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# **Preliminary Servicing and Stormwater Management Report**

**Clark-Heinmiller Subdivision  
Palmerston, Town of Minto**

**November 2022**



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Project No.: 5008

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November 14, 2022

Breymark Homes  
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Attention: Keith Reycraft

Dear Mr. Reycraft,

**Re: Preliminary Servicing and Stormwater Management Report  
Clark-Heinmiller Subdivision (Palmerston)  
Town of Minto, Wellington County**

Please find our Preliminary Servicing and Stormwater Management Report for the above-noted project, in support of a submission for Draft Plan re-approval.

Our servicing report identifies constraints for sanitary sewerage, water supply, and storm drainage/stormwater management. Our report also considers grading constraints, transportation issues, and utility availability. Where necessary, reasonable assumptions based on normal industry practices have been used and are described as such.

It is our opinion that adequate services exist to support this project. Recommendations from our report shall be incorporated into the detailed design phase of the project, following approval of the draft plan.

Yours very truly,

**MERITECH ENGINEERING**

Chris H. Togeretz, P.Eng.  
Manager, Design Services

CHT/  
Enclosures (1)



cc Genevieve Scott, Cuesta Planning Consultants



## Executive Summary

The intent of this report is to demonstrate that adequate services exist within the vicinity of the site for Phase 1 of the Clark-Heinmiller Subdivision in Palmerston.

The subject site is located on the north side of Main Street West at the entrance of Lorne Street in Palmerston (Town of Minto). It is bordered by employment lands to the west, future development to the north, existing residential and mixed-use lands to the east, and existing residential dwellings facing Main Street West to the south. The site itself has recently been rezoned by the Town of Minto from agricultural (A-1) to residential (R1C, R2, and R3) and open space (OS1) but will need to be rezoned again.

The project is in the preliminary design stage and this report has been prepared in support of a redline submission for Draft Plan re-approval of Phase 1 of the Clark-Heinmiller Subdivision development. This circulation describes how the servicing and stormwater management (SWM) plan satisfies the objectives for the site, confirms spatial relationships of the plan within the confines of the site, and provides recommendations to be implemented in the detailed design. For subdivisions, Draft Plan approval is contingent upon approval of the Preliminary Design Report.

From the Town of Minto's Draft Servicing Strategy, it has been confirmed that there is enough reserve and storage capacity of the existing water distribution and wastewater collection systems to support the proposed development. It is recommended that the Town confirms that downstream capacity exists for the increase in sanitary flows and water demand for the subject lands.

The proposed watermain is 150mm diameter which provides sufficient flow to meet domestic demand as well as meet both FUS and OBC calculations for fire flow requirements. Hydrants will be provided with standard hydrant spacing and to ensure the watermain at high points in the streets is served with a hydrant. A proposed blowoff is to be at the dead end of Street A, towards Noble Road, to assist with maintenance of the distribution system between phases of development.

The existing sanitary sewer already running through the subdivision provides sufficient capacity to service the sanitary flows generated from the proposed development.

The proposed stormwater management (SWM) design is to address the needs of the proposed development in accordance with municipal, MECP, and Conservation Authority practices as well as improve upon the existing conditions of the low-lying area on the site. The proposed SWM facility will be a dry pond configuration for quantity control of storm events from the 2-year to the 100-year storm and safe conveyance of flows in excess of these storms (i.e. Hurricane Hazel). For quality control a OGS unit upstream of the dry pond will be used to attain an Enhanced level of runoff treatment as per MECP guidelines.

Agencies shall review and approve this document as a suitable approach to preliminary design configuration and approve the draft plan of subdivision.

## **Disclaimer**

This report was prepared by Meritech Engineering for BreyMark Homes. The comments, recommendations and materials presented in this report reflect our best judgement in light of the information available at the time of preparation. Except for approval and commenting municipalities and agencies in their review and approval of this project, any use which a third party makes of this report, or any reliance upon, or decisions as a result of, are the responsibility of such third parties. Meritech Engineering accepts no responsibility for damages suffered by any third party, other than an approval or commenting municipality or agency, as a result of decisions made or actions taken based on this report.

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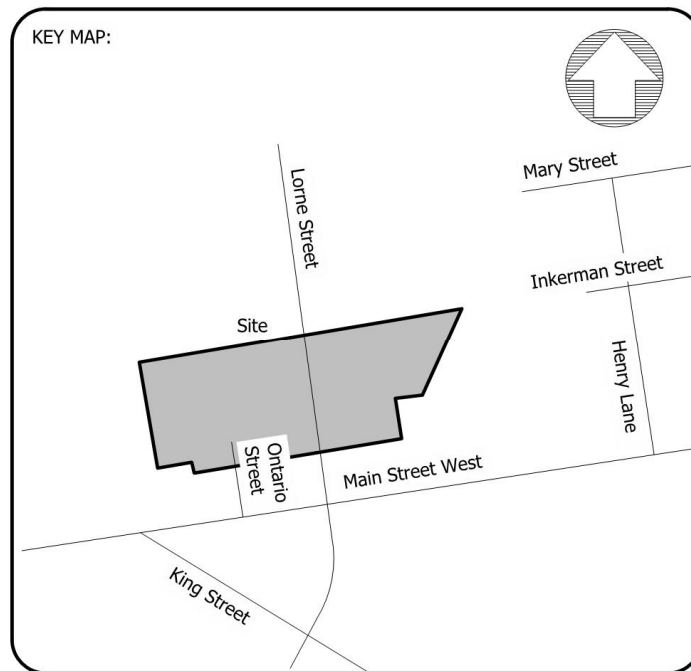
**Appendices**

- Appendix A: Draft Plan
- Appendix B: Conceptual Design Drawings
- Appendix C: Calculations
- Appendix D: Modelling
  - Appendix D.1: Pre-Development Conditions
  - Appendix D.2: Post-Development Conditions
- Appendix E: Hydrant Flow Test Results
- Appendix F: Geotechnical Data

## **Introduction**

This report has been prepared for the above noted project in support of a Draft Plan red-line amendment for the Clark-Heinmiller Subdivision. It is understood that the updates to the Draft Plan focus on the area recognized as Phase 1 and include considerations for future phases of development for the lands to the north. The intent of this report is to demonstrate the functionality of the servicing strategy for the Phase 1 development lands, including water/sanitary layout and the stormwater management (SWM) strategy, and to ensure no negative impacts to the receiving infrastructure. Considerations for future development phases are integrated into the preliminary design described herein. Additional information will be provided through detailed design and the final approval process.

The site is in Palmerston (Town of Minto) and the current area of interest is the southern 3-hectare portion that is proposed for development, referred to as Phase 1. The location can be seen in Figure 1 below. The subject site is bordered by employment lands to the west, future development to the north, existing residential and mixed-use lands to the east, and existing residential dwellings facing Main Street West to the south. The site itself has recently been rezoned by the Town of Minto from agricultural (A-1) to residential (R1C, R2, and R3) and open space (OS1); re-zoning is required to support the proposed townhouses shown on the revised Draft Plan.



**Figure 1: Site Location**

The overall site generally slopes from north to south from the existing farm dwellings with a drainage split from the existing driveway entrance from Lorne Street which directs overland flow east and west. The slopes on the site range from 1% to 5%, with sheet flows to the east collecting in a low-lying area in the southeast corner equipped with a hickenbottom drain.

Piped flows are then conveyed through an easement and outlet to existing storm sewers on Main Street West. The sheet flows to the west are directed to the southwest corner of the property where they eventually infiltrate in the low-lying area or else get collected in tile drainage.

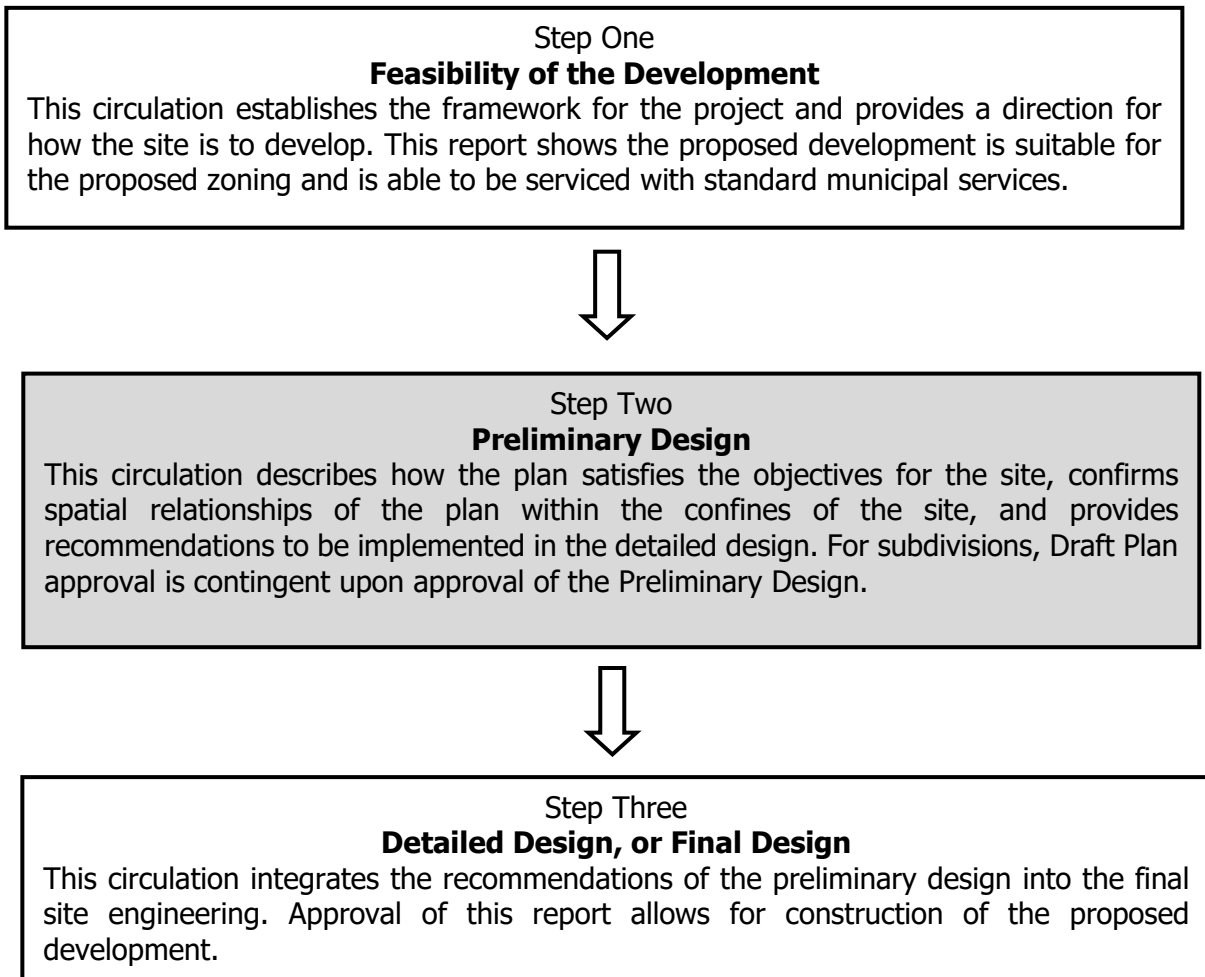
The proposed development consists of 12 blocks of townhomes (2.35 ha) assumed to be two-stories with basements, totalling 61 units, a local street and utility corridors (0.38 ha), and a stormwater management (SWM) block (0.29 ha). The primary access to the site will be off Main Street West through the extension of Ontario Street into the subject site. Parking for the site will be provided with standard driveways at each individual unit. The proposed streets will be of standard urban design including a curb/gutter configuration and storm sewers to collect and convey runoff. The development will be serviced with municipal water and sewage. The Draft Plan has been attached in Appendix A.

## **Approach**

A previous submission for a residential Draft Plan of Subdivision was completed in 2016 to the County of Wellington. This included a Functional Servicing Report prepared by Triton Engineering Services Limited in 2015 which was utilized as a reference point while developing a revised servicing strategy for the project.

Since 2015 there have been changes in ownership, proposed development plans, zoning designations, and in the municipal boundary. As a result, a need has been identified for a revised submission of Draft Plan of Subdivision to reflect the current proposal.

The following flowchart explains a typical submission and approvals process. The section highlighted in grey indicates the status of this circulation:



**Figure 2: Approach Flowchart**

## **Policy Framework**

This chapter outlines the framework upon which the plan is built upon. Previous studies, municipal and provincial standards, as well as any field investigations undertaken to support the project, are examples of information described in this chapter. This background information is then used to build an appropriate plan for the site. The next chapter, Objectives and Targets, describes the site-specific requirements noted from the following sources:

### **Planning Documents**

#### *County of Wellington Official Plan, February 24, 2011*

The Official Plan was approved by Wellington County Council on May 6, 1999. The contents of the Official Plan reflect the latest consolidation of Official Plan amendments, as of February 24, 2011. Phases 1 and 2 of the subdivision have already been considered in the Official Plan.

#### *West Palmerston Secondary Plan May 1, 2018*

This document includes analysis to support expanding Palmerston's urban boundary and provides a rational development approach to make effective use of lands and municipal services.

#### *ZBA 2015-03 – Clark/Heinmiller Subdivision, February 16, 2021*

The Town of Minto issued a zoning amendment of the south portion of the Heinmiller property that is subdivided in the previous Draft Plan of Subdivision in February 2021. This will be used as a baseline to inform the project servicing to ensure compliance with the Town's strategic plan. Zoning will be revised to allow for the proposed unit types.

#### *Town of Minto Water and Sanitary Systems Servicing Strategy, January 26, 2022*

The report amalgamates previous work to provide guidance for upgrades, expansions, and operation changes to the Town's horizontal and vertical infrastructure for water and sanitary systems to service existing and future populations. This document will be used to ensure the receiving distribution and collections systems are able to service the proposed development.

### **MECP Guidelines**

#### *Stormwater Management Planning and Design Manual, Ministry of the Environment, 2003*

This manual provides guidelines on the planning and design of stormwater management facilities in Ontario.

#### *Guidelines for Drinking Water Systems, Ministry of the Environment, 2008*

This manual provides guidelines on the planning and design of drinking water systems in Ontario.

#### *Runoff Volume Control Targets for Ontario, 2016*

The report describes the Minimum Runoff Volume Control Target for Ontario and was established to inform the development of the MECP Low Impact Development Stormwater Management Guidance Manual, which is currently published as a draft.

## Municipal Guidelines

*Town of Minto Municipal Servicing and Design Standards, 2020*

This manual provides the procedure for development of private lands requiring the design, construction, and approval of Municipal Services. This includes Town specifications, standard drawings, and rainfall coefficients to be used in modelling of synthetic design storms.

## Conservation Authority Guidelines

*Maitland Valley Conservation Authority Policies and Procedures for Compliance with the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation. O.Reg 164/06, July 2016*

This document is to provide the MVCA with policies and guidelines to assist MVCA in interpreting the Conservation Authority Act, Section 28(1) Regulations.

*Maitland Valley Conservation Authority Stormwater Management Policies*

Provided by MVCA staff, this document provides a summary of the SWM policy statements and technical guidelines that are used by the reviewing agency. This document will be referred to when developing the design of the SWM facility and associated storm servicing strategy.

## Environmental and Tree Management Studies

No reports are believed to have been completed to date.

## Geotechnical Studies

A geotechnical investigation has been performed on the site to ascertain general soil, groundwater, and infiltration parameters for the property.

CMT Engineering Inc. conducted the on-site geotechnical analysis investigation in Jun 2014. Excerpts from the report are included in Appendix F. Key findings from the report include:

- Existing topsoil thickness is 150-410mm (average 218mm)
- Stratigraphic units were encountered including topsoil, sand and silt, silty sandy and gravel, silt and sand till, and groundwater
- Groundwater was found at boreholes 3 and 6 at elevations of ±395.9m and ±393.8m
- The estimated coefficient of permeability is  $2.25 \times 10^{-6}$  cm/sec for native sandy silt which would not be considered suitable to provide focused infiltration measures

## Transportation Studies

A Transportation Impact Brief was prepared by Paradigm in February 2022 to assess the potential traffic impact resulting from the proposed subdivision. For the development (at the time, assumed to consist of 71 units), the analysis prepared by Paradigm shows that no left-turn lanes are required, and that the existing lane geometrics are sufficient for the additional traffic.

## **Pre-Submission Consultation/Design Criteria**

A pre-submission design meeting was held with the Town of Minto's Engineer (Triton Engineering) on October 15, 2021, to discuss constraints and criteria with respect to the servicing design of the subdivision. In the meeting it was determined that the temporary SWM facility proposed to service the farmland north of Phase 1 would not require an ECA and that a Servicing Strategy Report is expected to be released by the Town in 2022 to comment on the existing flows in the sewer. Lastly, it was confirmed that the common practice of looping the proposed watermain network is preferred and was desired to be from Noble Road (primary) and Mary Street (secondary).

A pre-consultation meeting with the Town of Minto and Triton Engineering was held on November 9, 2021 where pertinent items were discussed with respect to the submission.

With respect to servicing criteria, it was confirmed from the Town's engineer that the key target for the SWM strategy will be to not surpass the capacity of the receiving storm sewer in the easement between the site and Main Street West. With respect to sanitary servicing, it was confirmed that the original Wellington County Official Plan identified sufficient capacity of the Town's sanitary sewer system and treatment plant to service the proposed development. Schematic drawings of the existing storm, sanitary, and water systems was requested and later provided. These were used to confirm some details of the surrounding municipal services and the servicing strategy of the proposed development.

Previously proposed Draft Plans have had varying unit counts and associated sanitary demands; however, the Town's engineer had no concerns with respect to sanitary capacity for the currently-proposed unit count.

Subsequent to the meeting with Triton Engineering in November 2021, additional discussions were had in August and September 2022 with respect to the capacity of the receiving storm sewer system. As a result of extensive investigations of the downstream storm sewers, it is believed that the performance of our SWM facility cannot be governed by gravity-flow targets, as the downstream system operates under surcharged conditions during conventional design events.

## **Reconnaissance**

Meritech staff have visited the site on multiple occasions in order to verify existing drainage patterns of the site and adjacent properties, to confirm existing infrastructure surrounding the site, and to make note of all aboveground features on neighbouring properties. Shown in Figure 3 are existing conditions as of September 17, 2021.



Looking west across the site from Ontario Street



Looking east across the site from south-west corner of site



Looking west across the site from 365 Main Street West (neighbour's rear yard)

### **Figure 3: Existing Condition Photographs**

A number of subsequent site visits were completed. The visit on November 16, 2021 further investigated adjacent infrastructure important to the functional design, and the visit on April 21, 2022 was made to confirm the ultimate overland flow route. Finally, visits on July 7 and August 31, 2022 were made to complete Meritech's understanding of the receiving storm sewer system, which necessitated the assistance of a sewer CCTV firm in order to locate a buried manhole. Shown in Figure 4 are conditions of the overland flow route discovered as part of the site visit in April 2022.



900mm x 770mm CSP culvert crossing rail trail at vacant lot on Bell Street



Outlet of CSP culvert to low-lying wetland area



Outlet of low-lying wetland area, 600mm diameter CSP culvert crossing King Street

**Figure 4: Existing Components of Downstream Overland Flow Route**

## **Objectives and Criteria**

This section outlines the objectives and criteria for the wide variety of issues considered in this report; the following Discussion section will demonstrate how the objectives presented have been achieved and how the criteria are met.

### **Sanitary Servicing**

The primary objective with respect to sanitary servicing is that a sanitary sewer system servicing the site can be constructed as per MECP, Wellington County, and Town of Minto standards. The development will outlet into existing sanitary infrastructure at the southeast corner of the site; it has already been confirmed that the existing sewers and treatment plant have capacity for this development.

### **Water Servicing**

There are two objectives regarding water servicing: provide domestic water supply as per MECP, Wellington County, and Town of Minto requirements, and ensuring that an adequate firefighting water supply is available as per Ontario Building Code and other municipal requirements.

## Storm Servicing

The primary objective with respect to storm servicing is that a storm sewer system servicing the site can be constructed as per MECP and Town of Minto standards. The storm drainage scheme for the development will be designed on the dual drainage concept of major and minor systems with the storm sewers into the SWM facility sized for the 5-year storm event. The development will outlet into existing infrastructure, and it is necessary to demonstrate that the existing sewers have capacity for this development. On-site stormwater management features shall be reviewed in conjunction with the storm servicing.

## Stormwater Management

The following table presents typical stormwater management solutions. Each one is ranked as to the level of performance for Water Quality, Erosion, Water Quantity and Infiltration. The last two columns present whether or not the control is proposed in the stormwater management solution, along with a commentary of its suitability to this project.

<b>Lot Level &amp; Conveyance Controls</b>	<b>Water Quality</b>	<b>Erosion</b>	<b>Water Quantity</b>	<b>Infiltration</b>	<b>Incl. In Plan?</b>	<b>Comments</b>
Flat Lot Grading	M	M	L	H	N	Soils not suitable
Control of Roof Leaders	M	M	L	H	Y	Discharge to grade
Control of Foundation Drains	M	M	L	H	N	If basements present, weeping tile system required
Grassed Swales	M	M	M	H	Y	
Filter Strips	M	M	L	H	N	Not necessary
Infiltration Trench	H	M	L	H	N	Not recommended due to soils
Pervious pipes, catchbasins	H	M	L	H	N	Not recommended due to lack of pre-treatment
Oil / Grit Separator	M	L	L	L	N	Included
Rooftop Storage	L	M	H	L	N	Not required
Parking Lot Storage	L	M	H	L	N	Not applicable
Underground Storage	L	M	H	L	N	Not required
<b>End of Pipe Controls</b>						
Sediment Forebay	H	M	L	L	N	Contributing area not large enough
Wet Pond	H	H	H	L	N	Not suitable
Constructed Wetland	H	H	H	L	N	Not suitable
Dry Pond	M	H	H	L	Y	Included
Infiltration Pond	H	M	L	H	N	Soils not suitable

**Table 1: Selection of Stormwater Management Practises**  
(Compiled From 2003 MOE Manual)

Stormwater management techniques will follow MOE/MECP design guidelines and will be necessary where outlet flows exceed outlet capacities and/or where required as a condition of Draft Plan approval and/or Drainage Act requirements.

To the natural water cycle, the proposed development is anticipated to increase the quantity of surface runoff to an extent that – without control – flows would surpass existing outlet capacities and decrease the overall quality of stormwater exiting the site. As it is the intention of the development to have no negative impact on the receiving storm drainage system, the following SWM criteria are proposed:

- Quality control of site runoff to ensure sediment and pollutant loading is minimized before release into the existing storm sewer system. “Enhanced” control represented by an 80% removal in total suspended solids removal is proposed.
- Quantity control such that the capacity (either by gravity or under pressurized conditions) of the receiving municipal storm infrastructure is not surpassed. Allowances for future development phases is to be considered.
- Safe conveyance of major storm event runoff in excess of the proposed SWM system’s design capacity.
- Sufficient separation from the proposed SWM facility to groundwater to reduce groundwater intrusion. In the event of high water table a physical barrier (i.e. clay liner) could be proposed.

## **Water Balance, Infiltration and Groundwater Conditions**

Another example of the impact of development on the natural water cycle is groundwater recharge. The increase in impervious cover prevents water from soaking into the ground. Cumulatively, these minor losses can cause significant loss to the groundwater regime. Analysis of these impacts, in the form of a water budget, is sometimes undertaken with the intent of designing appropriate mechanisms for infiltration and recharge.

Groundwater is present across the site, as described in the geotechnical study, approximately at depths in the order of  $\pm 0.2\text{m}$  on the east end (Borehole 6) and  $\pm 2.5\text{m}$  in the middle of the proposed development. The native soils are generally described as ‘sandy silt till’ and are not highly conducive to infiltration, therefore infiltration is not proposed. Due to this, maintaining existing infiltration rates is not proposed.

## **Grading and Drainage**

The typical objective is to reduce the cost of the development by minimizing earthworks costs, excessive retaining walls, etc., in addition to meeting the municipality’s requirements related to the grading of useable yards. In support of Draft Plan approval, it is necessary to demonstrate that the general grading concept works with the conceptual storm and sanitary sewers.

## Transportation

The road network proposed on the Draft Plan should meet the standard right-of-way widths presented in the Town of Minto Municipal Servicing and Design Standards.

## Utilities

The following utility companies will be contacted to confirm their ability to service the development:

- Westario Power
- Hydro One
- Eastlink
- KWIC Internet Services
- Wightman Telecom
- Rogers
- Enbridge (formerly Union Gas)

## Discussion

### Subdivision Design

The general configuration of the proposed street network for the site is largely determined by the existing municipal streets abutting the property and the layout of future development phases. As shown on the Draft Plan attached in Appendix A, Ontario Street is proposed to extend northwards to connect with Street A, which serves as the primary street through the proposed development area. In Phase 1, Street A terminates to the west in a bulb with a stub extending to the north for future development phases. To the east the street bends northwards and will be constructed as a temporary secondary access to Mary Street.

This secondary access road is key for development of Phase 1 as both a construction and emergency access and as a provision for a watermain connection to the existing infrastructure on Mary Street. This temporary access road aligns with a municipal right-of-way anticipated in future phases of development. Appropriate easements for this temporary access road will be obtained. Preliminary discussions with the landowner regarding this access have been successful, as they agree with the proposed modification of their land. This also includes removal of their existing driveway from Lorne Street, provision of a gravel driveway from the temporary access from Mary Street, minor grading works at the southern limits of their property (bordering Phase 1 lands), construction of a temporary stormwater management feature, and modification of the existing tile drain system to ensure continued positive drainage of the farmlands.

The Draft Plan shows several blocks of townhome units with frontages ranging from 6.05m to 12.72m. The following subsections describe the proposed strategies for each primary service (sanitary, water, storm) into the site and subsequently to each unit. Considerations for the future phases of development have been explored as part of this servicing report. The preliminary design drawings are found in Appendix B.

## Sanitary Servicing

A sanitary sewer was installed across the site as part of the Palmerston Industrial Park Development. The 300mm diameter sanitary sewer is at a depth of  $\pm 2.5\text{m}$  to  $\pm 5\text{m}$  through the proposed development area in a way that it aligns with the proposed road configuration. Flows in the existing sewer are ultimately directed south to the existing infrastructure on Main Street West.

Based on the unit counts provided by the Draft Plan, peak flows were used by applying peaking factors to the average day demands shown in Table 2. As a high-level analysis, the flows from the entire site were calculated together to provide a total site peak flow discharge.

Unit Type	Flow
Residential	450 L/cap/day
Infiltration	0.15 L/s/ha

**Table 2: Average Daily Sanitary Flows**

The proposed 61-unit residential development (using a *persons per unit* value of 2.44 used in the Region of Waterloo for townhouses as the Town of Minto does not appear to specify a "ppu" value to determine the design population) is anticipated to produce approximately 3.7 L/s of sanitary flow. Refer to the design sheet in Appendix C. This represents less than 10% of the capacity of the existing 300mm diameter sewer.

The Town of Minto's Water and Sanitary Systems Servicing Strategy (2022) stated the average daily flow in the years 2018-2020 was recorded as 1,243 m<sup>3</sup>/day, resulting in a hydraulic reserve capacity of 767 m<sup>3</sup>/day for the Palmerston wastewater treatment plant. This equates to an additional 768 equivalent residential units that can be serviced by the existing treatment plant without surpassing design capacity for the year 2020. This number is reduced to 547 equivalent residential units when forecasted to the year 2026. Phase 2 of the development is anticipated to produce approximately 300 units, showing that there is already capacity for the larger development.

