
        + ID2= 2 (0201):    14.90   3.031     6.25    57.67
          ==================================================
          ID = 3 (0501):    16.44   3.274     6.25    56.69

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR (0301) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          .0000      .0000    |   1.5850      .6086
                          .0280      .2947    |   1.7390      .6775
                          .5610      .3828    |   1.8750      .7480
                          .9810      .4762    |  15.3160     1.2909
                         1.1570      .5414    |    .0000      .0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (0501)      16.44      3.27      6.25      56.69
     OUTFLOW: ID= 1 (0301)      16.44      1.06      6.42      56.53

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 32.41
                   TIME SHIFT OF PEAK FLOW         (min)= 10.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  .5060

--------------------------------------------------------------------------------
```

```
  ****************************
  ** SIMULATION NUMBER:   5 **  25-year 12-hour SCS Storm
  ****************************


--------------------
|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              25Y12HSCS.STM
| Ptotal= 85.31 mm |    Comments: 25yr/12hr Fergus Shand Dam 2007 SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .25     .00 |  3.50    3.41 |  6.75   15.35 | 10.00    2.99
                  .50    2.13 |  3.75    3.41 |  7.00    6.82 | 10.25    2.99
                  .75    2.13 |  4.00    3.41 |  7.25    6.82 | 10.50    1.71
                 1.00    2.13 |  4.25    3.41 |  7.50    5.12 | 10.75    1.71
                 1.25    2.13 |  4.50    5.12 |  7.75    5.12 | 11.00    1.71
                 1.50    2.13 |  4.75    5.12 |  8.00    5.12 | 11.25    1.71
                 1.75    2.13 |  5.00    6.82 |  8.25    5.12 | 11.50    1.71
                 2.00    2.13 |  5.25    6.82 |  8.50    2.99 | 11.75    1.71
                 2.25    2.13 |  5.50   10.24 |  8.75    2.99 | 12.00    1.71
                 2.50    2.56 |  5.75   10.24 |  9.00    2.99 | 12.25    1.71
                 2.75    2.56 |  6.00   40.94 |  9.25    2.99 |
                 3.00    2.56 |  6.25  112.60 |  9.50    2.99 |
                 3.25    2.56 |  6.50   15.35 |  9.75    2.99 |

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--------------------
| CALIB            |
| STANDHYD  (0202) |   Area    (ha)=   1.54
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .77          .77
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     101.30        40.00
     Mannings n           =       .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083     .00 | 3.167    2.56 | 6.250  112.60 |   9.33    2.99
                 .167     .00 | 3.250    2.56 | 6.333   15.35 |   9.42    2.99
                 .250     .00 | 3.333    3.41 | 6.417   15.35 |   9.50    2.99
                 .333    2.13 | 3.417    3.41 | 6.500   15.35 |   9.58    2.99
                 .417    2.13 | 3.500    3.41 | 6.583   15.35 |   9.67    2.99
                 .500    2.13 | 3.583    3.41 | 6.667   15.35 |   9.75    2.99
                 .583    2.13 | 3.667    3.41 | 6.750   15.35 |   9.83    2.99
                 .667    2.13 | 3.750    3.41 | 6.833    6.82 |   9.92    2.99
                 .750    2.13 | 3.833    3.41 | 6.917    6.82 |  10.00    2.99
                 .833    2.13 | 3.917    3.41 | 7.000    6.82 |  10.08    2.99
                 .917    2.13 | 4.000    3.41 | 7.083    6.82 |  10.17    2.99
                1.000    2.13 | 4.083    3.41 | 7.167    6.82 |  10.25    2.99
                1.083    2.13 | 4.167    3.41 | 7.250    6.82 |  10.33    1.71
                1.167    2.13 | 4.250    3.41 | 7.333    5.12 |  10.42    1.71
                1.250    2.13 | 4.333    5.12 | 7.417    5.12 |  10.50    1.71
                1.333    2.13 | 4.417    5.12 | 7.500    5.12 |  10.58    1.71
                1.417    2.13 | 4.500    5.12 | 7.583    5.12 |  10.67    1.71
                1.500    2.13 | 4.583    5.12 | 7.667    5.12 |  10.75    1.71
                1.583    2.13 | 4.667    5.12 | 7.750    5.12 |  10.83    1.71
                1.667    2.13 | 4.750    5.12 | 7.833    5.12 |  10.92    1.71
                1.750    2.13 | 4.833    6.82 | 7.917    5.12 |  11.00    1.71
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                1.833    2.13 | 4.917    6.82 | 8.000    5.12 | 11.08    1.71
                1.917    2.13 | 5.000    6.82 | 8.083    5.12 | 11.17    1.71
                2.000    2.13 | 5.083    6.82 | 8.167    5.12 | 11.25    1.71
                2.083    2.13 | 5.167    6.82 | 8.250    5.12 | 11.33    1.71
                2.167    2.13 | 5.250    6.82 | 8.333    2.99 | 11.42    1.71
                2.250    2.13 | 5.333   10.24 | 8.417    2.99 | 11.50    1.71
                2.333    2.56 | 5.417   10.24 | 8.500    2.99 | 11.58    1.71
                2.417    2.56 | 5.500   10.24 | 8.583    2.99 | 11.67    1.71
                2.500    2.56 | 5.583   10.24 | 8.667    2.99 | 11.75    1.71
                2.583    2.56 | 5.667   10.24 | 8.750    2.99 | 11.83    1.71
                2.667    2.56 | 5.750   10.24 | 8.833    2.99 | 11.92    1.71
                2.750    2.56 | 5.833   40.94 | 8.917    2.99 | 12.00    1.71
                2.833    2.56 | 5.917   40.94 | 9.000    2.99 | 12.08    1.71
                2.917    2.56 | 6.000   40.94 | 9.083    2.99 | 12.17    1.71
                3.000    2.56 | 6.083  112.60 | 9.167    2.99 | 12.25    1.71
                3.083    2.56 | 6.167  112.60 | 9.250    2.99 |

     Max.Eff.Inten.(mm/hr)=     112.60        53.21
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.46 (ii)   11.54 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=        .30          .09
                                                          *TOTALS*
     PEAK FLOW      (cms)=         .24          .07           .302 (iii)
     TIME TO PEAK   (hrs)=        6.25         6.33           6.25
     RUNOFF VOLUME    (mm)=      84.31        32.27          58.29
     TOTAL RAINFALL   (mm)=      85.31        85.31          85.31
     RUNOFF COEFFICIENT   =        .99          .38            .68

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD  (0201) |   Area    (ha)=  14.90
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      11.17         3.72
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     315.20        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=     112.60        71.76
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.85 (ii)    9.31 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .22          .12
                                                          *TOTALS*
     PEAK FLOW      (cms)=        3.17          .54          3.703 (iii)
     TIME TO PEAK   (hrs)=        6.25         6.25           6.25
     RUNOFF VOLUME    (mm)=      84.31        36.43          69.94
     TOTAL RAINFALL   (mm)=      85.31        85.31          85.31
     RUNOFF COEFFICIENT   =        .99          .43            .82

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
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| ADD HYD   (0501) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0202):     1.54    .302     6.25    58.29
        + ID2= 2 (0201):    14.90   3.703     6.25    69.94
          ===============================================
          ID = 3 (0501):    16.44   4.005     6.25    68.85

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| RESERVOIR (0301) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          .0000      .0000    |   1.5850      .6086
                          .0280      .2947    |   1.7390      .6775
                          .5610      .3828    |   1.8750      .7480
                          .9810      .4762    |  15.3160     1.2909
                         1.1570      .5414    |    .0000      .0000

                                 AREA     QPEAK     TPEAK       R.V.
                                 (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (0501)      16.44      4.00      6.25      68.85
     OUTFLOW: ID= 1 (0301)      16.44      1.46      6.42      68.69

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 36.45
                   TIME SHIFT OF PEAK FLOW         (min)= 10.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  .5921

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  ****************************
  ** SIMULATION NUMBER:   6 **  50-year 12-hour SCS Storm

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|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              50Y12HSCS.STM
| Ptotal= 95.31 mm |    Comments: 50yr/12hr Fergus Shand Dam 2007 SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .25     .00 |  3.50    3.81 |  6.75   17.15 | 10.00    3.34
                  .50    2.38 |  3.75    3.81 |  7.00    7.62 | 10.25    3.34
                  .75    2.38 |  4.00    3.81 |  7.25    7.62 | 10.50    1.91
                 1.00    2.38 |  4.25    3.81 |  7.50    5.72 | 10.75    1.91
                 1.25    2.38 |  4.50    5.72 |  7.75    5.72 | 11.00    1.91
                 1.50    2.38 |  4.75    5.72 |  8.00    5.72 | 11.25    1.91
                 1.75    2.38 |  5.00    7.62 |  8.25    5.72 | 11.50    1.91
                 2.00    2.38 |  5.25    7.62 |  8.50    3.34 | 11.75    1.91
                 2.25    2.38 |  5.50   11.44 |  8.75    3.34 | 12.00    1.91
                 2.50    2.86 |  5.75   11.44 |  9.00    3.34 | 12.25    1.91
                 2.75    2.86 |  6.00   45.74 |  9.25    3.34 |
                 3.00    2.86 |  6.25  125.80 |  9.50    3.34 |
                 3.25    2.86 |  6.50   17.15 |  9.75    3.34 |

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--------------------
| CALIB            |
| STANDHYD  (0202) |   Area    (ha)=   1.54
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
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--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .77          .77
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     101.30        40.00
     Mannings n          =        .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                              ---- TRANSFORMED HYETOGRAPH ----
                TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                 hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                .083     .00 | 3.167    2.86 | 6.250  125.80 |  9.33    3.34
                .167     .00 | 3.250    2.86 | 6.333   17.15 |  9.42    3.34
                .250     .00 | 3.333    3.81 | 6.417   17.15 |  9.50    3.34
                .333    2.38 | 3.417    3.81 | 6.500   17.15 |  9.58    3.34
                .417    2.38 | 3.500    3.81 | 6.583   17.15 |  9.67    3.34
                .500    2.38 | 3.583    3.81 | 6.667   17.15 |  9.75    3.34
                .583    2.38 | 3.667    3.81 | 6.750   17.15 |  9.83    3.34
                .667    2.38 | 3.750    3.81 | 6.833    7.62 |  9.92    3.34
                .750    2.38 | 3.833    3.81 | 6.917    7.62 | 10.00    3.34
                .833    2.38 | 3.917    3.81 | 7.000    7.62 | 10.08    3.34
                .917    2.38 | 4.000    3.81 | 7.083    7.62 | 10.17    3.34
               1.000    2.38 | 4.083    3.81 | 7.167    7.62 | 10.25    3.34
               1.083    2.38 | 4.167    3.81 | 7.250    7.62 | 10.33    1.91
               1.167    2.38 | 4.250    3.81 | 7.333    5.72 | 10.42    1.91
               1.250    2.38 | 4.333    5.72 | 7.417    5.72 | 10.50    1.91
               1.333    2.38 | 4.417    5.72 | 7.500    5.72 | 10.58    1.91
               1.417    2.38 | 4.500    5.72 | 7.583    5.72 | 10.67    1.91
               1.500    2.38 | 4.583    5.72 | 7.667    5.72 | 10.75    1.91
               1.583    2.38 | 4.667    5.72 | 7.750    5.72 | 10.83    1.91
               1.667    2.38 | 4.750    5.72 | 7.833    5.72 | 10.92    1.91
               1.750    2.38 | 4.833    7.62 | 7.917    5.72 | 11.00    1.91
               1.833    2.38 | 4.917    7.62 | 8.000    5.72 | 11.08    1.91
               1.917    2.38 | 5.000    7.62 | 8.083    5.72 | 11.17    1.91
               2.000    2.38 | 5.083    7.62 | 8.167    5.72 | 11.25    1.91
               2.083    2.38 | 5.167    7.62 | 8.250    5.72 | 11.33    1.91
               2.167    2.38 | 5.250    7.62 | 8.333    3.34 | 11.42    1.91
               2.250    2.38 | 5.333   11.44 | 8.417    3.34 | 11.50    1.91
               2.333    2.86 | 5.417   11.44 | 8.500    3.34 | 11.58    1.91
               2.417    2.86 | 5.500   11.44 | 8.583    3.34 | 11.67    1.91
               2.500    2.86 | 5.583   11.44 | 8.667    3.34 | 11.75    1.91
               2.583    2.86 | 5.667   11.44 | 8.750    3.34 | 11.83    1.91
               2.667    2.86 | 5.750   11.44 | 8.833    3.34 | 11.92    1.91
               2.750    2.86 | 5.833   45.74 | 8.917    3.34 | 12.00    1.91
               2.833    2.86 | 5.917   45.74 | 9.000    3.34 | 12.08    1.91
               2.917    2.86 | 6.000   45.74 | 9.083    3.34 | 12.17    1.91
               3.000    2.86 | 6.083  125.80 | 9.167    3.34 | 12.25    1.91
               3.083    2.86 | 6.167  125.80 | 9.250    3.34 |

     Max.Eff.Inten.(mm/hr)=     125.80        63.92
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.35 (ii)   10.79 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=        .30          .09
                                                          *TOTALS*
     PEAK FLOW       (cms)=        .27          .09         .346 (iii)
     TIME TO PEAK    (hrs)=       6.25         6.33          6.25
     RUNOFF VOLUME    (mm)=      94.31        38.87         66.58
     TOTAL RAINFALL   (mm)=      95.31        95.31         95.31
     RUNOFF COEFFICIENT   =        .99          .41           .70

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
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     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| STANDHYD  (0201) |   Area    (ha)=  14.90
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      11.17         3.72
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     315.20        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=     125.80        85.53
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.64 (ii)    8.91 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .22          .12
                                                          *TOTALS*
     PEAK FLOW       (cms)=       3.55          .66          4.207 (iii)
     TIME TO PEAK    (hrs)=       6.25         6.25           6.25
     RUNOFF VOLUME    (mm)=      94.31        43.55          79.08
     TOTAL RAINFALL   (mm)=      95.31        95.31          95.31
     RUNOFF COEFFICIENT   =        .99          .46            .83

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD   (0501) |
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0202):     1.54     .346     6.25    66.58
        + ID2= 2 (0201):    14.90    4.207     6.25    79.08
          ===============================================
          ID = 3 (0501):    16.44    4.552     6.25    77.91

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR (0301) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          .0000      .0000    |   1.5850      .6086
                          .0280      .2947    |   1.7390      .6775
                          .5610      .3828    |   1.8750      .7480
                          .9810      .4762    |  15.3160     1.2909
                         1.1570      .5414    |    .0000      .0000

                                  AREA     QPEAK     TPEAK       R.V.
                                  (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (0501)       16.44      4.55      6.25      77.91
     OUTFLOW: ID= 1 (0301)       16.44      1.67      6.42      77.75

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 36.73
                   TIME SHIFT OF PEAK FLOW        (min)= 10.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  .6516

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  ****************************
  ** SIMULATION NUMBER:   7 **   100-year 12-hour SCS Storm
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--------------------
|    READ STORM    |    Filename: S:\Projects\2014\14119\Hydrotechnica
|                  |              l\1st Sub - FSR - 2015 July\VO2\Storms\
|                  |              100Y12HSCS.STM
| Ptotal=105.31 mm |    Comments: 100yr/12hr Fergus Shand Dam 2007 SCS
--------------------
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                  .25     .00 |  3.50    4.21 |  6.75   18.95 | 10.00    3.69
                  .50    2.63 |  3.75    4.21 |  7.00    8.42 | 10.25    3.69
                  .75    2.63 |  4.00    4.21 |  7.25    8.42 | 10.50    2.11
                 1.00    2.63 |  4.25    4.21 |  7.50    6.32 | 10.75    2.11
                 1.25    2.63 |  4.50    6.32 |  7.75    6.32 | 11.00    2.11
                 1.50    2.63 |  4.75    6.32 |  8.00    6.32 | 11.25    2.11
                 1.75    2.63 |  5.00    8.42 |  8.25    6.32 | 11.50    2.11
                 2.00    2.63 |  5.25    8.42 |  8.50    3.69 | 11.75    2.11
                 2.25    2.63 |  5.50   12.64 |  8.75    3.69 | 12.00    2.11
                 2.50    3.16 |  5.75   12.64 |  9.00    3.69 | 12.25    2.11
                 2.75    3.16 |  6.00   50.54 |  9.25    3.69 |
                 3.00    3.16 |  6.25  139.00 |  9.50    3.69 |
                 3.25    3.16 |  6.50   18.95 |  9.75    3.69 |

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--------------------
| CALIB              |
| STANDHYD  (0202) |   Area    (ha)=   1.54
|ID= 1 DT= 5.0 min |   Total Imp(%)=  50.00   Dir. Conn.(%)=  50.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=        .77          .77
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     101.30        40.00
     Mannings n           =       .013         .250

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                          ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr |   hrs   mm/hr
                 .083     .00 | 3.167    3.16 | 6.250  139.00 |  9.33    3.69
                 .167     .00 | 3.250    3.16 | 6.333   18.95 |  9.42    3.69
                 .250     .00 | 3.333    4.21 | 6.417   18.95 |  9.50    3.69
                 .333    2.63 | 3.417    4.21 | 6.500   18.95 |  9.58    3.69
                 .417    2.63 | 3.500    4.21 | 6.583   18.95 |  9.67    3.69
                 .500    2.63 | 3.583    4.21 | 6.667   18.95 |  9.75    3.69
                 .583    2.63 | 3.667    4.21 | 6.750   18.95 |  9.83    3.69
                 .667    2.63 | 3.750    4.21 | 6.833    8.42 |  9.92    3.69
                 .750    2.63 | 3.833    4.21 | 6.917    8.42 | 10.00    3.69
                 .833    2.63 | 3.917    4.21 | 7.000    8.42 | 10.08    3.69
                 .917    2.63 | 4.000    4.21 | 7.083    8.42 | 10.17    3.69
                1.000    2.63 | 4.083    4.21 | 7.167    8.42 | 10.25    3.69
                1.083    2.63 | 4.167    4.21 | 7.250    8.42 | 10.33    2.11
                1.167    2.63 | 4.250    4.21 | 7.333    6.32 | 10.42    2.11
                1.250    2.63 | 4.333    6.32 | 7.417    6.32 | 10.50    2.11
                1.333    2.63 | 4.417    6.32 | 7.500    6.32 | 10.58    2.11
                1.417    2.63 | 4.500    6.32 | 7.583    6.32 | 10.67    2.11
                1.500    2.63 | 4.583    6.32 | 7.667    6.32 | 10.75    2.11
                1.583    2.63 | 4.667    6.32 | 7.750    6.32 | 10.83    2.11
                1.667    2.63 | 4.750    6.32 | 7.833    6.32 | 10.92    2.11
                1.750    2.63 | 4.833    8.42 | 7.917    6.32 | 11.00    2.11
                1.833    2.63 | 4.917    8.42 | 8.000    6.32 | 11.08    2.11
```

```
                1.917    2.63 | 5.000    8.42 | 8.083    6.32 | 11.17    2.11
                2.000    2.63 | 5.083    8.42 | 8.167    6.32 | 11.25    2.11
                2.083    2.63 | 5.167    8.42 | 8.250    6.32 | 11.33    2.11
                2.167    2.63 | 5.250    8.42 | 8.333    3.69 | 11.42    2.11
                2.250    2.63 | 5.333   12.64 | 8.417    3.69 | 11.50    2.11
                2.333    3.16 | 5.417   12.64 | 8.500    3.69 | 11.58    2.11
                2.417    3.16 | 5.500   12.64 | 8.583    3.69 | 11.67    2.11
                2.500    3.16 | 5.583   12.64 | 8.667    3.69 | 11.75    2.11
                2.583    3.16 | 5.667   12.64 | 8.750    3.69 | 11.83    2.11
                2.667    3.16 | 5.750   12.64 | 8.833    3.69 | 11.92    2.11
                2.750    3.16 | 5.833   50.54 | 8.917    3.69 | 12.00    2.11
                2.833    3.16 | 5.917   50.54 | 9.000    3.69 | 12.08    2.11
                2.917    3.16 | 6.000   50.54 | 9.083    3.69 | 12.17    2.11
                3.000    3.16 | 6.083  139.00 | 9.167    3.69 | 12.25    2.11
                3.083    3.16 | 6.167  139.00 | 9.250    3.69 |

     Max.Eff.Inten.(mm/hr)=     139.00        75.08
               over (min)        5.00        15.00
     Storage Coeff.  (min)=       2.26 (ii)   10.17 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=        .30          .10
                                                           *TOTALS*
     PEAK FLOW       (cms)=        .30          .11           .390 (iii)
     TIME TO PEAK    (hrs)=       6.25         6.33           6.25
     RUNOFF VOLUME    (mm)=     104.31        45.77          75.04
     TOTAL RAINFALL   (mm)=     105.31       105.31         105.31
     RUNOFF COEFFICIENT   =        .99          .43            .71

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD  (0201) |   Area    (ha)=  14.90
|ID= 1 DT= 5.0 min |   Total Imp(%)=  75.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      11.17         3.72
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     315.20        40.00
     Mannings n           =       .013         .250

     Max.Eff.Inten.(mm/hr)=     139.00        99.78
               over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.46 (ii)    8.56 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=        .23          .12
                                                           *TOTALS*
     PEAK FLOW       (cms)=       3.94          .78          4.717 (iii)
     TIME TO PEAK    (hrs)=       6.25         6.25           6.25
     RUNOFF VOLUME    (mm)=     104.31        50.96          88.30
     TOTAL RAINFALL   (mm)=     105.31       105.31         105.31
     RUNOFF COEFFICIENT   =        .99          .48            .84

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  68.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
```

```
--------------------
| ADD HYD   (0501) |
|   1 +  2 =  3    |        AREA    QPEAK    TPEAK     R.V.
--------------------        (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (0202):     1.54    .390     6.25    75.04
        + ID2= 2 (0201):    14.90   4.717     6.25    88.30
          ==================================================
          ID = 3 (0501):    16.44   5.107     6.25    87.06

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR (0301) |
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                           .0000      .0000   |   1.5850      .6086
                           .0280      .2947   |   1.7390      .6775
                           .5610      .3828   |   1.8750      .7480
                           .9810      .4762   |  15.3160     1.2909
                          1.1570      .5414   |    .0000      .0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
     INFLOW : ID= 2 (0501)     16.44      5.11      6.25      87.06
     OUTFLOW: ID= 1 (0301)     16.44      1.81      6.42      86.90

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 35.40
                   TIME SHIFT OF PEAK FLOW         (min)= 10.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  .7173

-------------------------------------------------------------------------------

 FINISH
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APPENDIX “E”

Site Water Balance Calculations

VALDOR ENGINEERING INC.

File: 14119

Date: July 2015

Table E.1: Site Water Balance Calculations (Annual)
Moco Subdivision, Town of Grand Valley

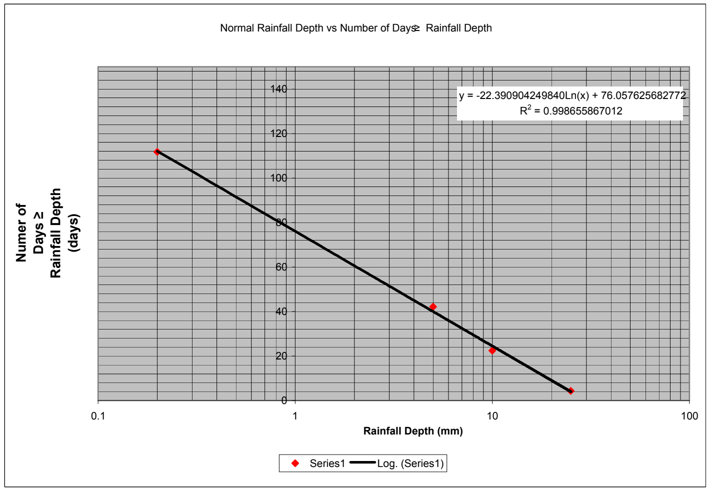
Condition	Site Area (ha)	Water Balance Components	Pervious Area Without Infiltration BMP's	Impervious Area Without Infiltration BMP's	Impervious Area With Basic Infiltration BMP's	TOTAL SITE VOLUMES Precipitation (m^3)	Evapotranspiration (m^3)	Surplus (m^3)	Runoff (m^3)	Infiltration (m^3)	Percent of Existing Infiltration (%)
Existing	**16.436**	Area (ha)	16.436	0.000	0.000	130,337	94,870	35,023	18,562	16,461	100.0
		HSG	BC	n/a	BC						
		Weighted WHC (mm)	175	n/a	175						
		Infiltration Factor	0.470	0.00	0.000						
		Precipitation (mm)	793.0	793.0	793.0						
		Evapotranspiration (mm)	577	0.0	577						
		Surplus (mm)	213	793.0	213						
		Infiltration (mm)	100.2	0.0	0.0						
		Runoff (mm)	112.9	793.0	213.1						
Proposed (No Infiltration BMP's)	**16.436**	Area (ha)	4.694	11.742	0.000	130,337	25,020	105,148	98,590	6,558	39.8
		HSG	BC	n/a	BC						
		Weighted WHC (mm)	100	n/a	100						
		Infiltration Factor	0.545	0.00	0.431						
		Precipitation (mm)	793.0	793.0	793.0						
		Evapotranspiration (mm)	533	0.0	533						
		Surplus (mm)	256	793.0	256						
		Infiltration (mm)	139.7	0.0	110.4						
		Runoff (mm)	116.6	793.0	146.0						
Proposed (With Basic Infiltration BMP's)	**16.436**	Area (ha)	4.694	10.242	1.500	130,337	33,018	97,096	88,882	8,214	49.9
		HSG	BC	n/a	BC						
		Weighted WHC (mm)	100	n/a	100						
		Infiltration Factor	0.545	0.00	0.431						
		Precipitation (mm)	793.0	793.0	793.0						
		Evapotranspiration (mm)	533	0.0	533						
		Surplus (mm)	256	793.0	256						
		Infiltration (mm)	139.7	0.0	110.4						
		Runoff (mm)	116.6	793.0	146.0						
Proposed (With Enhanced Infiltration BMP's)	**16.436**		**See Table E.6**						8214 + 8538	16,752	101.8

Notes:

1. Site water balance calculations based on methodology per *Stormwater Management Planning and Design Manual* (MOE, March 2003).
2. Basic Infiltration BMP's consist of roof leaders that discharge to pervious areas.
3. Enhanced Infiltration BMP's consist of the proposed infiltration trenches.

Table E.2: Rainfall Analysis

VALDOR ENGINEERING INC.
File: 14119
Date: July 2015


Normal Rainfall Depth vs Number of Days ≥ Rainfall Depth

Normal Rainfall Depth (mm)	Normal Days ≥ Rainfall Depth (days)
0.2	111.8
5	42.1
10	22.4
25	4.3

Toronto Pearson Airport Climate Normals (1971 - 2000)

684.6	Normal Annual Rainfall Depth (mm)
111.8	Normal Annual Days with Rainfall (≥ 0.2 mm)
792.7	Normal Annual Precipitation Depth (mm)

Simulated Depth (mm)	Simulated Days ≥ Sim Depth (days)	Average Event Depth (mm)	Simulated Days Equal to Avg Depth (days)	Assumed IA (mm)	Runoff (Rain - IA) (mm)	INF Design Storm (mm)	Event Based Maximum Design INF Depth (mm)	Event Based Design INF Depth (mm)	Annual Incremental Design INF Depth (mm)	Annual Cumulative Design INF Depth (mm)	Annual Incremental Total Rain Depth (mm)	Annual Percent of Total Rain (%)	Annual Cumulative Total Rain Depth (mm)	Annual Cumulative Percent of Total Depth (%)
0.2	112.09													
0.5	91.58	0.2 - 0.5	20.52	**5.00**	0.00	**15.00**	10.00	0.00	0.00	0.00		0.000	0.0	0.000
1.5	66.98	1	24.60	5.00	0.00	15.00	10.00	0.00	0.00	0.00	24.60	0.036	24.6	0.036
2.5	55.54	2	11.44	5.00	0.00	15.00	10.00	0.00	0.00	0.00	22.88	0.033	47.5	0.069
3.5	48.01	3	7.53	5.00	0.00	15.00	10.00	0.00	0.00	0.00	22.60	0.033	70.1	0.102
4.5	42.38	4	5.63	5.00	0.00	15.00	10.00	0.00	0.00	0.00	22.51	0.033	92.6	0.135
5.5	37.89	5	4.49	5.00	0.00	15.00	10.00	0.00	0.00	0.00	22.47	0.033	115.1	0.168
6.5	34.15	6	3.74	5.00	1.00	15.00	10.00	1.00	3.74	3.74	22.44	0.033	137.5	0.201
7.5	30.94	7	3.20	5.00	2.00	15.00	10.00	2.00	6.41	10.15	22.43	0.033	159.9	0.234
8.5	28.14	8	2.80	5.00	3.00	15.00	10.00	3.00	8.41	18.56	22.42	0.033	182.3	0.266
9.5	25.65	9	2.49	5.00	4.00	15.00	10.00	4.00	9.96	28.52	22.41	0.033	204.8	0.299
10.5	23.41	10	2.24	5.00	5.00	15.00	10.00	5.00	11.20	39.72	22.41	0.033	227.2	0.332
11.5	21.37	11	2.04	5.00	6.00	15.00	10.00	6.00	12.22	51.94	22.41	0.033	249.6	0.365
12.5	19.50	12	1.87	5.00	7.00	15.00	10.00	7.00	13.07	65.01	22.40	0.033	272.0	0.397
13.5	17.78	13	1.72	5.00	8.00	15.00	10.00	8.00	13.79	78.80	22.40	0.033	294.4	0.430
14.5	16.18	14	1.60	5.00	9.00	15.00	10.00	9.00	14.40	93.20	22.40	0.033	316.8	0.463
15.5	14.69	15	1.49	5.00	10.00	15.00	10.00	10.00	14.93	108.13	22.40	0.033	339.2	0.495
16.5	13.29	16	1.40	5.00	11.00	15.00	10.00	10.00	14.00	122.13	22.40	0.033	361.6	0.528
17.5	11.97	17	1.32	5.00	12.00	15.00	10.00	10.00	13.17	135.31	22.40	0.033	384.0	0.561
18.5	10.73	18	1.24	5.00	13.00	15.00	10.00	10.00	12.44	147.75	22.40	0.033	406.4	0.594
19.5	9.55	19	1.18	5.00	14.00	15.00	10.00	10.00	11.79	159.54	22.40	0.033	428.8	0.626
20.5	8.43	20	1.12	5.00	15.00	15.00	10.00	10.00	11.20	170.73	22.40	0.033	451.2	0.659
21.5	7.36	21	1.07	5.00	16.00	15.00	10.00	10.00	10.66	181.40	22.40	0.033	473.6	0.692
22.5	6.34	22	1.02	5.00	17.00	15.00	10.00	10.00	10.18	191.58	22.39	0.033	496.0	0.724
23.5	5.37	23	0.97	5.00	18.00	15.00	10.00	10.00	9.74	201.31	22.39	0.033	518.3	0.757
24.5	4.44	24	0.93	5.00	19.00	15.00	10.00	10.00	9.33	210.65	22.39	0.033	540.7	0.790
25.5	3.54	25	0.90	5.00	20.00	15.00	10.00	10.00	8.96	219.60	22.39	0.033	563.1	0.823
26.5	2.68	26	0.86	5.00	21.00	15.00	10.00	10.00	8.61	228.22	22.39	0.033	585.5	0.855
27.5	1.85	27	0.83	5.00	22.00	15.00	10.00	10.00	8.29	236.51	22.39	0.033	607.9	0.888
28.5	1.05	28	0.80	5.00	23.00	15.00	10.00	10.00	8.00	244.51	22.39	0.033	630.3	0.921
29	0.66	≥ 29	0.66	5.00	24.00	15.00	10.00	10.00	6.61	251.12	54.28	0.079	684.6	1.000

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Table E.3: Water Holding Capacity (WHC) Calculations

Per MOE Methodology (SWM Planning & Design Manual, MOE, March 2003)

Existing Conditions (Pervious Area)
BC HSG
Moderately Rooted Crops
175 WHC (mm)

Proposed Conditions (Pervious Area)
BC HSG
Lawn
100 WHC (mm)

Urban Lawns/Shallow Rooted Crops (spinach, beans, beets, carrots)		
Fine Sand	**A**	**50**
	AB	**63**
Fine Sandy Loam	**B**	**75**
	BC	**100**
Silt Loam, Muck	**C**	**125**
Clay Loam	**CD**	**100**
Clay	**D**	**75**
Moderately Rooted Crops (corn and cereal grains)		
Fine Sand	**A**	**75**
	AB	**113**
Fine Sandy Loam	**B**	**150**
	BC	**175**
Silt Loam,Muck	**C**	**200**
Clay Loam	**CD**	**200**
Clay	**D**	**150**
Pasture and Shrubs		
Fine Sand	**A**	**100**
	AB	**125**
Fine Sandy Loam	**B**	**150**
	BC	**200**
Silt Loam, Muck	**C**	**250**
Clay Loam	**CD**	**250**
Clay	**D**	**200**
Mature Forests		
Fine Sand	**A**	**250**
	AB	**275**
Fine Sandy Loam	**B**	**300**
	BC	**350**
Silt Loam, Muck	**C**	**400**
Clay Loam	**CD**	**400**
Clay	**D**	**350**

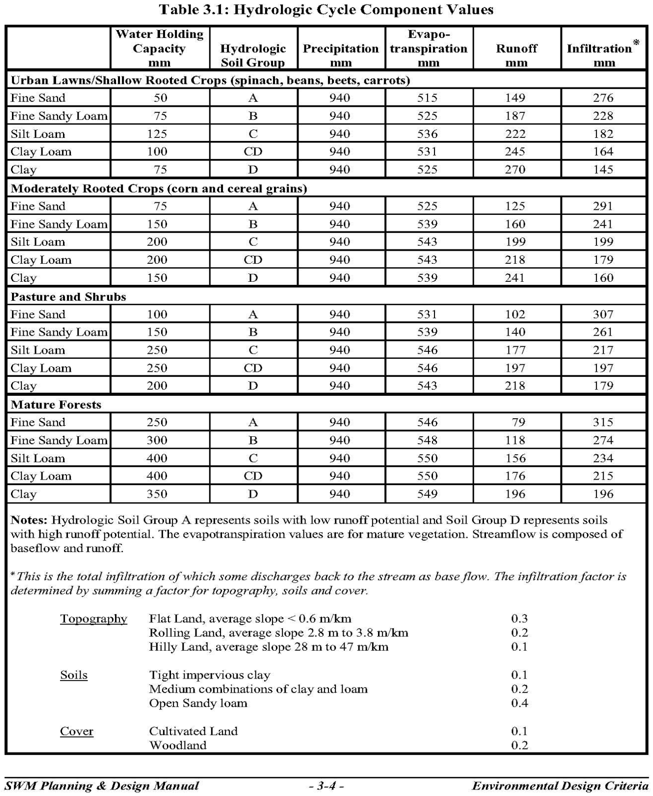

Table 3.1: Hydrologic Cycle Component Values

	Water Holding Capacity mm	Hydrologic Soil Group	Precipitation mm	Evapo-transpiration mm	Runoff mm	Infiltration* mm
Urban Lawns/Shallow Rooted Crops (spinach, beans, beets, carrots)						
Fine Sand	50	A	940	515	149	276
Fine Sandy Loam	75	B	940	525	187	228
Silt Loam	125	C	940	536	222	182
Clay Loam	100	CD	940	531	245	164
Clay	75	D	940	525	270	145
Moderately Rooted Crops (corn and cereal grains)						
Fine Sand	75	A	940	525	125	291
Fine Sandy Loam	150	B	940	539	160	241
Silt Loam	200	C	940	543	199	199
Clay Loam	200	CD	940	543	218	179
Clay	150	D	940	539	241	160
Pasture and Shrubs						
Fine Sand	100	A	940	531	102	307
Fine Sandy Loam	150	B	940	539	140	261
Silt Loam	250	C	940	546	177	217
Clay Loam	250	CD	940	546	197	197
Clay	200	D	940	543	218	179
Mature Forests						
Fine Sand	250	A	940	546	79	315
Fine Sandy Loam	300	B	940	548	118	274
Silt Loam	400	C	940	550	156	234
Clay Loam	400	CD	940	550	176	215
Clay	350	D	940	549	196	196

Notes: Hydrologic Soil Group A represents soils with low runoff potential and Soil Group D represents soils with high runoff potential. The evapotranspiration values are for mature vegetation. Streamflow is composed of baseflow and runoff.