The layout of the sanitary sewers allows for connections to the north for future phases of development. Further details confirming the adequacy of the Phase 1 sanitary system for the purposes of servicing future phases will be completed in the detailed design stage.

## Water Servicing

### Existing Infrastructure

The subject lands are surrounded by available infrastructure as noted by location, size, and material below:

1. Main Street West – 200mm diameter cast iron watermain
2. Mary Street – 150mm diameter ductile iron watermain
3. Noble Road – 150mm diameter PVC watermain

## Proposed Development & Firefighting Flow Rates

Determined in the pre-consultation meeting with the Town, the common practice of watermain looping is desired to reduce dead ends, prevent stagnant water, and minimize service disruptions during repairs. The watermain servicing the proposed development will loop from Main Street West through Ontario Street to Mary Street. A second watermain loop may be provided to Noble Road in future phases of the development. The proposed watermain through the development is a 150mm watermain with 25mm service connections to the townhome units. Three internal hydrants are required to provide coverage under OBC. The servicing plan is included in Appendix B to show the proposed watermains for the development.

Temporary easement(s) will be required to provide the loop to Mary Street as the watermain will extend across lands outside of the proposed Draft Plan.

The average day demand from the proposed 61-unit residential development is anticipated to be approximately 0.8 L/s. Applying peaking factors in accordance with current MECF Design Guidelines for Drinking-Water Systems, the resulting max daily demand is 3.9 L/s and peak demand flow of 5.9 L/s.

Both OBC and FUS methods were applied to calculate the fire flow demand of a townhome block. The resulting fire demand flows are 90 L/s and up to 164 L/s for each approach respectively – refer to Appendix C.

Hydrant flow tests were completed at each of the potential connection locations, one at the end of Noble Road, one on Main Street West, and the other at the intersection of Mary Street and Henry Lane. The results for two ports flowing are summarized in Table 3 below and the field reports for each test are attached in Appendix E.

Location	Measured Flow GPM (L/s)	Residual Pressure psi (kPa)	Available Fire Flow <sup>1</sup> GPM (L/s)
Noble Road	1,711 (108)	55 (379)	3,464 (219)
Main Street West	1,744 (110)	54 (372)	3,392 (214)
Mary Street	1,556 (98)	57 (393)	3,589 (226)

<sup>1</sup> Calculated at 20 psi residual pressure

**Table 3: Hydrant Flow Test Results (Two Ports Open)**

As determined by the Town of Minto's Reserve Capacity Calculation for Water Supply, using recent demands from 2018-2020, the firm reserve capacity of the municipal water distribution system is 642 m<sup>3</sup>/day which equates to an additional 614 equivalent residential units that can be serviced. These number has been forecasted to be 436 by the year 2026. Therefore, under current and near future conditions there is sufficient water capacity to meet the design flow (maximum day plus fire scenario) of the proposed development. Phase 2 of the development is anticipated to produce approximately 300 units, showing that there is capacity for the larger development.

Further analysis, including confirming the firefighting flows once house designs are finalized and producing network modelling, will be completed in detailed design to confirm these initial findings and determine the influence on the allowable pressures in the existing and proposed water distribution network. As the water supply appears to be consistent at the various connection points (see Table 3), no obvious concerns have been identified.

The associated layout and preliminary sizing of the proposed watermain and its appurtenances allow for connections to the north for future phases of development through the connections to Noble Road and Mary Street. Further details confirming the adequacy of the Phase 1 water distribution network for the purposes of servicing future phases will be completed in the detailed design stage.

## **Storm Servicing and Stormwater Management**

### **Existing Infrastructure**

The existing storm servicing and stormwater management system is comprised of a low-lying area that collects overland runoff from the farmlands and adjacent residential properties as well as from the existing tile drainage system on the farm property. Stormwater collected in this existing *de facto* facility is routed through a hickenbottom riser attached to a 200mm Big 'O' pipe which transitions to a 250mm PVC pipe as it conveys water eastwards through an easement to a manhole at the rear of the adjacent vacant site. From this manhole, flow is directed southwards through a 600mm concrete pipe in an easement towards Main Street West. The future stormwater system serving the site will utilize this same outlet location and easement as a connection point.

Downstream of Main Street West, the 600mm concrete pipe combines with a 700mm CSP pipe draining the sewers on Main Street West. The resulting 900mm concrete sewer drains south; through Bell Street, under the rail trail, through a new townhouse development site, and then to King Street. Downstream of King Street the sewer is a 1200mm concrete pipe up to its outlet point at the southwest corner of the wastewater treatment plant.

### **Proposed Stormwater Management Plan**

From the background information and criteria presented in the previous chapters, an appropriate stormwater management plan was developed as described herein. The plan consists of a series of quality and quantity control measures:

- Lot-level
  - Downspouts to grades
  - Rear lot catch basins as required
  - Grassed swales
- Conveyance
  - Piped minor flows
  - Overland major flows
- End-of-pipe
  - Oil grit separator for "enhanced" quality control

- Dry pond stormwater management facility for quantity control (2- through 100-year design storms)
- Emergency outlet for Regional storm (Hurricane Hazel)

### **Minor/Major System Routing**

The proposed schematic of the storm sewer system is comprised of a storm sewer main within the right-of-way of Street A with catchbasins along the curb line and storm leads from rear lot catchbasins. In the minor storm events, runoff from the development will be collected by this system and directed to the SWM facility in the south-east corner of the development. On each lot, buildings with basements should have a weeping tile system and roof drains that outlet to grade where feasible and connected to the storm sewer system elsewhere.

The storm system will be sufficiently sized to convey the 5-year design storm. Further calculations detailing the storm sewer design will be provided in the next stage of engineering design, following Draft Plan Approval.

The downstream storm sewer system is believed to operate under surcharged conditions during conventional design events (e.g. 2-year, 5-year). Therefore, the proposed SWM pond design will be based on a local post-to-pre approach based on hydraulic grade line elevations at the controlling conduit downstream; the performance of the SWM facility cannot be governed by gravity-flow targets due to the existing sewers being undersized to convey existing flows using gravity flow.

The existing system can handle the controlled, frequent event flows from the subdivision with what is assumed to be minimal surcharging. A coarse hydraulic model of the trunk storm sewer between the subdivision and the beginning of the 1200mm diameter storm sewer at King Street will be developed to assist in understand the existing conditions as well as the potential impact on hydraulic grade lines downstream of the subdivision.

During the major storm events, runoff from the development will be conveyed as overland flow to the SWM facility via Street A. Flows that exceed the storage capacity of the SWM facility are directed to a proposed overland flow route in the municipal easement to the east that extends through the adjacent vacant lot and to Main Street West. Fine detail for the overland flow route design will be provided in further engineering submissions, following Draft Plan Approval.

Through discussions with the Town's Engineer, it was confirmed that under existing conditions the current stormwater management (low-lying) area does not have a known overland flow outlet. As a result, minor flooding is a frequent occurrence in the local area.

Following our site investigations, our understanding of the extended overland flow route from Main Street West is that flows could drain southwards through a grassed corridor (between 330 and 326 Main Street West), across Bell Street, then under the railway trail through a 900mm x 770mm CSP culvert. There is an existing low-lying wetland area between the railway trail and King Street that receives the overland flow and routes it to the southwest under King Street via a 600mm CSP culvert. The flow route continues to the southwest and connects to the Palmerston-Wallace Municipal Drain. This route can be seen in Appendix B.

## Winter Conditions

Should the stormwater management facility outlet become clogged or frozen in winter conditions, the facility will overflow away from the development via an emergency overland flow weir and toward Main Street West.

## Quantity

The following section outlines the runoff modelling completed for the preliminary design of each SWM facility to confirm the proposed SWM block size is sufficient for Draft Plan Approval. To do so a post-development model was created to establish the storm runoff for the proposed development.

## Catchment Numbering Convention

The following catchment number convention was used to identify the characteristics of each catchment:

Description:			Catchment #
Existing	Internal	Uncontrolled	100
Existing	External	Uncontrolled	200
Existing	Internal	Controlled	300
Existing	External	Controlled	400
Proposed	Internal	Uncontrolled	500
Proposed	External	Uncontrolled	600
Proposed	Internal	Controlled	700
Proposed	External	Controlled	800

**Table 4: Catchment Naming Convention**

## Hydrologic Model

Hydrologic modelling was performed using MIDUSS software, which is a widely accepted model for urban developments. It has been used for many years in southern Ontario.

## Rainfall Data

A Chicago-type storm was selected and coefficients for the various storm events were converted from the rainfall data gathered from the Ontario Ministry of Transportation IDF Curve Look-Up website for the development location, as directed by the Town's Design Standards. The converted coefficients and rainfall depths used to represent the local storm events are seen in Table 5 below.

Design Storm	Definition	a	b	c	r	Depth mm
2-year, 3 hour	Design quality	409.87	0.068	0.7009	0.4	32.280
5-year, 3 hour	Minor System	547.19	0.093	0.7022	0.4	42.801
10-year, 3 hour		626.22	0.043	0.6990	0.4	49.813
25-year, 3 hour		734.55	0.020	0.6984	0.4	58.617
50-year, 3 hour		813.88	0.008	0.6984	0.4	64.951
100-year, 3 hour	Major System	896.53	0.027	0.6989	0.4	71.356

**Table 5: Coefficients for Design Storms**

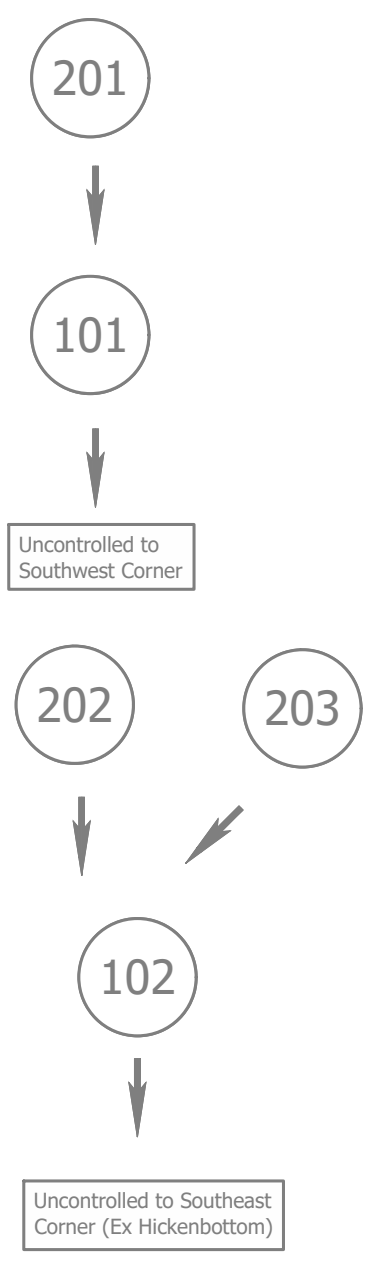
Although the rainfall depths very closely resemble the rainfall events used in Triton’s 2015 report, the peak rainfall intensity in larger storm events is greater. This means that the peak runoff rates from uncontrolled catchments are larger than modeled by Triton.

**Pre-Development**

The site was subdivided into pre-development catchments as shown in Figure 5. Suitable modelling parameters for each of the catchments were chosen, as presented in Table 6. Generated peak flows from each catchment are also summarized in Table 6.

Catchment	Area (ha)			Imper-vious (%)	Slope Length (m)	Slope Gradient (%)	SCS CN (pervious)	Peak Flow (m³/s)	
	Controlled	Uncontrolled	Total					5-year	100-year
Internal									
101		9.517	9.517	0	170	2.1	83	0.272	0.873
102		5.712	5.712	0	120	3	83	0.206	0.671
Subtotal:		15.229	15.229						
External									
201		0.720	0.720	16	33	2	75	0.041	0.089
202		0.802	0.802	22	44	2	75	0.057	0.115
203		0.508	0.508	0	45	2	75	0.011	0.050
Subtotal:		2.030	2.030						
Total		17.259	17.259						

**Table 6: Pre-Development Modelling Parameters**



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**Pre-Development Catchment Plan  
Clark-Heimiller Development (Palmerston)**

DRAWING:			
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## Post-Development

Post-development catchments incorporate the routing of the minor storm system to the proposed stormwater management facility. The post-development catchment plan displaying the catchments and orientation of the overland flow routes can be found in Figure 6.

Suitable modelling parameters were selected for each catchment, as presented in Table 7. The percentage impervious values were confirmed based on a comparison with standard coefficients used in the Rational Method, using the formula:

$$C = 0.14 + (0.65 \times \%imp) + (0.05 \times S)$$

where %imp = percent impervious (e.g. 0.60), and  
S = slope in percent (e.g. 2).

For example, a catchment of 63% imperviousness and a slope of 2.5% results in a rational runoff design coefficient of 0.67, which is representative of this type of development.

The SCS curve number soil parameters shown represent the pervious fraction of runoff, which combined with the impervious fraction, yields a CN value of 79, which is also representative of this type of development.

Catchment	Area (ha)			Imper- vicious (%)	Slope Length (m)	Slope Gradient (%)	SCS CN (pervious)	Peak Flows (m <sup>3</sup> /s)	
	Controlled	Uncontrolled	Total					5- year	100-year
Internal									
501	7.777		7.777	0	50	3	83	0.403	1.311
502	3.970		3.970	0	35	4	83	0.258	0.805
701	2.728		2.728	63	30	2	79	0.588	1.086
702	0.296		0.296	30	15	20	77	0.041	0.092
703	0.458		0.458	30	15	20	77	0.063	0.142
Subtotal:	15.229		15.229						
External									
801	0.805		0.805	16	10	2	74	0.057	0.138
802	0.717		0.717	2	44	2	74	0.017	0.071
803	0.508		0.508	0	45	2	74	0.011	0.050
Subtotal:	2.03		2.03						
Total	17.259		17.259						

**Table 7: Post-Development Modelling Parameters**

Storm runoff from the Phase 1 lands (Catchment 701) combines with existing external contributions (Catchment 801) and will be routed through the SWM facility located in Catchment 702. The Phase 1 SWM facility will consist of a dry pond with an upstream OGS

unit to provide water quality treatment and outlet controls to attenuate storm events up to the 100-year storm.

External catchments 802 and 803 will bypass the Phase 1 SWM facility and connect to the proposed 450mm storm sewer. Each catchment will have at least one designated catchbasin, either within the easement or on the external lands, equipped with a one-way check valve in its connection to the primary storm sewer outlet. This is to ensure that flows from the subdivision do not have the opportunity to negatively impact the external catchments.

To maintain the existing drainage patterns of the farmlands to the north, denoted by Catchment 501 and 502, the following modifications to the lands outside of Phase 1 are proposed:

1. Create a temporary pond in Catchment 703
2. Modify the existing tile drain system
3. Perform minor grading adjacent to Phase 1
4. Install a culvert under the temporary access road to Mary Street
5. Move the existing farm dwelling's driveway access from Lorne Street to the proposed access road connection to Mary Street

As previously stated, the owner of the lands associated with the above proposed modifications has been consulted with and is in agreeance with the above works. Formal acceptance of the proposed plan will be obtained from the landowner before detailed design is finalized.

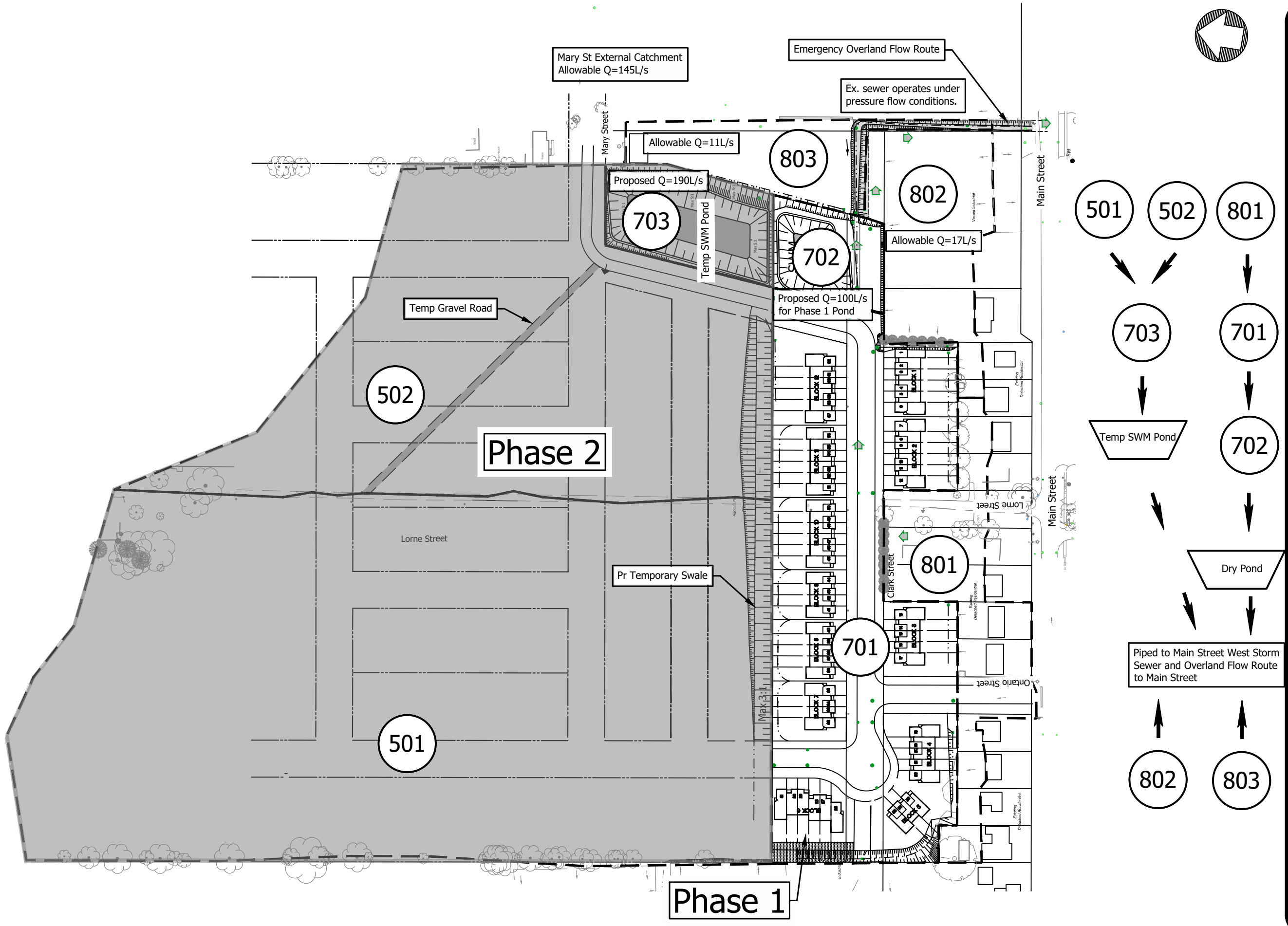
The temporary pond is not expected to have any formal quality control and will be designed simply to control peak flows for storms up to the 100-year storm. It will outlet both its major and minor flows to the proposed infrastructure to the east, bypassing the Phase 1 SWM facility. Refer to the MIDUSS modelling results in Appendix D for further information.

These measures are intended to be maintained and remain in place until future phases of development are being constructed. It is our assumption that through detailed design of future phases, the SWM areas shown as catchments 702 and 703 will be combined to service both Phase 1 and the additional developed lands – in other words, that the two ponds will be combined in the future into one larger facility.

Table 8 shows that the unattenuated post-development peak flows are greater than the allowable flows. As a result, attenuation measures in the form of a controlled outlet facility are proposed.

Event/Condition	2-year (m <sup>3</sup> /s)	5-year (m <sup>3</sup> /s)	100-year (m <sup>3</sup> /s)
Pre-development	0.232	0.508	1.672
Unattenuated Post-development	0.570	0.944	2.958

**Table 8: Comparison of Unattenuated Peak Flows (m<sup>3</sup>/s)**



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**DRAWING:** Post-Development Catchment Plan  
Clark-Heimiller Development (Palmerston)

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## Quality

### Pre-Treatment

Downspouts are to be directed to grass areas wherever possible to provide 'pre-treatment' polishing of stormwater runoff and helps to capture much of the grit carried by the runoff.

Conveyance via pipes in minor storm events is to the OGS unit ensuring that road runoff is treated prior to entering the SWM facility and to the existing infrastructure to the east.

### Oil-Grit Separator

The treatment of stormwater runoff will meet the MOE Enhanced level of water quality control through the provision of an OGS unit upstream of the dry pond SWM facility. Alternative facility configurations, such as a wetland or wet pond, will not be suitable to service the subject lands as the small contributing area would not be able to maintain permanent pool levels.

To support future maintenance purposes, an access extending to the bottom of the pond is recommended so that the facility can be easily accessed for future cleanouts.

### Water Balance, Infiltration, and Groundwater

During detailed design, whether or not it is necessary for the proposed SWM facility to be designed with a clay liner or equivalent form of separation to prevent interplay with the high groundwater table at the SWM block location will be considered. As the facility is a dry facility, it is anticipated that separation is not required or desirable.

To assist in maintaining the proposed buildings dry from surface water seepage, the grading design will ensure that exterior grades around the buildings be sloped down and away at 2% gradient of more for a minimum of 2.0m as per recommendations from the geotechnical report. Rainwater leaders are to discharge with positive drainage at least 1.5m away from the proposed building's foundations to a drainage swale. A weeping tile system around the perimeter of the foundations will be required.

### Performance of SWM Facilities

The pond configuration and outlet control structures combine to satisfy the objective of peak flow attenuation of post-development conditions to below pre-development peak flow rates. Future work will confirm the impact of the flows on the receiving infrastructure.

Pond volumes were estimated for each contour, the resulting stage-storage characteristics of the dry pond servicing Phase 1 of development is summarized in Table 9.

Elev.	Depth	Description	Discharge			Volumes	
			Orifice	Weir	Total	Incr. Vol.	Live Storage
(m)	(m)		(m <sup>3</sup> /s)	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)	(m <sup>3</sup> )	(m <sup>3</sup> )
393.8	0.0	Bottom of Pond & Orifice Invert	0.000		0.000	0	<b>0</b>
393.9	0.1		0.005		0.005	39	<b>39</b>
394.0	0.2		0.023		0.023	42	<b>81</b>
394.1	0.3		0.036		0.036	47	<b>128</b>
394.2	0.4		0.045		0.045	52	<b>180</b>
394.3	0.5		0.053		0.053	57	<b>237</b>
394.4	0.6		0.060		0.060	62	<b>299</b>
394.5	0.7		0.066		0.066	67	<b>366</b>
394.6	0.8		0.072		0.072	72	<b>438</b>
394.7	0.9		0.077		0.077	78	<b>516</b>
394.8	1.0		0.082		0.082	84	<b>600</b>
394.9	1.1		0.086		0.086	90	<b>690</b>
395.0	1.2		0.091		0.091	96	<b>786</b>
395.1	1.3		0.095		0.095	102	<b>888</b>
395.2	1.4		0.099		0.099	109	<b>997</b>
395.3	1.5		0.103		0.103	116	<b>1,113</b>
395.4	1.6		0.106		0.106	123	<b>1,236</b>
395.5	1.7		0.110		0.110	129	<b>1,365</b>
395.6	1.8		0.113		0.113	138	<b>1,503</b>
395.7	1.9	Weir	0.117	0	0.117	142	<b>1,645</b>
395.8	2.0		0.121	0.252	0.373	141	<b>1,786</b>
395.9	2.1		0.125	0.745	0.870	59	<b>1,845</b>
396.0	2.2	Top of Pond	0.129	1.426	1.555	60	<b>1,905</b>

**Table 9: Stage Storage Discharge for Phase 1 Dry Pond**

The temporary pond servicing the farm fields to the north of the Phase 1 development lands is described through the stage-storage in Table 10.

Elev.	Depth	Description	Discharge			Volumes	
			Orif.	Weir	Total	Incr. Vol.	Live Stor.
(m)	(m)		(m <sup>3</sup> /s)	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)	(m <sup>3</sup> )	(m <sup>3</sup> )
394.70	0.00	Bottom of Pond & Orifice Invert	0.022		0.022	0	<b>0</b>
394.80	0.10		0.071		0.071	126	<b>126</b>
394.90	0.20		0.085		0.085	136	<b>262</b>
395.00	0.30		0.097		0.097	147	<b>409</b>
395.10	0.40		0.108		0.108	157	<b>566</b>
395.20	0.50		0.117		0.117	168	<b>734</b>
395.30	0.60		0.126		0.126	179	<b>913</b>
395.43	0.70		0.135		0.135	190	<b>1,103</b>
395.50	0.80		0.143		0.143	202	<b>1,305</b>
395.60	0.93		0.150		0.150	214	<b>1,519</b>
395.70	1.00		0.157		0.157	225	<b>1,744</b>
395.80	1.10		0.164		0.164	238	<b>1,982</b>
395.90	1.20		0.171		0.171	250	<b>2,232</b>
396.00	1.30		0.177		0.177	263	<b>2,495</b>
396.10	1.40		0.183		0.183	275	<b>2,770</b>
396.20	1.50	Weir	0.189	0	0.189	288	<b>3,058</b>
396.30	1.60		0.196	0.252	0.448	301	<b>3,359</b>
396.40	1.70		0.203	0.745	0.948	315	<b>3,674</b>
396.50	1.80	Top of Pond	0.210	1.425	1.635	121	<b>3,795</b>

**Table 10: Stage Storage Discharge for Temporary Pond**

During the 2-year and 5-year storm events, the majority of flows will be piped to the SWM facility. The flow is attenuated by a orifice plates at an invert level with the bottom of the ponds, which forces ponding to occur.

During the 100-year storm event, additional flow will be overland to the SWM facility. The SWM facility will operate in a similar manner as in smaller storms. Larger storms will result in ponding depths exceeding the maximum ponding elevation of 395.50, at which point flows would overtop the "overflow weir" towards the overland flow route to the east.

Tables 11 and 12 summarize the overall performance of the ponds.

Description	Elevation (m)	Depth (m)	Volume (m <sup>3</sup> )	Discharge (m <sup>3</sup> /s)
Bottom of dry pond	393.80	0	0	0
2-year storm	394.44	0.64	323	0.062
5-year storm	394.68	0.88	502	0.076
100-year storm	395.29	1.49	1,106	0.102
Weir	395.70	1.90	1,645	0.117
Hurricane Hazel	395.83	2.03	1,806	0.538
Maximum ponding	396.00	2.20	1,905	1.555

**Table 11: Pond Performance Table (Phase 1 Pond)**

Description	Elevation (m)	Depth (m)	Volume (m <sup>3</sup> )	Discharge (m <sup>3</sup> /s)
Bottom of dry pond	394.70	0	0	0
2-year storm	395.00	0.30	421	0.098
5-year storm	395.32	0.62	958	0.128
100-year storm	396.19	1.49	3,036	0.189
Weir	396.20	1.50	3,058	0.189
Hurricane Hazel	396.45	1.75	3,736	1.788
Maximum ponding	396.50	1.80	3,795	2.265

**Table 12: Pond Performance Table (Temporary Pond)**

### Peak Flow Control

Table 13 shows the total post-development peak flows to the receiving infrastructure. This includes all controlled and uncontrolled catchments that are to be directed through the 450mm diameter pipe leaving the site.