** This is the total infiltration of which some discharges back to the stream as base flow. The infiltration factor is determined by summing a factor for topography, soils and cover.*

Topography	Flat Land, average slope < 0.6 m/km	0.3
	Rolling Land, average slope 2.8 m to 3.8 m/km	0.2
	Hilly Land, average slope 28 m to 47 m/km	0.1
Soils	Tight impervious clay	0.1
	Medium combinations of clay and loam	0.2
	Open Sandy loam	0.4
Cover	Cultivated Land	0.1
	Woodland	0.2

SWM Planning & Design Manual - 3-4 - *Environmental Design Criteria*

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Date: July 2015

Table E.4: Infiltration Factor Calculation

Per MOE Methodology (SWM Planning & Design Manual, MOE, March 2003)

Topography	
0.3	Flat Land (avg slope < 0.06%)
0.225	0.06% to 0.27%
0.15	Rolling Land (avg slope between 0.28% and 0.38%)
0.125	0.39% to 2.7%
0.1	Hilly Land (avg slope between 2.8% and 4.7%)
Soils	
0.4	HSG A - open sandy loam
0.35	HSG AB
0.3	HSG B
0.27	HSG BC
0.23	HSG C
0.2	HSG CD - medium combinations of clay and loam
0.1	HSG D - tight impervious clay
Cover	
0.1	cultivated land (crops)
0.15	pasture, lawns
0.2	woodland (forest)

Infiltration Factor Calculations

Existing Conditions	
0.100	Topography
0.270	Soils
0.100	Cover
0.470	Total Infiltration Factor (Existing Conditions)

Proposed Conditions	
0.125	Topography
0.270	Soils
0.150	Cover
0.545	Total Infiltration Factor (Proposed Conditions)

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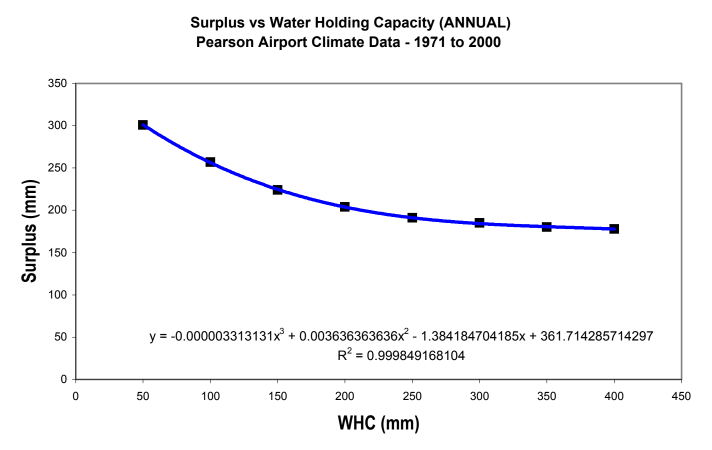
Date: July 2015

Table E.5: Surplus and Actual Evapotranspiration vs Water Holding Capacity (WHC) Regression Analysis

AES Water Balance Model Results for a Range of WHC
Pearson Airport Climate Data (1971 - 2000)

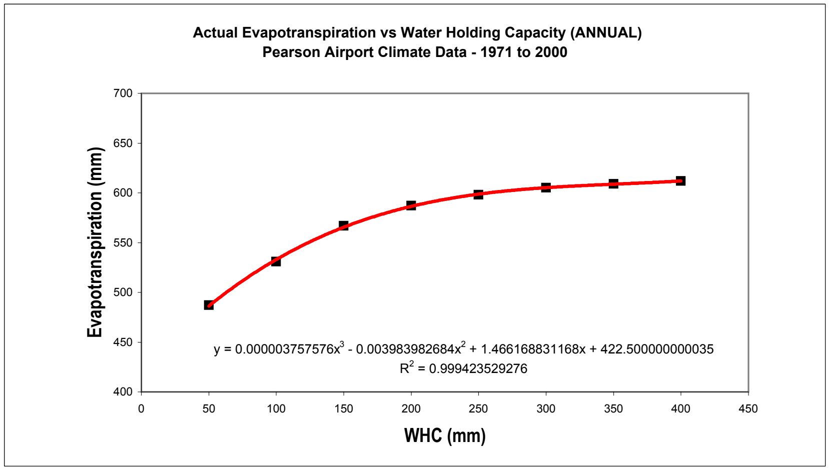
Existing Condition

Trendline			AES Model Results	
Surplus	**AE**	**WHC**	**Surplus**	**AE**
(mm)	**(mm)**	**(mm)**	**(mm)**	**(mm)**
301	486	50	301	487
256	533	100	257	531
225	565	150	224	567
204	586	200	204	587
191	599	250	191	598
184	605	300	185	605
181	609	350	180	609
178	612	400	178	612
213.1	577.2	**175.00**	**TOTAL SITE**	


Surplus vs Water Holding Capacity (ANNUAL)
Pearson Airport Climate Data - 1971 to 2000

Proposed Condition

Trendline			AES Model Results	
Surplus	**AE**	**WHC**	**Surplus**	**AE**
(mm)	**(mm)**	**(mm)**	**(mm)**	**(mm)**
301	486	50	301	487
256	533	100	257	531
225	565	150	224	567
204	586	200	204	587
191	599	250	191	598
184	605	300	185	605
181	609	350	180	609
178	612	400	178	612
256.3	533.0	**100.00**	**TOTAL SITE**	


Actual Evapotranspiration vs Water Holding Capacity (ANNUAL)
Pearson Airport Climate Data - 1971 to 2000

Moco Subdivision, Town of Grand Valley

Table E.6: Infiltration Trench Calculation

VALDOR ENGINEERING INC.
741 Rowntree Dairy Road, Suite 2, Woodbridge, Ontario L4L 5T9
Tel: 905-264-0054 Fax: 905-264-0069
info@valdor-engineering.com www.valdor-engineering.com

Designed By: PA
Checked By: BC

File No.: 14119

Total Req'd Annual Infiltration Volume to Achieve Target (m^3)	*Total Actual Annual Infiltration Volume per Design (m^3)*	*Soil Percolation Rate (mm/h)*	*Drainage Area (ha)*	*Maximum Trench Length per Site Plan (m)*	*Initial Abstraction (Trench Drainage Area) (mm)*	*Retention Time (hr)*	*Total Annual Rainfall Depth (Per 1971-2000 Climate Normals for Pearson Airport) (mm)*	*Total Rainfall Depth Available for Infiltration Per Rainfall Analysis (mm)*	*Annual Rainfall Depth Needed to Achieve Target Infiltration (mm)*	*Req'd Design Storm Depth to Achieve Annual Infiltration Requirements (mm)*	*Req'd Event-Based Runoff Volume to be Infiltrated (Based on Req'd Design Storm Depth (m^3)*
8,247	8,538	**15.0**	**3.400**	**-**	**5.0**	**48**	**684.6**	**251.1**	242.6	**15.0**	442.0

Infiltration Type	**Infiltration Trench with Clear Stone**

Infiltration Facility Design

Minimum Required Bottom Area (m^2)	*Max Allowable Depth (m)*	*Design Depth (m)*	*Design Bottom Area (m^2)*	*Required Length (m)*	*Design Width (m)*	*Check*
1,535	0.72	**0.72**	1,534.72	1,534.7	**1.00**	**OK**

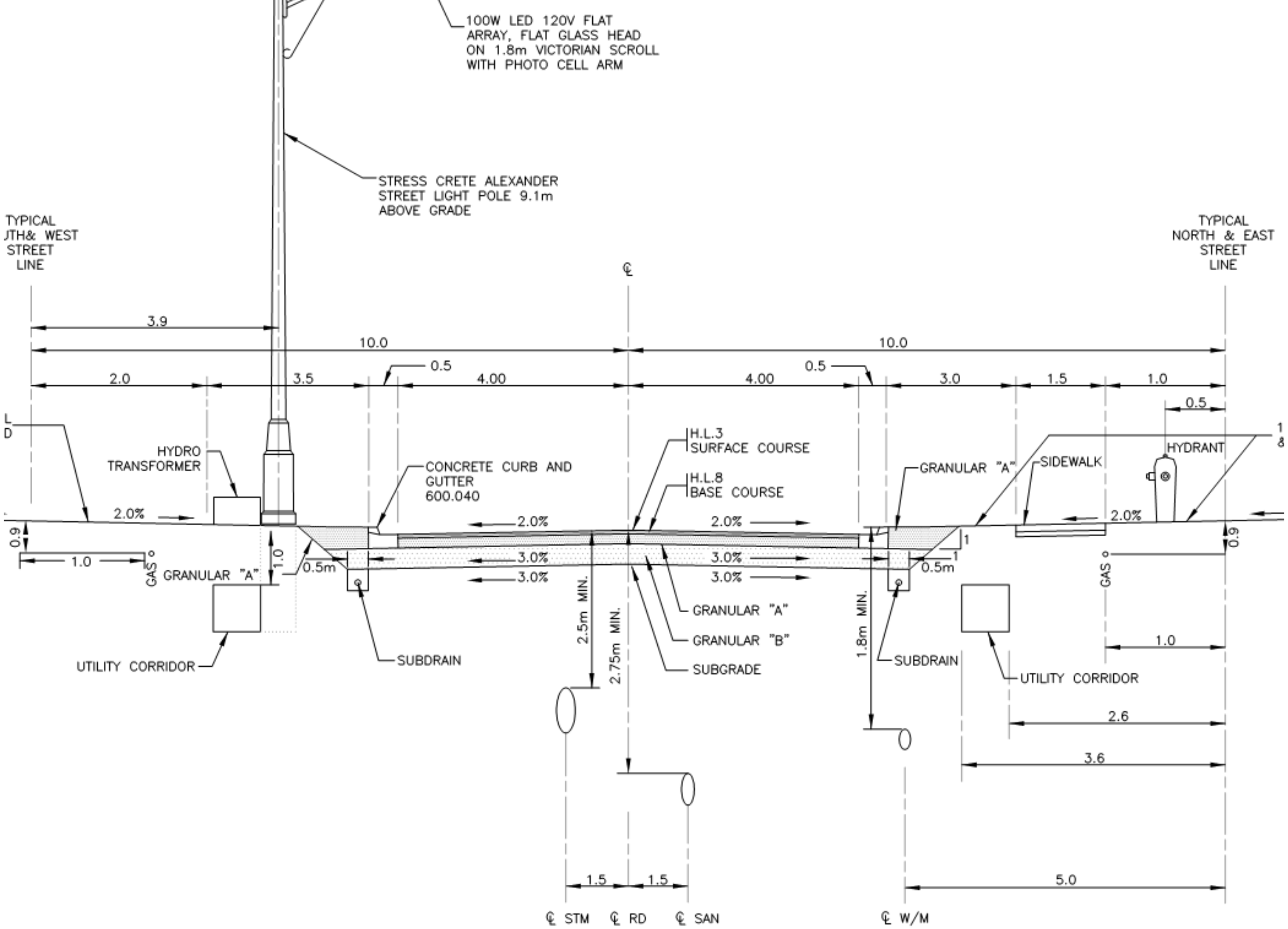
Notes:

Infiltration facilities are sized based on the following criteria (SWMPDM, MOE, 2003) and/or assumptions:

(1) Infiltration trench volume should be sized based on the runoff generated by a 4-hr 15-mm event or smaller.
(2) Drainage area should be sufficient to provide req'd runoff quantity.
(3) The maximum allowable depth of the infiltration facility is based on the soil percolation rate and the retention time.
(4) It is feasible to convey the runoff to the infiltration facility.
(5) The seasonal high water table should be at least 1 m below the infiltration trench.

APPENDIX “F”

Standard Road Cross Sections



N.T.S.

TOWN OF GRAND VALLEY
ENGINEERING STANDARDS

STANDARD ROAD
CROSS-SECTION - 20m R.O.W.

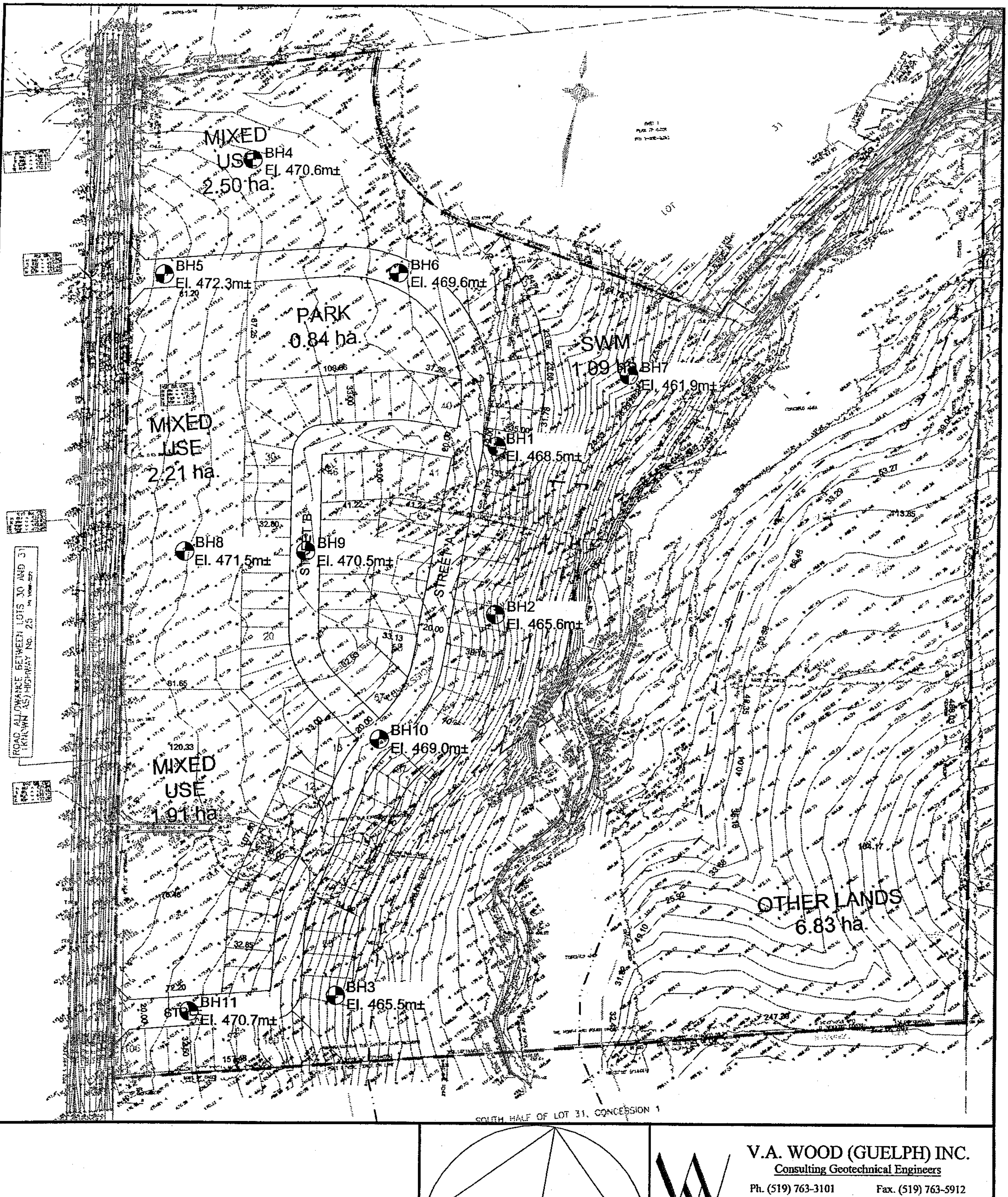
DRAFTED BY: VAN HARTEN SURVEYING INC.

REVISION NO.: 0	DATE: AUGUST

dwg

APPENDIX “G”

Geotechnical Bore Hole / Test Pit Logs



V.A. WOOD (GUELPH) INC.
Consulting Geotechnical Engineers
Ph. (519) 763-3101 Fax. (519) 763-5912
405 York Road, Guelph, Ontario N1E 3H3

Borehole Location Plan
North Half of Lot 31
Concession 1
Grand Valley, Ontario

Scale: NTS	Ref. No. G3525-4-11
Date: November 20, 2014	Enclosure 1

REFERENCE No: G3525-4-11

CLIENT: Moco Farms Limited

PROJECT: Proposed Subdivision

LOCATION: Grand Valley, ON

BOREHOLE No: 1

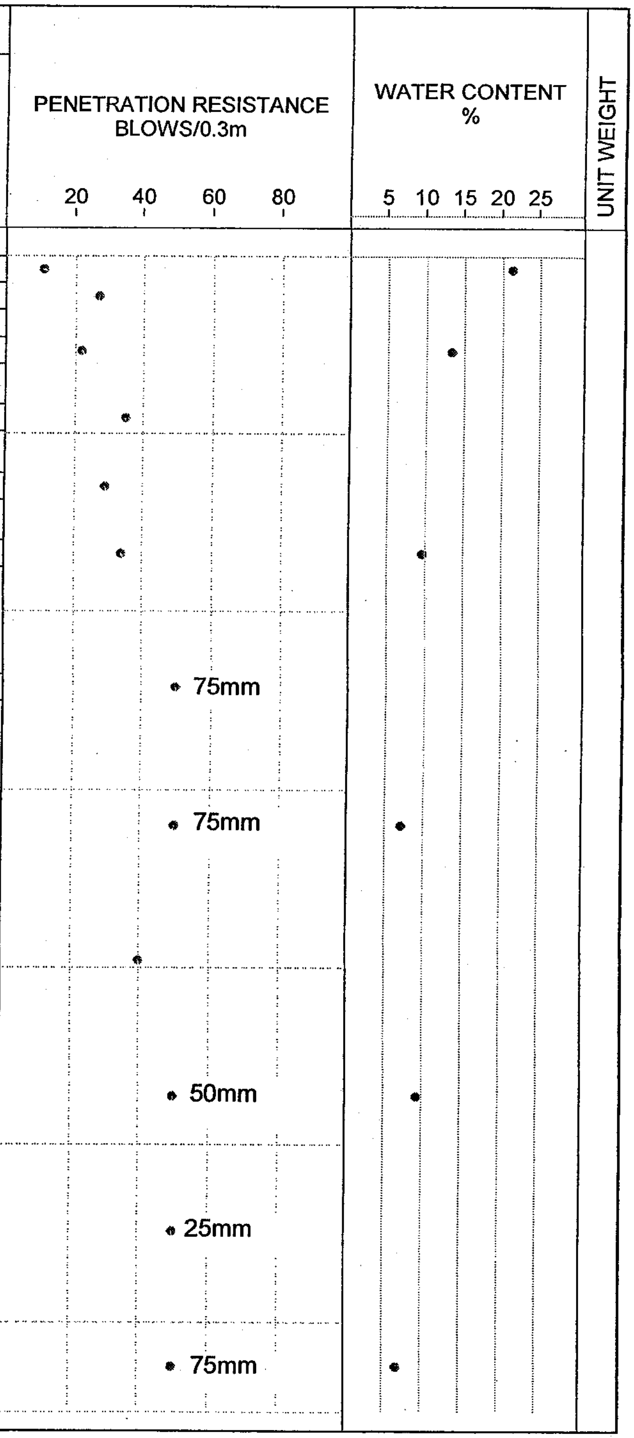
ENCLOSURE No: 2

SUPERVISOR: J.D.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	468.5					
	125mm Topsoil			W.L. @ El. 464.2m (11-Nov-14)	1	SS	11
	brown, stiff to hard CLAY AND SILT trace sand, trace gravel, moist				1	SS	27
					2	SS	22
2.3		466.2			3	SS	35
	brown, very stiff to hard CLAY AND SILT TILL trace sand, trace gravel, some wet sand and gravel seams moist to saturated				4	SS	29
					5	SS	34
					6	SS	50
7.7		460.8			7	SS	50
	grey, hard SILTY CLAY TILL some sand, trace gravel, some wet sand and gravel seams moist to saturated				8	SS	40
					9	SS	50
					10	SS	50
12.6		455.9			11	SS	50
	End of Borehole						



DRILLED BY: London Soil Test Limited

DRILL METHOD: Hollow Stem Augers

DRILL DATE: November 10 & 11, 2014

HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

REFERENCE No: G3525-4-11

BOREHOLE No: 2

CLIENT: Moco Farms Limited

PROJECT: Proposed Subdivision

ENCLOSURE No: 3

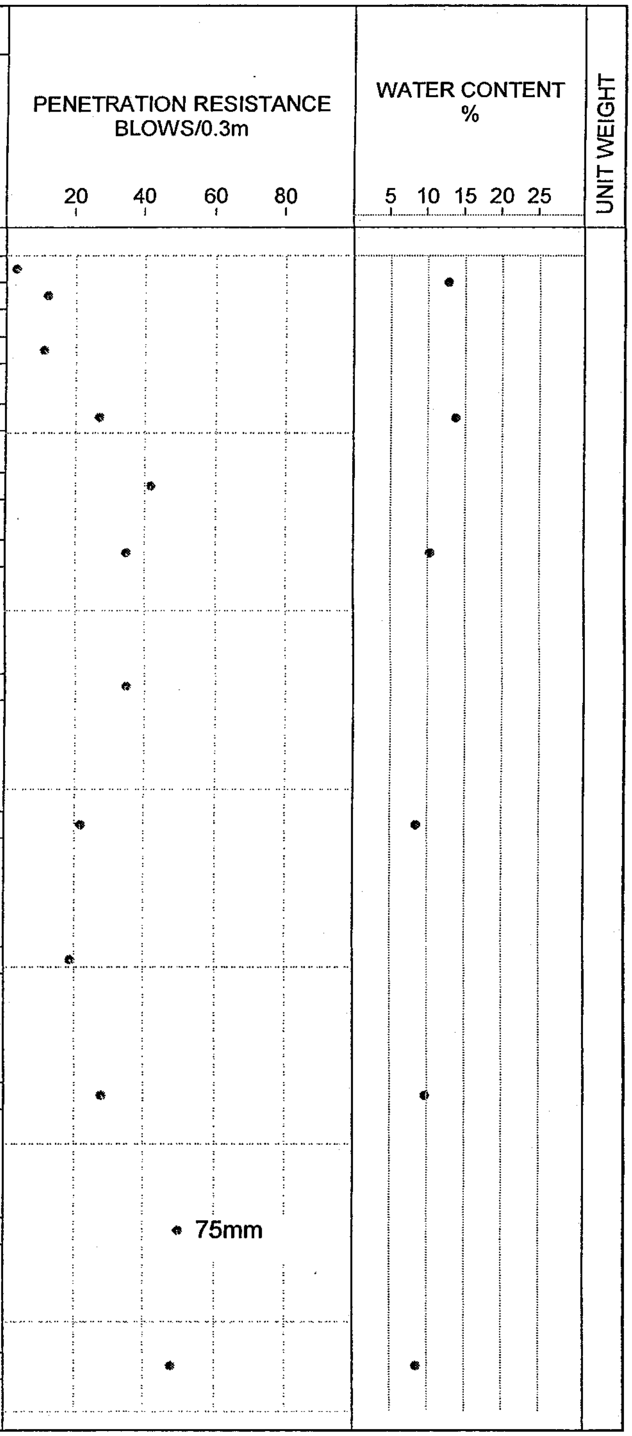
LOCATION: Grand Valley, ON

SUPERVISOR: J.D.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	465.6					
	200mm Topsoil				1	SS	3
	brown, stiff CLAY AND SILT trace sand, trace gravel, moist				1	SS	12
					2	SS	11
1.5		464.1					
	brown, very stiff to hard CLAY AND SILT TILL trace sand, trace gravel, moist				3	SS	27
					4	SS	42
					5	SS	35
					6	SS	35
6.1		459.5					
	brown, very stiff to hard SILTY CLAY TILL some sand, trace gravel, moist				7	SS	22
				▽ Cave-in @ El. 457.1m (10-Nov-14)	8	SS	19
					9	SS	28
					10	SS	50
12.6		453.0			11	SS	48
	End of Borehole						



DRILLED BY: London Soil Test Limited

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Augers

DATUM: Geodetic

DRILL DATE: November 10, 2014

SHEET: 1 of 1

REFERENCE No: G3525-4-11

BOREHOLE No: 3

CLIENT: Moco Farms Limited

PROJECT: Proposed Subdivision

ENCLOSURE No: 4

LOCATION: Grand Valley, ON

SUPERVISOR: B.R.F.

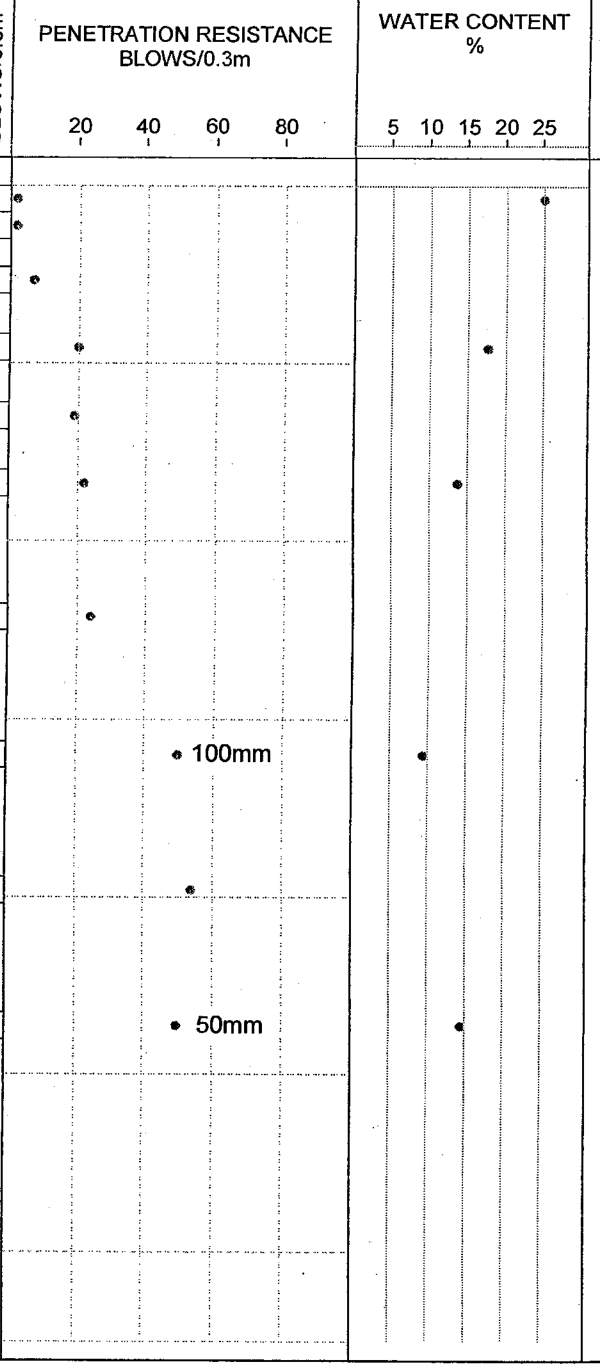
V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE			SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	465.5			
	200mm Topsoil		1	SS	2
	brown, soft to very stiff CLAY AND SILT trace sand, trace gravel, moist		1	SS	2
			2	SS	7
			3	SS	20
			4	SS	19
			5	SS	22
4.6		460.9			
	brown, compact to very dense SAND AND GRAVEL saturated moist		6	SS	24
			7	SS	50
7.6		457.9			
	brown, very dense SILTY SAND AND GRAVEL TILL saturated		8	SS	54
9.1		456.4			
9.6	brown, very dense SILTY SAND saturated	455.9	9	SS	50
	End of Borehole				

SYMBOL

GROUND WATER: W.L. @ El. 462.5m (10-Nov-14)



DRILLED BY: London Soil Test Limited

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Augers

DATUM: Geodetic

DRILL DATE: November 10, 2014

SHEET: 1 of 1

REFERENCE No: G3525-4-11

CLIENT: Moco Farms Limited

PROJECT: Proposed Subdivision

LOCATION: Grand Valley, ON

BOREHOLE No: 4

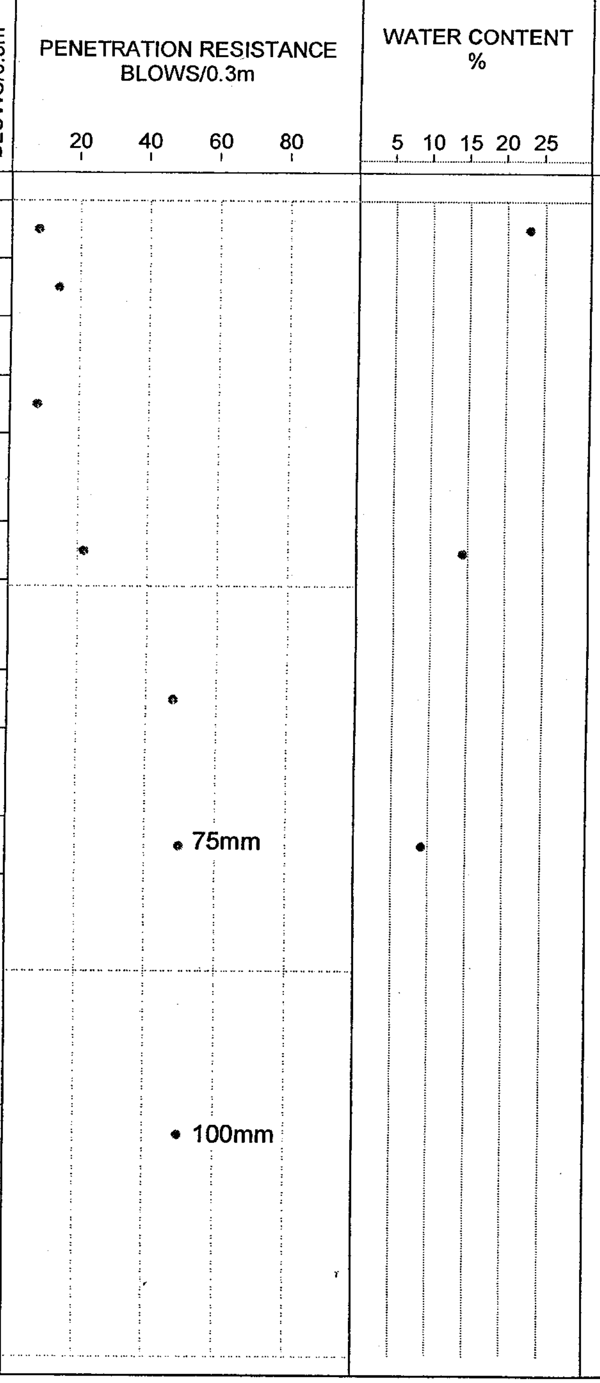
ENCLOSURE No: 5

SUPERVISOR: J.D.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE					
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
0.0	Ground Surface	470.6								
0.2	200mm Topsoil	470.4			1	SS	8			
	brown, stiff to hard CLAY AND SILT trace sand, trace gravel, wet to moist			W.L. @ El. 470.0m (11-Nov-14)	1	SS	14			
					2	SS	8			
					3	SS	22			
					4	SS	48			
3.0		467.6								
	brown, hard CLAY AND SILT TILL trace sand, trace gravel, moist				5	SS	50	75mm		
4.6		466.0								
	grey, hard SILTY CLAY TILL some sand, trace gravel, moist									
5.0		465.6			6	SS	50	100mm		
	End of Borehole									



DRILLED BY: London Soil Test Limited

DRILL METHOD: Solid Stem Augers

DRILL DATE: November 11, 2014

HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

REFERENCE No: G3525-4-11

CLIENT: Moco Farms Limited

PROJECT: Proposed Subdivision

LOCATION: Grand Valley, ON

BOREHOLE No: 5

ENCLOSURE No: 6

SUPERVISOR: J.D.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
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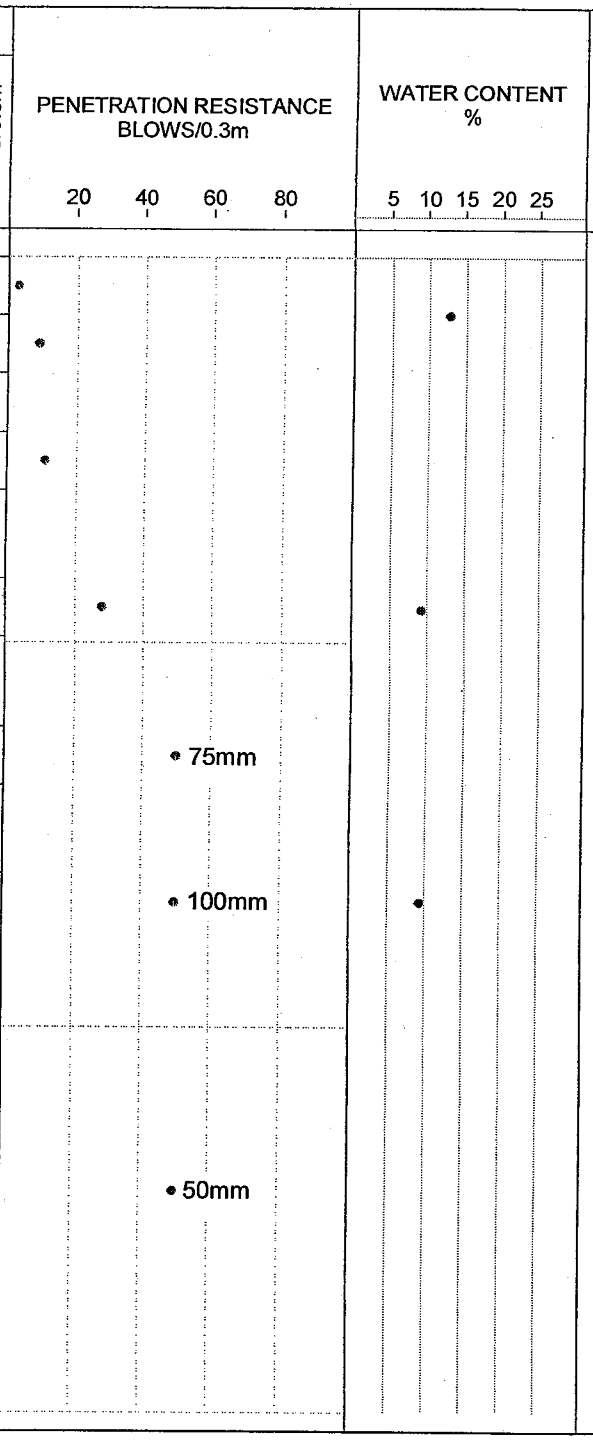
SUBSURFACE PROFILE					SAMPLE			
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	UNIT WEIGHT
0.0	Ground Surface	472.3						
0.2	175mm Topsoil	472.1			1	SS	3	
	brown, stiff to very stiff CLAY AND SILT trace sand, trace gravel, moist				1	SS	9	
				▼ W.L. @ El. 471.4m (11-Nov-14)	2	SS	11	
					3	SS	28	
2.3		470.0						
	brown, hard CLAY AND SILT TILL trace sand, trace gravel, moist				4	SS	50	
					5	SS	50	
4.6		467.7						
	grey, hard SILTY CLAY TILL some sand, trace gravel, moist				6	SS	50	
5.0		467.3						
	End of Borehole							



DRILLED BY: London Soil Test Limited

DRILL METHOD: Solid Stem Augers

DRILL DATE: November 11, 2014

HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

REFERENCE No: G3525-4-11

BOREHOLE No: 6

CLIENT: Moco Farms Limited

PROJECT: Proposed Subdivision

ENCLOSURE No: 7

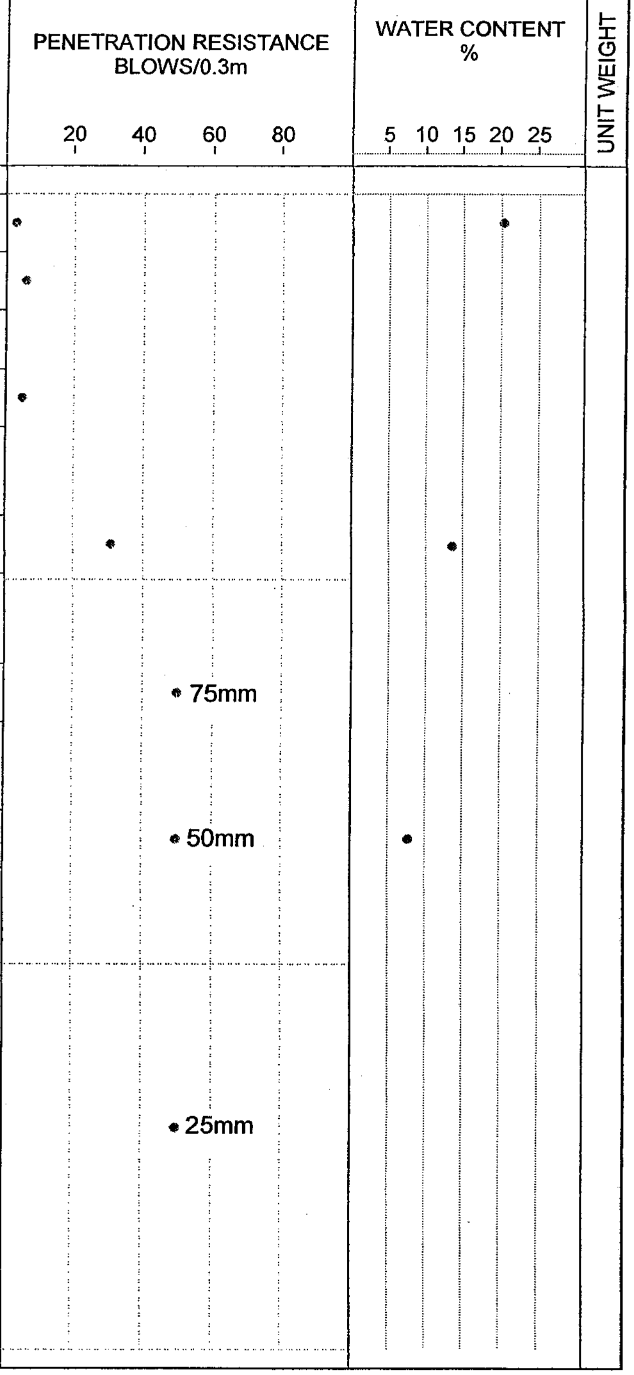
LOCATION: Grand Valley, ON

SUPERVISOR: J.D.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	469.6					
0.2	200mm Topsoil	469.4		DRY (11-Nov-14)	1	SS	3
	brown, medium to hard CLAY AND SILT trace sand, trace gravel, wet sand seams, moist				1	SS	6
					2	SS	5
					3	SS	31
					4	SS	50
3.3		466.3					
	brown, hard CLAY AND SILT TILL trace sand, trace gravel, wet sand and gravel seam, moist				5	SS	50
4.6		465.0					
	grey, hard SILTY CLAY TILL some sand, trace gravel wet sand seam, moist				6	SS	50
5.0		464.6					
	End of Borehole						