Event/Condition	2-year (m <sup>3</sup> /s)	5-year (m <sup>3</sup> /s)	100-year (m <sup>3</sup> /s)
Pre-development	0.232	0.508	1.672
Unattenuated Post-development	0.570	0.944	2.958
Attenuated Post-development	0.166	0.216	0.351

**Table 13: Comparison of Attenuated Peak Flows**

Further work will confirm the impact of the proposed attenuated flows on the existing storm sewer infrastructure, which is believed to be undersized for the existing condition.

## Grading and Drainage

Preliminary grading design has been completed and majority of the developed site is graded towards the SWM block. The proposed grading plan for the site is depicted in Appendix B.

The street design consists of a single crescent with a bulb at its end. The profile and cross-section of the roads will be shaped to convey stormwater from the lots and street towards the SWM block located at the east side of the development. All road runoff from the proposed road will be directed to the SWM facility.

Retaining walls are not anticipated to be required.

## Sediment & Erosion Control

Prior to the commencement of site preparation works, including topsoil stripping, heavy duty silt fence will be set up along the entire perimeter of the site to prevent mobilization of sediment from the site.

Following topsoil stripping and rough grading/earthworks, additional sediment and erosion control measures will be installed to ensure sediment laden runoff remains on site and surface erosion is minimized. The controls that are to be implemented are included in the list below:

- Drainage swales
- Erosion control blanket
- Mud mat
- Sediment control pond
- Silt fencing (light and heavy duty)
- Drainage swales
- Straw bales
- Rock check dams

As storm infrastructure is installed, catchbasin protection (erosion control filter cloth or geotextile silt sack) will be firmly attached to the underside of catchbasin lids to ensure adequate filtering of sediments.

All sediment and erosion control measures are to remain in place through the site servicing phase. The controls will be routinely monitored by the site inspector and contractor and will be maintained to be in good working order.

It is anticipated that a sediment control pond would be located at the existing low-lying stormwater management area in the southeast corner of the site and will remain in place until the site has been stabilized.

A detailed Erosion/Sediment Control Plan will be completed during detailed design once final grading plans are created.

## **Conclusions**

A number of reports have been prepared in support of development on the site, including a functional servicing report (Triton) and a geotechnical investigation (CMT). Draft Plan approval was previously provided, based on a earlier subdivision design.

Revisions to the Draft Plan require a new preliminary servicing report reflecting the implications to the servicing strategy.

Capacity at the wastewater treatment plant and in the sanitary sewer system currently exists for this development.

Provision of a 150mm diameter watermain into the site to internal hydrants is anticipated to provide adequate flow and pressure as per MOE and Town guidelines for firefighting supply as well as providing domestic supply to the site.

The stormwater management plan includes an oil/grit separator and a dry pond facility to provide water quality control and attenuate the 2-year through 100-year storm events.

As native soils are not conducive to infiltration, a water balance is not feasible and infiltration is not recommended.

## **Recommendations**

This preliminary report shall not be used for construction.

Roof drains should discharge to grade. Storm connections should be provided to each unit for foundation drainage.

Further work should confirm the HGL (hydraulic grade line) of existing downstream sewers.

Further coordination should occur during detailed design to confirm the extents of grading efforts external to the project site as they are key to support the proposed SWM design.

The pond size and sewer routing should be refined in the final design to incorporate the final servicing design.

A detailed siltation and erosion control plan should be developed as part of the final design and prior to any grading. Consideration should be given to the use of the proposed facility as an interim siltation pond until such time as upstream areas are re-vegetated and stabilized.

A landscape plan should be completed for the final design.

Approval agencies should review and approve this document as a suitable approach to a preliminary design configuration and Draft Plan Approval.

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# ***Appendix A: Draft Plan***



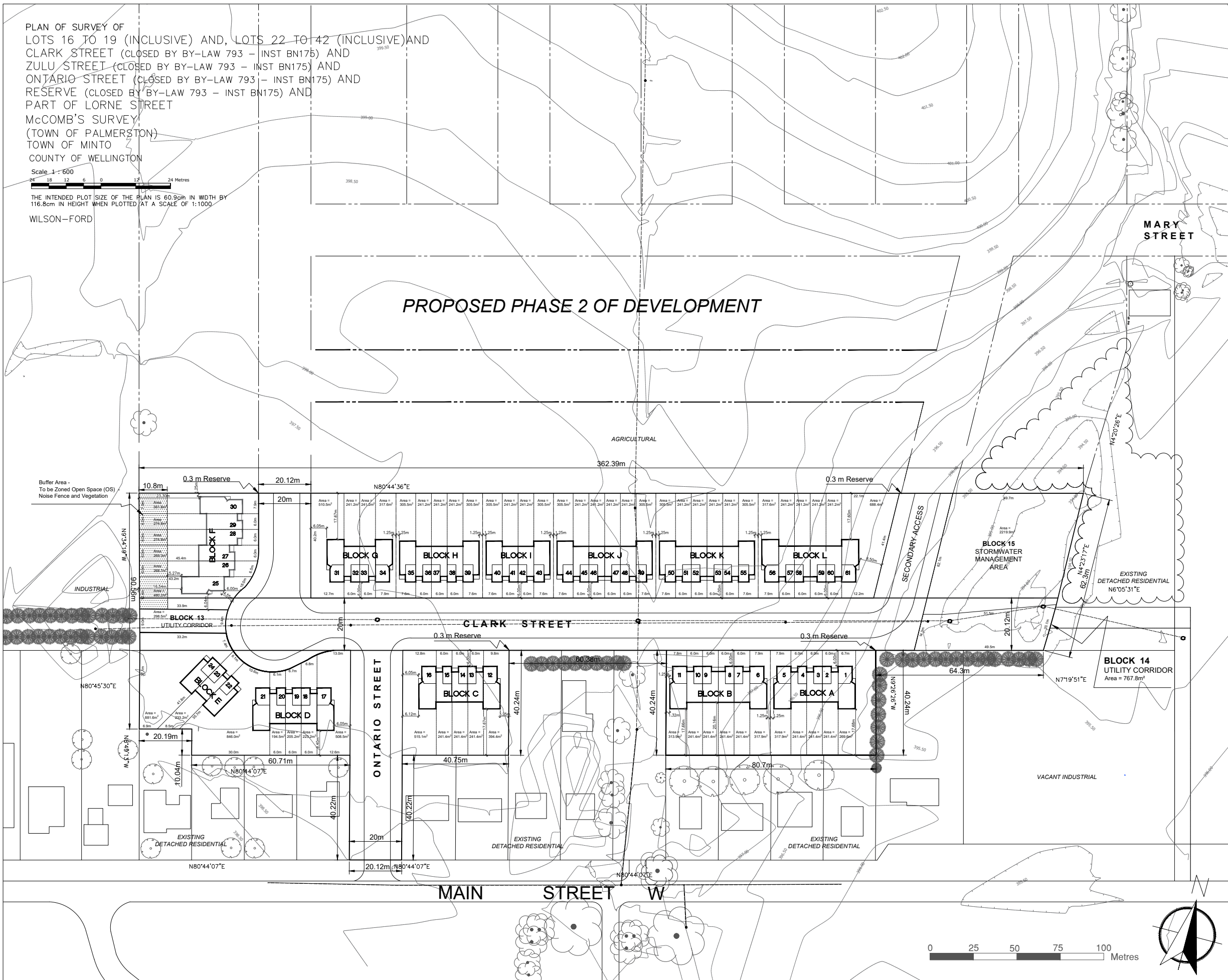
PLAN OF SURVEY OF  
 LOTS 16 TO 19 (INCLUSIVE) AND, LOTS 22 TO 42 (INCLUSIVE) AND  
 CLARK STREET (CLOSED BY BY-LAW 793 - INST BN175) AND  
 ZULU STREET (CLOSED BY BY-LAW 793 - INST BN175) AND  
 ONTARIO STREET (CLOSED BY BY-LAW 793 - INST BN175) AND  
 RESERVE (CLOSED BY BY-LAW 793 - INST BN175) AND  
 PART OF LORNE STREET  
 McCOMB'S SURVEY  
 (TOWN OF PALMERSTON)  
 TOWN OF MINTO  
 COUNTY OF WELLINGTON



THE INTENDED PLOT SIZE OF THE PLAN IS 60.9cm IN WIDTH BY  
 116.8cm IN HEIGHT WHEN PLOTTED AT A SCALE OF 1:1000

WILSON-FORD

**PROPOSED PHASE 2 OF DEVELOPMENT**



**SUBJECT PROPERTY**

**LOCATION MAP**

**ADDITIONAL INFORMATION AS REQUIRED UNDER SECTION 51(17) OF THE PLANNING ACT R.S.O 1990**

- a. AS SHOWN
- b. AS SHOWN
- c. AS SHOWN
- d. ATTACHED RESIDENTIAL DWELLINGS
- e. AS SHOWN
- f. AS SHOWN
- g. NOT APPLICABLE
- h. AS SHOWN
- i. MUNICIPAL WATER
- j. HARRISTON LOAM
- k. AS SHOWN
- l. AVAILABLE MUNICIPAL SERVICES - FIRE, SOLID WASTE, POLICE, WINTER ROAD MAINTENANCE, HYDRO, PHONE
- m. AS SHOWN

**LAND USE SCHEDULE**

TOTAL AREA OF LANDS TO BE SUBDIVIDED: 3.10 Ha. (7.65 Ac.)

LAND USE	BLOCKS	UNITS/BLOCK	Ha.	Ac.
Attached Dwellings	B, F, J-L	6		
	A, C, D, H	5		
	G, I	4		
	E	3		
Min. Lot Frontage = 6.0 m				
Min. Lot Area = 0.01945 ha				
			1.86	4.59
Stormwater/ Utility Corridor	13-15			
Stormwater Management, Utility Corridor	15		0.33	0.81
<b>TOTAL</b>	<b>15</b>	<b>61</b>	<b>2.19</b>	<b>5.40</b>
<b>ROADS</b>		<b>LENGTH</b>	<b>Ha.</b>	<b>Ac.</b>
Ontario Street	80.5 m	n/a	n/a	
Clark Street	253.3 m	n/a	n/a	

**OWNER'S AUTHORIZATION**

WE BEING THE REGISTERED OWNERS OF THE SUBJECT LANDS HEREBY AUTHORIZE CUESTA PLANNING CONSULTANTS INC. TO PREPARE AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION ON OUR BEHALF:

DATE: \_\_\_\_\_ SIGNED: \_\_\_\_\_

**SURVEYOR'S CERTIFICATE**

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

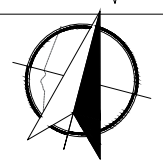
DATE: June 13, 2022 SIGNED: GREG FORD, P.ENG. ONTARIO LAND SURVEYOR

Rev. #	DATE	COMMENTS



Project No. 22101 DWN. By V. Muhunthan ISSUE DATE: June 13, 2022

DRAFT PLAN No.:



---

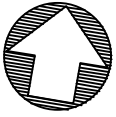
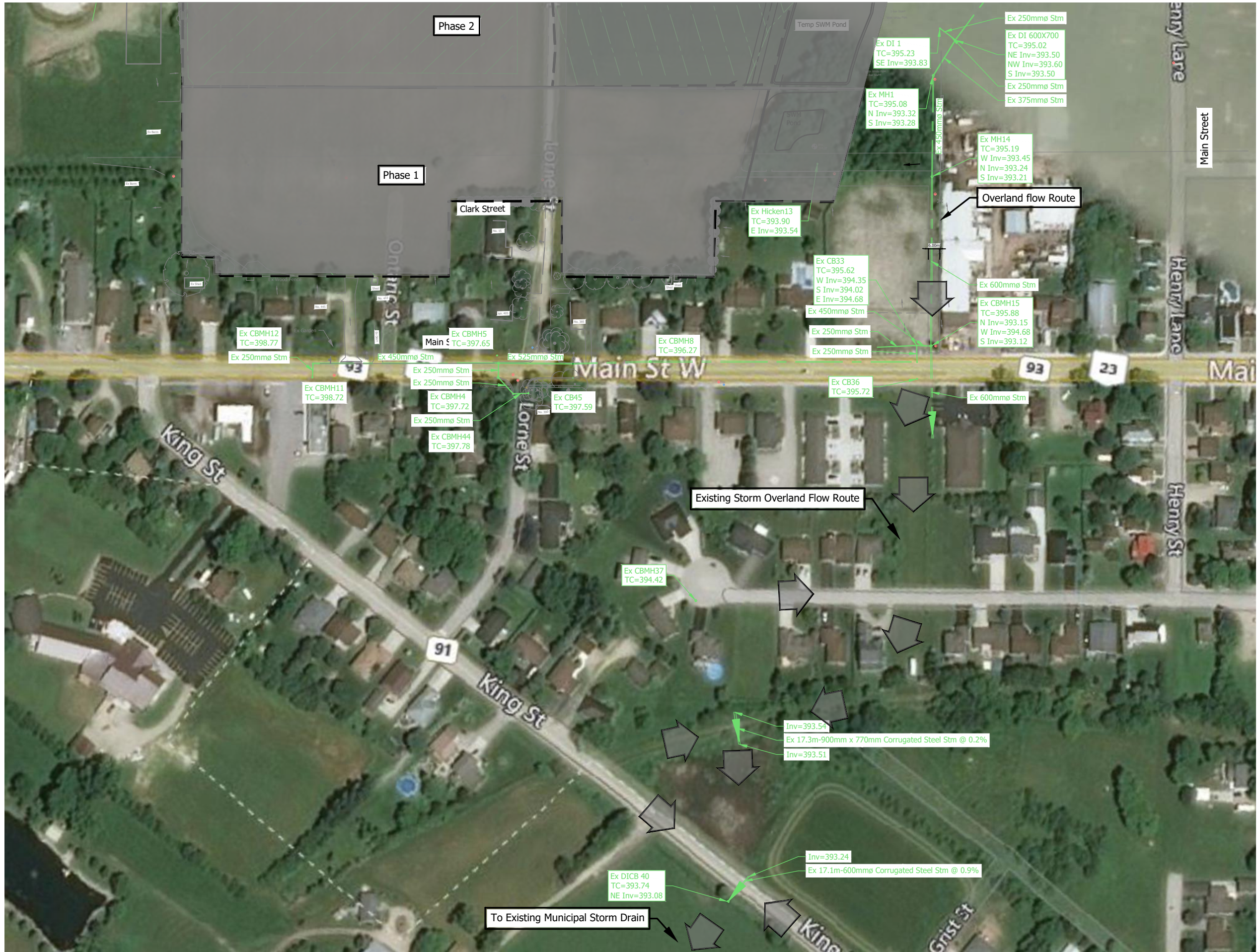
# ***Appendix B: Conceptual Design Drawings***











**Emergency Overland Route  
Clark-Heinmiller Development (Palmerston)**

DRAWING:

DRAWN BY: XCC	CHECKED BY: CHT	SCALE: 1:2000	EOR
FILE NAME: 5008	DATE: Jul 2022		

**MERITECH**  
engineering

1315 Bishop Street North, Suite 202 Cambridge  
T 519.623.1140 F 519.623.7334 www.meritech.ca

File Path: c:\m\meritech\engineering\proj - docs\5008\cad\sheet\5008\_fig.dwg

---

# ***Appendix C: Calculations***



### Sanitary Sewer Design Sheet

Project: Palmerston  
File: 5008

for  
**Town of Minto**

Calc'd by: BGS  
Date: 24-May-22  
Chk'd by: CHT  
Date: 9-Jun-22

Ref#

Pipe Velocities: 0.60 m/s min. (pipe full)  
3.00 m/s max. (actual flow)  
n= 0.013 all pipe material

Residential average daily flow (q): 450 L/cap/d Minto Municipal Servicing and Design Standards

Unit extraneous flow (E): 0.15 L/s/ha Minto Municipal Servicing and Design Standards

q = average daily per capita flow (L/cap/d)  
I = Unit of peak extraneous flow (L/s/ha)  
Q(p) = peak population flow (L/s)  
Q(I) = peak extraneous flow (L/s)  
Q(d) = peak design flow (L/s)

Peaking Factor:  
 $M = 1 + 14/(4+(P/1000)^{0.5})$   
 $Q(p) = (P/1000)qM/86.4$  (L/s)  
 $Q(I) = IA$  (L/s) ; where A = Area in hectares  
 $Q(d) = Q(p) + Q(I)$  (L/s)

Manning Equation:  
 $Q_{cap.} = (D/1000)^{2.667} * (S/100)^{0.5} / (3.211 * n) * 1000$  (L/s)  
D: pipe size (mm)  
S: slope (grade) of pipe (%)  
n: roughness coefficient

Location		Unit Count (ppu)	Residential 0.0052 (L/s/cap)						Infiltration 0.15			Pipe								
From	To	2.44 Town	Individual		Accumulative		Peak Factor M	Pop. Q(p) (L/s)	Total Area	Accum Total Area	Extran. Q(I) (L/s)	Design Q(d) (L/s)	Length L (m)	Size D (mm)	Pipe Mat'l	Slope S (%)	Capacity Qcap. (L/s)	Velocity V (m/s)	Q(d)/Qcap	Actual Velocity (m/s)
			P (person)	Area (ha)	P (person)	Area (ha)														
Street A		61	149	2.73	149	2.73	4.192	3.253	2.730	2.730	0.410	3.663	104.5	300	PVC	0.17%	41.600	0.570	8.8%	0.365

## Fire Fighting Supply

Project Name: **Palmerston**  
Project #: **5008**

Calculated By: **BGS**  
Date: **2-May-22**

Checked By: **CHT**  
Date: **9-Jun-22**

Building requires an on-site water supply, based on the criteria set by the OBC, that is available for fire fighting purposes not less than the amount derived from the following equation:

$$Q = K \cdot V \cdot S_{tot}$$

where **K** = water supply coefficient  
**V** = total building volume (m<sup>3</sup>)  
**Stot** = spatial coefficient

**K** =  (OBC, Volume 2, Table 1 of A-3.2.5.7)

**Floor Area (m<sup>2</sup>)** =  **# Floors**  **Height of floors (m)**

**V (m<sup>3</sup>)** =

**Stot** =  (OBC, Figure 1 A-3.2.5.7)

**Q (Litres)** =

Therefore, based on Table 2 of A-3.2.5.7, the required flow rate for this building is:

=  litres/min.

=  litres/sec.

2012 Ontario Building Code (OBC)  
Division B, Section A-3.2.5.7

## Fire Flow Calculations

*1999 Fire Underwriters Survey (FUS) Method*

Project: Palmerston  
 File: 5008  
 Calculated by: BGS  
 Date: 4-May-22  
 Checked by: CHT  
 Date: 9-Jun-22

Buildings require a sufficient amount of water, based on the FUS, for fire fighting purposes. The required fire flow (L/minute) is expressed by the equation:

$$F = 220 \cdot C \cdot \sqrt{A}$$

where **C** = Coefficient related to the type of construction.  
**A** = Floor area (m<sup>2</sup>)

- A) Building structure 'C'**  
**B) A (m<sup>2</sup>)**  
**C) # Floors (excl. basement)**

=	1.0
=	540.00
=	2

- D) F (L/min)**  
**Rounded**

=	7230
=	<b>7000</b>

- E) Type of occupancy/contents**

- Non-Combustible       Free Burning  
 Limited Combustible       Rapid Burning  
 Combustible

Fire hazard adjustment  
**Adjustment**  
**F<sub>adj</sub> (L/min)**

=	-15%
=	<b>-1050</b>
=	<b>5950</b>

- F) % reduction**  
 based on sprinkler  
 system effectiveness  
**Reduction**

=	0.00%
-	<b>0</b>

- G)**

Distance to nearest building (m) % addition

N	32.0	5%
E	2.5	25%
S	30.0	10%
W	2.5	25%

**% addition based on**  
**building separation**  
**Addition**

=	65%
+	<b>3868</b>

- H) Total Fire Flow**

=	9818	L/min
=	<b>164</b>	<b>L/sec</b>

---

# ***Appendix D: Modelling***



---

# ***Appendix D.1: Pre-Development Conditions***



MIDUSS output for 2-year pre-development storm event

```

"          MIDUSS Output ----->"
"          MIDUSS version                      Version 2.25  rev. 473"
"          MIDUSS created                      Sunday, February 7, 2010"
"          10  Units used:                      ie METRIC"
"          Job folder:                          C:\M\Meritech Engineering\PRJ - DOCS\5008\
"                                               60-Design\SWM\MIDUSS"
"          Output filename:                    5008x2yrSep292022.out"
"          Licensee name:                      Windows User"
"          Company                             "
"          Date & Time last used:              9/29/2022 at 11:40:42 AM"
" 81      ADD COMMENT=====
"          2  Lines of comment"
"          SWM analysis for the Palmerston Subdivision"
"          2-year, 3 hour pre-development event"
" 31      TIME PARAMETERS"
"          5.000  Time Step"
"          180.000  Max. Storm length"
"          1500.000  Max. Hydrograph"
" 32      STORM Chicago storm"
"          1  Chicago storm"
"          409.870  Coefficient A"
"          0.068  Constant B"
"          0.701  Exponent C"
"          0.400  Fraction R"
"          180.000  Duration"
"          1.000  Time step multiplier"
"          Maximum intensity          131.388  mm/hr"
"          Total depth                32.263  mm"
"          6  002hyd  Hydrograph extension used in this file"
" 81      ADD COMMENT=====
"          1  Lines of comment"
"          Internal Catchments"
" 33      CATCHMENT 101"
"          1  Triangular SCS"
"          1  Equal length"
"          1  SCS method"
"          101  West Side"
"          0.000  % Impervious"
"          9.517  Total Area"
"          170.000  Flow length"
"          2.100  Overland Slope"
"          9.517  Pervious Area"
"          170.000  Pervious length"
"          2.100  Pervious slope"
"          0.000  Impervious Area"
"          170.000  Impervious length"
"          2.100  Impervious slope"
"          0.250  Pervious Manning 'n'"
"          83.000  Pervious SCS Curve No."
"          0.287  Pervious Runoff coefficient"
"          0.100  Pervious Ia/S coefficient"
"          5.202  Pervious Initial abstraction"
"          0.015  Impervious Manning 'n'"
"          98.000  Impervious SCS Curve No."
"          0.000  Impervious Runoff coefficient"
"          0.100  Impervious Ia/S coefficient"
"          0.518  Impervious Initial abstraction"
"          0.122  0.000  0.000  0.000 c.m/sec"
"          Catchment 101          Pervious  Impervious Total Area "

```

MIDUSS output for 2-year pre-development storm event

```

"      Surface Area      9.517      0.000      9.517      hectare"
"      Time of concentration  51.260      5.749      51.260      minutes"
"      Time to Centroid    177.121      99.113      177.121      minutes"
"      Rainfall depth      32.263      32.263      32.263      mm"
"      Rainfall volume     3070.48      0.00      3070.48      c.m"
"      Rainfall losses     23.005      5.074      23.005      mm"
"      Runoff depth        9.258      27.189      9.258      mm"
"      Runoff volume       881.08      0.00      881.08      c.m"
"      Runoff coefficient   0.287      0.000      0.287      "
"      Maximum flow        0.122      0.000      0.122      c.m/sec"
" 40      HYDROGRAPH Add Runoff "
"      4      Add Runoff "
"              0.122      0.122      0.000      0.000"
" 33      CATCHMENT 102"
"      1      Triangular SCS"
"      1      Equal length"
"      1      SCS method"
"      102      East Side"
"      0.000      % Impervious"
"      5.712      Total Area"
"      120.000      Flow length"
"      3.000      Overland Slope"
"      5.712      Pervious Area"
"      120.000      Pervious length"
"      3.000      Pervious slope"
"      0.000      Impervious Area"
"      120.000      Impervious length"
"      3.000      Impervious slope"
"      0.250      Pervious Manning 'n'"
"      83.000      Pervious SCS Curve No."
"      0.287      Pervious Runoff coefficient"
"      0.100      Pervious Ia/S coefficient"
"      5.202      Pervious Initial abstraction"
"      0.015      Impervious Manning 'n'"
"      98.000      Impervious SCS Curve No."
"      0.000      Impervious Runoff coefficient"
"      0.100      Impervious Ia/S coefficient"
"      0.518      Impervious Initial abstraction"
"              0.095      0.122      0.000      0.000 c.m/sec"
"      Catchment 102      Pervious      Impervious      Total Area "
"      Surface Area      5.712      0.000      5.712      hectare"
"      Time of concentration  37.372      4.191      37.372      minutes"
"      Time to Centroid    156.823      96.573      156.823      minutes"
"      Rainfall depth      32.263      32.263      32.263      mm"
"      Rainfall volume     1842.87      0.00      1842.87      c.m"
"      Rainfall losses     23.007      5.282      23.007      mm"
"      Runoff depth        9.256      26.981      9.256      mm"
"      Runoff volume       528.71      0.00      528.72      c.m"
"      Runoff coefficient   0.287      0.000      0.287      "
"      Maximum flow        0.095      0.000      0.095      c.m/sec"
" 40      HYDROGRAPH Add Runoff "
"      4      Add Runoff "
"              0.095      0.211      0.000      0.000"
" 81      ADD COMMENT=====
"      1      Lines of comment"
"      External catchments"
" 33      CATCHMENT 201"
"      1      Triangular SCS"
"      1      Equal length"

```

MIDUSS output for 2-year pre-development storm event

```

"          1  SCS method"
"          201 External area to SW, to 101"
"         16.000 % Impervious"
"          0.720 Total Area"
"         33.000 Flow length"
"          2.000 Overland Slope"
"          0.605 Pervious Area"
"         33.000 Pervious length"
"          2.000 Pervious slope"
"          0.115 Impervious Area"
"         33.000 Impervious length"
"          2.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"         74.000 Pervious SCS Curve No."
"          0.150 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          8.924 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"         98.000 Impervious SCS Curve No."
"          0.839 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"
"                0.027      0.211      0.000      0.000 c.m/sec"
"          Catchment 201      Pervious      Impervious Total Area "
"          Surface Area      0.605      0.115      0.720      hectare"
"          Time of concentration 28.401      2.182      14.868      minutes"
"          Time to Centroid      145.058      93.099      118.240      minutes"
"          Rainfall depth      32.263      32.263      32.263      mm"
"          Rainfall volume      195.13      37.17      232.29      c.m"
"          Rainfall losses      27.429      5.188      23.870      mm"
"          Runoff depth      4.835      27.075      8.393      mm"
"          Runoff volume      29.24      31.19      60.43      c.m"
"          Runoff coefficient      0.150      0.839      0.260      "
"          Maximum flow      0.005      0.027      0.027      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"                0.027      0.219      0.000      0.000"
" 33          CATCHMENT 202"
"          1      Triangular SCS"
"          1      Equal length"
"          1      SCS method"
"          202 External area to SE, to 102"
"         22.000 % Impervious"
"          0.802 Total Area"
"         44.000 Flow length"
"          2.000 Overland Slope"
"          0.626 Pervious Area"
"         44.000 Pervious length"
"          2.000 Pervious slope"
"          0.176 Impervious Area"
"         44.000 Impervious length"
"          2.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"         74.000 Pervious SCS Curve No."
"          0.150 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          8.924 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"         98.000 Impervious SCS Curve No."