DRILLED BY: London Soil Test Limited

HOLE DIAMETER: 210mm

DRILL METHOD: Solid Stem Augers

DATUM: Geodetic

DRILL DATE: November 11, 2014

SHEET: 1 of 1

REFERENCE No: G3525-4-11

CLIENT: Moco Farms Limited

PROJECT: Proposed Subdivision

LOCATION: Grand Valley, ON

BOREHOLE No: 7

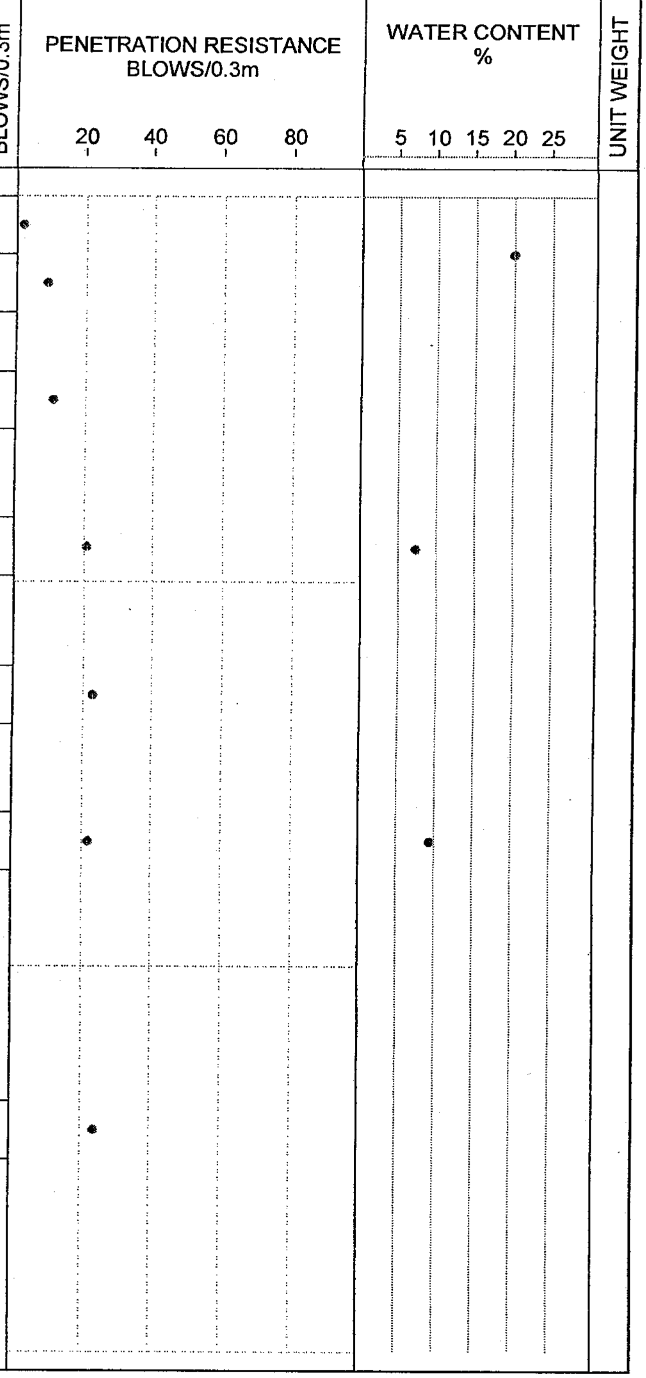
ENCLOSURE No: 8

SUPERVISOR: J.D.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	461.9					
0.2	200mm Topsoil	461.7		DRY (11-Nov-14)	1	SS	2
	brown, stiff to very stiff CLAY AND SILT trace sand, trace gravel, occasional wet sand seams, moist to wet				1	SS	9
					2	SS	11
					3	SS	21
					4	SS	23
					5	SS	22
4.6		457.3					
	grey, very stiff SILTY CLAY some sand, trace gravel, moist				6	SS	24
5.0		456.9					
	End of Borehole						



DRILLED BY: London Soil Test Limited

DRILL METHOD: Solid Stem Augers

DRILL DATE: November 11, 2014

HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

REFERENCE No: G3525-4-11

BOREHOLE No: 8

CLIENT: Moco Farms Limited

PROJECT: Proposed Subdivision

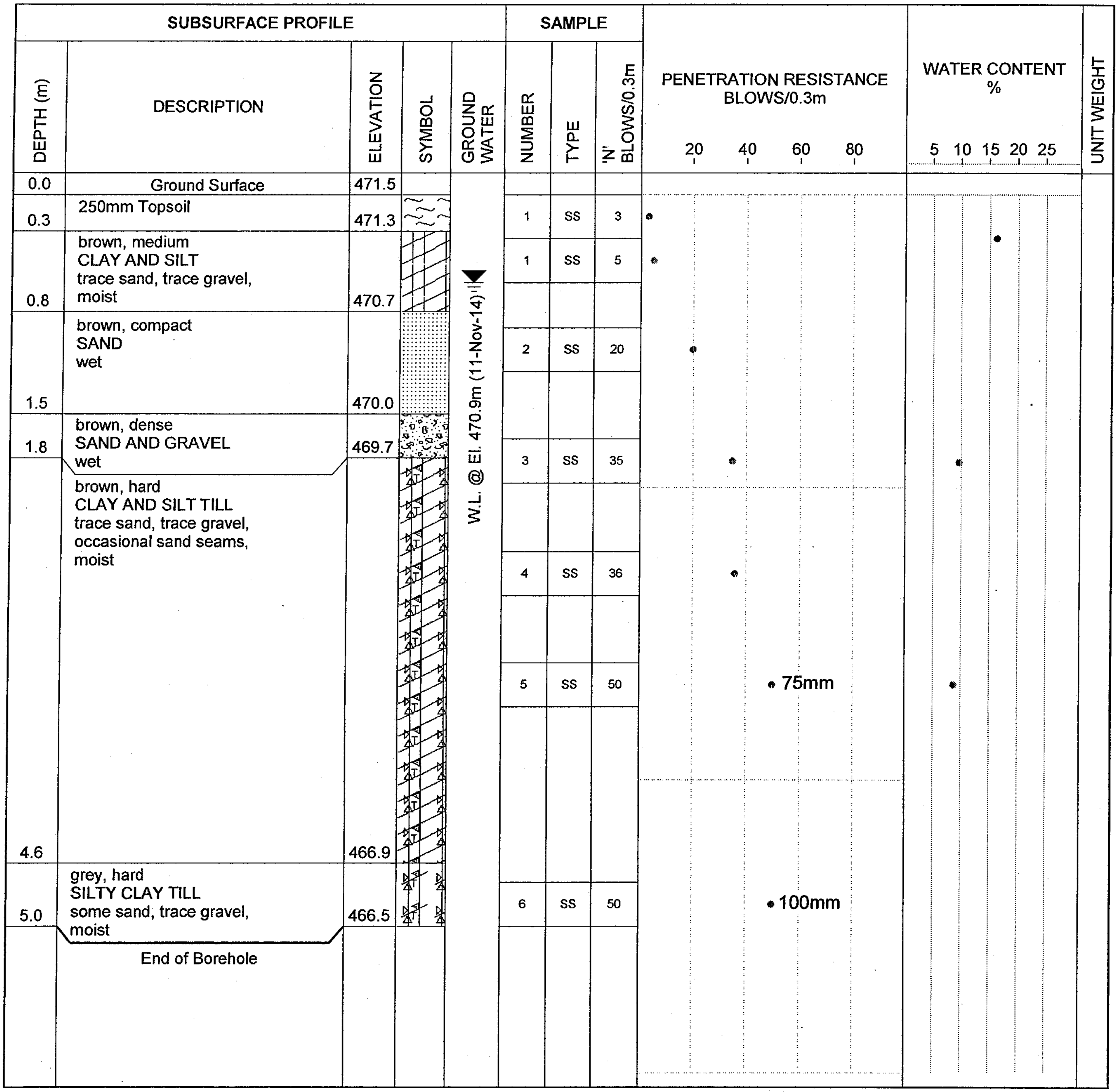
ENCLOSURE No: 9

LOCATION: Grand Valley, ON

SUPERVISOR: J.D.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912



SUBSURFACE PROFILE

DEPTH (m)	DESCRIPTION	ELEVATION
0.0	Ground Surface	471.5
0.3	250mm Topsoil	471.3
0.8	brown, medium CLAY AND SILT trace sand, trace gravel, moist	470.7
1.5	brown, compact SAND wet	470.0
1.8	brown, dense SAND AND GRAVEL wet	469.7
4.6	brown, hard CLAY AND SILT TILL trace sand, trace gravel, occasional sand seams, moist	466.9
5.0	grey, hard SILTY CLAY TILL some sand, trace gravel, moist	466.5
	End of Borehole	

GROUND WATER: W.L. @ El. 470.9m (11-Nov-14)

SAMPLE

NUMBER	TYPE	'N' BLOWS/0.3m
1	SS	3
1	SS	5
2	SS	20
3	SS	35
4	SS	36
5	SS	50
6	SS	50

DRILLED BY: London Soil Test Limited

HOLE DIAMETER: 210mm

DRILL METHOD: Solid Stem Augers

DATUM: Geodetic

DRILL DATE: November 11, 2014

SHEET: 1 of 1

REFERENCE No: G3525-4-11

BOREHOLE No: 9

CLIENT: Moco Farms Limited

PROJECT: Proposed Subdivision

ENCLOSURE No: 10

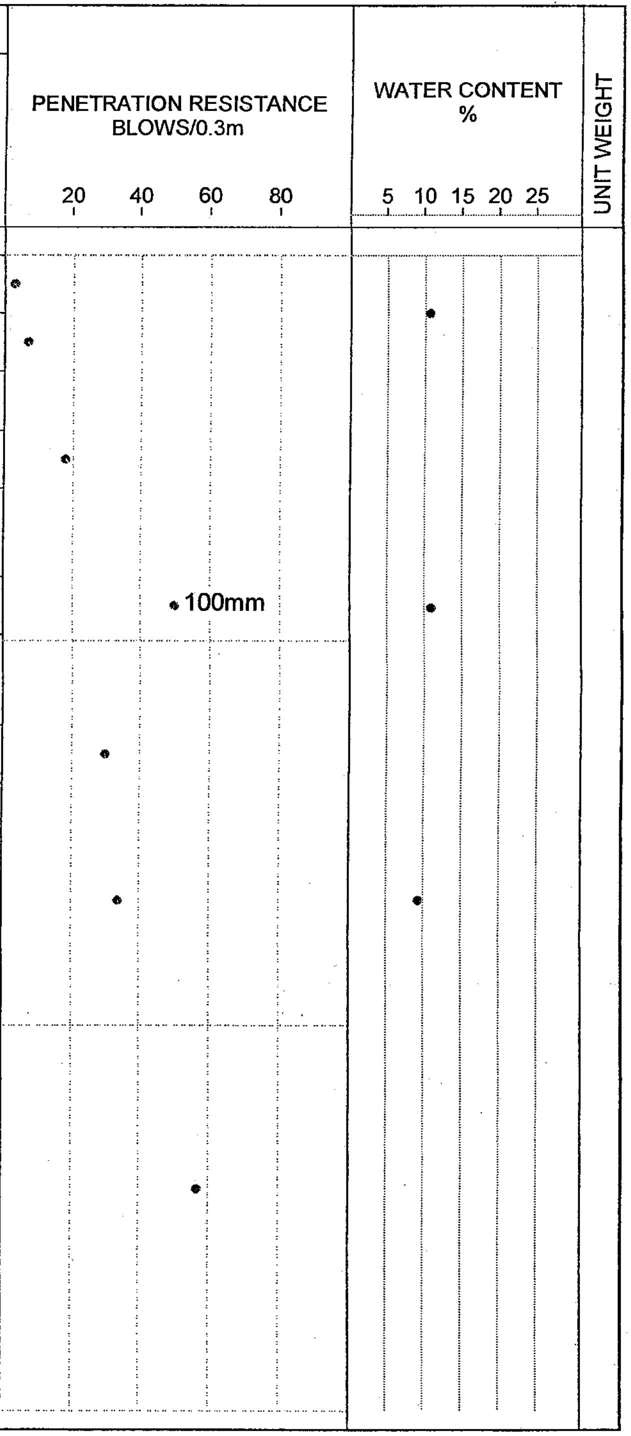
LOCATION: Grand Valley, ON

SUPERVISOR: J.D.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	470.5		DRY (11-Nov-14)			
0.2	250mm Topsoil	470.3			1	SS	3
	brown, medium to hard CLAY AND SILT trace sand, trace gravel, moist				1	SS	7
					2	SS	18
					3	SS	50
					4	SS	30
					5	SS	34
4.6		465.9					
5.0	grey, hard SILTY CLAY TILL some sand, trace gravel, moist	465.5			6	SS	57
	End of Borehole						



DRILLED BY: London Soil Test Limited

HOLE DIAMETER: 210mm

DRILL METHOD: Solid Stem Augers

DATUM: Geodetic

DRILL DATE: November 11, 2014

SHEET: 1 of 1

REFERENCE No: G3525-4-11

CLIENT: Moco Farms Limited

PROJECT: Proposed Subdivision

LOCATION: Grand Valley, ON

BOREHOLE No: 10

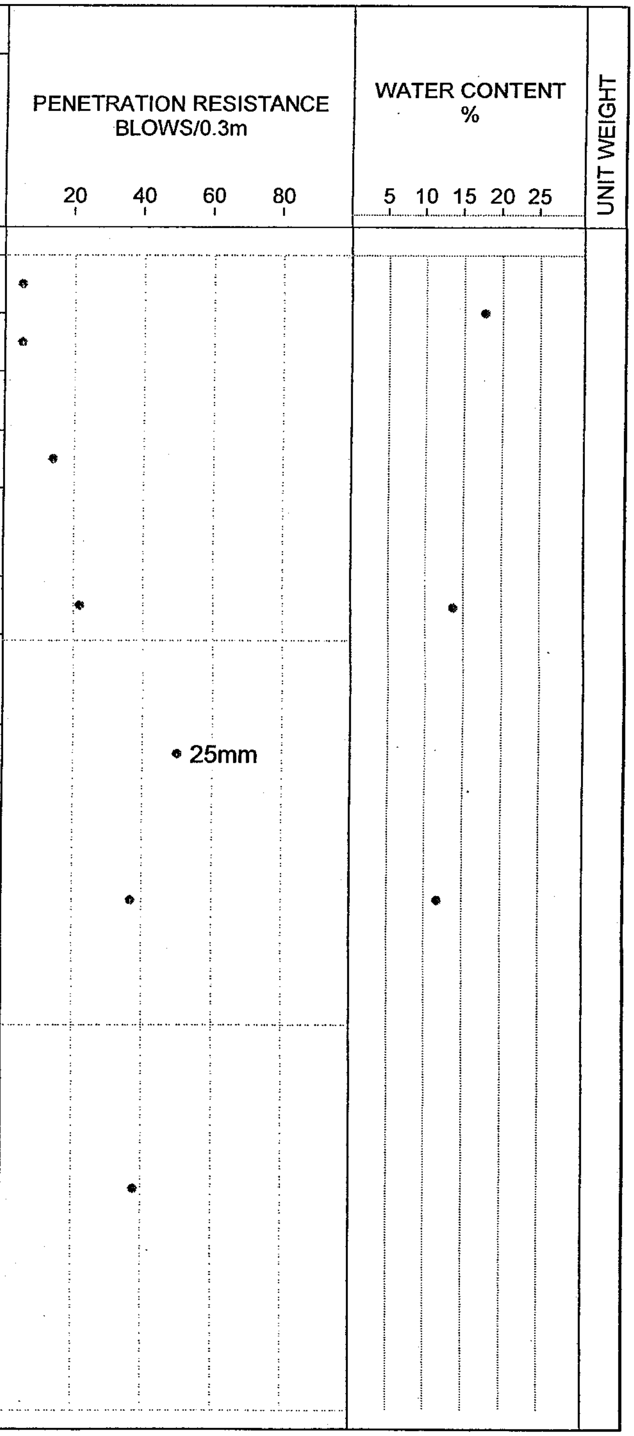
ENCLOSURE No: 11

SUPERVISOR: J.D.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	469.0					
0.2	150mm Topsoil	468.9			1	SS	5
	brown, medium to hard CLAY AND SILT trace sand, trace gravel, moist				1	SS	5
					2	SS	14
					3	SS	22
					4	SS	50
3.2		465.8					
	grey, hard SILTY CLAY some sand, trace gravel, moist			W.L. @ El. 465.0m (11-Nov-14)	5	SS	37
					6	SS	38
5.0		464.0					
	End of Borehole						



DRILLED BY: London Soil Test Limited

DRILL METHOD: Solid Stem Augers

DRILL DATE: November 11, 2014

HOLE DIAMETER: 210mm

DATUM: Geodetic

SHEET: 1 of 1

REFERENCE No: G3525-4-11

CLIENT: Moco Farms Limited

PROJECT: Proposed Subdivision

LOCATION: Grand Valley, ON

BOREHOLE No: 11

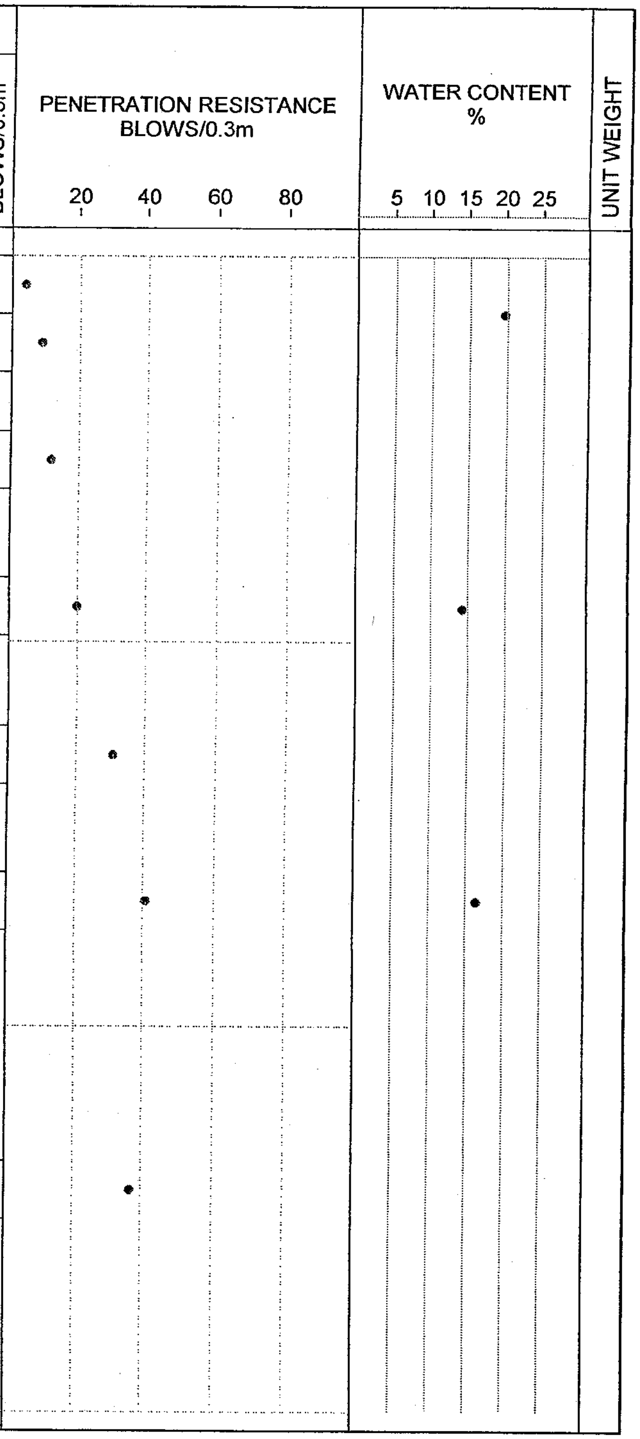
ENCLOSURE No: 12

SUPERVISOR: J.D.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	470.7		DRY (11-Nov-14)			
	100mm Topsoil				1	SS	4
	brown, medium to hard CLAY AND SILT trace sand, trace gravel, moist				1	SS	9
					2	SS	12
					3	SS	20
					4	SS	31
					5	SS	41
4.6		466.1					
	grey, hard SILTY CLAY some sand, trace gravel, moist				6	SS	37
5.0		465.7					
	End of Borehole						



DRILLED BY: London Soil Test Limited

HOLE DIAMETER: 210mm

DRILL METHOD: Solid Stem Augers

DATUM: Geodetic

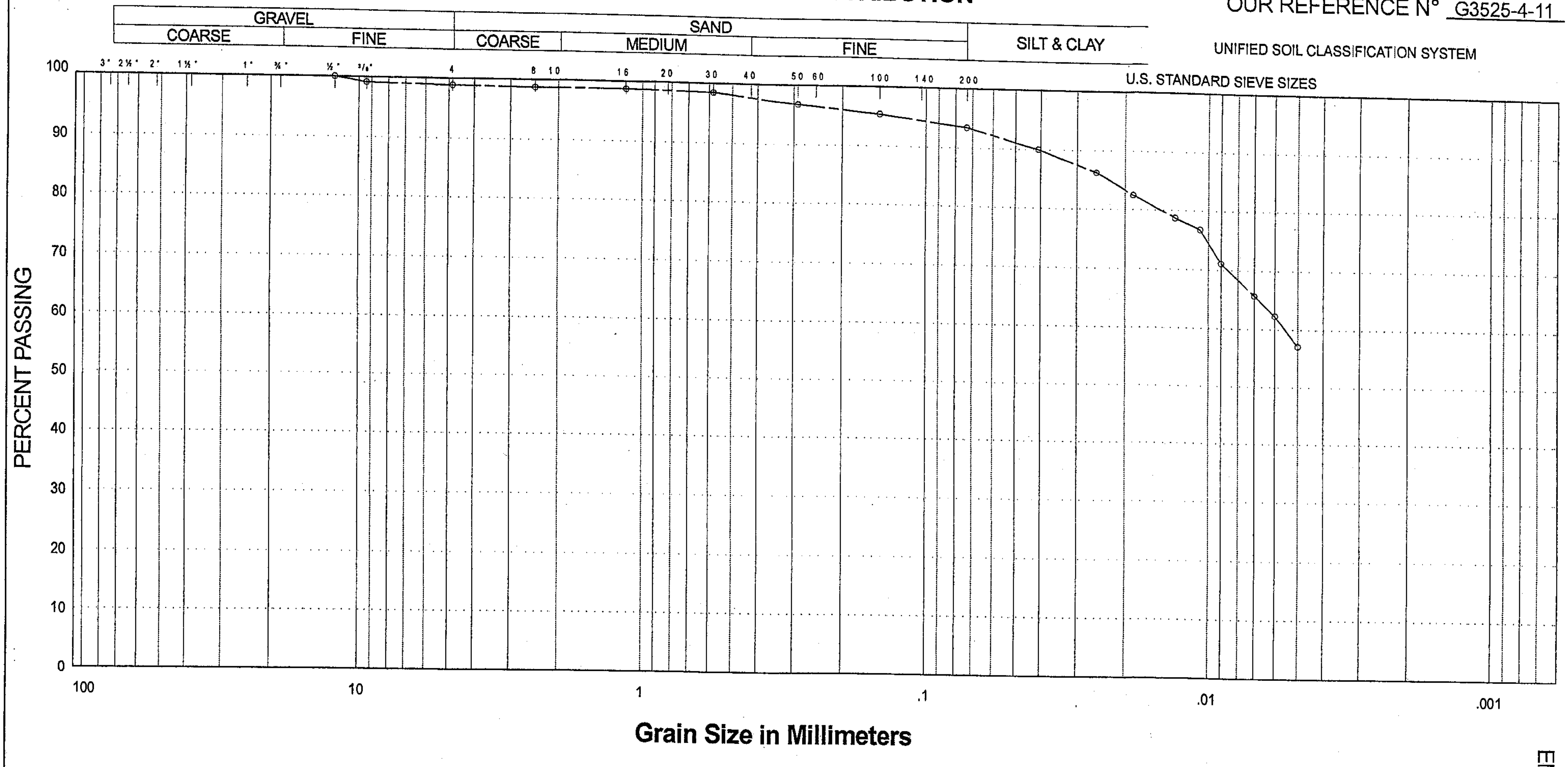
DRILL DATE: November 12, 2014

SHEET: 1 of 1

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G3525-4-11

UNIFIED SOIL CLASSIFICATION SYSTEM



PROJECT: Proposed Residential Development
LOCATION: North Half of Lot 31, Conc. 1, Grand Valley ON
BOREHOLE N°: 3
SAMPLE N°: 4
DEPTH: 2.3 - 2.7m±
ELEVATION: 463.2 - 462.8m±

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

CLAY AND SILT, trace sand, trace gravel, (ML - OL)

PLASTIC PROPERTIES

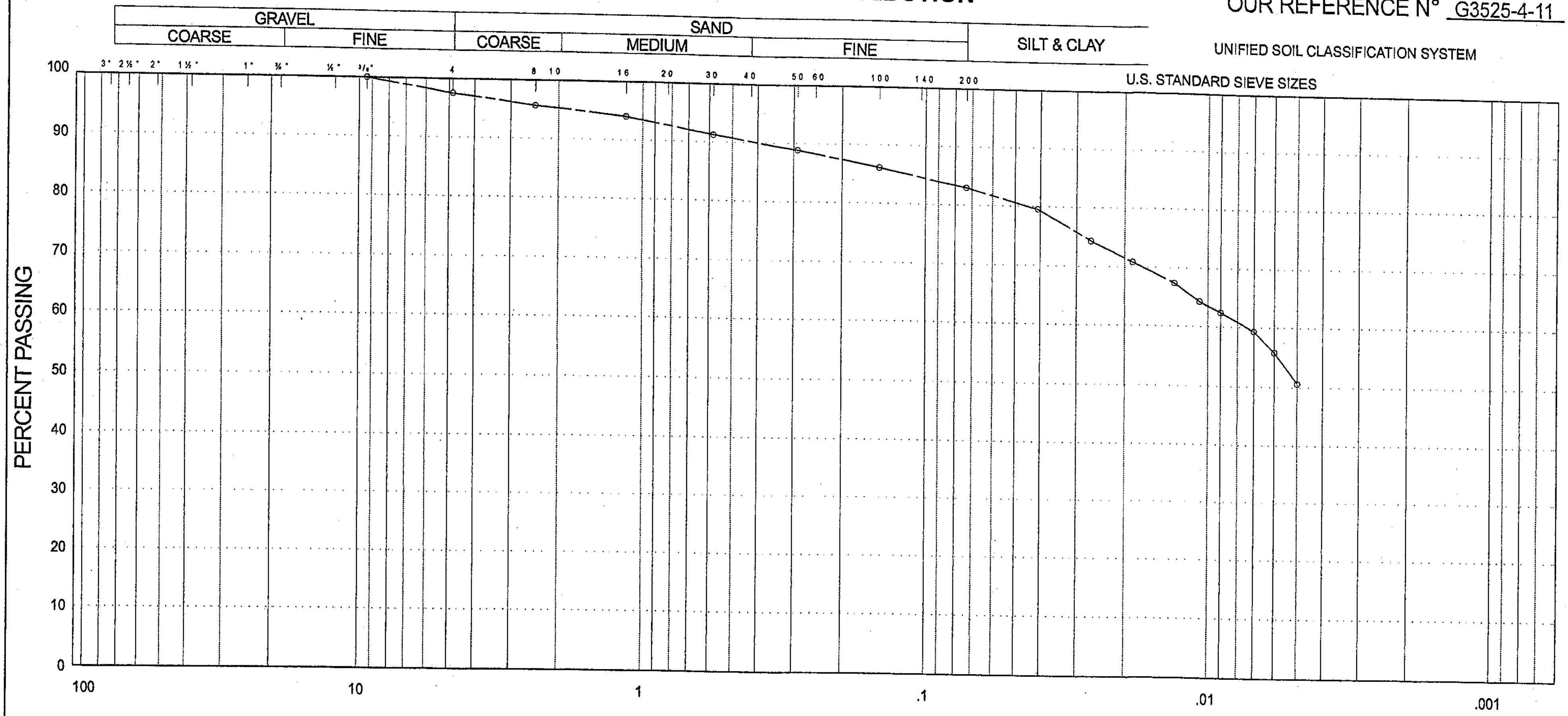
LIQUID LIMIT	% = 33.7
PLASTIC LIMIT	% = 28.3
PLASTICITY INDEX	% = 5.4
MOISTURE CONTENT	% = 20.0

ENCLOSURE N° 13

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G3525-4-11



PROJECT: Proposed Residential Development

LOCATION: North Half of of Lot 31, Conc. 1, Grand Valley ON

BOREHOLE N°: 10

SAMPLE N°: 6

DEPTH: 4.6 - 5.0m±

ELEVATION: 464.4 - 464.0m±

COEFFICIENT OF UNIFORMITY:

COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SILTY CLAY, some sand, trace gravel, (CL)

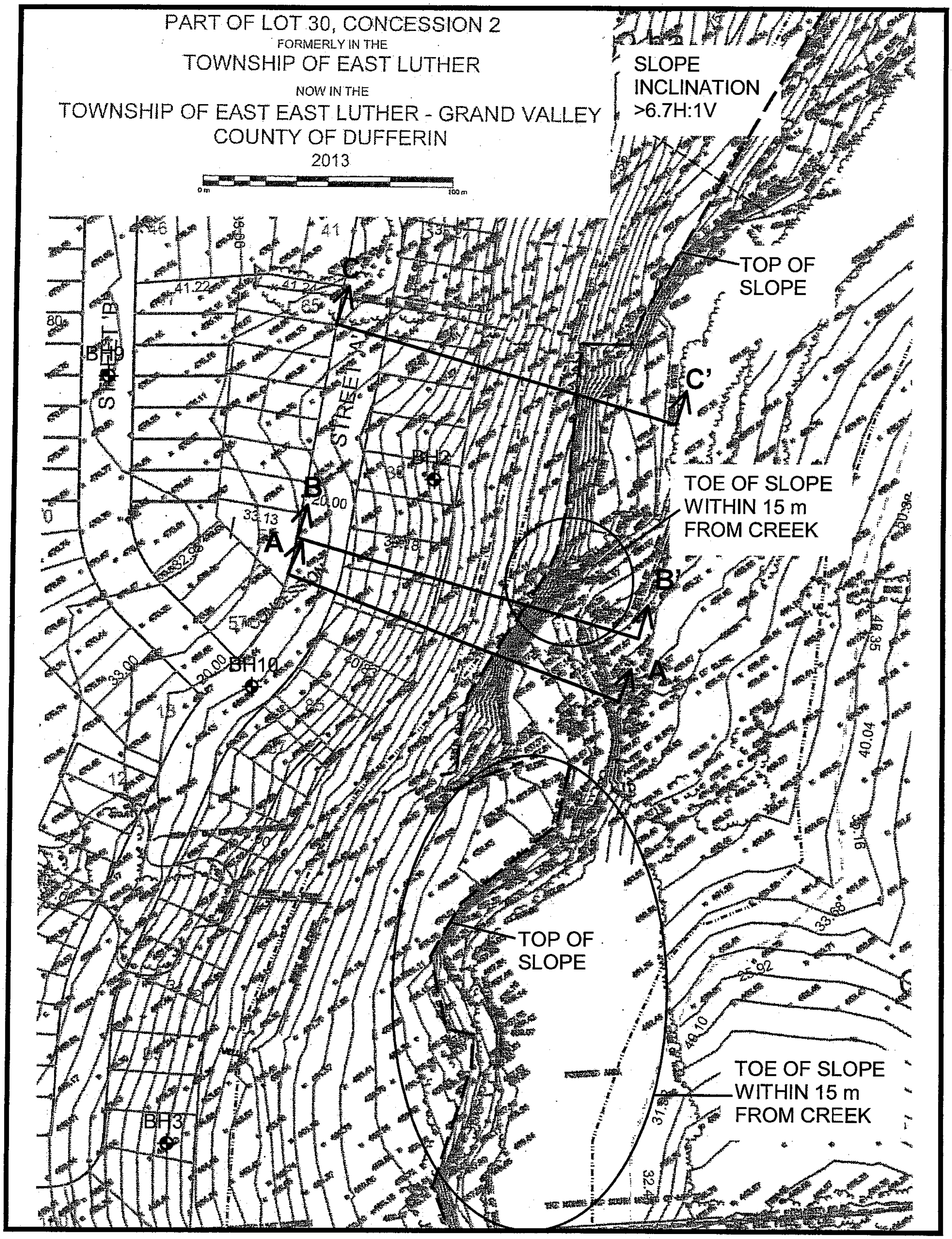
PLASTIC PROPERTIES	
LIQUID LIMIT	% = 30.3
PLASTIC LIMIT	% = 16.9
PLASTICITY INDEX	% = 13.4
MOISTURE CONTENT	% = 5.7