```

MIDUSS output for 2-year pre-development storm event

```

"      0.839  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"              0.039      0.219      0.000      0.000 c.m/sec"
"      Catchment 202      Pervious      Impervious      Total Area  "
"      Surface Area      0.626      0.176      0.802      hectare"
"      Time of concentration  33.752      2.593      14.680      minutes"
"      Time to Centroid      152.086      93.762      116.387      minutes"
"      Rainfall depth      32.263      32.263      32.263      mm"
"      Rainfall volume      201.83      56.93      258.75      c.m"
"      Rainfall losses      27.426      5.204      22.537      mm"
"      Runoff depth      4.837      27.059      9.726      mm"
"      Runoff volume      30.26      47.74      78.00      c.m"
"      Runoff coefficient      0.150      0.839      0.301      "
"      Maximum flow      0.005      0.039      0.039      c.m/sec"
" 40      HYDROGRAPH Add Runoff  "
"      4      Add Runoff  "
"              0.039      0.228      0.000      0.000"
" 33      CATCHMENT 203"
"      1      Triangular SCS"
"      1      Equal length"
"      1      SCS method"
"      203      External area to East, to 102"
"      0.000      % Impervious"
"      0.508      Total Area"
"      45.000      Flow length"
"      2.000      Overland Slope"
"      0.508      Pervious Area"
"      45.000      Pervious length"
"      2.000      Pervious slope"
"      0.000      Impervious Area"
"      45.000      Impervious length"
"      2.000      Impervious slope"
"      0.250      Pervious Manning 'n'"
"      74.000      Pervious SCS Curve No."
"      0.150      Pervious Runoff coefficient"
"      0.100      Pervious Ia/S coefficient"
"      8.924      Pervious Initial abstraction"
"      0.015      Impervious Manning 'n'"
"      98.000      Impervious SCS Curve No."
"      0.000      Impervious Runoff coefficient"
"      0.100      Impervious Ia/S coefficient"
"      0.518      Impervious Initial abstraction"
"              0.004      0.228      0.000      0.000 c.m/sec"
"      Catchment 203      Pervious      Impervious      Total Area  "
"      Surface Area      0.508      0.000      0.508      hectare"
"      Time of concentration  34.210      2.628      34.210      minutes"
"      Time to Centroid      152.692      93.833      152.691      minutes"
"      Rainfall depth      32.263      32.263      32.263      mm"
"      Rainfall volume      163.90      0.00      163.90      c.m"
"      Rainfall losses      27.427      5.208      27.427      mm"
"      Runoff depth      4.836      27.055      4.836      mm"
"      Runoff volume      24.57      0.00      24.57      c.m"
"      Runoff coefficient      0.150      0.000      0.150      "
"      Maximum flow      0.004      0.000      0.004      c.m/sec"
" 40      HYDROGRAPH Add Runoff  "
"      4      Add Runoff  "
"              0.004      0.232      0.000      0.000"
" 40      HYDROGRAPH Copy to Outflow"

```

MIDUSS output for 2-year pre-development storm event

---

```

"          8   Copy to Outflow"
"          0.004   0.232   0.232   0.000"
" 40         HYDROGRAPH   Combine   203"
"          6   Combine  "
"        203   Node #"
"          Total outflow"
"          Maximum flow           0.232   c.m/sec"
"          Hydrograph volume       1572.796   c.m"
"          0.004   0.232   0.232   0.232"
" 38         START/RE-START TOTALS 203"
"          3   Runoff Totals on EXIT"
"          Total Catchment area           17.259   hectare"
"          Total Impervious area         0.292   hectare"
"          Total % impervious           1.690"
" 19         EXIT"

```

```

"          MIDUSS Output ----->"
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"          MIDUSS created                      Sunday, February 7, 2010"
"          10  Units used:                      ie METRIC"
"          Job folder:                         C:\M\Meritech Engineering\PRJ - DOCS\5008\
"                                               60-Design\SWM\MIDUSS"
"          Output filename:                   5008x5yrSep292022.out"
"          Licensee name:                     Windows User"
"          Company                            "
"          Date & Time last used:             9/29/2022 at 11:44:03 AM"
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"          2  Lines of comment"
"          SWM analysis for the Palmerston Subdivision"
"          5-year, 3 hour pre-development event"
" 31      TIME PARAMETERS"
"          5.000  Time Step"
"          180.000 Max. Storm length"
"          1500.000 Max. Hydrograph"
" 32      STORM Chicago storm"
"          1  Chicago storm"
"          547.190 Coefficient A"
"          0.093  Constant B"
"          0.702  Exponent C"
"          0.400  Fraction R"
"          180.000 Duration"
"          1.000  Time step multiplier"
"          Maximum intensity          174.519  mm/hr"
"          Total depth                42.845  mm"
"          6  005hyd  Hydrograph extension used in this file"
" 81      ADD COMMENT=====
"          1  Lines of comment"
"          Internal Catchments"
" 33      CATCHMENT 101"
"          1  Triangular SCS"
"          1  Equal length"
"          1  SCS method"
"          101 West Side"
"          0.000 % Impervious"
"          9.517 Total Area"
"          170.000 Flow length"
"          2.100 Overland Slope"
"          9.517 Pervious Area"
"          170.000 Pervious length"
"          2.100 Pervious slope"
"          0.000 Impervious Area"
"          170.000 Impervious length"
"          2.100 Impervious slope"
"          0.250 Pervious Manning 'n'"
"          83.000 Pervious SCS Curve No."
"          0.369 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          5.202 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"          98.000 Impervious SCS Curve No."
"          0.000 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"
"          0.272  0.000  0.000  0.000 c.m/sec"
"          Catchment 101          Pervious  Impervious Total Area "

```

MIDUSS output for 5-year pre-development storm event

```

"          Surface Area          9.517      0.000      9.517      hectare"
"          Time of concentration 40.339      5.067      40.339      minutes"
"          Time to Centroid      160.788     97.001     160.788     minutes"
"          Rainfall depth        42.845     42.845     42.845      mm"
"          Rainfall volume       4077.56    0.00       4077.56    c.m"
"          Rainfall losses       27.046     5.252     27.046      mm"
"          Runoff depth          15.799     37.593     15.799      mm"
"          Runoff volume         1503.58    0.00       1503.58    c.m"
"          Runoff coefficient     0.369     0.000     0.369      "
"          Maximum flow          0.272     0.000     0.272      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"                  0.272      0.272      0.000      0.000"
" 33          CATCHMENT 102"
"          1      Triangular SCS"
"          1      Equal length"
"          1      SCS method"
"          102     East Side"
"          0.000   % Impervious"
"          5.712   Total Area"
"          120.000 Flow length"
"          3.000   Overland Slope"
"          5.712   Pervious Area"
"          120.000 Pervious length"
"          3.000   Pervious slope"
"          0.000   Impervious Area"
"          120.000 Impervious length"
"          3.000   Impervious slope"
"          0.250   Pervious Manning 'n'"
"          83.000   Pervious SCS Curve No."
"          0.369   Pervious Runoff coefficient"
"          0.100   Pervious Ia/S coefficient"
"          5.202   Pervious Initial abstraction"
"          0.015   Impervious Manning 'n'"
"          98.000   Impervious SCS Curve No."
"          0.000   Impervious Runoff coefficient"
"          0.100   Impervious Ia/S coefficient"
"          0.518   Impervious Initial abstraction"
"                  0.206      0.272      0.000      0.000 c.m/sec"
"          Catchment 102          Pervious      Impervious Total Area "
"          Surface Area          5.712      0.000      5.712      hectare"
"          Time of concentration 29.410      3.694      29.410      minutes"
"          Time to Centroid      144.301     94.909     144.301     minutes"
"          Rainfall depth        42.845     42.845     42.845      mm"
"          Rainfall volume       2447.31    0.00       2447.31    c.m"
"          Rainfall losses       27.051     6.158     27.051      mm"
"          Runoff depth          15.794     36.687     15.794      mm"
"          Runoff volume         902.18     0.00       902.18     c.m"
"          Runoff coefficient     0.369     0.000     0.369      "
"          Maximum flow          0.206     0.000     0.206      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"                  0.206      0.463      0.000      0.000"
" 81          ADD COMMENT=====
"          1      Lines of comment"
"          External catchments"
" 33          CATCHMENT 201"
"          1      Triangular SCS"
"          1      Equal length"

```

MIDUSS output for 5-year pre-development storm event

```

"          1  SCS method"
"          201 External area to SW, to 101"
"         16.000 % Impervious"
"          0.720 Total Area"
"         33.000 Flow length"
"          2.000 Overland Slope"
"          0.605 Pervious Area"
"         33.000 Pervious length"
"          2.000 Pervious slope"
"          0.115 Impervious Area"
"         33.000 Impervious length"
"          2.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"         74.000 Pervious SCS Curve No."
"          0.218 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          8.924 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"         98.000 Impervious SCS Curve No."
"          0.869 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"
"              0.041      0.463      0.000      0.000 c.m/sec"
"          Catchment 201      Pervious      Impervious Total Area "
"          Surface Area      0.605      0.115      0.720      hectare"
"          Time of concentration  20.122      1.923      12.265      minutes"
"          Time to Centroid      132.775      91.694      115.039      minutes"
"          Rainfall depth      42.845      42.845      42.845      mm"
"          Rainfall volume      259.13      49.36      308.48      c.m"
"          Rainfall losses      33.509      5.610      29.046      mm"
"          Runoff depth      9.336      37.235      13.799      mm"
"          Runoff volume      56.46      42.89      99.36      c.m"
"          Runoff coefficient      0.218      0.869      0.322      "
"          Maximum flow      0.015      0.038      0.041      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"              0.041      0.479      0.000      0.000"
" 33          CATCHMENT 202"
"          1      Triangular SCS"
"          1      Equal length"
"          1      SCS method"
"          202 External area to SE, to 102"
"         22.000 % Impervious"
"          0.802 Total Area"
"         44.000 Flow length"
"          2.000 Overland Slope"
"          0.626 Pervious Area"
"         44.000 Pervious length"
"          2.000 Pervious slope"
"          0.176 Impervious Area"
"         44.000 Impervious length"
"          2.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"         74.000 Pervious SCS Curve No."
"          0.218 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          8.924 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"         98.000 Impervious SCS Curve No."

```

MIDUSS output for 5-year pre-development storm event

```

"      0.874  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"              0.057      0.479      0.000      0.000 c.m/sec"
"      Catchment 202      Pervious      Impervious      Total Area  "
"      Surface Area      0.626      0.176      0.802      hectare"
"      Time of concentration  23.913      2.285      12.438      minutes"
"      Time to Centroid      138.127      92.266      113.794      minutes"
"      Rainfall depth      42.845      42.845      42.845      mm"
"      Rainfall volume      268.02      75.60      343.62      c.m"
"      Rainfall losses      33.505      5.412      27.324      mm"
"      Runoff depth      9.340      37.433      15.521      mm"
"      Runoff volume      58.43      66.05      124.48      c.m"
"      Runoff coefficient      0.218      0.874      0.362      "
"      Maximum flow      0.014      0.056      0.057      c.m/sec"
" 40      HYDROGRAPH Add Runoff  "
"      4      Add Runoff  "
"              0.057      0.498      0.000      0.000"
" 33      CATCHMENT 203"
"      1      Triangular SCS"
"      1      Equal length"
"      1      SCS method"
"      203      External area to East, to 102"
"      0.000      % Impervious"
"      0.508      Total Area"
"      45.000      Flow length"
"      2.000      Overland Slope"
"      0.508      Pervious Area"
"      45.000      Pervious length"
"      2.000      Pervious slope"
"      0.000      Impervious Area"
"      45.000      Impervious length"
"      2.000      Impervious slope"
"      0.250      Pervious Manning 'n'"
"      74.000      Pervious SCS Curve No."
"      0.218      Pervious Runoff coefficient"
"      0.100      Pervious Ia/S coefficient"
"      8.924      Pervious Initial abstraction"
"      0.015      Impervious Manning 'n'"
"      98.000      Impervious SCS Curve No."
"      0.000      Impervious Runoff coefficient"
"      0.100      Impervious Ia/S coefficient"
"      0.518      Impervious Initial abstraction"
"              0.011      0.498      0.000      0.000 c.m/sec"
"      Catchment 203      Pervious      Impervious      Total Area  "
"      Surface Area      0.508      0.000      0.508      hectare"
"      Time of concentration  24.238      2.316      24.238      minutes"
"      Time to Centroid      138.584      92.303      138.583      minutes"
"      Rainfall depth      42.845      42.845      42.845      mm"
"      Rainfall volume      217.65      0.00      217.65      c.m"
"      Rainfall losses      33.505      5.410      33.505      mm"
"      Runoff depth      9.340      37.435      9.340      mm"
"      Runoff volume      47.45      0.00      47.45      c.m"
"      Runoff coefficient      0.218      0.000      0.218      "
"      Maximum flow      0.011      0.000      0.011      c.m/sec"
" 40      HYDROGRAPH Add Runoff  "
"      4      Add Runoff  "
"              0.011      0.508      0.000      0.000"
" 40      HYDROGRAPH Copy to Outflow"

```

MIDUSS output for 5-year pre-development storm event

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```

"          8   Copy to Outflow"
"          0.011   0.508   0.508   0.000"
" 40         HYDROGRAPH   Combine   203"
"          6   Combine  "
"        203   Node #"
"          Total outflow"
"          Maximum flow           0.508   c.m/sec"
"          Hydrograph volume       2677.037   c.m"
"          0.011   0.508   0.508   0.508"
" 38         START/RE-START TOTALS 203"
"          3   Runoff Totals on EXIT"
"          Total Catchment area           17.259   hectare"
"          Total Impervious area         0.292   hectare"
"          Total % impervious           1.690"
" 19         EXIT"

```

MIDUSS output for 25-year pre-development storm event

```

"          MIDUSS Output ----->"
"          MIDUSS version                      Version 2.25  rev. 473"
"          MIDUSS created                      Sunday, February 7, 2010"
"          10  Units used:                      ie METRIC"
"          Job folder:                         C:\M\Meritech Engineering\PRJ - DOCS\5008\
"                                               60-Design\SWM\MIDUSS"
"          Output filename:                    5008x25yrSep292022.out"
"          Licensee name:                      Windows User"
"          Company                             "
"          Date & Time last used:              9/29/2022 at 11:44:45 AM"
" 81      ADD COMMENT=====
"          2  Lines of comment"
"          SWM analysis for the Palmerston Subdivision"
"          25-year, 3 hour pre-development event"
" 31      TIME PARAMETERS"
"          5.000  Time Step"
"          180.000 Max. Storm length"
"          1500.000 Max. Hydrograph"
" 32      STORM Chicago storm"
"          1  Chicago storm"
"          734.550 Coefficient A"
"          0.020  Constant B"
"          0.698  Exponent C"
"          0.400  Fraction R"
"          180.000 Duration"
"          1.000  Time step multiplier"
"          Maximum intensity          238.194  mm/hr"
"          Total depth                 58.739  mm"
"          6  025hyd  Hydrograph extension used in this file"
" 81      ADD COMMENT=====
"          1  Lines of comment"
"          Internal Catchments"
" 33      CATCHMENT 101"
"          1  Triangular SCS"
"          1  Equal length"
"          1  SCS method"
"          101 West Side"
"          0.000 % Impervious"
"          9.517 Total Area"
"          170.000 Flow length"
"          2.100 Overland Slope"
"          9.517 Pervious Area"
"          170.000 Pervious length"
"          2.100 Pervious slope"
"          0.000 Impervious Area"
"          170.000 Impervious length"
"          2.100 Impervious slope"
"          0.250 Pervious Manning 'n'"
"          83.000 Pervious SCS Curve No."
"          0.462 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          5.202 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"          98.000 Impervious SCS Curve No."
"          0.000 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"
"          0.586      0.000      0.000      0.000 c.m/sec"
"          Catchment 101          Pervious  Impervious Total Area "

```

MIDUSS output for 25-year pre-development storm event

```

"          Surface Area          9.517      0.000      9.517      hectare"
"          Time of concentration 31.938      4.434      31.938      minutes"
"          Time to Centroid      147.537     95.167     147.537     minutes"
"          Rainfall depth        58.739     58.739     58.739      mm"
"          Rainfall volume       5590.21    0.01       5590.22    c.m"
"          Rainfall losses       31.614     5.659     31.614      mm"
"          Runoff depth          27.125     53.080     27.125      mm"
"          Runoff volume         2581.53    0.01       2581.53    c.m"
"          Runoff coefficient     0.462     0.000     0.462      "
"          Maximum flow          0.586     0.000     0.586      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"                  0.586      0.586      0.000      0.000"
" 33          CATCHMENT 102"
"          1      Triangular SCS"
"          1      Equal length"
"          1      SCS method"
"          102     East Side"
"          0.000   % Impervious"
"          5.712   Total Area"
"          120.000 Flow length"
"          3.000   Overland Slope"
"          5.712   Pervious Area"
"          120.000 Pervious length"
"          3.000   Pervious slope"
"          0.000   Impervious Area"
"          120.000 Impervious length"
"          3.000   Impervious slope"
"          0.250   Pervious Manning 'n'"
"          83.000   Pervious SCS Curve No."
"          0.462   Pervious Runoff coefficient"
"          0.100   Pervious Ia/S coefficient"
"          5.202   Pervious Initial abstraction"
"          0.015   Impervious Manning 'n'"
"          98.000   Impervious SCS Curve No."
"          0.000   Impervious Runoff coefficient"
"          0.100   Impervious Ia/S coefficient"
"          0.518   Impervious Initial abstraction"
"                  0.452      0.586      0.000      0.000 c.m/sec"
"          Catchment 102          Pervious      Impervious      Total Area "
"          Surface Area          5.712      0.000      5.712      hectare"
"          Time of concentration 23.285      3.232      23.285      minutes"
"          Time to Centroid      134.116     93.172     134.116     minutes"
"          Rainfall depth        58.739     58.739     58.739      mm"
"          Rainfall volume       3355.19    0.00       3355.19    c.m"
"          Rainfall losses       31.599     6.296     31.599      mm"
"          Runoff depth          27.140     52.444     27.140      mm"
"          Runoff volume         1550.23    0.00       1550.23    c.m"
"          Runoff coefficient     0.462     0.000     0.462      "
"          Maximum flow          0.452     0.000     0.452      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"                  0.452      0.992      0.000      0.000"
" 81          ADD COMMENT=====
"          1      Lines of comment"
"          External catchments"
" 33          CATCHMENT 201"
"          1      Triangular SCS"
"          1      Equal length"

```

MIDUSS output for 25-year pre-development storm event

```

"          1  SCS method"
"          201 External area to SW, to 101"
"         16.000 % Impervious"
"          0.720 Total Area"
"         33.000 Flow length"
"          2.000 Overland Slope"
"          0.605 Pervious Area"
"         33.000 Pervious length"
"          2.000 Pervious slope"
"          0.115 Impervious Area"
"         33.000 Impervious length"
"          2.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"         74.000 Pervious SCS Curve No."
"          0.304 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          8.924 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"         98.000 Impervious SCS Curve No."
"          0.896 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"
"              0.064      0.992      0.000      0.000 c.m/sec"
"          Catchment 201      Pervious      Impervious Total Area "
"          Surface Area      0.605      0.115      0.720      hectare"
"          Time of concentration 14.894      1.683      10.141      minutes"
"          Time to Centroid      123.783      90.366      111.762      minutes"
"          Rainfall depth      58.739      58.739      58.739      mm"
"          Rainfall volume      355.26      67.67      422.92      c.m"
"          Rainfall losses      40.904      6.132      35.340      mm"
"          Runoff depth      17.836      52.607      23.399      mm"
"          Runoff volume      107.87      60.60      168.47      c.m"
"          Runoff coefficient      0.304      0.896      0.398      "
"          Maximum flow      0.040      0.055      0.064      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"              0.064      1.027      0.000      0.000"
" 33          CATCHMENT 202"
"          1      Triangular SCS"
"          1      Equal length"
"          1      SCS method"
"          202 External area to SE, to 102"
"         22.000 % Impervious"
"          0.802 Total Area"
"         44.000 Flow length"
"          2.000 Overland Slope"
"          0.626 Pervious Area"
"         44.000 Pervious length"
"          2.000 Pervious slope"
"          0.176 Impervious Area"
"         44.000 Impervious length"
"          2.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"         74.000 Pervious SCS Curve No."
"          0.304 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          8.924 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"         98.000 Impervious SCS Curve No."

```

MIDUSS output for 25-year pre-development storm event

```

"      0.900  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"              0.088      1.027      0.000      0.000 c.m/sec"
"      Catchment 202      Pervious  Impervious Total Area  "
"      Surface Area      0.626      0.176      0.802      hectare"
"      Time of concentration  17.700      1.999      10.551      minutes"
"      Time to Centroid      127.897      91.003      111.098      minutes"
"      Rainfall depth      58.739      58.739      58.739      mm"
"      Rainfall volume      367.45      103.64      471.09      c.m"
"      Rainfall losses      40.902      5.870      33.195      mm"
"      Runoff depth      17.838      52.869      25.545      mm"
"      Runoff volume      111.59      93.28      204.87      c.m"
"      Runoff coefficient      0.304      0.900      0.435      "
"      Maximum flow      0.034      0.081      0.088      c.m/sec"
" 40      HYDROGRAPH Add Runoff  "
"      4      Add Runoff  "
"              0.088      1.067      0.000      0.000"
" 33      CATCHMENT 203"
"      1      Triangular SCS"
"      1      Equal length"
"      1      SCS method"
"      203      External area to East, to 102"
"      0.000      % Impervious"
"      0.508      Total Area"
"      45.000      Flow length"
"      2.000      Overland Slope"
"      0.508      Pervious Area"
"      45.000      Pervious length"
"      2.000      Pervious slope"
"      0.000      Impervious Area"
"      45.000      Impervious length"
"      2.000      Impervious slope"
"      0.250      Pervious Manning 'n'"
"      74.000      Pervious SCS Curve No."
"      0.304      Pervious Runoff coefficient"
"      0.100      Pervious Ia/S coefficient"
"      8.924      Pervious Initial abstraction"
"      0.015      Impervious Manning 'n'"
"      98.000      Impervious SCS Curve No."
"      0.000      Impervious Runoff coefficient"
"      0.100      Impervious Ia/S coefficient"
"      0.518      Impervious Initial abstraction"
"              0.027      1.067      0.000      0.000 c.m/sec"
"      Catchment 203      Pervious  Impervious Total Area  "
"      Surface Area      0.508      0.000      0.508      hectare"
"      Time of concentration  17.940      2.027      17.940      minutes"
"      Time to Centroid      128.252      91.052      128.252      minutes"
"      Rainfall depth      58.739      58.739      58.739      mm"
"      Rainfall volume      298.40      0.00      298.40      c.m"
"      Rainfall losses      40.904      5.832      40.904      mm"
"      Runoff depth      17.835      52.908      17.835      mm"
"      Runoff volume      90.60      0.00      90.60      c.m"
"      Runoff coefficient      0.304      0.000      0.304      "
"      Maximum flow      0.027      0.000      0.027      c.m/sec"
" 40      HYDROGRAPH Add Runoff  "
"      4      Add Runoff  "
"              0.027      1.090      0.000      0.000"
" 40      HYDROGRAPH Copy to Outflow"

```

MIDUSS output for 25-year pre-development storm event

---

```

"          8   Copy to Outflow"
"              0.027   1.090   1.090   0.000"
" 40          HYDROGRAPH   Combine   203"
"          6   Combine  "
"        203   Node #"
"          Total outflow"
"          Maximum flow              1.090   c.m/sec"
"          Hydrograph volume          4595.706   c.m"
"              0.027   1.090   1.090   1.090"
" 38          START/RE-START TOTALS 203"
"          3   Runoff Totals on EXIT"
"          Total Catchment area              17.259   hectare"
"          Total Impervious area              0.292   hectare"
"          Total % impervious              1.690"
" 19          EXIT"

```

MIDUSS output for 100-year pre-development storm event

```

"          MIDUSS Output ----->"
"          MIDUSS version                Version 2.25  rev. 473"
"          MIDUSS created                Sunday, February 7, 2010"
"          10  Units used:                ie METRIC"
"          Job folder:                   C:\M\Meritech Engineering\PRJ - DOCS\5008\
"                                         60-Design\SWM\MIDUSS"
"          Output filename:              5008x100yrSep292022.out"
"          Licensee name:                 Windows User"
"          Company                        "
"          Date & Time last used:         9/29/2022 at 11:45:20 AM"
" 81  ADD COMMENT=====
"          2  Lines of comment"
"          SWM analysis for the Palmerston Subdivision"
"          100-year, 3 hour pre-development event"
" 31  TIME PARAMETERS"
"          5.000  Time Step"
"          180.000  Max. Storm length"
"          1500.000  Max. Hydrograph"
" 32  STORM Chicago storm"
"          1  Chicago storm"
"          896.530  Coefficient A"
"          0.027  Constant B"
"          0.699  Exponent C"
"          0.400  Fraction R"
"          180.000  Duration"
"          1.000  Time step multiplier"
"          Maximum intensity                289.968  mm/hr"
"          Total depth                      71.319  mm"
"          6  100hyd  Hydrograph extension used in this file"
" 81  ADD COMMENT=====
"          1  Lines of comment"
"          Internal Catchments"
" 33  CATCHMENT 101"
"          1  Triangular SCS"
"          1  Equal length"
"          1  SCS method"
"          101  West Side"
"          0.000  % Impervious"
"          9.517  Total Area"
"          170.000  Flow length"
"          2.100  Overland Slope"
"          9.517  Pervious Area"
"          170.000  Pervious length"
"          2.100  Pervious slope"
"          0.000  Impervious Area"
"          170.000  Impervious length"
"          2.100  Impervious slope"
"          0.250  Pervious Manning 'n'"
"          83.000  Pervious SCS Curve No."
"          0.518  Pervious Runoff coefficient"
"          0.100  Pervious Ia/S coefficient"
"          5.202  Pervious Initial abstraction"
"          0.015  Impervious Manning 'n'"
"          98.000  Impervious SCS Curve No."
"          0.000  Impervious Runoff coefficient"
"          0.100  Impervious Ia/S coefficient"
"          0.518  Impervious Initial abstraction"
"          0.873  0.000  0.000  0.000 c.m/sec"
"          Catchment 101          Pervious  Impervious Total Area "

```

MIDUSS output for 100-year pre-development storm event

```

"          Surface Area          9.517      0.000      9.517      hectare"
"          Time of concentration  27.954      4.083      27.954      minutes"
"          Time to Centroid      140.714     94.115     140.714     minutes"
"          Rainfall depth        71.319     71.319     71.319      mm"
"          Rainfall volume       6787.42    0.01       6787.43    c.m"
"          Rainfall losses       34.341     6.239     34.341      mm"
"          Runoff depth          36.978     65.080     36.978      mm"
"          Runoff volume         3519.18    0.01       3519.19    c.m"
"          Runoff coefficient     0.518     0.000     0.518      "
"          Maximum flow          0.873     0.000     0.873      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"                  0.873      0.873      0.000      0.000"
" 33          CATCHMENT 102"
"          1      Triangular SCS"
"          1      Equal length"
"          1      SCS method"
"          102     East Side"
"          0.000   % Impervious"
"          5.712   Total Area"
"          120.000 Flow length"
"          3.000   Overland Slope"
"          5.712   Pervious Area"
"          120.000 Pervious length"
"          3.000   Pervious slope"
"          0.000   Impervious Area"
"          120.000 Impervious length"
"          3.000   Impervious slope"
"          0.250   Pervious Manning 'n'"
"          83.000   Pervious SCS Curve No."
"          0.519   Pervious Runoff coefficient"
"          0.100   Pervious Ia/S coefficient"
"          5.202   Pervious Initial abstraction"
"          0.015   Impervious Manning 'n'"
"          98.000   Impervious SCS Curve No."
"          0.000   Impervious Runoff coefficient"
"          0.100   Impervious Ia/S coefficient"
"          0.518   Impervious Initial abstraction"
"                  0.671      0.873      0.000      0.000 c.m/sec"
"          Catchment 102          Pervious  Impervious Total Area "
"          Surface Area          5.712      0.000      5.712      hectare"
"          Time of concentration  20.380     2.977     20.380     minutes"
"          Time to Centroid      128.800    92.152    128.800    minutes"
"          Rainfall depth        71.319     71.319     71.319      mm"
"          Rainfall volume       4073.74    0.00       4073.74    c.m"
"          Rainfall losses       34.338     6.249     34.338      mm"
"          Runoff depth          36.981     65.070     36.981      mm"
"          Runoff volume         2112.35    0.00       2112.35    c.m"
"          Runoff coefficient     0.519     0.000     0.519      "
"          Maximum flow          0.671     0.000     0.671      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"                  0.671      1.502      0.000      0.000"
" 81          ADD COMMENT=====
"          1      Lines of comment"
"          External catchments"
" 33          CATCHMENT 201"
"          1      Triangular SCS"
"          1      Equal length"

```

MIDUSS output for 100-year pre-development storm event