ENCLOSURE N° 14

V. A. WOOD (GUELPH) INCORPORATED

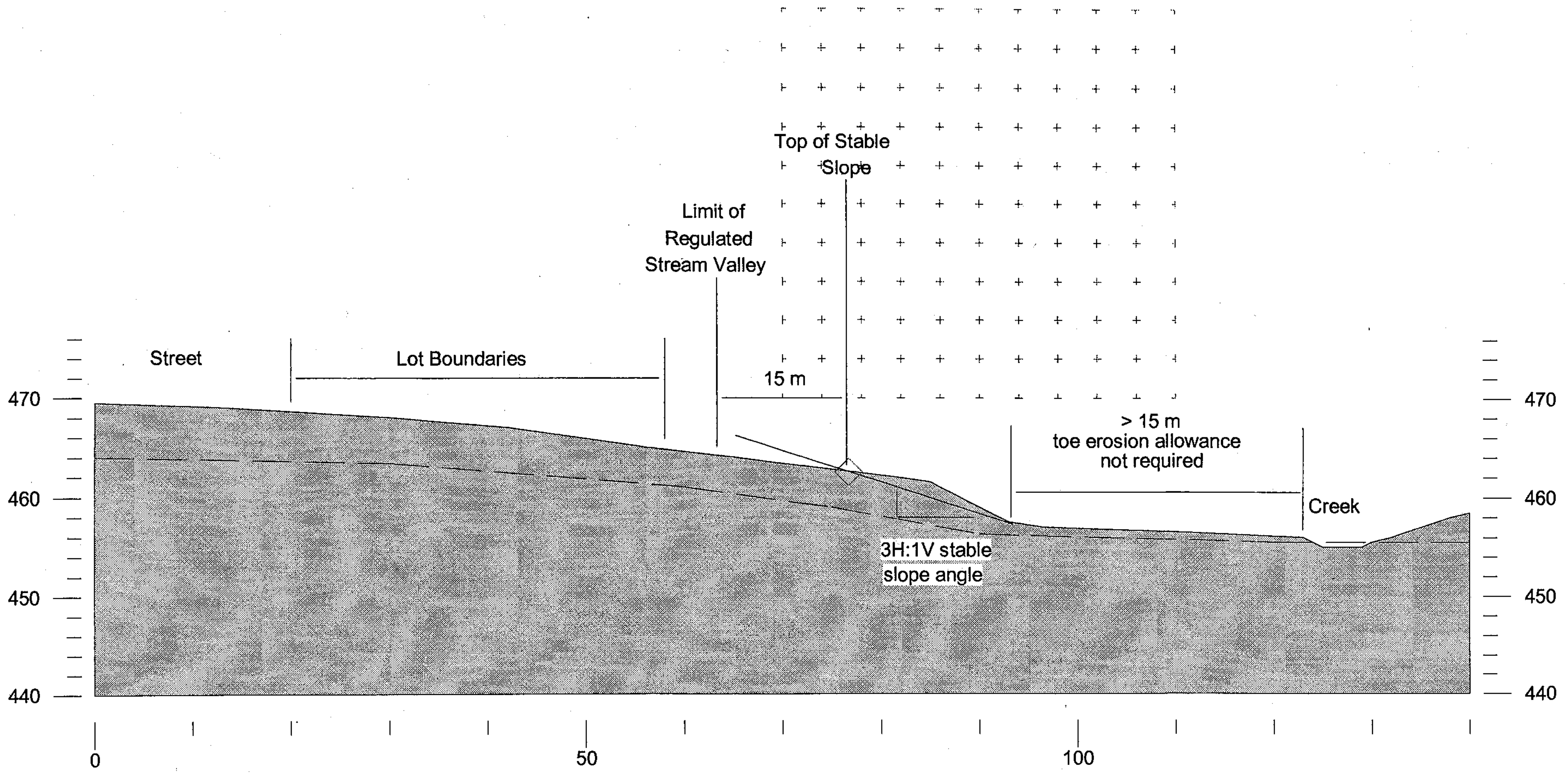
Ref. No. G-3525-4-11

Enclosure 1



SLOPE ASSESSMENT PLAN

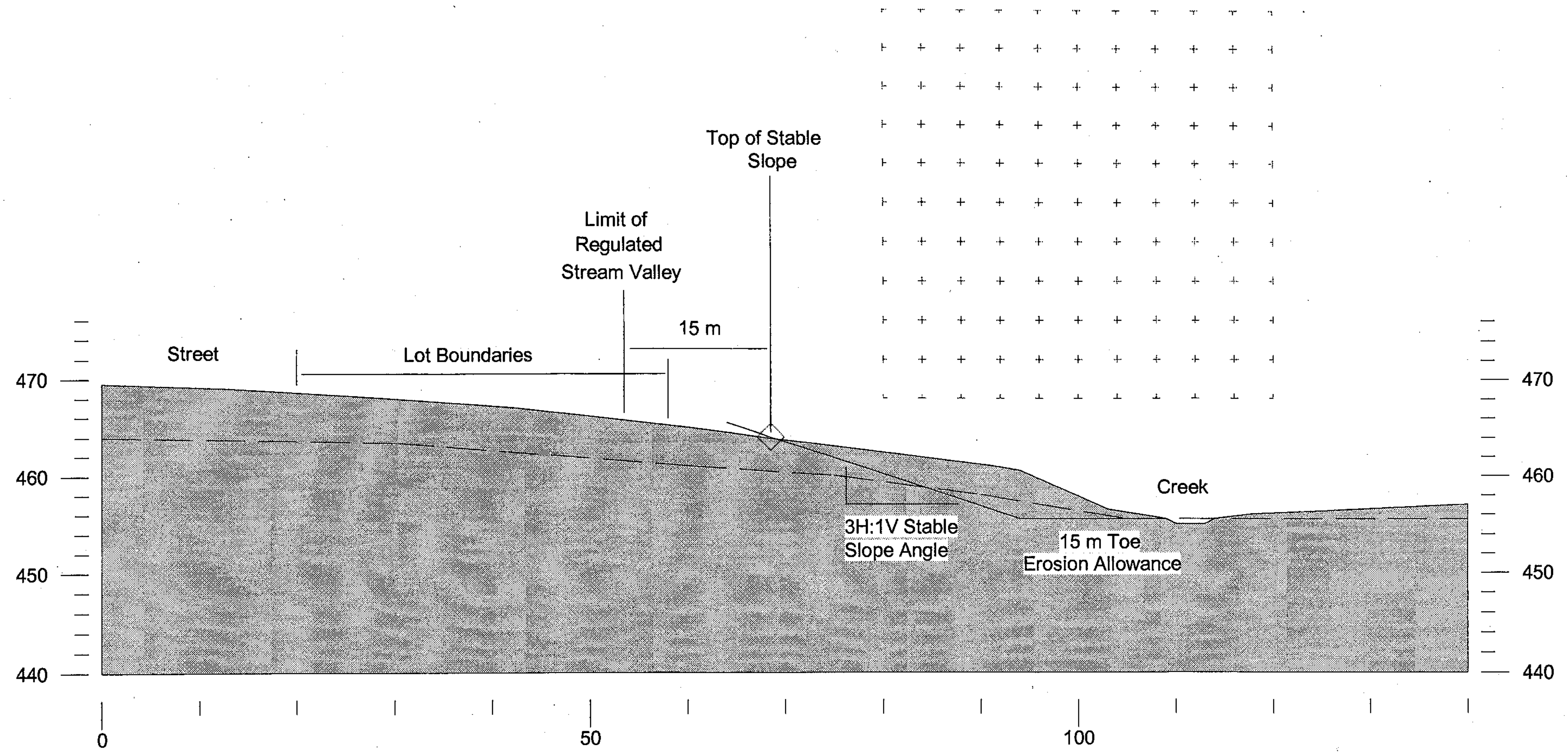
V.A. Wood Associates - Scarborough, ON
G3525-4-11
N 1/2 Lot 31, Con 1, Township of East Luther
December 2014
Slope Assessment
Section A-A'



01/06/2015 12:44:10 PM S:\VAW-CU~1\G3525\SECA.GSL

Enclosure 2, Section A-A'

V.A. Wood Associates - Scarborough, ON
G3525-4-11
N 1/2 Lot 31, Con 1, Township of East Luther
December 2014
Slope Assessment
Section B-B'



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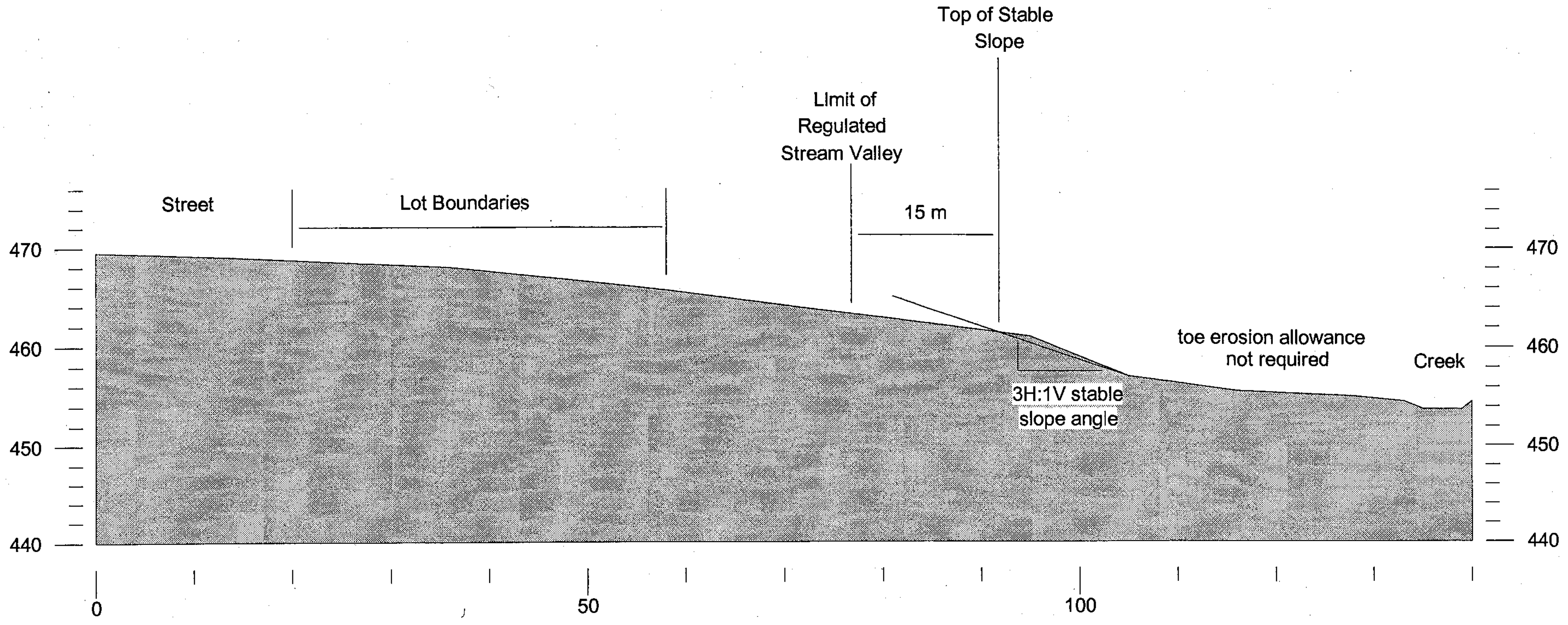
Enclosure 3, Section B-B'

V.A. Wood Associates - Scarborough, ON
G3525-4-11
N 1/2 Lot 31, Con 1, Township of East Luther
December 2014
Slope Assessment
Section C-C'

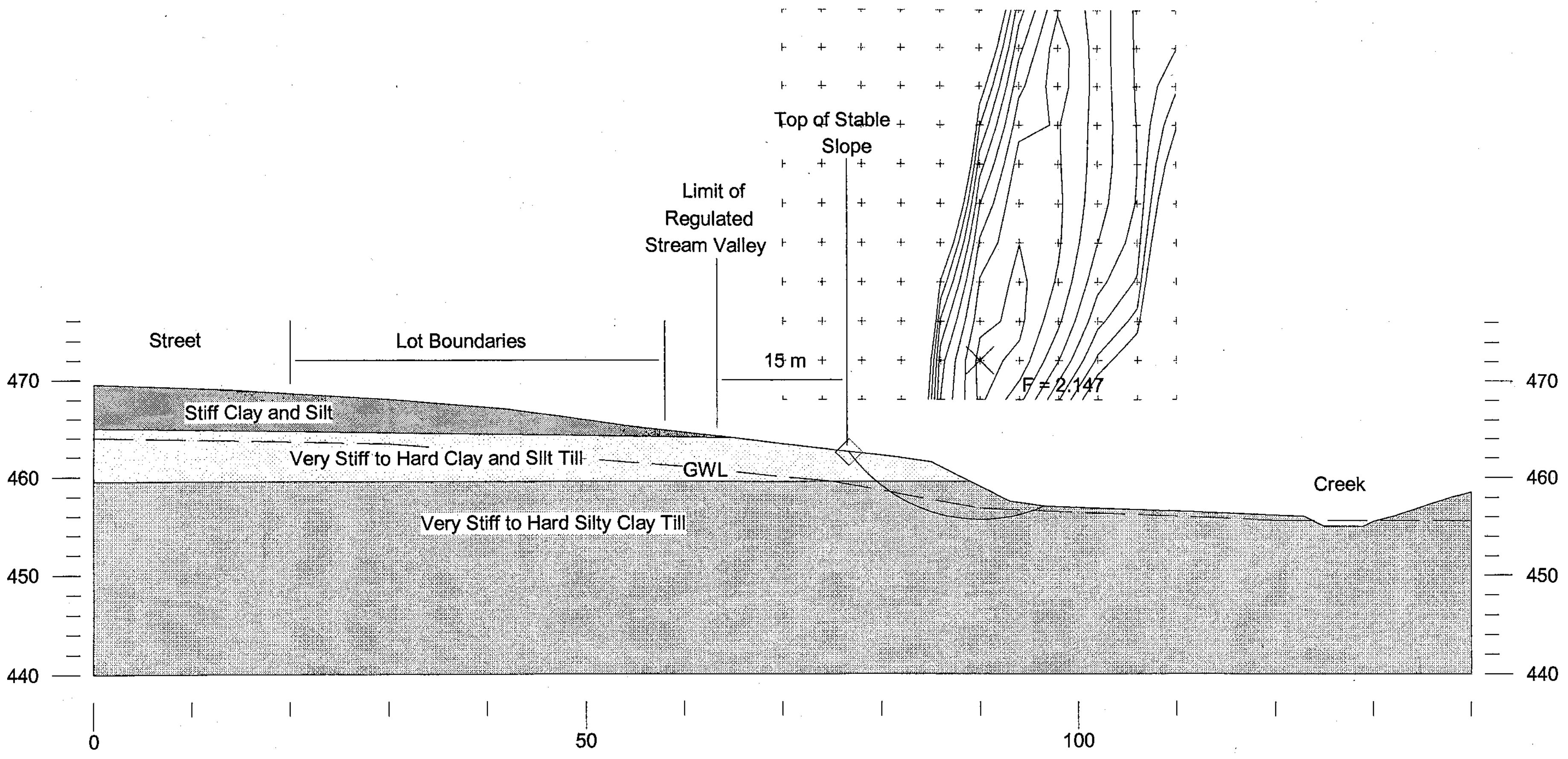


Enclosure 4, Section C-C'

01/06/2015 12:40:45 PM S:\VAW-CU~1\G3525\SECC.GSL V.A. Wood Associates - Scarborough, ON

	Gamma kN/m3	C kPa	Phi deg	Plezo Surf.
Stiff Clay/Silt	19	0	28	1
VS-Hard C/S Till	20	3	30	1
VS-Hard SClay Ti	20	3	30	1

V.A. Wood Associates - Scarborough, ON
G3525-4-11
N 1/2 Lot 31, Con 1, Township of East Luther
December 2014
Slope Assessment
Section A-A'

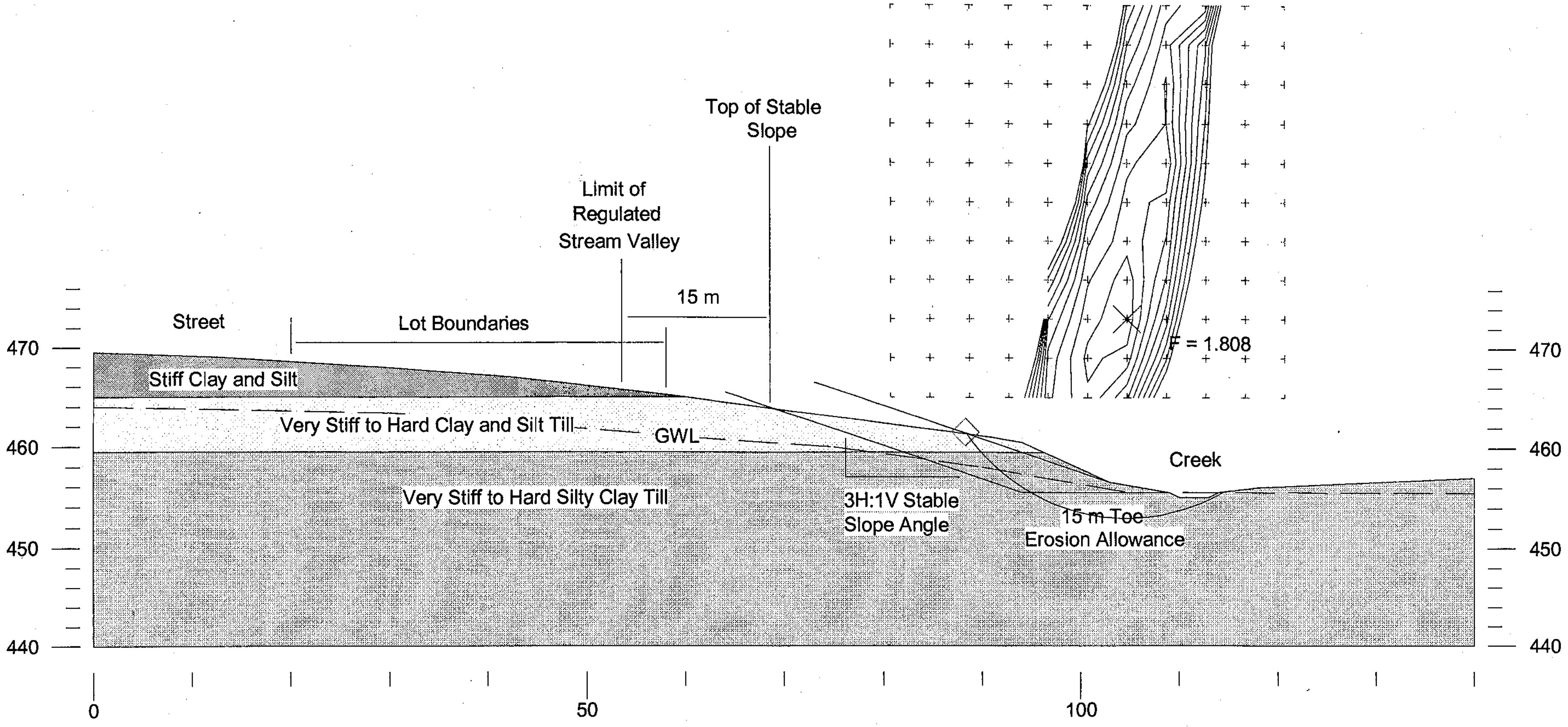


01/06/2015 12:52:07 PM S:\VAW-CU~1\G3525\SECAG.GSL F = 2.147

Enclosure 5, Section A-A'

	Gamma kN/m3	C kPa	Phi deg	Piezo Surf.
Stiff Clay/Silt	19	0	28	1
VS-Hard C/S Till	20	3	30	1
VS-Hard SClay Ti	20	3	30	1

V.A. Wood Associates - Scarborough, ON
G3525-4-11
N 1/2 Lot 31, Con 1, Township of East Luther
December 2014
Slope Assessment
Section B-B'