```

"          1  SCS method"
"          201 External area to SW, to 101"
"         16.000 % Impervious"
"          0.720 Total Area"
"         33.000 Flow length"
"          2.000 Overland Slope"
"          0.605 Pervious Area"
"         33.000 Pervious length"
"          2.000 Pervious slope"
"          0.115 Impervious Area"
"         33.000 Impervious length"
"          2.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"         74.000 Pervious SCS Curve No."
"          0.359 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          8.924 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"         98.000 Impervious SCS Curve No."
"          0.909 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"
"              0.089      1.502      0.000      0.000 c.m/sec"
"          Catchment 201      Pervious      Impervious Total Area "
"          Surface Area      0.605      0.115      0.720      hectare"
"          Time of concentration      12.645      1.549      9.035      minutes"
"          Time to Centroid      119.362      89.653      109.695      minutes"
"          Rainfall depth      71.319      71.319      71.319      mm"
"          Rainfall volume      431.34      82.16      513.50      c.m"
"          Rainfall losses      45.726      6.513      39.452      mm"
"          Runoff depth      25.593      64.806      31.867      mm"
"          Runoff volume      154.79      74.66      229.44      c.m"
"          Runoff coefficient      0.359      0.909      0.447      "
"          Maximum flow      0.064      0.069      0.089      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"              0.089      1.564      0.000      0.000"
" 33          CATCHMENT 202"
"          1      Triangular SCS"
"          1      Equal length"
"          1      SCS method"
"          202 External area to SE, to 102"
"         22.000 % Impervious"
"          0.802 Total Area"
"         44.000 Flow length"
"          2.000 Overland Slope"
"          0.626 Pervious Area"
"         44.000 Pervious length"
"          2.000 Pervious slope"
"          0.176 Impervious Area"
"         44.000 Impervious length"
"          2.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"         74.000 Pervious SCS Curve No."
"          0.360 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          8.924 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"         98.000 Impervious SCS Curve No."

```

MIDUSS output for 100-year pre-development storm event

```

"      0.912  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"              0.115      1.564      0.000      0.000 c.m/sec"
"      Catchment 202      Pervious  Impervious Total Area  "
"      Surface Area      0.626      0.176      0.802      hectare"
"      Time of concentration  15.027      1.841      9.530      minutes"
"      Time to Centroid      122.923      90.174      109.269      minutes"
"      Rainfall depth      71.319      71.319      71.319      mm"
"      Rainfall volume      446.14      125.84      571.98      c.m"
"      Rainfall losses      45.668      6.289      37.004      mm"
"      Runoff depth      25.651      65.030      34.315      mm"
"      Runoff volume      160.46      114.74      275.20      c.m"
"      Runoff coefficient      0.360      0.912      0.481      "
"      Maximum flow      0.062      0.102      0.115      c.m/sec"
" 40      HYDROGRAPH Add Runoff  "
"      4      Add Runoff  "
"              0.115      1.630      0.000      0.000"
" 33      CATCHMENT 203"
"      1      Triangular SCS"
"      1      Equal length"
"      1      SCS method"
"      203      External area to East, to 102"
"      0.000      % Impervious"
"      0.508      Total Area"
"      45.000      Flow length"
"      2.000      Overland Slope"
"      0.508      Pervious Area"
"      45.000      Pervious length"
"      2.000      Pervious slope"
"      0.000      Impervious Area"
"      45.000      Impervious length"
"      2.000      Impervious slope"
"      0.250      Pervious Manning 'n'"
"      74.000      Pervious SCS Curve No."
"      0.360      Pervious Runoff coefficient"
"      0.100      Pervious Ia/S coefficient"
"      8.924      Pervious Initial abstraction"
"      0.015      Impervious Manning 'n'"
"      98.000      Impervious SCS Curve No."
"      0.000      Impervious Runoff coefficient"
"      0.100      Impervious Ia/S coefficient"
"      0.518      Impervious Initial abstraction"
"              0.050      1.630      0.000      0.000 c.m/sec"
"      Catchment 203      Pervious  Impervious Total Area  "
"      Surface Area      0.508      0.000      0.508      hectare"
"      Time of concentration  15.231      1.866      15.231      minutes"
"      Time to Centroid      123.239      90.224      123.239      minutes"
"      Rainfall depth      71.319      71.319      71.319      mm"
"      Rainfall volume      362.30      0.00      362.30      c.m"
"      Rainfall losses      45.675      6.254      45.675      mm"
"      Runoff depth      25.644      65.065      25.644      mm"
"      Runoff volume      130.27      0.00      130.27      c.m"
"      Runoff coefficient      0.360      0.000      0.360      "
"      Maximum flow      0.050      0.000      0.050      c.m/sec"
" 40      HYDROGRAPH Add Runoff  "
"      4      Add Runoff  "
"              0.050      1.672      0.000      0.000"
" 40      HYDROGRAPH Copy to Outflow"

```

MIDUSS output for 100-year pre-development storm event

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```

"          8   Copy to Outflow"
"          0.050   1.672   1.672   0.000"
" 40         HYDROGRAPH   Combine   203"
"          6   Combine  "
"        203   Node #"
"          Total outflow"
"          Maximum flow           1.672   c.m/sec"
"          Hydrograph volume       6266.466   c.m"
"          0.050   1.672   1.672   1.672"
" 38         START/RE-START TOTALS 203"
"          3   Runoff Totals on EXIT"
"          Total Catchment area           17.259   hectare"
"          Total Impervious area           0.292   hectare"
"          Total % impervious           1.690"
" 19         EXIT"

```

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# ***Appendix D.2: Post-Development Conditions***



MIDUSS output for 2-year post-development storm event

```

"          MIDUSS Output ----->"
"          MIDUSS version                      Version 2.25  rev. 473"
"          MIDUSS created                      Sunday, February 7, 2010"
"          10  Units used:                      ie METRIC"
"          Job folder:                         C:\M\Meritech Engineering\PRJ - DOCS\5008\
"                                               60-Design\SWM\MIDUSS"
"          Output filename:                    5008d2yrOct032022.out"
"          Licensee name:                      Windows User"
"          Company                             "
"          Date & Time last used:              10/3/2022 at 1:26:27 PM"
" 81      ADD COMMENT=====
"          2  Lines of comment"
"          P1 2yr post development conditions. Phase 1 SWM pond and "
"          temporary pond."
" 31      TIME PARAMETERS"
"          5.000  Time Step"
"          180.000  Max. Storm length"
"          1500.000  Max. Hydrograph"
" 32      STORM Chicago storm"
"          1  Chicago storm"
"          409.870  Coefficient A"
"          0.068  Constant B"
"          0.701  Exponent C"
"          0.400  Fraction R"
"          180.000  Duration"
"          1.000  Time step multiplier"
"          Maximum intensity          131.388  mm/hr"
"          Total depth                32.263  mm"
"          4  2hyd  Hydrograph extension used in this file"
" 33      CATCHMENT 801"
"          1  Triangular SCS"
"          1  Equal length"
"          1  SCS method"
"          801  801 External Southwest Catchment"
"          16.000  % Impervious"
"          0.805  Total Area"
"          10.000  Flow length"
"          2.000  Overland Slope"
"          0.676  Pervious Area"
"          10.000  Pervious length"
"          2.000  Pervious slope"
"          0.129  Impervious Area"
"          10.000  Impervious length"
"          2.000  Impervious slope"
"          0.250  Pervious Manning 'n'"
"          74.000  Pervious SCS Curve No."
"          0.150  Pervious Runoff coefficient"
"          0.100  Pervious Ia/S coefficient"
"          8.924  Pervious Initial abstraction"
"          0.015  Impervious Manning 'n'"
"          98.000  Impervious SCS Curve No."
"          0.815  Impervious Runoff coefficient"
"          0.100  Impervious Ia/S coefficient"
"          0.518  Impervious Initial abstraction"
"          0.037  0.000  0.000  0.000 c.m/sec"
"          Catchment 801          Pervious  Impervious Total Area "
"          Surface Area          0.676  0.129  0.805  hectare"
"          Time of concentration  13.875  1.066  7.351  minutes"
"          Time to Centroid      125.943  91.118  108.206  minutes"

```

MIDUSS output for 2-year post-development storm event

"		Rainfall depth	32.263	32.263	32.263	mm"
"		Rainfall volume	218.16	41.55	259.72	c.m"
"		Rainfall losses	27.435	5.953	23.998	mm"
"		Runoff depth	4.828	26.310	8.265	mm"
"		Runoff volume	32.65	33.89	66.53	c.m"
"		Runoff coefficient	0.150	0.815	0.256	"
"		Maximum flow	0.010	0.035	0.037	c.m/sec"
" 40		HYDROGRAPH Add Runoff "				
"	4	Add Runoff "				
"			0.037	0.037	0.000	0.000"
" 33		CATCHMENT 701"				
"	1	Triangular SCS"				
"	1	Equal length"				
"	1	SCS method"				
"	701	Pl Development Catchment"				
"	63.000	% Impervious"				
"	2.728	Total Area"				
"	30.000	Flow length"				
"	2.000	Overland Slope"				
"	1.009	Pervious Area"				
"	30.000	Pervious length"				
"	2.000	Pervious slope"				
"	1.719	Impervious Area"				
"	30.000	Impervious length"				
"	2.000	Impervious slope"				
"	0.250	Pervious Manning 'n'"				
"	79.000	Pervious SCS Curve No."				
"	0.217	Pervious Runoff coefficient"				
"	0.100	Pervious Ia/S coefficient"				
"	6.752	Pervious Initial abstraction"				
"	0.015	Impervious Manning 'n'"				
"	98.000	Impervious SCS Curve No."				
"	0.838	Impervious Runoff coefficient"				
"	0.100	Impervious Ia/S coefficient"				
"	0.518	Impervious Initial abstraction"				
"			0.409	0.037	0.000	0.000 c.m/sec"
"		Catchment 701	Pervious	Impervious	Total Area	"
"		Surface Area	1.009	1.719	2.728	hectare"
"		Time of concentration	21.356	2.060	4.605	minutes"
"		Time to Centroid	134.591	92.903	98.401	minutes"
"		Rainfall depth	32.263	32.263	32.263	mm"
"		Rainfall volume	325.65	554.49	880.14	c.m"
"		Rainfall losses	25.273	5.239	12.651	mm"
"		Runoff depth	6.990	27.024	19.612	mm"
"		Runoff volume	70.56	464.45	535.01	c.m"
"		Runoff coefficient	0.217	0.838	0.608	"
"		Maximum flow	0.018	0.406	0.409	c.m/sec"
" 40		HYDROGRAPH Add Runoff "				
"	4	Add Runoff "				
"			0.409	0.446	0.000	0.000"
" 33		CATCHMENT 702"				
"	1	Triangular SCS"				
"	1	Equal length"				
"	1	SCS method"				
"	702	Pl SWM Pond"				
"	30.000	% Impervious"				
"	0.296	Total Area"				
"	15.000	Flow length"				
"	20.000	Overland Slope"				

MIDUSS output for 2-year post-development storm event

```

"      0.207  Pervious Area"
"      15.000  Pervious length"
"      20.000  Pervious slope"
"      0.089  Impervious Area"
"      15.000  Impervious length"
"      20.000  Impervious slope"
"      0.250  Pervious Manning 'n'"
"      77.000  Pervious SCS Curve No."
"      0.187  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      7.587  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"      98.000  Impervious SCS Curve No."
"      0.797  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"          0.027      0.446      0.000      0.000 c.m/sec"
"      Catchment 702      Pervious      Impervious Total Area "
"      Surface Area      0.207      0.089      0.296      hectare"
"      Time of concentration  7.679      0.681      3.158      minutes"
"      Time to Centroid      116.387      91.071      100.030      minutes"
"      Rainfall depth      32.263      32.263      32.263      mm"
"      Rainfall volume      66.85      28.65      95.50      c.m"
"      Rainfall losses      26.228      6.553      20.325      mm"
"      Runoff depth      6.035      25.710      11.938      mm"
"      Runoff volume      12.51      22.83      35.34      c.m"
"      Runoff coefficient      0.187      0.797      0.370      "
"      Maximum flow      0.006      0.025      0.027      c.m/sec"
" 40      HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"          0.027      0.472      0.000      0.000"
" 81      ADD COMMENT=====
"          1      Lines of comment"
"          Phase 1 SWM Pond"
" 54      POND DESIGN"
"          0.472  Current peak flow      c.m/sec"
"          0.150  Target outflow      c.m/sec"
"          636.9  Hydrograph volume      c.m"
"          23.    Number of stages"
"          393.800  Minimum water level      metre"
"          396.000  Maximum water level      metre"
"          393.800  Starting water level      metre"
"          0      Keep Design Data: 1 = True; 0 = False"
"          Level Discharge      Volume"
"          393.800      0.000      0.000"
"          393.900      0.00488      39.000"
"          394.000      0.02264      81.000"
"          394.100      0.03579      128.000"
"          394.200      0.04527      180.000"
"          394.300      0.05309      237.000"
"          394.400      0.05989      299.000"
"          394.500      0.06599      366.000"
"          394.600      0.07158      438.000"
"          394.700      0.07676      516.000"
"          394.800      0.08161      600.000"
"          394.900      0.08619      690.000"
"          395.000      0.09054      786.000"
"          395.100      0.09469      888.000"
"          395.200      0.09867      997.000"

```

MIDUSS output for 2-year post-development storm event

```

"          395.300      0.1025  1113.000"
"          395.400      0.1062  1236.000"
"          395.500      0.1097  1365.000"
"          395.600      0.1132  1503.000"
"          395.700      0.1165  1645.000"
"          395.800      0.3731  1786.000"
"          395.900      0.8703  1845.000"
"          396.000      1.555   1905.000"
"      1.  WEIRS"
"          Crest      Weir      Crest      Left      Right"
"          elevation coefficient  breadth  sideslope  sideslope"
"          395.700      0.900      5.000      3.000      3.000"
"      1.  ORIFICES"
"          Orifice  Orifice  Orifice  Number of"
"          invert coefficient  diameter  orifices"
"          393.800      0.630      0.2000      1.000"
"          Peak outflow                                0.062      c.m/sec"
"          Maximum level                                394.436      metre"
"          Maximum storage                              322.863      c.m"
"          Centroidal lag                              2.995      hours"
"          0.027      0.472      0.062      0.000 c.m/sec"
" 40  HYDROGRAPH  Combine  1"
"      6  Combine "
"      1  Node #"
"          Total discharge"
"          Maximum flow                                0.062      c.m/sec"
"          Hydrograph volume                          636.885      c.m"
"          0.027      0.472      0.062      0.062"
" 40  HYDROGRAPH Start - New Tributary"
"      2  Start - New Tributary"
"          0.027      0.000      0.062      0.062"
" 33  CATCHMENT 802"
"      1  Triangular SCS"
"      1  Equal length"
"      1  SCS method"
"      802 External Southeast Catchment"
"      2.000 % Impervious"
"      0.717 Total Area"
"      44.000 Flow length"
"      2.000 Overland Slope"
"      0.703 Pervious Area"
"      44.000 Pervious length"
"      2.000 Pervious slope"
"      0.014 Impervious Area"
"      44.000 Impervious length"
"      2.000 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      74.000 Pervious SCS Curve No."
"      0.150 Pervious Runoff coefficient"
"      0.100 Pervious Ia/S coefficient"
"      8.924 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
"      98.000 Impervious SCS Curve No."
"      0.839 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"
"      0.518 Impervious Initial abstraction"
"          0.006      0.000      0.062      0.062 c.m/sec"
"          Catchment 802      Pervious  Impervious Total Area "
"          Surface Area      0.703      0.014      0.717      hectare"

```

MIDUSS output for 2-year post-development storm event

```

"           Time of concentration  33.752    2.593    30.559    minutes"
"           Time to Centroid      152.086   93.762   146.110   minutes"
"           Rainfall depth        32.263   32.263   32.263    mm"
"           Rainfall volume       226.70    4.63    231.33    c.m"
"           Rainfall losses       27.426    5.204   26.982    mm"
"           Runoff depth          4.837    27.059   5.282     mm"
"           Runoff volume         33.99     3.88    37.87     c.m"
"           Runoff coefficient     0.150    0.839    0.164     "
"           Maximum flow          0.006    0.003    0.006     c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"           4    Add Runoff "
"                 0.006    0.006    0.062    0.062"
" 33          CATCHMENT 803"
"           1    Triangular SCS"
"           1    Equal length"
"           1    SCS method"
"           803  External East Catchment"
"           0.000 % Impervious"
"           0.508 Total Area"
"           45.000 Flow length"
"           2.000 Overland Slope"
"           0.508 Pervious Area"
"           45.000 Pervious length"
"           2.000 Pervious slope"
"           0.000 Impervious Area"
"           45.000 Impervious length"
"           2.000 Impervious slope"
"           0.250 Pervious Manning 'n'"
"           74.000 Pervious SCS Curve No."
"           0.150 Pervious Runoff coefficient"
"           0.100 Pervious Ia/S coefficient"
"           8.924 Pervious Initial abstraction"
"           0.015 Impervious Manning 'n'"
"           98.000 Impervious SCS Curve No."
"           0.000 Impervious Runoff coefficient"
"           0.100 Impervious Ia/S coefficient"
"           0.518 Impervious Initial abstraction"
"                 0.004    0.006    0.062    0.062 c.m/sec"
"           Catchment 803          Pervious  Impervious Total Area "
"           Surface Area          0.508    0.000    0.508    hectare"
"           Time of concentration  34.210    2.628    34.210   minutes"
"           Time to Centroid      152.692   93.833   152.691   minutes"
"           Rainfall depth        32.263   32.263   32.263    mm"
"           Rainfall volume       163.90    0.00    163.90    c.m"
"           Rainfall losses       27.427    5.208   27.427    mm"
"           Runoff depth          4.836    27.055   4.836     mm"
"           Runoff volume         24.57     0.00    24.57     c.m"
"           Runoff coefficient     0.150    0.000    0.150     "
"           Maximum flow          0.004    0.000    0.004     c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"           4    Add Runoff "
"                 0.004    0.010    0.062    0.062"
" 40          HYDROGRAPH Copy to Outflow"
"           8    Copy to Outflow"
"                 0.004    0.010    0.010    0.062"
" 40          HYDROGRAPH Combine 1"
"           6    Combine "
"           1    Node #"
"           Total discharge"

```

MIDUSS output for 2-year post-development storm event

```

"          Maximum flow                0.072    c.m/sec"
"          Hydrograph volume           699.321    c.m"
"          0.004    0.010    0.010    0.072"
" 40      HYDROGRAPH Start - New Tributary"
"          2    Start - New Tributary"
"          0.004    0.000    0.010    0.072"
" 33      CATCHMENT 501"
"          1    Triangular SCS"
"          1    Equal length"
"          1    SCS method"
"          501   West Farm Field"
"          0.000   % Impervious"
"          7.777   Total Area"
"          50.000   Flow length"
"          3.000   Overland Slope"
"          7.777   Pervious Area"
"          50.000   Pervious length"
"          3.000   Pervious slope"
"          0.000   Impervious Area"
"          50.000   Impervious length"
"          3.000   Impervious slope"
"          0.250   Pervious Manning 'n'"
"          83.000   Pervious SCS Curve No."
"          0.287   Pervious Runoff coefficient"
"          0.100   Pervious Ia/S coefficient"
"          5.202   Pervious Initial abstraction"
"          0.015   Impervious Manning 'n'"
"          98.000   Impervious SCS Curve No."
"          0.000   Impervious Runoff coefficient"
"          0.100   Impervious Ia/S coefficient"
"          0.518   Impervious Initial abstraction"
"          0.196    0.000    0.010    0.072 c.m/sec"
"          Catchment 501      Pervious      Impervious      Total Area  "
"          Surface Area      7.777      0.000      7.777      hectare"
"          Time of concentration  22.101    2.479    22.101    minutes"
"          Time to Centroid      134.505   93.538   134.505   minutes"
"          Rainfall depth        32.263    32.263    32.263    mm"
"          Rainfall volume        2509.10   0.00     2509.10   c.m"
"          Rainfall losses        23.019    5.187    23.019    mm"
"          Runoff depth           9.244     27.076    9.244     mm"
"          Runoff volume          718.91    0.00     718.92    c.m"
"          Runoff coefficient      0.287    0.000    0.287     "
"          Maximum flow          0.196    0.000    0.196     c.m/sec"
" 40      HYDROGRAPH Add Runoff  "
"          4    Add Runoff  "
"          0.196    0.196    0.010    0.072"
" 33      CATCHMENT 502"
"          1    Triangular SCS"
"          1    Equal length"
"          1    SCS method"
"          502   East Farm Field"
"          0.000   % Impervious"
"          3.970   Total Area"
"          35.000   Flow length"
"          4.000   Overland Slope"
"          3.970   Pervious Area"
"          35.000   Pervious length"
"          4.000   Pervious slope"
"          0.000   Impervious Area"

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MIDUSS output for 2-year post-development storm event

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"      35.000  Impervious length"
"      4.000  Impervious slope"
"      0.250  Pervious Manning 'n'"
"     83.000  Pervious SCS Curve No."
"      0.286  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      5.202  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"     98.000  Impervious SCS Curve No."
"      0.000  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"              0.129      0.196      0.010      0.072 c.m/sec"
"      Catchment 502      Pervious      Impervious      Total Area  "
"      Surface Area      3.970      0.000      3.970      hectare"
"      Time of concentration  16.368      1.836      16.368      minutes"
"      Time to Centroid      126.169      92.472      126.169      minutes"
"      Rainfall depth      32.263      32.263      32.263      mm"
"      Rainfall volume      1280.84      0.00      1280.85      c.m"
"      Rainfall losses      23.029      5.350      23.029      mm"
"      Runoff depth      9.234      26.913      9.234      mm"
"      Runoff volume      366.60      0.00      366.60      c.m"
"      Runoff coefficient      0.286      0.000      0.286      "
"      Maximum flow      0.129      0.000      0.129      c.m/sec"
" 40      HYDROGRAPH Add Runoff  "
"      4      Add Runoff  "
"              0.129      0.308      0.010      0.072"
" 33      CATCHMENT 703"
"      1      Triangular SCS"
"      1      Equal length"
"      1      SCS method"
"      703      Temp SWM Pond"
"     30.000  % Impervious"
"      0.458  Total Area"
"     15.000  Flow length"
"     20.000  Overland Slope"
"      0.321  Pervious Area"
"     15.000  Pervious length"
"     20.000  Pervious slope"
"      0.137  Impervious Area"
"     15.000  Impervious length"
"     20.000  Impervious slope"
"      0.250  Pervious Manning 'n'"
"     77.000  Pervious SCS Curve No."
"      0.187  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      7.587  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"     98.000  Impervious SCS Curve No."
"      0.797  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"              0.041      0.308      0.010      0.072 c.m/sec"
"      Catchment 703      Pervious      Impervious      Total Area  "
"      Surface Area      0.321      0.137      0.458      hectare"
"      Time of concentration  7.679      0.681      3.158      minutes"
"      Time to Centroid      116.387      91.071      100.030      minutes"
"      Rainfall depth      32.263      32.263      32.263      mm"
"      Rainfall volume      103.44      44.33      147.77      c.m"

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MIDUSS output for 2-year post-development storm event

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"          Rainfall losses          26.228      6.553      20.325      mm"
"          Runoff depth              6.035      25.710      11.938      mm"
"          Runoff volume             19.35      35.33      54.67      c.m"
"          Runoff coefficient         0.187      0.797      0.370      "
"          Maximum flow              0.009      0.039      0.041      c.m/sec"
" 40      HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"                  0.041      0.318      0.010      0.072"
" 81      ADD COMMENT=====
"          1      Lines of comment"
"          Temporary Pond (Phase 2)"
" 54      POND DESIGN"
"          0.318      Current peak flow      c.m/sec"
"          0.250      Target outflow      c.m/sec"
"          1140.2      Hydrograph volume      c.m"
"          19.      Number of stages"
"          394.700      Minimum water level      metre"
"          396.500      Maximum water level      metre"
"          394.700      Starting water level      metre"
"          0      Keep Design Data: 1 = True; 0 = False"
"          Level Discharge      Volume"
"          394.700      0.02264      0.000"
"          394.800      0.07054      126.000"
"          394.900      0.08468      262.000"
"          395.000      0.09678      409.000"
"          395.100      0.1075      566.000"
"          395.200      0.1173      734.000"
"          395.300      0.1263      913.000"
"          395.400      0.1347      1103.000"
"          395.500      0.1426      1305.000"
"          395.600      0.1501      1519.000"
"          395.700      0.1573      1744.000"
"          395.800      0.1641      1982.000"
"          395.900      0.1707      2232.000"
"          396.000      0.1770      2495.000"
"          396.100      0.1831      2770.000"
"          396.200      0.1890      3058.000"
"          396.300      0.4480      3359.000"
"          396.400      0.9476      3674.000"
"          396.500      1.635      3795.000"
"          1.      WEIRS"
"          Crest      Weir      Crest      Left      Right"
"          elevation coefficie      breadth sideslope sideslope"
"          396.200      0.900      5.000      3.000      3.000"
"          1.      ORIFICES"
"          Orifice      Orifice      Orifice      Number of"
"          invert coefficie      diameter orifices"
"          394.400      0.630      0.2600      1.000"
"          Peak outflow              0.098      c.m/sec"
"          Maximum level              395.008      metre"
"          Maximum storage              420.903      c.m"
"          Centroidal lag              3.117      hours"
"          0.041      0.318      0.098      0.072 c.m/sec"
" 40      HYDROGRAPH Combine      1"
"          6      Combine "
"          1      Node #"
"          Total discharge"
"          Maximum flow              0.166      c.m/sec"
"          Hydrograph volume              1839.601      c.m"