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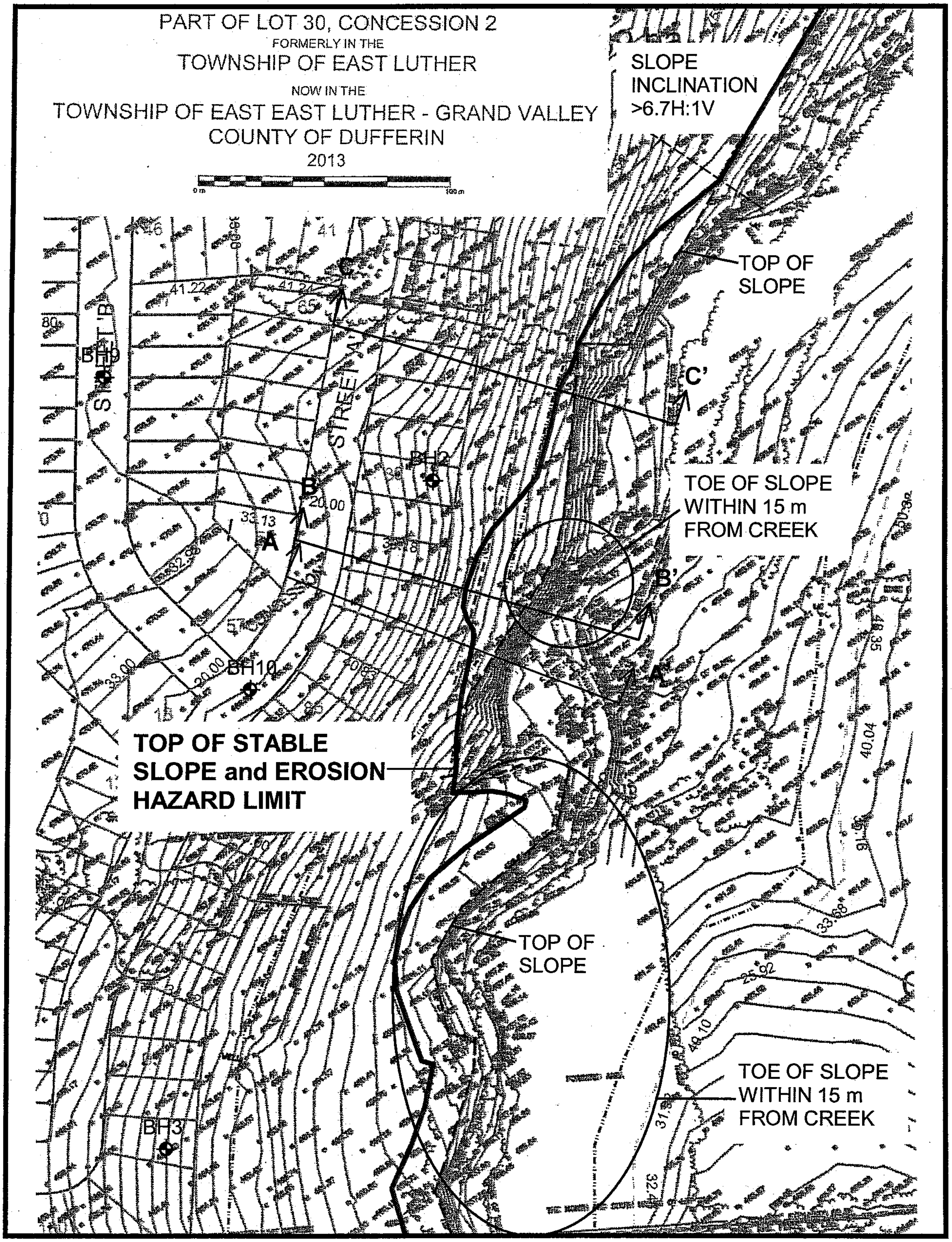
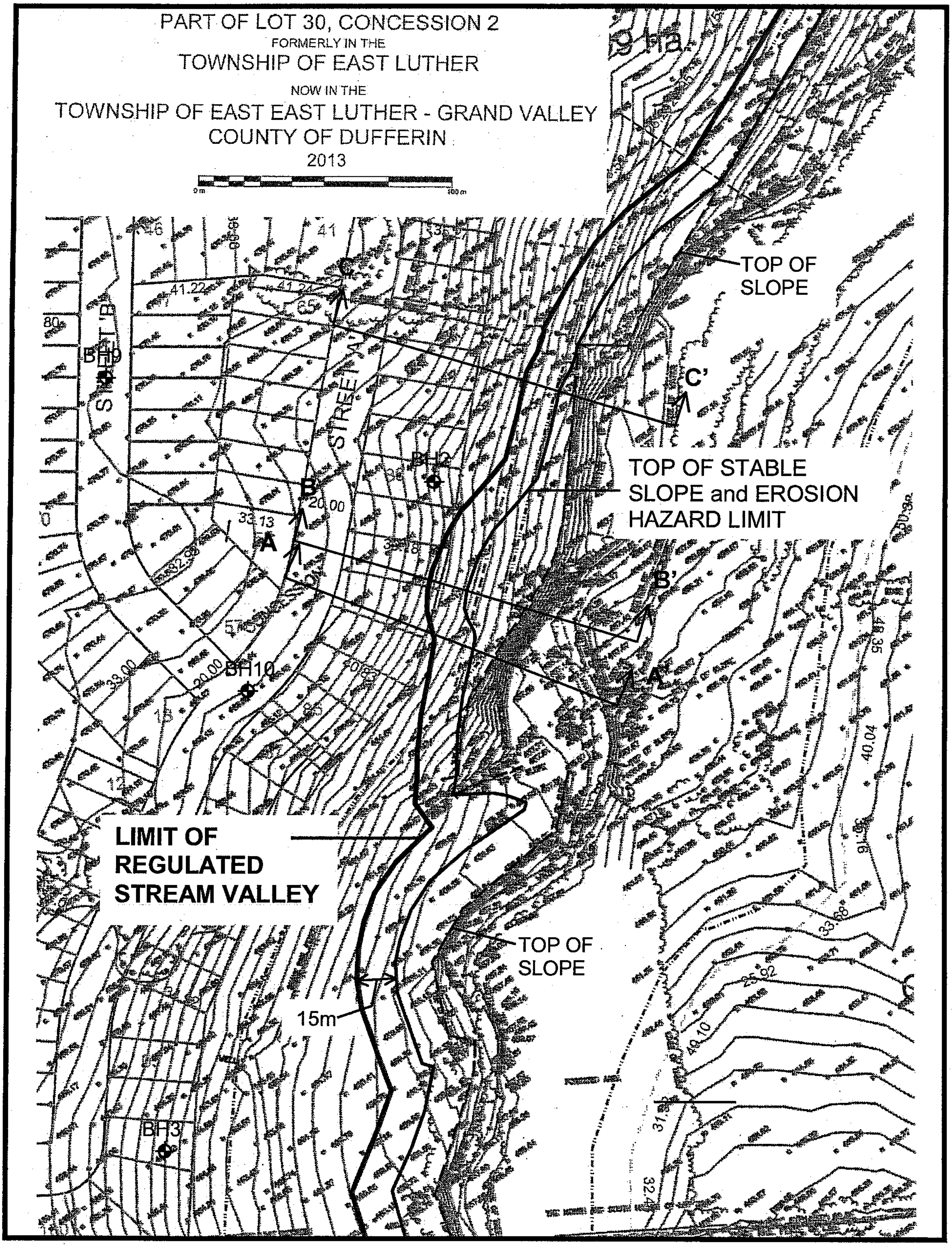
Enclosure 6, Section B-B'



EROSION HAZARD LIMIT

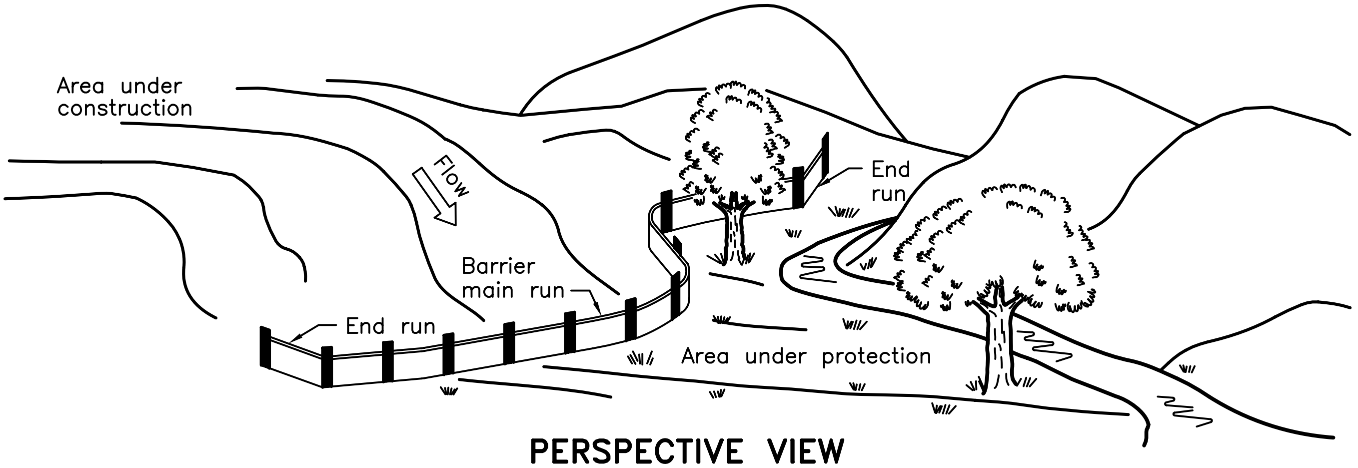
Enclosure 8



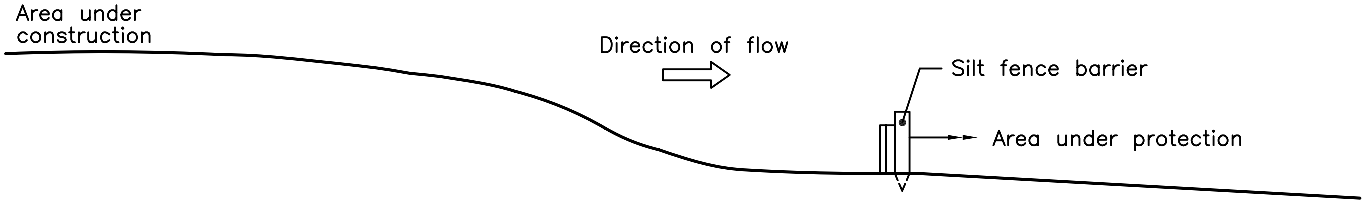
REGULATED STREAM VALLEY

APPENDIX “H”

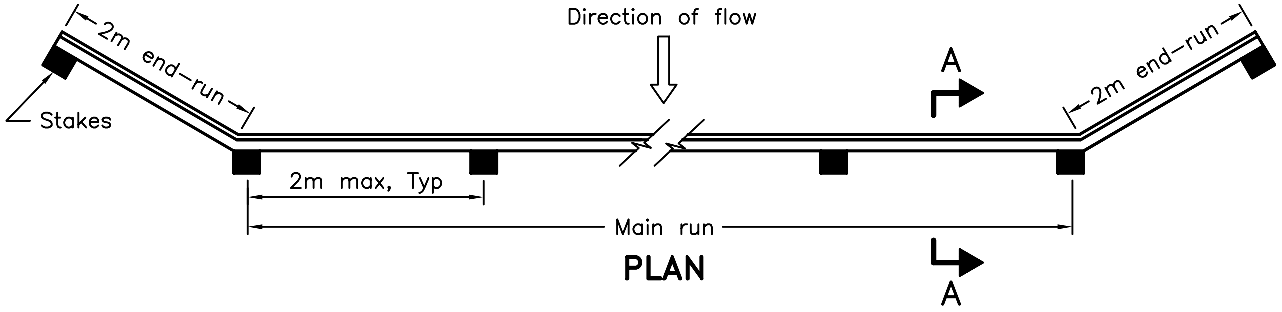
Erosion & Sediment Control Details



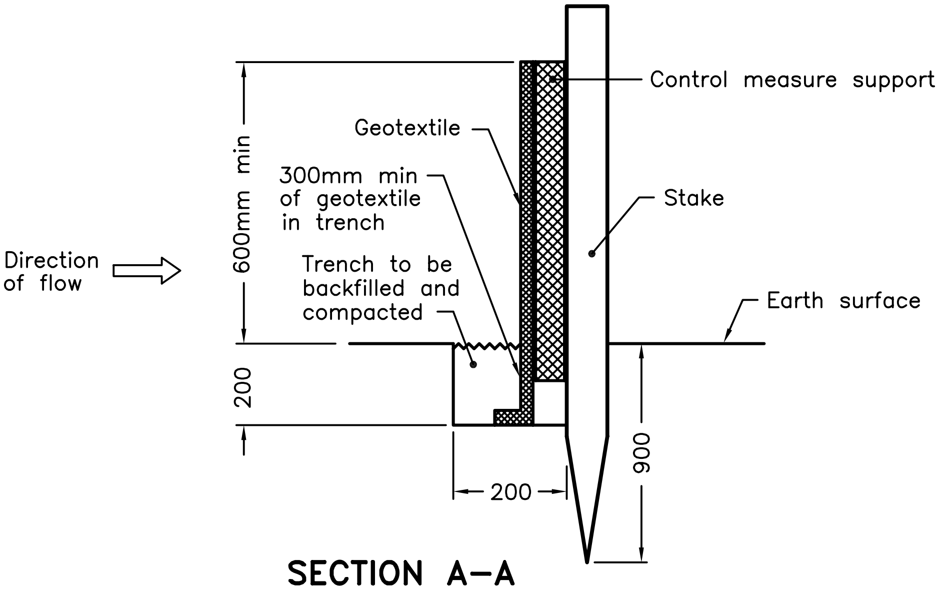
PERSPECTIVE VIEW



SECTION



PLAN



SECTION A–A

NOTE:

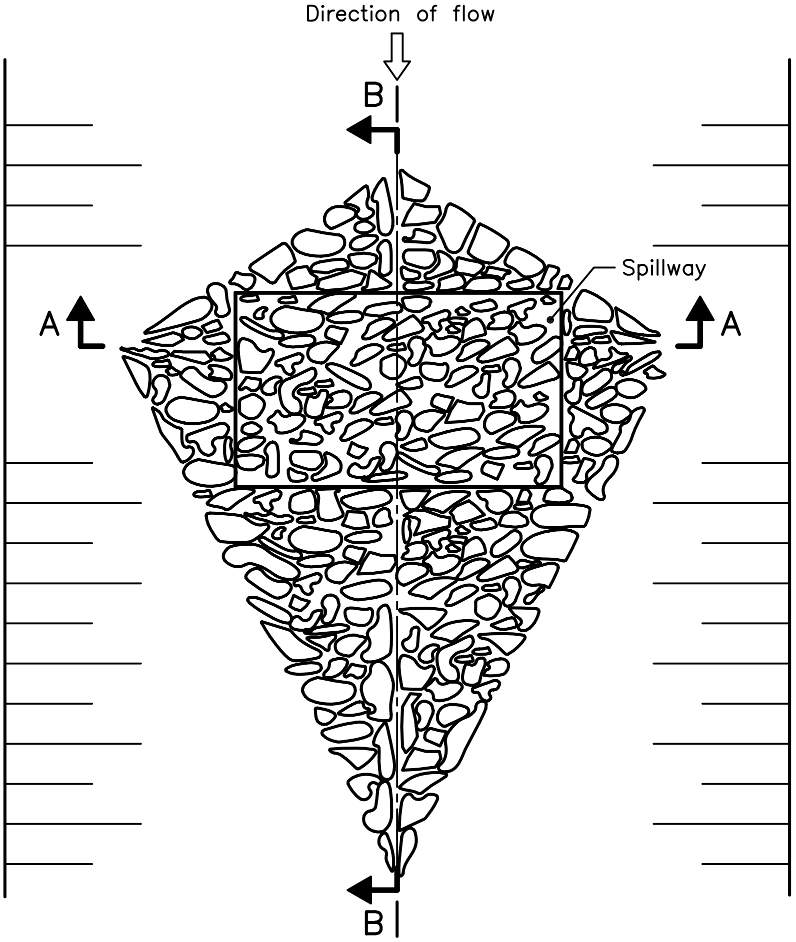
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING

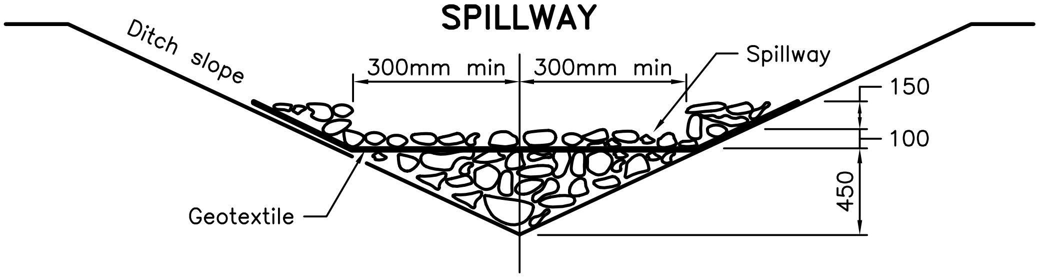
Nov 2006 | Rev 1

HEAVY–DUTY SILT FENCE BARRIER

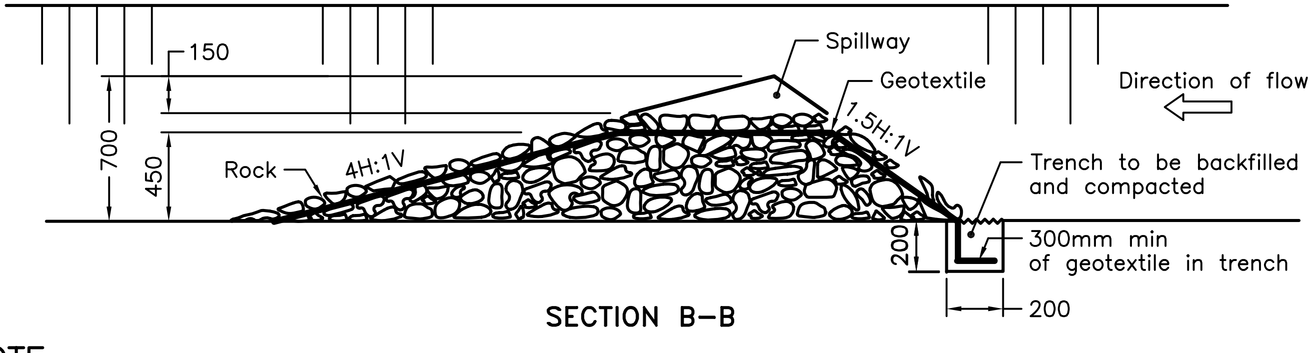
OPSD 219.130



PLAN
SPILLWAY



SECTION A–A



SECTION B–B

NOTE:

A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING
Nov 2006
Rev 1

ROCK FLOW CHECK DAM

V–DITCH

OPSD 219.210