```

MIDUSS output for 2-year post-development storm event

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"          0.041    0.318    0.098    0.166"
" 38      START/RE-START TOTALS 703"
"          3  Runoff Totals on EXIT"
"          Total Catchment area          17.259    hectare"
"          Total Impervious area          2.088    hectare"
"          Total % impervious          12.098"
" 19      EXIT"

```

MIDUSS output for 5-year post-development storm event

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"          MIDUSS Output ----->"
"          MIDUSS version                      Version 2.25  rev. 473"
"          MIDUSS created                      Sunday, February 7, 2010"
"          10  Units used:                      ie METRIC"
"          Job folder:                         C:\M\Meritech Engineering\PRJ - DOCS\5008\
"                                               60-Design\SWM\MIDUSS"
"          Output filename:                    5008d5yrOct032022.out"
"          Licensee name:                      Windows User"
"          Company                             "
"          Date & Time last used:              10/3/2022 at 1:27:42 PM"
" 81      ADD COMMENT=====
"          2  Lines of comment"
"          P1 5yr post development conditions. Phase 1 SWM pond and "
"          temporary pond."
" 31      TIME PARAMETERS"
"          5.000  Time Step"
"          180.000  Max. Storm length"
"          1500.000  Max. Hydrograph"
" 32      STORM Chicago storm"
"          1  Chicago storm"
"          547.190  Coefficient A"
"          0.093  Constant B"
"          0.702  Exponent C"
"          0.400  Fraction R"
"          180.000  Duration"
"          1.000  Time step multiplier"
"          Maximum intensity          174.519  mm/hr"
"          Total depth                42.845  mm"
"          4  5hyd Hydrograph extension used in this file"
" 33      CATCHMENT 801"
"          1  Triangular SCS"
"          1  Equal length"
"          1  SCS method"
"          801  801 External Southwest Catchment"
"          16.000  % Impervious"
"          0.805  Total Area"
"          10.000  Flow length"
"          2.000  Overland Slope"
"          0.676  Pervious Area"
"          10.000  Pervious length"
"          2.000  Pervious slope"
"          0.129  Impervious Area"
"          10.000  Impervious length"
"          2.000  Impervious slope"
"          0.250  Pervious Manning 'n'"
"          74.000  Pervious SCS Curve No."
"          0.217  Pervious Runoff coefficient"
"          0.100  Pervious Ia/S coefficient"
"          8.924  Pervious Initial abstraction"
"          0.015  Impervious Manning 'n'"
"          98.000  Impervious SCS Curve No."
"          0.843  Impervious Runoff coefficient"
"          0.100  Impervious Ia/S coefficient"
"          0.518  Impervious Initial abstraction"
"          0.057  0.000  0.000  0.000 c.m/sec"
"          Catchment 801          Pervious  Impervious Total Area "
"          Surface Area          0.676  0.129  0.805  hectare"
"          Time of concentration  9.830  0.939  6.047  minutes"
"          Time to Centroid      118.354  89.840  106.221  minutes"

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MIDUSS output for 5-year post-development storm event

"		Rainfall depth	42.845	42.845	42.845	mm"
"		Rainfall volume	289.72	55.18	344.90	c.m"
"		Rainfall losses	33.561	6.745	29.270	mm"
"		Runoff depth	9.284	36.100	13.575	mm"
"		Runoff volume	62.78	46.50	109.28	c.m"
"		Runoff coefficient	0.217	0.843	0.317	"
"		Maximum flow	0.024	0.049	0.057	c.m/sec"
" 40		HYDROGRAPH Add Runoff "				
"	4	Add Runoff "				
"			0.057	0.057	0.000	0.000"
" 33		CATCHMENT 701"				
"	1	Triangular SCS"				
"	1	Equal length"				
"	1	SCS method"				
"	701	P1 Development Catchment"				
"	63.000	% Impervious"				
"	2.728	Total Area"				
"	30.000	Flow length"				
"	2.000	Overland Slope"				
"	1.009	Pervious Area"				
"	30.000	Pervious length"				
"	2.000	Pervious slope"				
"	1.719	Impervious Area"				
"	30.000	Impervious length"				
"	2.000	Impervious slope"				
"	0.250	Pervious Manning 'n'"				
"	79.000	Pervious SCS Curve No."				
"	0.292	Pervious Runoff coefficient"				
"	0.100	Pervious Ia/S coefficient"				
"	6.752	Pervious Initial abstraction"				
"	0.015	Impervious Manning 'n'"				
"	98.000	Impervious SCS Curve No."				
"	0.867	Impervious Runoff coefficient"				
"	0.100	Impervious Ia/S coefficient"				
"	0.518	Impervious Initial abstraction"				
"			0.588	0.057	0.000	0.000 c.m/sec"
"		Catchment 701	Pervious	Impervious	Total Area	"
"		Surface Area	1.009	1.719	2.728	hectare"
"		Time of concentration	16.213	1.816	4.196	minutes"
"		Time to Centroid	125.783	91.480	97.150	minutes"
"		Rainfall depth	42.845	42.845	42.845	mm"
"		Rainfall volume	432.46	736.35	1168.81	c.m"
"		Rainfall losses	30.315	5.686	14.798	mm"
"		Runoff depth	12.530	37.159	28.047	mm"
"		Runoff volume	126.48	638.64	765.11	c.m"
"		Runoff coefficient	0.292	0.867	0.655	"
"		Maximum flow	0.045	0.579	0.588	c.m/sec"
" 40		HYDROGRAPH Add Runoff "				
"	4	Add Runoff "				
"			0.588	0.644	0.000	0.000"
" 33		CATCHMENT 702"				
"	1	Triangular SCS"				
"	1	Equal length"				
"	1	SCS method"				
"	702	P1 SWM Pond"				
"	30.000	% Impervious"				
"	0.296	Total Area"				
"	15.000	Flow length"				
"	20.000	Overland Slope"				

MIDUSS output for 5-year post-development storm event

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"      0.207  Pervious Area"
"      15.000  Pervious length"
"      20.000  Pervious slope"
"      0.089  Impervious Area"
"      15.000  Impervious length"
"      20.000  Impervious slope"
"      0.250  Pervious Manning 'n'"
"      77.000  Pervious SCS Curve No."
"      0.260  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      7.587  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"      98.000  Impervious SCS Curve No."
"      0.821  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"          0.041      0.644      0.000      0.000 c.m/sec"
"      Catchment 702      Pervious      Impervious      Total Area "
"      Surface Area      0.207      0.089      0.296      hectare"
"      Time of concentration  5.697      0.601      2.767      minutes"
"      Time to Centroid      111.153      90.080      99.039      minutes"
"      Rainfall depth      42.845      42.845      42.845      mm"
"      Rainfall volume      88.77      38.05      126.82      c.m"
"      Rainfall losses      31.701      7.687      24.497      mm"
"      Runoff depth      11.144      35.158      18.348      mm"
"      Runoff volume      23.09      31.22      54.31      c.m"
"      Runoff coefficient      0.260      0.821      0.428      "
"      Maximum flow      0.014      0.035      0.041      c.m/sec"
" 40      HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"          0.041      0.685      0.000      0.000"
" 81      ADD COMMENT=====
"          1      Lines of comment"
"          Phase 1 SWM Pond"
" 54      POND DESIGN"
"          0.685      Current peak flow      c.m/sec"
"          0.150      Target outflow      c.m/sec"
"          928.7      Hydrograph volume      c.m"
"          23.      Number of stages"
"          393.800      Minimum water level      metre"
"          396.000      Maximum water level      metre"
"          393.800      Starting water level      metre"
"          0      Keep Design Data: 1 = True; 0 = False"
"          Level Discharge      Volume"
"          393.800      0.000      0.000"
"          393.900      0.00488      39.000"
"          394.000      0.02264      81.000"
"          394.100      0.03579      128.000"
"          394.200      0.04527      180.000"
"          394.300      0.05309      237.000"
"          394.400      0.05989      299.000"
"          394.500      0.06599      366.000"
"          394.600      0.07158      438.000"
"          394.700      0.07676      516.000"
"          394.800      0.08161      600.000"
"          394.900      0.08619      690.000"
"          395.000      0.09054      786.000"
"          395.100      0.09469      888.000"
"          395.200      0.09867      997.000"

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MIDUSS output for 5-year post-development storm event

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"          395.300      0.1025  1113.000"
"          395.400      0.1062  1236.000"
"          395.500      0.1097  1365.000"
"          395.600      0.1132  1503.000"
"          395.700      0.1165  1645.000"
"          395.800      0.3731  1786.000"
"          395.900      0.8703  1845.000"
"          396.000      1.555   1905.000"
"      1.  WEIRS"
"          Crest      Weir      Crest      Left      Right"
"          elevation coefficient  breadth  sideslope  sideslope"
"          395.700      0.900      5.000      3.000      3.000"
"      1.  ORIFICES"
"          Orifice  Orifice  Orifice  Number of"
"          invert coefficient  diameter  orifices"
"          393.800      0.630      0.2000      1.000"
"          Peak outflow                                0.076      c.m/sec"
"          Maximum level                                394.683      metre"
"          Maximum storage                                502.379      c.m"
"          Centroidal lag                                3.201      hours"
"          0.041      0.685      0.076      0.000 c.m/sec"
" 40  HYDROGRAPH  Combine  1"
"      6  Combine "
"      1  Node #"
"          Total discharge"
"          Maximum flow                                0.076      c.m/sec"
"          Hydrograph volume                            928.800      c.m"
"          0.041      0.685      0.076      0.076"
" 40  HYDROGRAPH Start - New Tributary"
"      2  Start - New Tributary"
"          0.041      0.000      0.076      0.076"
" 33  CATCHMENT 802"
"      1  Triangular SCS"
"      1  Equal length"
"      1  SCS method"
"      802 External Southeast Catchment"
"      2.000 % Impervious"
"      0.717 Total Area"
"      44.000 Flow length"
"      2.000 Overland Slope"
"      0.703 Pervious Area"
"      44.000 Pervious length"
"      2.000 Pervious slope"
"      0.014 Impervious Area"
"      44.000 Impervious length"
"      2.000 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      74.000 Pervious SCS Curve No."
"      0.218 Pervious Runoff coefficient"
"      0.100 Pervious Ia/S coefficient"
"      8.924 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
"      98.000 Impervious SCS Curve No."
"      0.874 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"
"      0.518 Impervious Initial abstraction"
"          0.017      0.000      0.076      0.076 c.m/sec"
"          Catchment 802      Pervious  Impervious Total Area "
"          Surface Area      0.703      0.014      0.717      hectare"

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MIDUSS output for 5-year post-development storm event

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"           Time of concentration  23.914      2.285      22.278      minutes"
"           Time to Centroid      138.127    92.266    134.660    minutes"
"           Rainfall depth        42.845     42.845     42.845     mm"
"           Rainfall volume       301.06     6.14      307.20     c.m"
"           Rainfall losses       33.505     5.412     32.943     mm"
"           Runoff depth          9.340      37.433     9.902      mm"
"           Runoff volume         65.63      5.37      71.00      c.m"
"           Runoff coefficient     0.218      0.874     0.231      "
"           Maximum flow          0.016      0.005     0.017      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"           4  Add Runoff "
"               0.017      0.017      0.076      0.076"
" 33          CATCHMENT 803"
"           1  Triangular SCS"
"           1  Equal length"
"           1  SCS method"
"           803 External East Catchment"
"           0.000 % Impervious"
"           0.508 Total Area"
"           45.000 Flow length"
"           2.000 Overland Slope"
"           0.508 Pervious Area"
"           45.000 Pervious length"
"           2.000 Pervious slope"
"           0.000 Impervious Area"
"           45.000 Impervious length"
"           2.000 Impervious slope"
"           0.250 Pervious Manning 'n'"
"           74.000 Pervious SCS Curve No."
"           0.218 Pervious Runoff coefficient"
"           0.100 Pervious Ia/S coefficient"
"           8.924 Pervious Initial abstraction"
"           0.015 Impervious Manning 'n'"
"           98.000 Impervious SCS Curve No."
"           0.000 Impervious Runoff coefficient"
"           0.100 Impervious Ia/S coefficient"
"           0.518 Impervious Initial abstraction"
"               0.011      0.017      0.076      0.076 c.m/sec"
"           Catchment 803          Pervious  Impervious Total Area "
"           Surface Area          0.508      0.000      0.508      hectare"
"           Time of concentration  24.238     2.316     24.238     minutes"
"           Time to Centroid      138.584    92.303    138.583    minutes"
"           Rainfall depth        42.845     42.845     42.845     mm"
"           Rainfall volume       217.65     0.00      217.65     c.m"
"           Rainfall losses       33.505     5.410     33.505     mm"
"           Runoff depth          9.340      37.435     9.340      mm"
"           Runoff volume         47.45      0.00      47.45      c.m"
"           Runoff coefficient     0.218      0.000     0.218      "
"           Maximum flow          0.011      0.000     0.011      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"           4  Add Runoff "
"               0.011      0.028      0.076      0.076"
" 40          HYDROGRAPH Copy to Outflow"
"           8  Copy to Outflow"
"               0.011      0.028      0.028      0.076"
" 40          HYDROGRAPH Combine  1"
"           6  Combine "
"           1  Node #"
"           Total discharge"

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MIDUSS output for 5-year post-development storm event

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"           Maximum flow                0.101    c.m/sec"
"           Hydrograph volume            1047.247  c.m"
"           0.011    0.028    0.028    0.101"
" 40        HYDROGRAPH Start - New Tributary"
"           2    Start - New Tributary"
"           0.011    0.000    0.028    0.101"
" 33        CATCHMENT 501"
"           1    Triangular SCS"
"           1    Equal length"
"           1    SCS method"
"           501   West Farm Field"
"           0.000  % Impervious"
"           7.777  Total Area"
"           50.000 Flow length"
"           3.000  Overland Slope"
"           7.777  Pervious Area"
"           50.000 Pervious length"
"           3.000  Pervious slope"
"           0.000  Impervious Area"
"           50.000 Impervious length"
"           3.000  Impervious slope"
"           0.250  Pervious Manning 'n'"
"           83.000 Pervious SCS Curve No."
"           0.369  Pervious Runoff coefficient"
"           0.100  Pervious Ia/S coefficient"
"           5.202  Pervious Initial abstraction"
"           0.015  Impervious Manning 'n'"
"           98.000 Impervious SCS Curve No."
"           0.000  Impervious Runoff coefficient"
"           0.100  Impervious Ia/S coefficient"
"           0.518  Impervious Initial abstraction"
"           0.403    0.000    0.028    0.101 c.m/sec"
"           Catchment 501      Pervious  Impervious Total Area "
"           Surface Area      7.777      0.000      7.777      hectare"
"           Time of concentration 17.393      2.185      17.393      minutes"
"           Time to Centroid    126.167     92.134     126.166     minutes"
"           Rainfall depth      42.845     42.845     42.845      mm"
"           Rainfall volume     3332.06    0.00      3332.06    c.m"
"           Rainfall losses     27.051     5.430     27.051      mm"
"           Runoff depth        15.794     37.416     15.794      mm"
"           Runoff volume       1228.29    0.00      1228.30    c.m"
"           Runoff coefficient   0.369     0.000     0.369      "
"           Maximum flow        0.403     0.000     0.403      c.m/sec"
" 40        HYDROGRAPH Add Runoff "
"           4    Add Runoff "
"           0.403    0.403    0.028    0.101"
" 33        CATCHMENT 502"
"           1    Triangular SCS"
"           1    Equal length"
"           1    SCS method"
"           502   East Farm Field"
"           0.000  % Impervious"
"           3.970  Total Area"
"           35.000 Flow length"
"           4.000  Overland Slope"
"           3.970  Pervious Area"
"           35.000 Pervious length"
"           4.000  Pervious slope"
"           0.000  Impervious Area"

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MIDUSS output for 5-year post-development storm event

```

"      35.000  Impervious length"
"      4.000  Impervious slope"
"      0.250  Pervious Manning 'n'"
"     83.000  Pervious SCS Curve No."
"      0.367  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      5.202  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"     98.000  Impervious SCS Curve No."
"      0.000  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"              0.258      0.403      0.028      0.101 c.m/sec"
"      Catchment 502      Pervious      Impervious      Total Area  "
"      Surface Area      3.970      0.000      3.970      hectare"
"      Time of concentration  12.881      1.618      12.881      minutes"
"      Time to Centroid      119.430      91.093      119.430      minutes"
"      Rainfall depth      42.845      42.845      42.845      mm"
"      Rainfall volume      1700.95      0.00      1700.95      c.m"
"      Rainfall losses      27.109      5.782      27.109      mm"
"      Runoff depth      15.736      37.063      15.736      mm"
"      Runoff volume      624.72      0.00      624.72      c.m"
"      Runoff coefficient      0.367      0.000      0.367      "
"      Maximum flow      0.258      0.000      0.258      c.m/sec"
" 40      HYDROGRAPH Add Runoff  "
"      4      Add Runoff  "
"              0.258      0.661      0.028      0.101"
" 33      CATCHMENT 703"
"      1      Triangular SCS"
"      1      Equal length"
"      1      SCS method"
"      703      Temp SWM Pond"
"     30.000  % Impervious"
"      0.458  Total Area"
"     15.000  Flow length"
"     20.000  Overland Slope"
"      0.321  Pervious Area"
"     15.000  Pervious length"
"     20.000  Pervious slope"
"      0.137  Impervious Area"
"     15.000  Impervious length"
"     20.000  Impervious slope"
"      0.250  Pervious Manning 'n'"
"     77.000  Pervious SCS Curve No."
"      0.260  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      7.587  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"     98.000  Impervious SCS Curve No."
"      0.821  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"              0.063      0.661      0.028      0.101 c.m/sec"
"      Catchment 703      Pervious      Impervious      Total Area  "
"      Surface Area      0.321      0.137      0.458      hectare"
"      Time of concentration  5.697      0.601      2.767      minutes"
"      Time to Centroid      111.153      90.080      99.039      minutes"
"      Rainfall depth      42.845      42.845      42.845      mm"
"      Rainfall volume      137.36      58.87      196.23      c.m"

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MIDUSS output for 5-year post-development storm event

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"          Rainfall losses          31.701      7.687      24.497      mm"
"          Runoff depth             11.144      35.158      18.348      mm"
"          Runoff volume            35.73       48.31       84.04       c.m"
"          Runoff coefficient        0.260       0.821       0.428       "
"          Maximum flow             0.021       0.054       0.063       c.m/sec"
" 40      HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"                  0.063      0.684      0.028      0.101"
" 81      ADD COMMENT=====
"          1      Lines of comment"
"          Temporary Pond (Phase 2)"
" 54      POND DESIGN"
"          0.684      Current peak flow      c.m/sec"
"          0.250      Target outflow      c.m/sec"
"          1937.1      Hydrograph volume      c.m"
"          19.      Number of stages"
"          394.700      Minimum water level      metre"
"          396.500      Maximum water level      metre"
"          394.700      Starting water level      metre"
"          0      Keep Design Data: 1 = True; 0 = False"
"          Level Discharge      Volume"
"          394.700      0.02264      0.000"
"          394.800      0.07054      126.000"
"          394.900      0.08468      262.000"
"          395.000      0.09678      409.000"
"          395.100      0.1075       566.000"
"          395.200      0.1173       734.000"
"          395.300      0.1263       913.000"
"          395.400      0.1347      1103.000"
"          395.500      0.1426      1305.000"
"          395.600      0.1501      1519.000"
"          395.700      0.1573      1744.000"
"          395.800      0.1641      1982.000"
"          395.900      0.1707      2232.000"
"          396.000      0.1770      2495.000"
"          396.100      0.1831      2770.000"
"          396.200      0.1890      3058.000"
"          396.300      0.4480      3359.000"
"          396.400      0.9476      3674.000"
"          396.500      1.635       3795.000"
"          1.      WEIRS"
"          Crest      Weir      Crest      Left      Right"
"          elevation coefficient      breadth      sideslope      sideslope"
"          396.200      0.900      5.000      3.000      3.000"
"          1.      ORIFICES"
"          Orifice      Orifice      Orifice      Number of"
"          invert coefficient      diameter      orifices"
"          394.400      0.630      0.2600      1.000"
"          Peak outflow                      0.128      c.m/sec"
"          Maximum level                      395.324      metre"
"          Maximum storage                      957.684      c.m"
"          Centroidal lag                      3.614      hours"
"          0.063      0.684      0.128      0.101 c.m/sec"
" 40      HYDROGRAPH Combine      1"
"          6      Combine "
"          1      Node #"
"          Total discharge"
"          Maximum flow                      0.216      c.m/sec"
"          Hydrograph volume                  2985.543      c.m"

```

MIDUSS output for 5-year post-development storm event

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"          0.063    0.684    0.128    0.216"
" 38      START/RE-START TOTALS 703"
"          3  Runoff Totals on EXIT"
"          Total Catchment area          17.259    hectare"
"          Total Impervious area          2.088    hectare"
"          Total % impervious          12.098"
" 19      EXIT"

```

MIDUSS output for 25-year post-development storm event

```

"          MIDUSS Output ----->"
"          MIDUSS version                      Version 2.25  rev. 473"
"          MIDUSS created                      Sunday, February 7, 2010"
"          10  Units used:                      ie METRIC"
"          Job folder:                         C:\M\Meritech Engineering\PRJ - DOCS\5008\
"                                               60-Design\SWM\MIDUSS"
"          Output filename:                    5008d25yrOct032022.out"
"          Licensee name:                      Windows User"
"          Company                             "
"          Date & Time last used:              10/3/2022 at 1:27:04 PM"
" 81      ADD COMMENT=====
"          2  Lines of comment"
"          P1 25yr post development conditions. Phase 1 SWM pond and "
"          temporary pond."
" 31      TIME PARAMETERS"
"          5.000  Time Step"
"          180.000  Max. Storm length"
"          1500.000  Max. Hydrograph"
" 32      STORM Chicago storm"
"          1  Chicago storm"
"          734.550  Coefficient A"
"          0.020  Constant B"
"          0.698  Exponent C"
"          0.400  Fraction R"
"          180.000  Duration"
"          1.000  Time step multiplier"
"          Maximum intensity          238.194  mm/hr"
"          Total depth                58.739  mm"
"          5  25hyd  Hydrograph extension used in this file"
" 33      CATCHMENT 801"
"          1  Triangular SCS"
"          1  Equal length"
"          1  SCS method"
"          801  801 External Southwest Catchment"
"          16.000  % Impervious"
"          0.805  Total Area"
"          10.000  Flow length"
"          2.000  Overland Slope"
"          0.676  Pervious Area"
"          10.000  Pervious length"
"          2.000  Pervious slope"
"          0.129  Impervious Area"
"          10.000  Impervious length"
"          2.000  Impervious slope"
"          0.250  Pervious Manning 'n'"
"          74.000  Pervious SCS Curve No."
"          0.302  Pervious Runoff coefficient"
"          0.100  Pervious Ia/S coefficient"
"          8.924  Pervious Initial abstraction"
"          0.015  Impervious Manning 'n'"
"          98.000  Impervious SCS Curve No."
"          0.867  Impervious Runoff coefficient"
"          0.100  Impervious Ia/S coefficient"
"          0.518  Impervious Initial abstraction"
"          0.093  0.000  0.000  0.000 c.m/sec"
"          Catchment 801          Pervious  Impervious Total Area "
"          Surface Area          0.676  0.129  0.805  hectare"
"          Time of concentration  7.276  0.822  4.995  minutes"
"          Time to Centroid      112.686  88.975  104.305  minutes"

```

MIDUSS output for 25-year post-development storm event

"		Rainfall depth	58.739	58.739	58.739	mm"
"		Rainfall volume	397.20	75.66	472.85	c.m"
"		Rainfall losses	40.998	7.814	35.689	mm"
"		Runoff depth	17.741	50.925	23.050	mm"
"		Runoff volume	119.96	65.59	185.56	c.m"
"		Runoff coefficient	0.302	0.867	0.392	"
"		Maximum flow	0.071	0.069	0.093	c.m/sec"
" 40		HYDROGRAPH Add Runoff "				
"	4	Add Runoff "				
"			0.093	0.093	0.000	0.000"
" 33		CATCHMENT 701"				
"	1	Triangular SCS"				
"	1	Equal length"				
"	1	SCS method"				
"	701	P1 Development Catchment"				
"	63.000	% Impervious"				
"	2.728	Total Area"				
"	30.000	Flow length"				
"	2.000	Overland Slope"				
"	1.009	Pervious Area"				
"	30.000	Pervious length"				
"	2.000	Pervious slope"				
"	1.719	Impervious Area"				
"	30.000	Impervious length"				
"	2.000	Impervious slope"				
"	0.250	Pervious Manning 'n'"				
"	79.000	Pervious SCS Curve No."				
"	0.384	Pervious Runoff coefficient"				
"	0.100	Pervious Ia/S coefficient"				
"	6.752	Pervious Initial abstraction"				
"	0.015	Impervious Manning 'n'"				
"	98.000	Impervious SCS Curve No."				
"	0.894	Impervious Runoff coefficient"				
"	0.100	Impervious Ia/S coefficient"				
"	0.518	Impervious Initial abstraction"				
"			0.859	0.093	0.000	0.000 c.m/sec"
"		Catchment 701	Pervious	Impervious	Total Area	"
"		Surface Area	1.009	1.719	2.728	hectare"
"		Time of concentration	12.501	1.589	3.787	minutes"
"		Time to Centroid	118.728	90.223	95.963	minutes"
"		Rainfall depth	58.739	58.739	58.739	mm"
"		Rainfall volume	592.89	1009.52	1602.41	c.m"
"		Rainfall losses	36.182	6.202	17.295	mm"
"		Runoff depth	22.558	52.537	41.445	mm"
"		Runoff volume	227.69	902.92	1130.61	c.m"
"		Runoff coefficient	0.384	0.894	0.706	"
"		Maximum flow	0.095	0.834	0.859	c.m/sec"
" 40		HYDROGRAPH Add Runoff "				
"	4	Add Runoff "				
"			0.859	0.949	0.000	0.000"
" 33		CATCHMENT 702"				
"	1	Triangular SCS"				
"	1	Equal length"				
"	1	SCS method"				
"	702	P1 SWM Pond"				
"	30.000	% Impervious"				
"	0.296	Total Area"				
"	15.000	Flow length"				
"	20.000	Overland Slope"				

MIDUSS output for 25-year post-development storm event

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"      0.207  Pervious Area"
"      15.000 Pervious length"
"      20.000 Pervious slope"
"      0.089  Impervious Area"
"      15.000 Impervious length"
"      20.000 Impervious slope"
"      0.250  Pervious Manning 'n'"
"     77.000 Pervious SCS Curve No."
"      0.347 Pervious Runoff coefficient"
"      0.100 Pervious Ia/S coefficient"
"      7.587 Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"     98.000 Impervious SCS Curve No."
"      0.838 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"
"      0.518 Impervious Initial abstraction"
"          0.067      0.949      0.000      0.000 c.m/sec"
"      Catchment 702      Pervious      Impervious Total Area "
"      Surface Area      0.207      0.089      0.296      hectare"
"      Time of concentration  4.328      0.525      2.394      minutes"
"      Time to Centroid      107.196      89.156      98.023      minutes"
"      Rainfall depth      58.739      58.739      58.739      mm"
"      Rainfall volume      121.71      52.16      173.87      c.m"
"      Rainfall losses      38.358      9.540      29.713      mm"
"      Runoff depth      20.381      49.199      29.027      mm"
"      Runoff volume      42.23      43.69      85.92      c.m"
"      Runoff coefficient  0.347      0.838      0.494      "
"      Maximum flow      0.028      0.049      0.067      c.m/sec"
" 40      HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"          0.067      1.016      0.000      0.000"
" 81      ADD COMMENT=====
"          1      Lines of comment"
"          Phase 1 SWM Pond"
" 54      POND DESIGN"
"          1.016  Current peak flow      c.m/sec"
"          0.150  Target outflow      c.m/sec"
"         1402.1  Hydrograph volume      c.m"
"          23.    Number of stages"
"         393.800  Minimum water level      metre"
"         396.000  Maximum water level      metre"
"         393.800  Starting water level      metre"
"          0      Keep Design Data: 1 = True; 0 = False"
"          Level Discharge      Volume"
"         393.800      0.000      0.000"
"         393.900      0.00488      39.000"
"         394.000      0.02264      81.000"
"         394.100      0.03579      128.000"
"         394.200      0.04527      180.000"
"         394.300      0.05309      237.000"
"         394.400      0.05989      299.000"
"         394.500      0.06599      366.000"
"         394.600      0.07158      438.000"
"         394.700      0.07676      516.000"
"         394.800      0.08161      600.000"
"         394.900      0.08619      690.000"
"         395.000      0.09054      786.000"
"         395.100      0.09469      888.000"
"         395.200      0.09867      997.000"

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MIDUSS output for 25-year post-development storm event

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"          395.300      0.1025  1113.000"
"          395.400      0.1062  1236.000"
"          395.500      0.1097  1365.000"
"          395.600      0.1132  1503.000"
"          395.700      0.1165  1645.000"
"          395.800      0.3731  1786.000"
"          395.900      0.8703  1845.000"
"          396.000      1.555   1905.000"
"      1.  WEIRS"
"          Crest      Weir      Crest      Left      Right"
"          elevation coefficient  breadth  sideslope  sideslope"
"          395.700      0.900      5.000      3.000      3.000"
"      1.  ORIFICES"
"          Orifice  Orifice  Orifice  Number of"
"          invert coefficient  diameter  orifices"
"          393.800      0.630      0.2000      1.000"
"          Peak outflow                      0.092      c.m/sec"
"          Maximum level                      395.034      metre"
"          Maximum storage                      820.165      c.m"
"          Centroidal lag                      3.569      hours"
"          0.067      1.016      0.092      0.000 c.m/sec"
" 40  HYDROGRAPH  Combine  1"
"      6  Combine "
"      1  Node #"
"          Total discharge"
"          Maximum flow                      0.092      c.m/sec"
"          Hydrograph volume                      1402.092      c.m"
"          0.067      1.016      0.092      0.092"
" 40  HYDROGRAPH Start - New Tributary"
"      2  Start - New Tributary"
"          0.067      0.000      0.092      0.092"
" 33  CATCHMENT 802"
"      1  Triangular SCS"
"      1  Equal length"
"      1  SCS method"
"      802 External Southeast Catchment"
"      2.000 % Impervious"
"      0.717 Total Area"
"      44.000 Flow length"
"      2.000 Overland Slope"
"      0.703 Pervious Area"
"      44.000 Pervious length"
"      2.000 Pervious slope"
"      0.014 Impervious Area"
"      44.000 Impervious length"
"      2.000 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      74.000 Pervious SCS Curve No."
"      0.304 Pervious Runoff coefficient"
"      0.100 Pervious Ia/S coefficient"
"      8.924 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
"      98.000 Impervious SCS Curve No."
"      0.900 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"
"      0.518 Impervious Initial abstraction"
"          0.040      0.000      0.092      0.092 c.m/sec"
"          Catchment 802      Pervious  Impervious Total Area "
"          Surface Area                      0.703      0.014      0.717      hectare"

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MIDUSS output for 25-year post-development storm event

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"          Time of concentration  17.700      1.999      16.804      minutes"
"          Time to Centroid       127.897    91.003    125.793    minutes"
"          Rainfall depth         58.739    58.739    58.739     mm"
"          Rainfall volume        412.74    8.42      421.16     c.m"
"          Rainfall losses        40.902    5.870     40.201     mm"
"          Runoff depth           17.838    52.869    18.538     mm"
"          Runoff volume          125.34    7.58      132.92     c.m"
"          Runoff coefficient      0.304    0.900     0.316     "
"          Maximum flow           0.038    0.007     0.040     c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4  Add Runoff "
"              0.040      0.040      0.092      0.092"
" 33          CATCHMENT 803"
"          1  Triangular SCS"
"          1  Equal length"
"          1  SCS method"
"          803 External East Catchment"
"          0.000 % Impervious"
"          0.508 Total Area"
"          45.000 Flow length"
"          2.000 Overland Slope"
"          0.508 Pervious Area"
"          45.000 Pervious length"
"          2.000 Pervious slope"
"          0.000 Impervious Area"
"          45.000 Impervious length"
"          2.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"          74.000 Pervious SCS Curve No."
"          0.304 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          8.924 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"          98.000 Impervious SCS Curve No."
"          0.000 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"
"              0.027      0.040      0.092      0.092 c.m/sec"
"          Catchment 803          Pervious  Impervious Total Area "
"          Surface Area          0.508      0.000      0.508      hectare"
"          Time of concentration  17.940      2.027      17.940     minutes"
"          Time to Centroid       128.252    91.052    128.252    minutes"
"          Rainfall depth         58.739    58.739    58.739     mm"
"          Rainfall volume        298.40    0.00      298.40     c.m"
"          Rainfall losses        40.904    5.832     40.904     mm"
"          Runoff depth           17.835    52.908    17.835     mm"
"          Runoff volume          90.60     0.00      90.60      c.m"
"          Runoff coefficient      0.304    0.000     0.304     "
"          Maximum flow           0.027    0.000     0.027     c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4  Add Runoff "
"              0.027      0.067      0.092      0.092"
" 40          HYDROGRAPH Copy to Outflow"
"          8  Copy to Outflow"
"              0.027      0.067      0.067      0.092"
" 40          HYDROGRAPH  Combine  1"
"          6  Combine "
"          1  Node #"
"          Total discharge"

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MIDUSS output for 25-year post-development storm event

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"           Maximum flow                0.153    c.m/sec"
"           Hydrograph volume            1625.615  c.m"
"           0.027    0.067    0.067    0.153"
" 40        HYDROGRAPH Start - New Tributary"
"           2    Start - New Tributary"
"           0.027    0.000    0.067    0.153"
" 33        CATCHMENT 501"
"           1    Triangular SCS"
"           1    Equal length"
"           1    SCS method"
"           501   West Farm Field"
"           0.000  % Impervious"
"           7.777  Total Area"
"           50.000 Flow length"
"           3.000  Overland Slope"
"           7.777  Pervious Area"
"           50.000 Pervious length"
"           3.000  Pervious slope"
"           0.000  Impervious Area"
"           50.000 Impervious length"
"           3.000  Impervious slope"
"           0.250  Pervious Manning 'n'"
"           83.000 Pervious SCS Curve No."
"           0.462  Pervious Runoff coefficient"
"           0.100  Pervious Ia/S coefficient"
"           5.202  Pervious Initial abstraction"
"           0.015  Impervious Manning 'n'"
"           98.000 Impervious SCS Curve No."
"           0.000  Impervious Runoff coefficient"
"           0.100  Impervious Ia/S coefficient"
"           0.518  Impervious Initial abstraction"
"           0.889    0.000    0.067    0.153 c.m/sec"
"           Catchment 501      Pervious  Impervious Total Area "
"           Surface Area      7.777      0.000      7.777      hectare"
"           Time of concentration 13.771      1.912      13.771      minutes"
"           Time to Centroid    119.373     90.841     119.373     minutes"
"           Rainfall depth      58.739     58.739     58.739     mm"
"           Rainfall volume     4568.15    0.00      4568.15    c.m"
"           Rainfall losses     31.630     5.971     31.630     mm"
"           Runoff depth        27.109     52.769     27.109     mm"
"           Runoff volume       2108.25    0.00      2108.25    c.m"
"           Runoff coefficient   0.462     0.000     0.462     "
"           Maximum flow       0.889     0.000     0.889     c.m/sec"
" 40        HYDROGRAPH Add Runoff "
"           4    Add Runoff "
"           0.889    0.889    0.067    0.153"
" 33        CATCHMENT 502"
"           1    Triangular SCS"
"           1    Equal length"
"           1    SCS method"
"           502   East Farm Field"
"           0.000  % Impervious"
"           3.970  Total Area"
"           35.000 Flow length"
"           4.000  Overland Slope"
"           3.970  Pervious Area"
"           35.000 Pervious length"
"           4.000  Pervious slope"
"           0.000  Impervious Area"

```

MIDUSS output for 25-year post-development storm event

```

"      35.000  Impervious length"
"      4.000  Impervious slope"
"      0.250  Pervious Manning 'n'"
"     83.000  Pervious SCS Curve No."
"      0.460  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      5.202  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"     98.000  Impervious SCS Curve No."
"      0.000  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"              0.498      0.889      0.067      0.153 c.m/sec"
"      Catchment 502      Pervious      Impervious      Total Area  "
"      Surface Area      3.970      0.000      3.970      hectare"
"      Time of concentration  10.198      1.416      10.198      minutes"
"      Time to Centroid      113.868      90.063      113.868      minutes"
"      Rainfall depth      58.739      58.739      58.739      mm"
"      Rainfall volume      2331.95      0.00      2331.95      c.m"
"      Rainfall losses      31.726      6.387      31.726      mm"
"      Runoff depth      27.013      52.352      27.013      mm"
"      Runoff volume      1072.42      0.00      1072.42      c.m"
"      Runoff coefficient      0.460      0.000      0.460      "
"      Maximum flow      0.498      0.000      0.498      c.m/sec"
" 40      HYDROGRAPH Add Runoff  "
"      4      Add Runoff  "
"              0.498      1.387      0.067      0.153"
" 33      CATCHMENT 703"
"      1      Triangular SCS"
"      1      Equal length"
"      1      SCS method"
"      703      Temp SWM Pond"
"     30.000  % Impervious"
"      0.458  Total Area"
"     15.000  Flow length"
"     20.000  Overland Slope"
"      0.321  Pervious Area"
"     15.000  Pervious length"
"     20.000  Pervious slope"
"      0.137  Impervious Area"
"     15.000  Impervious length"
"     20.000  Impervious slope"
"      0.250  Pervious Manning 'n'"
"     77.000  Pervious SCS Curve No."
"      0.347  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      7.587  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"     98.000  Impervious SCS Curve No."
"      0.838  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"              0.103      1.387      0.067      0.153 c.m/sec"
"      Catchment 703      Pervious      Impervious      Total Area  "
"      Surface Area      0.321      0.137      0.458      hectare"
"      Time of concentration  4.328      0.525      2.394      minutes"
"      Time to Centroid      107.196      89.156      98.023      minutes"
"      Rainfall depth      58.739      58.739      58.739      mm"
"      Rainfall volume      188.32      80.71      269.03      c.m"

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MIDUSS output for 25-year post-development storm event

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"          Rainfall losses          38.358      9.540      29.713      mm"
"          Runoff depth              20.381     49.199     29.027      mm"
"          Runoff volume              65.34      67.60     132.94      c.m"
"          Runoff coefficient          0.347      0.838      0.494      "
"          Maximum flow               0.044      0.075      0.103      c.m/sec"
" 40      HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"                  0.103      1.420      0.067      0.153"
" 81      ADD COMMENT=====
"          1      Lines of comment"
"          Temporary Pond (Phase 2)"
" 54      POND DESIGN"
"          1.420      Current peak flow      c.m/sec"
"          0.250      Target outflow      c.m/sec"
"          3313.6      Hydrograph volume      c.m"
"          19.      Number of stages"
"          394.700      Minimum water level      metre"
"          396.500      Maximum water level      metre"
"          394.700      Starting water level      metre"
"          0      Keep Design Data: 1 = True; 0 = False"
"          Level Discharge      Volume"
"          394.700      0.02264      0.000"
"          394.800      0.07054      126.000"
"          394.900      0.08468      262.000"
"          395.000      0.09678      409.000"
"          395.100      0.1075      566.000"
"          395.200      0.1173      734.000"
"          395.300      0.1263      913.000"
"          395.400      0.1347      1103.000"
"          395.500      0.1426      1305.000"
"          395.600      0.1501      1519.000"
"          395.700      0.1573      1744.000"
"          395.800      0.1641      1982.000"
"          395.900      0.1707      2232.000"
"          396.000      0.1770      2495.000"
"          396.100      0.1831      2770.000"
"          396.200      0.1890      3058.000"
"          396.300      0.4480      3359.000"
"          396.400      0.9476      3674.000"
"          396.500      1.635      3795.000"
"          1.      WEIRS"
"          Crest      Weir      Crest      Left      Right"
"          elevation coefficie      breadth sideslope sideslope"
"          396.200      0.900      5.000      3.000      3.000"
"          1.      ORIFICES"
"          Orifice      Orifice      Orifice      Number of"
"          invert coefficie      diameter orifices"
"          394.400      0.630      0.2600      1.000"
"          Peak outflow              0.165      c.m/sec"
"          Maximum level              395.817      metre"
"          Maximum storage              2025.021      c.m"
"          Centroidal lag              4.391      hours"
"          0.103      1.420      0.165      0.153 c.m/sec"
" 40      HYDROGRAPH Combine      1"
"          6      Combine "
"          1      Node #"
"          Total discharge"
"          Maximum flow              0.288      c.m/sec"
"          Hydrograph volume              4938.940      c.m"

```

MIDUSS output for 25-year post-development storm event

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"          0.103      1.420      0.165      0.288"
" 38      START/RE-START TOTALS 703"
"          3  Runoff Totals on EXIT"
"          Total Catchment area          17.259      hectare"
"          Total Impervious area          2.088      hectare"
"          Total % impervious          12.098"
" 19      EXIT"

```

MIDUSS output for 100-year post-development storm event

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"          MIDUSS Output ----->"
"          MIDUSS version                      Version 2.25  rev. 473"
"          MIDUSS created                      Sunday, February 7, 2010"
"          10  Units used:                      ie METRIC"
"          Job folder:                          C:\M\Meritech Engineering\PRJ - DOCS\5008\
"                                               60-Design\SWM\MIDUSS"
"          Output filename:                    5008d100yrOct032022.out"
"          Licensee name:                      Windows User"
"          Company                             "
"          Date & Time last used:              10/3/2022 at 1:12:14 PM"
" 81      ADD COMMENT=====
"          2  Lines of comment"
"          P1 100yr post development conditions. Phase 1 SWM pond and "
"          temporary phase 2 pond."
" 31      TIME PARAMETERS"
"          5.000  Time Step"
"          180.000 Max. Storm length"
"          1500.000 Max. Hydrograph"
" 32      STORM Chicago storm"
"          1  Chicago storm"
"          896.530 Coefficient A"
"          0.027  Constant B"
"          0.699  Exponent C"
"          0.400  Fraction R"
"          180.000 Duration"
"          1.000  Time step multiplier"
"          Maximum intensity          289.968  mm/hr"
"          Total depth                 71.319  mm"
"          6  100hyd Hydrograph extension used in this file"
" 33      CATCHMENT 801"
"          1  Triangular SCS"
"          1  Equal length"
"          1  SCS method"
"          801 801 External Southwest Catchment"
"          16.000 % Impervious"
"          0.805 Total Area"
"          10.000 Flow length"
"          2.000 Overland Slope"
"          0.676 Pervious Area"
"          10.000 Pervious length"
"          2.000 Pervious slope"
"          0.129 Impervious Area"
"          10.000 Impervious length"
"          2.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"          74.000 Pervious SCS Curve No."
"          0.357 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          8.924 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"          98.000 Impervious SCS Curve No."
"          0.878 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"
"          0.138 0.000 0.000 0.000 c.m/sec"
"          Catchment 801 Pervious Impervious Total Area "
"          Surface Area 0.676 0.129 0.805 hectare"
"          Time of concentration 6.178 0.757 4.449 minutes"
"          Time to Centroid 109.703 88.507 102.943 minutes"

```

MIDUSS output for 100-year post-development storm event

"		Rainfall depth	71.319	71.319	71.319	mm"
"		Rainfall volume	482.26	91.86	574.12	c.m"
"		Rainfall losses	45.848	8.691	39.903	mm"
"		Runoff depth	25.471	62.627	31.416	mm"
"		Runoff volume	172.24	80.66	252.90	c.m"
"		Runoff coefficient	0.357	0.878	0.441	"
"		Maximum flow	0.113	0.085	0.138	c.m/sec"
" 40		HYDROGRAPH Add Runoff "				
"	4	Add Runoff "				
"			0.138	0.138	0.000	0.000"
" 33		CATCHMENT 701"				
"	1	Triangular SCS"				
"	1	Equal length"				
"	1	SCS method"				
"	701	P1 Development Catchment"				
"	63.000	% Impervious"				
"	2.728	Total Area"				
"	30.000	Flow length"				
"	2.000	Overland Slope"				
"	1.009	Pervious Area"				
"	30.000	Pervious length"				
"	2.000	Pervious slope"				
"	1.719	Impervious Area"				
"	30.000	Impervious length"				
"	2.000	Impervious slope"				
"	0.250	Pervious Manning 'n'"				
"	79.000	Pervious SCS Curve No."				
"	0.442	Pervious Runoff coefficient"				
"	0.100	Pervious Ia/S coefficient"				
"	6.752	Pervious Initial abstraction"				
"	0.015	Impervious Manning 'n'"				
"	98.000	Impervious SCS Curve No."				
"	0.907	Impervious Runoff coefficient"				
"	0.100	Impervious Ia/S coefficient"				
"	0.518	Impervious Initial abstraction"				
"			1.086	0.138	0.000	0.000 c.m/sec"
"		Catchment 701	Pervious	Impervious	Total Area	"
"		Surface Area	1.009	1.719	2.728	hectare"
"		Time of concentration	10.803	1.463	3.541	minutes"
"		Time to Centroid	115.044	89.581	95.246	minutes"
"		Rainfall depth	71.319	71.319	71.319	mm"
"		Rainfall volume	719.87	1225.72	1945.58	c.m"
"		Rainfall losses	39.809	6.632	18.908	mm"
"		Runoff depth	31.510	64.687	52.411	mm"
"		Runoff volume	318.05	1111.74	1429.78	c.m"
"		Runoff coefficient	0.442	0.907	0.735	"
"		Maximum flow	0.144	1.040	1.086	c.m/sec"
" 40		HYDROGRAPH Add Runoff "				
"	4	Add Runoff "				
"			1.086	1.217	0.000	0.000"
" 33		CATCHMENT 702"				
"	1	Triangular SCS"				
"	1	Equal length"				
"	1	SCS method"				
"	702	P1 SWM Pond"				
"	30.000	% Impervious"				
"	0.296	Total Area"				
"	15.000	Flow length"				
"	20.000	Overland Slope"				

MIDUSS output for 100-year post-development storm event

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"      0.207  Pervious Area"
"      15.000  Pervious length"
"      20.000  Pervious slope"
"      0.089  Impervious Area"
"      15.000  Impervious length"
"      20.000  Impervious slope"
"      0.250  Pervious Manning 'n'"
"      77.000  Pervious SCS Curve No."
"      0.398  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      7.587  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"      98.000  Impervious SCS Curve No."
"      0.849  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"          0.092      1.217      0.000      0.000 c.m/sec"
"      Catchment 702      Pervious      Impervious Total Area "
"      Surface Area      0.207      0.089      0.296      hectare"
"      Time of concentration  3.715      0.484      2.172      minutes"
"      Time to Centroid      105.171      88.482      97.201      minutes"
"      Rainfall depth      71.319      71.319      71.319      mm"
"      Rainfall volume      147.77      63.33      211.10      c.m"
"      Rainfall losses      42.936      10.784      33.290      mm"
"      Runoff depth      28.383      60.535      38.029      mm"
"      Runoff volume      58.81      53.75      112.56      c.m"
"      Runoff coefficient      0.398      0.849      0.533      "
"      Maximum flow      0.042      0.060      0.092      c.m/sec"
" 40      HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"          0.092      1.309      0.000      0.000"
" 81      ADD COMMENT=====
"          1      Lines of comment"
"          Phase 1 SWM Pond"
" 54      POND DESIGN"
"          1.309      Current peak flow      c.m/sec"
"          0.150      Target outflow      c.m/sec"
"          1795.2      Hydrograph volume      c.m"
"          23.      Number of stages"
"          393.800      Minimum water level      metre"
"          396.000      Maximum water level      metre"
"          393.800      Starting water level      metre"
"          0      Keep Design Data: 1 = True; 0 = False"
"          Level Discharge      Volume"
"          393.800      0.000      0.000"
"          393.900      0.00488      39.000"
"          394.000      0.02264      81.000"
"          394.100      0.03579      128.000"
"          394.200      0.04527      180.000"
"          394.300      0.05309      237.000"
"          394.400      0.05989      299.000"
"          394.500      0.06599      366.000"
"          394.600      0.07158      438.000"
"          394.700      0.07676      516.000"
"          394.800      0.08161      600.000"
"          394.900      0.08619      690.000"
"          395.000      0.09054      786.000"
"          395.100      0.09469      888.000"
"          395.200      0.09867      997.000"

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MIDUSS output for 100-year post-development storm event

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"          395.300      0.1025  1113.000"
"          395.400      0.1062  1236.000"
"          395.500      0.1097  1365.000"
"          395.600      0.1132  1503.000"
"          395.700      0.1165  1645.000"
"          395.800      0.3731  1786.000"
"          395.900      0.8703  1845.000"
"          396.000      1.555   1905.000"
"      1.  WEIRS"
"          Crest      Weir      Crest      Left      Right"
"          elevation coefficient breadth sideslope sideslope"
"          395.700      0.900      5.000      3.000      3.000"
"      1.  ORIFICES"
"          Orifice Orifice Orifice Number of"
"          invert coefficient diameter orifices"
"          393.800      0.630      0.2000      1.000"
"          Peak outflow                                0.102      c.m/sec"
"          Maximum level                                395.294      metre"
"          Maximum storage                              1106.314      c.m"
"          Centroidal lag                               3.877      hours"
"          0.092      1.309      0.102      0.000 c.m/sec"
" 40  HYDROGRAPH Combine 1"
"      6  Combine "
"      1  Node #"
"          Total discharge"
"          Maximum flow                                0.102      c.m/sec"
"          Hydrograph volume                            1795.216      c.m"
"          0.092      1.309      0.102      0.102"
" 40  HYDROGRAPH Start - New Tributary"
"      2  Start - New Tributary"
"          0.092      0.000      0.102      0.102"
" 33  CATCHMENT 802"
"      1  Triangular SCS"
"      1  Equal length"
"      1  SCS method"
"      802 External Southeast Catchment"
"      2.000 % Impervious"
"      0.717 Total Area"
"      44.000 Flow length"
"      2.000 Overland Slope"
"      0.703 Pervious Area"
"      44.000 Pervious length"
"      2.000 Pervious slope"
"      0.014 Impervious Area"
"      44.000 Impervious length"
"      2.000 Impervious slope"
"      0.250 Pervious Manning 'n'"
"      74.000 Pervious SCS Curve No."
"      0.360 Pervious Runoff coefficient"
"      0.100 Pervious Ia/S coefficient"
"      8.924 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
"      98.000 Impervious SCS Curve No."
"      0.912 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"
"      0.518 Impervious Initial abstraction"
"          0.071      0.000      0.102      0.102 c.m/sec"
"          Catchment 802      Pervious      Impervious Total Area "
"          Surface Area      0.703      0.014      0.717      hectare"

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MIDUSS output for 100-year post-development storm event

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"           Time of concentration  15.027      1.841      14.379      minutes"
"           Time to Centroid      122.924     90.174     121.312     minutes"
"           Rainfall depth        71.319     71.319     71.319      mm"
"           Rainfall volume       501.13     10.23     511.36      c.m"
"           Rainfall losses       45.668     6.289     44.880      mm"
"           Runoff depth          25.651     65.030     26.439      mm"
"           Runoff volume         180.24     9.33      189.57      c.m"
"           Runoff coefficient     0.360     0.912     0.371       "
"           Maximum flow          0.069     0.008     0.071      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"           4  Add Runoff "
"               0.071      0.071      0.102      0.102"
" 33          CATCHMENT 803"
"           1  Triangular SCS"
"           1  Equal length"
"           1  SCS method"
"           803 External East Catchment"
"           0.000 % Impervious"
"           0.508 Total Area"
"           45.000 Flow length"
"           2.000 Overland Slope"
"           0.508 Pervious Area"
"           45.000 Pervious length"
"           2.000 Pervious slope"
"           0.000 Impervious Area"
"           45.000 Impervious length"
"           2.000 Impervious slope"
"           0.250 Pervious Manning 'n'"
"           74.000 Pervious SCS Curve No."
"           0.360 Pervious Runoff coefficient"
"           0.100 Pervious Ia/S coefficient"
"           8.924 Pervious Initial abstraction"
"           0.015 Impervious Manning 'n'"
"           98.000 Impervious SCS Curve No."
"           0.000 Impervious Runoff coefficient"
"           0.100 Impervious Ia/S coefficient"
"           0.518 Impervious Initial abstraction"
"               0.050      0.071      0.102      0.102 c.m/sec"
"           Catchment 803          Pervious  Impervious Total Area "
"           Surface Area          0.508      0.000      0.508      hectare"
"           Time of concentration  15.231     1.866     15.231     minutes"
"           Time to Centroid      123.239     90.224     123.239     minutes"
"           Rainfall depth        71.319     71.319     71.319      mm"
"           Rainfall volume       362.30     0.00      362.30      c.m"
"           Rainfall losses       45.675     6.254     45.675      mm"
"           Runoff depth          25.644     65.065     25.644      mm"
"           Runoff volume         130.27     0.00      130.27      c.m"
"           Runoff coefficient     0.360     0.000     0.360       "
"           Maximum flow          0.050     0.000     0.050      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"           4  Add Runoff "
"               0.050      0.121      0.102      0.102"
" 40          HYDROGRAPH Copy to Outflow"
"           8  Copy to Outflow"
"               0.050      0.121      0.121      0.102"
" 40          HYDROGRAPH Combine  1"
"           6  Combine "
"           1  Node #"
"           Total discharge"

```

MIDUSS output for 100-year post-development storm event

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"          Maximum flow                0.214    c.m/sec"
"          Hydrograph volume            2115.055  c.m"
"          0.050    0.121    0.121    0.214"
" 40      HYDROGRAPH Start - New Tributary"
"          2      Start - New Tributary"
"          0.050    0.000    0.121    0.214"
" 33      CATCHMENT 501"
"          1      Triangular SCS"
"          1      Equal length"
"          1      SCS method"
"          501    West Farm Field"
"          0.000    % Impervious"
"          7.777    Total Area"
"          50.000    Flow length"
"          3.000    Overland Slope"
"          7.777    Pervious Area"
"          50.000    Pervious length"
"          3.000    Pervious slope"
"          0.000    Impervious Area"
"          50.000    Impervious length"
"          3.000    Impervious slope"
"          0.250    Pervious Manning 'n'"
"          83.000    Pervious SCS Curve No."
"          0.518    Pervious Runoff coefficient"
"          0.100    Pervious Ia/S coefficient"
"          5.202    Pervious Initial abstraction"
"          0.015    Impervious Manning 'n'"
"          98.000    Impervious SCS Curve No."
"          0.000    Impervious Runoff coefficient"
"          0.100    Impervious Ia/S coefficient"
"          0.518    Impervious Initial abstraction"
"          1.311    0.000    0.121    0.214 c.m/sec"
"          Catchment 501      Pervious      Impervious Total Area "
"          Surface Area      7.777      0.000      7.777      hectare"
"          Time of concentration 12.053      1.760      12.053      minutes"
"          Time to Centroid    115.701      89.999      115.701      minutes"
"          Rainfall depth      71.319      71.319      71.319      mm"
"          Rainfall volume     5546.47      0.01      5546.48      c.m"
"          Rainfall losses     34.364      6.333      34.364      mm"
"          Runoff depth        36.955      64.986      36.955      mm"
"          Runoff volume       2874.02      0.01      2874.02      c.m"
"          Runoff coefficient   0.518      0.000      0.518      "
"          Maximum flow       1.311      0.000      1.311      c.m/sec"
" 40      HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"          1.311    1.311    0.121    0.214"
" 33      CATCHMENT 502"
"          1      Triangular SCS"
"          1      Equal length"
"          1      SCS method"
"          502    East Farm Field"
"          0.000    % Impervious"
"          3.970    Total Area"
"          35.000    Flow length"
"          4.000    Overland Slope"
"          3.970    Pervious Area"
"          35.000    Pervious length"
"          4.000    Pervious slope"
"          0.000    Impervious Area"

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MIDUSS output for 100-year post-development storm event

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"      35.000  Impervious length"
"      4.000  Impervious slope"
"      0.250  Pervious Manning 'n'"
"     83.000  Pervious SCS Curve No."
"      0.518  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      5.202  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"     98.000  Impervious SCS Curve No."
"      0.000  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"              0.805      1.311      0.121      0.214 c.m/sec"
"      Catchment 502      Pervious      Impervious      Total Area  "
"      Surface Area      3.970      0.000      3.970      hectare"
"      Time of concentration      8.926      1.304      8.926      minutes"
"      Time to Centroid      110.787      89.342      110.787      minutes"
"      Rainfall depth      71.319      71.319      71.319      mm"
"      Rainfall volume      2831.36      0.00      2831.36      c.m"
"      Rainfall losses      34.390      6.928      34.390      mm"
"      Runoff depth      36.929      64.391      36.929      mm"
"      Runoff volume      1466.07      0.00      1466.07      c.m"
"      Runoff coefficient      0.518      0.000      0.518      "
"      Maximum flow      0.805      0.000      0.805      c.m/sec"
" 40      HYDROGRAPH Add Runoff  "
"      4      Add Runoff  "
"              0.805      2.017      0.121      0.214"
" 33      CATCHMENT 703"
"      1      Triangular SCS"
"      1      Equal length"
"      1      SCS method"
"      703      Temp SWM Pond"
"     30.000  % Impervious"
"      0.458  Total Area"
"     15.000  Flow length"
"     20.000  Overland Slope"
"      0.321  Pervious Area"
"     15.000  Pervious length"
"     20.000  Pervious slope"
"      0.137  Impervious Area"
"     15.000  Impervious length"
"     20.000  Impervious slope"
"      0.250  Pervious Manning 'n'"
"     77.000  Pervious SCS Curve No."
"      0.398  Pervious Runoff coefficient"
"      0.100  Pervious Ia/S coefficient"
"      7.587  Pervious Initial abstraction"
"      0.015  Impervious Manning 'n'"
"     98.000  Impervious SCS Curve No."
"      0.849  Impervious Runoff coefficient"
"      0.100  Impervious Ia/S coefficient"
"      0.518  Impervious Initial abstraction"
"              0.142      2.017      0.121      0.214 c.m/sec"
"      Catchment 703      Pervious      Impervious      Total Area  "
"      Surface Area      0.321      0.137      0.458      hectare"
"      Time of concentration      3.715      0.484      2.172      minutes"
"      Time to Centroid      105.171      88.482      97.201      minutes"
"      Rainfall depth      71.319      71.319      71.319      mm"
"      Rainfall volume      228.65      97.99      326.64      c.m"

```

MIDUSS output for 100-year post-development storm event

```

"          Rainfall losses          42.936      10.784      33.290      mm"
"          Runoff depth              28.383      60.535      38.029      mm"
"          Runoff volume             91.00       83.17       174.17      c.m"
"          Runoff coefficient         0.398       0.849       0.533       "
"          Maximum flow               0.065       0.093       0.142       c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4      Add Runoff "
"                  0.142      2.053      0.121      0.214"
" 81          ADD COMMENT=====
"          1      Lines of comment"
"          Temporary Pond (Phase 2)"
" 54          POND DESIGN"
"          2.053      Current peak flow      c.m/sec"
"          0.250      Target outflow      c.m/sec"
"          4514.3      Hydrograph volume      c.m"
"          19.      Number of stages"
"          394.700      Minimum water level      metre"
"          396.500      Maximum water level      metre"
"          394.700      Starting water level      metre"
"          0      Keep Design Data: 1 = True; 0 = False"
"          Level Discharge      Volume"
"          394.700      0.02264      0.000"
"          394.800      0.07054      126.000"
"          394.900      0.08468      262.000"
"          395.000      0.09678      409.000"
"          395.100      0.1075       566.000"
"          395.200      0.1173       734.000"
"          395.300      0.1263       913.000"
"          395.400      0.1347      1103.000"
"          395.500      0.1426      1305.000"
"          395.600      0.1501      1519.000"
"          395.700      0.1573      1744.000"
"          395.800      0.1641      1982.000"
"          395.900      0.1707      2232.000"
"          396.000      0.1770      2495.000"
"          396.100      0.1831      2770.000"
"          396.200      0.1890      3058.000"
"          396.300      0.4480      3359.000"
"          396.400      0.9476      3674.000"
"          396.500      1.635      3795.000"
"          1.      WEIRS"
"          Crest      Weir      Crest      Left      Right"
"          elevation coefficie      breadth sideslope sideslope"
"          396.200      0.900      5.000      3.000      3.000"
"          1.      ORIFICES"
"          Orifice      Orifice      Orifice      Number of"
"          invert coefficie      diameter orifices"
"          394.400      0.630      0.2600      1.000"
"          Peak outflow              0.189      c.m/sec"
"          Maximum level              396.192      metre"
"          Maximum storage              3035.607      c.m"
"          Centroidal lag              5.003      hours"
"          0.142      2.053      0.189      0.214 c.m/sec"
" 40          HYDROGRAPH Combine      1"
"          6      Combine "
"          1      Node #"
"          Total discharge"
"          Maximum flow              0.351      c.m/sec"
"          Hydrograph volume          6630.585      c.m"

```

MIDUSS output for 100-year post-development storm event

---

```

"          0.142    2.053    0.189    0.351"
" 38      START/RE-START TOTALS 703"
"          3  Runoff Totals on EXIT"
"          Total Catchment area          17.259    hectare"
"          Total Impervious area          2.088    hectare"
"          Total % impervious          12.098"
" 19      EXIT"

```

---

# ***Appendix E: Hydrant Flow Test Results***



PROJECT INFORMATION			
Project Name:	Palmerston Flow Test #1	Const. Project #:	SMC-0002084
Site Address:	Mary Street/Henry Lane Palmerston ON	Design Project #:	2021-FCFP-355
City Contact:	Todd Rogers	Phone #:	519-323-8213
FCFP Contact:	Mike Ruck / Clayton Alderson	Phone #:	519-546-1955
Technical Contact:	<b>Andrew Peach</b>	Phone #:	<b>226-448-3436</b>

## SITE INFORMATION

### SITE MAP



Note: If the main is a dead end, the flowing hydrant shall be closest to the dead end

ITEMS TO LABEL ON MAP	HYDRANTS USED	MAIN SIZE
<input checked="" type="checkbox"/> Static / Residual & Flow Hydrants	<input checked="" type="checkbox"/> City Hydrant(s)	City: 6"
<input type="checkbox"/> Flow Direction (if the main is dead end)	<input type="checkbox"/> Site Hydrant(s)	Site:

SITE NOTES

## TEST INFORMATION

Minimum Required Flow:	NA	Min Ports:	2
FCFP Personnel Present:	Mike Ruck / Clayton Alderson	Test Date:	2021-10-08
City / External Company:	Town of Minto/Public Works	Test Time:	8:30 am

## TEST EQUIPMENT

<input type="checkbox"/> Hose Monsters with built in Pitot	Hose length used:
<input type="checkbox"/> Hand held pitot gauge	<input checked="" type="checkbox"/> Pollard diffuser elbow with built in Pitot
<input type="checkbox"/> Other:	

## TEST RESULTS

Number of Ports	Outlet Size (IN)	Discharge Coefficient	Pitot Reading (PSI)			Total Flow (GPM)	Static / Residual Pressure (PSI)
0 Ports	<b>STATIC</b>						67
1 Port	2.5	0.9	53			1,222	62
2 Ports	2.5	0.9	20	23		1,556	57
3 Ports	2.5	0.9				0	
4 Ports	2.5	0.9				0	
0 Ports	<b>STATIC RE-CHECK</b>						67

## TEST NOTES

Test Hydrant Mueller Century

## HYDRAULIC ADJUSTMENTS (FOR OFFICE USE ONLY)

### ADJUSTMENTS FOR HYDRAULIC GRADE LINE (HGL)

Reservoir HGL (m):		Site Elevation (m):	
Theoretical Static Head (PSI):	0	PSI to subtract from test pressures:	0

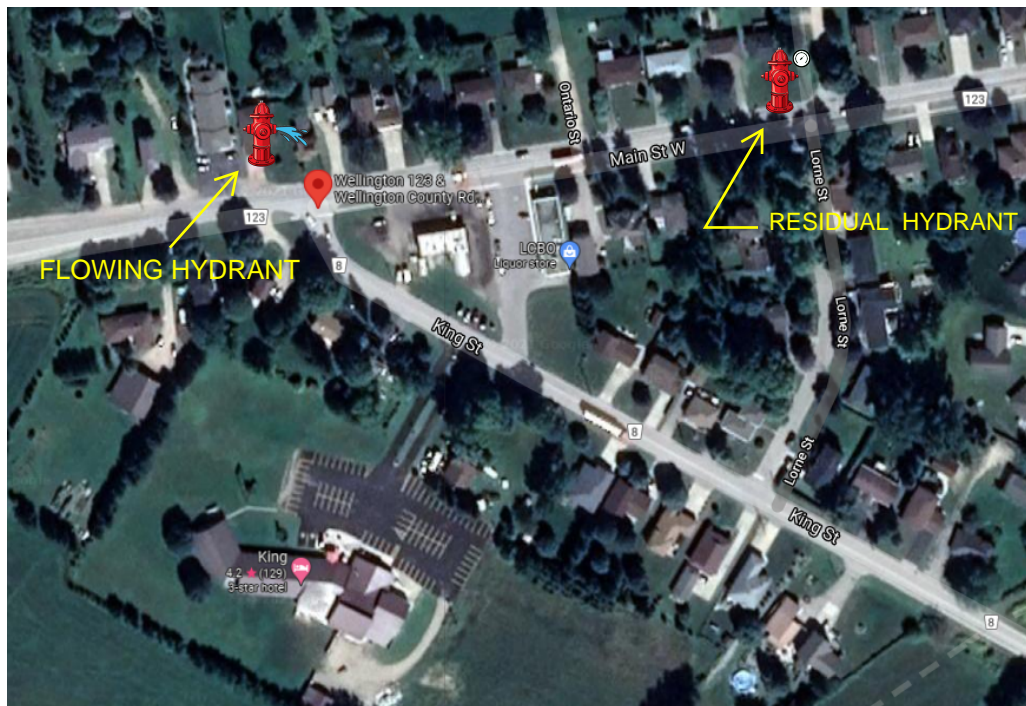
### OTHER HYDRAULIC ADJUSTMENTS

Other adjustment as required by the City / AHJ:

PROJECT INFORMATION			
Project Name:	Palmerston Flow Test #2	Const. Project #:	SMC-0002084
Site Address:	Main Street/King Street Palmerston ON	Design Project #:	2021-FCFP-355
City Contact:	Todd Rogers	Phone #:	519-323-8213
FCFP Contact:	Mike Ruck /Clayton Alderson	Phone #:	519-546-1955
Technical Contact:	<b>Andrew Peach</b>	Phone #:	<b>226-448-3436</b>

## SITE INFORMATION

### SITE MAP



Note: If the main is a dead end, the flowing hydrant shall be closest to the dead end

ITEMS TO LABEL ON MAP	HYDRANTS USED	MAIN SIZE
<input checked="" type="checkbox"/> Static / Residual & Flow Hydrants	<input checked="" type="checkbox"/> City Hydrant(s)	City: 8"
<input type="checkbox"/> Flow Direction (if the main is dead end)	<input type="checkbox"/> Site Hydrant(s)	Site:

SITE NOTES

## TEST INFORMATION

Minimum Required Flow:	NA	Min Ports:	2
FCFP Personnel Present:	Mike Ruck / Clayton Alderson	Test Date:	2021-10-08
City / External Company:	Town of Minto/Public Works	Test Time:	8:55 am

## TEST EQUIPMENT

<input type="checkbox"/> Hose Monsters with built in Pitot	Hose length used:
<input type="checkbox"/> Hand held pitot gauge	<input checked="" type="checkbox"/> Pollard diffuser elbow with built in Pitot
<input type="checkbox"/> Other:	

## TEST RESULTS

Number of Ports	Outlet Size (IN)	Discharge Coefficient	Pitot Reading (PSI)			Total Flow (GPM)	Static / Residual Pressure (PSI)
0 Ports	<b>STATIC</b>						68
1 Port	2.5	0.9	50			1,187	63
2 Ports	2.5	0.9	26	28		1,744	54
3 Ports	2.5	0.9				0	
4 Ports	2.5	0.9				0	
0 Ports	<b>STATIC RE-CHECK</b>						68

## TEST NOTES

Flow Hydrant Mueller Century

## HYDRAULIC ADJUSTMENTS (FOR OFFICE USE ONLY)

### ADJUSTMENTS FOR HYDRAULIC GRADE LINE (HGL)

Reservoir HGL (m):		Site Elevation (m):	
Theoretical Static Head (PSI):	0	PSI to subtract from test pressures:	0

### OTHER HYDRAULIC ADJUSTMENTS

Other adjustment as required by the City / AHJ:

PROJECT INFORMATION			
Project Name:	Palmerston Flow Test #3	Const. Project #:	SMC-0002084
Site Address:	Minto Rd/Noble Road Palmerston ON	Design Project #:	2021-FCFP-355
City Contact:	Todd Rogers	Phone #:	519-323-8213
FCFP Contact:	Mike Ruck /Clayton Alderson	Phone #:	519-546-1955
Technical Contact:	<b>Andrew Peach</b>	Phone #:	<b>226-448-3436</b>

## SITE INFORMATION

### SITE MAP



Note: If the main is a dead end, the flowing hydrant shall be closest to the dead end

ITEMS TO LABEL ON MAP	HYDRANTS USED	MAIN SIZE
<input checked="" type="checkbox"/> Static / Residual & Flow Hydrants	<input checked="" type="checkbox"/> City Hydrant(s)	City: 6"
<input type="checkbox"/> Flow Direction (if the main is dead end)	<input type="checkbox"/> Site Hydrant(s)	Site:

SITE NOTES

TEST INFORMATION			
Minimum Required Flow:	NA	Min Ports:	2
FCFP Personnel Present:	Mike Ruck / Clayton Alderson	Test Date:	2021-10-08
City / External Company:	Town of Minto/Public Works	Test Time:	9:20 am

TEST EQUIPMENT	
<input type="checkbox"/> Hose Monsters with built in Pitot	Hose length used:
<input type="checkbox"/> Hand held pitot gauge	<input checked="" type="checkbox"/> Pollard diffuser elbow with built in Pitot
<input type="checkbox"/> Other:	

TEST RESULTS						
Number of Ports	Outlet Size (IN)	Discharge Coefficient	Pitot Reading (PSI)		Total Flow (GPM)	Static / Residual Pressure (PSI)
0 Ports	<b>STATIC</b>					68
1 Port	2.5	0.9	48		1,163	63
2 Ports	2.5	0.9	26	26	1,712	55
3 Ports	2.5	0.9			0	
4 Ports	2.5	0.9			0	
0 Ports	<b>STATIC RE-CHECK</b>					68

TEST NOTES
Flow Hydrant Mueller Century

HYDRAULIC ADJUSTMENTS (FOR OFFICE USE ONLY)			
ADJUSTMENTS FOR HYDRAULIC GRADE LINE (HGL)			
Reservoir HGL (m):		Site Elevation (m):	
Theoretical Static Head (PSI):	0	PSI to subtract from test pressures:	0
OTHER HYDRAULIC ADJUSTMENTS			
Other adjustment as required by the City / AHJ:			

---

# ***Appendix F: Geotechnical Data***

(excerpts only)



# GEOTECHNICAL INVESTIGATION

**PROPOSED RESIDENTIAL DEVELOPMENT  
CLARK-HEINMILLER SUBDIVISION  
PALMERSTON, ONTARIO  
TOWN OF MINTO**

**CMT Project 13-603.R01**

**Prepared For:**

**Triton Engineering Services Limited**

**June 27, 2014**





*CMT Engineering Inc.*  
**CONSULTING ENGINEERS**  
1011 Industrial Crescent, Unit 1  
St. Clements, Ontario N0B 2M0  
*Tel: 519-699-5775*  
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[www.cmtinc.net](http://www.cmtinc.net)

June 27, 2014

13-603.R01

Triton Engineering Services Limited  
105 Queen Street West, Unit 14  
Fergus, Ontario  
N1M 1S6

Attention: Mr. Chris Clark

Dear Sir:

**Re: Geotechnical Investigation  
Proposed Residential Development  
Clark-Heinmiller Subdivision  
Palmerston, Ontario, Town of Minto**

As requested, CMT Engineering Inc. conducted a geotechnical investigation at the above-referenced site, and we are pleased to present the enclosed report.

We trust that this information meets your present requirements and we thank you for allowing us to undertake this project. Should you have any questions, please do not hesitate to contact our office.

Yours very truly,

A handwritten signature in blue ink, appearing to read 'Mark Vignault', is written over a light blue horizontal line.

Mark Vignault, B.A.Sc, EIT

ks

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## **1.0 INTRODUCTION**

The services of CMT Engineering Inc. (CMT Inc.) were retained by Chris Clark of Triton Engineering Services Limited to conduct a geotechnical investigation for the proposed Clark-Heinmiller Subdivision, in Palmerston, Ontario. The location of the site is shown on Drawing 1.

It is understood that the project will comprise nineteen (19) single-unit residential homes, as well as sixteen (16) semi-detached units (referenced as Block 20 and Block 21) and eight (8) townhomes (Block 22). A storm water management facility is proposed to be constructed in the southeast portion of the site. A new roadway will also be constructed, with access from Lorne Street.

The purpose of the geotechnical investigation was to assess the existing soil and groundwater conditions encountered in the boreholes. Included in the assessment are the soil classification and groundwater observations, as well as comments and recommendations regarding geotechnical resistance (bearing capacity); serviceability limit states (anticipated settlement); dewatering considerations; site classification for seismic site response; recommendations for site grading, site servicing, excavations and backfilling; recommendations for slab-on-grade construction; pavement design/drainage; soil infiltration and design properties; and a summary of the laboratory test results.

## **2.0 EXISTING SITE CONDITIONS**

The property is currently vacant and grassed. A gravel access roadway runs through the middle of the site. Overhead hydro wires also exist on the property. In general, the site is relatively flat. Residential properties bound the west, south and east sides, while rural farmland bounds the property on the north side.

## **3.0 FIELD AND LABORATORY PROCEDURES**

Prior to the commencement of the field drilling program, locates were organized by CMT Inc. to ensure that underground utilities would not be damaged.

The drilling field investigation was conducted on December 23, 2013 and comprised the advancement of six (6) boreholes (referenced as Boreholes 1 to 6), utilizing a Geoprobe 7822DT drillrig operated by employees of CMT Engineering Inc. Borehole 1 was advanced within proposed Lot 10, Borehole 2 was advanced within proposed Lot 7, Borehole 3 was advanced within proposed Lot 19, Borehole 4 was advanced within proposed Block 21, Borehole 5 was advanced within proposed Lot 21 and Borehole 6 was advanced within proposed Block 22, which is also in the area of the proposed storm water management area. The boreholes were all advanced to depths of 4.42 m (14.5 ft) below the existing ground surface elevations.

Soil sampling was undertaken utilizing the Standard Penetration Test (SPT) system and was generally conducted at 0.76 m (2.5 ft) intervals to borehole termination. Technical staff from CMT Inc. observed the drilling operation and collected and logged the recovered soil samples. A small portion of each sample was placed in a sealed, marked jar for moisture content determinations. Representative samples from the following boreholes and depths were submitted to our laboratory for grain size analyses:

- Borehole 2 – depth 2.3 m to 2.9 m
- Borehole 3 – depth 0.8 m to 1.4 m

As requested, a representative sample of the native soils from a depth of 0.76 m to 1.37 m in Borehole 5 was submitted to ALS Laboratory Group for chemical analysis. Please refer to Section 5.13 and Appendix D of this report for further details.

Boreholes 3 and 6 were equipped with monitoring wells comprising 3.0 m long screens, backfilled with #3 sand filter and riser pipe, backfilled with bentonite. The monitoring wells were installed in accordance with the Ontario Water Resources Act, Regulation 903 (Reg 903) by well technicians licensed by the Ministry of the Environment (MOE), working for a well contractor also licensed by the MOE. The boreholes that were not instrumented with monitoring wells were backfilled with bentonite in accordance with Reg 903. The monitoring wells are registered with the MOE and must be decommissioned in accordance with Reg 903 prior to future construction.

The borehole logs are provided in Appendix A, the grain size analyses are provided in Appendix B and the MOE well records are provided in Appendix C.

Triton Engineering Services Limited surveyed the ground surface elevations in April 2014 and the survey information was forwarded to CMT Inc. in June 2014. The ground surface elevations ranged from 394.08 m to 397.91 m at the borehole locations. The locations of the boreholes are shown on Drawing 2.

#### **4.0 SUBSOIL CONDITIONS**

The soils encountered in the boreholes are described briefly below and a more detailed stratigraphic description is provided on the borehole logs in Appendix A.

#### **4.1. Topsoil**

Dark brown, very loose silty topsoil was encountered at the surface of all boreholes. The topsoil ranged in thickness from 150 mm to 410 mm (average 218 mm) at the borehole locations. The topsoil was considered very moist, with moisture contents in the order of 34.4%.

#### **4.2. Sandy Silt**

Mottled light brown to brown sandy silt, with some clay and gravel, was encountered underlying the topsoil in Boreholes 1, 2, 3, 5 and 6, and underlying the silty sand and gravel in Borehole 4. The sandy silt was considered very loose to compact, with SPT N-values ranging from 2 to 35 blows per 0.30 m (average 12 blows per 0.30 m). The sandy silt was considered moist to saturated, with moisture contents ranging from 9.8% to 24.2% (average 15.0%).

#### **4.3. Silty Sand and Gravel**

Brown silty sand and gravel, with trace clay, was encountered underlying the sandy silt in Borehole 3 and underlying the topsoil in Borehole 4. The silty sand and gravel was considered loose to compact, with SPT N-values ranging from 5 to 29 blows per 0.30 m (average 18 blows per 0.30 m). The silty sand and gravel was considered very moist to saturated, with moisture contents ranging from 8.9% to 22.5% (average 14.0%).

#### **4.4. Silt and Sand Till**

Brown to grey silt and sand till, with some clay and gravel, was encountered underlying the sandy silt in Boreholes 2, 5 and 6. The silt and sand till was considered compact to very dense, with SPT N-values ranging from 18 to greater than 100 blows per 0.30 m (average 42 blows per 0.30 m). The silt and sand till was considered moist, with moisture contents ranging from 7.9% to 12.6% (average 10.3%).

#### **4.5. Groundwater**

Boreholes 3 and 6 were equipped with monitoring wells. CMT Engineering Inc. staff initially measured the water levels on January 8, 2014 and then again on June 18, 2014.

The following table summarizes the borehole number, ground surface elevation, elevation of water in the monitoring wells or accumulated in borehole, cave elevation, zone of saturation and the bottom of borehole elevation for each borehole:

BH No.	Ground Surface Elevation (m)	Measured Elevation of Water in Monitoring Well Jan 8/14 (m)	Measured Elevation of Water in Monitoring Well June 18/14 (m)	Cave Elevation (m)	Zone of Saturation Elevation (m)	Bottom of Borehole Elevation (m)
1	397.18	--	--	394.89	--	392.76
2	397.21	--	--	394.16	--	392.79
3	397.91	395.87 (MW)	394.95 (MW)	--	395.62 to termination	393.49
4	396.75	--	--	393.70	395.99 to 394.46	392.33
5	397.24	--	--	393.58	--	392.82
6	394.08	393.76 (MW)	393.98 (MW)	--	393.98 to 390.73	389.66

Recommendations with respect to dewatering conditions are provided in Section 5.8 of this report.

### **5.0 DISCUSSION AND RECOMMENDATIONS**

It is understood that the project will comprise the construction of nineteen (19) single-unit residential homes, as well as sixteen (16) semi-detached units (referenced as Block 20 and Block 21) and eight (8) townhomes (Block 22). A storm water management facility is proposed to be constructed in the southeast portion of the site (Block 22). A new roadway will also be constructed, with access from Lorne Street.

Utilizing the information gathered during the geotechnical investigation and assuming that the borehole information is representative of the subsoil conditions throughout the site, the following comments and recommendations are provided.

**5.1. Serviceability and Ultimate Limit Pressure**

Based on the information provided from the boreholes, the following table provides a summary of the preliminary Serviceability Limit State (SLS) and Ultimate Limit State (ULS) pressures at the various approximate elevations, including soil types:

Borehole No.	Ground Surface Elevation (m)	SLS kPa (psf)	ULS kPa (psf)	Estimated Highest Founding Elevation (m)	Soil Type
1	397.18	75 (1500) 150 (3000)	110 (2200) 225 (4500)	396.98 to 396.11 396.11 to termination	Sandy silt Sandy silt
2	397.21	75 (1500) 150 (3000)	110 (2200) 225 (4500)	396.45 to 395.69 395.69 to termination	Sandy silt Silt and sand till
3	397.91	75 (1500) 150 (3000)	110 (2200) 225 (4500)	397.15 to 396.39 396.39 to termination	Sandy silt Silty sand and gravel / Sandy silt
4	396.75	75 (1500) 150 (3000)	110 (2200) 225 (4500)	396.50 to 395.99 395.99 to termination	Silty sand and gravel Sandy silt
5	397.24	150 (3000)	225 (4500)	396.48 to termination	Sandy silt / Silt and sand till
6	394.08	75 (1500) 150 (3000)	110 (2200) 225 (4500)	391.79 to 390.73 390.73 to termination	Sandy silt Silt and sand till

It should be noted that the sandy silt at the founding elevation may be in a wet/dilatant state and may be too wet to provide suitable bearing for foundations without drainage or construction of a mud mat or granular drainage layer. It is imperative that the subgrade soils be inspected and approved by competent geotechnical personnel to ensure that the founding soils are suitable for bearing.

The serviceability limit pressure for granular structural fill placed and compacted in accordance with Section 5.4.2 of this report is estimated to be at least 150 kPa (3000 psf). With respect to the Serviceability Limit State (SLS), the total and differential footing settlements are not expected to exceed the generally acceptable limits of 25 mm (1") and 19 mm (3/4") respectively.

All exterior footings must be provided with a minimum of 1.2 m of soil cover or equivalent thermal protection in order to provide protection against frost action.

At the time of the investigation, the proposed finished floor elevations were not known. CMT Inc. would be pleased to review design drawings when they become available and provide recommendations with respect to bearing and foundation elevations.

## 5.2. Seismic Site Classification

The site classification for seismic response in Table 4.1.8.4 of the 2012 Ontario Building Code relates to the average properties of the upper 30 m of strata. The information obtained in the geotechnical field investigation was gathered from the upper 4.42 m of strata. Based on the information gathered in the geotechnical field investigation, the site classification for seismic site response would be considered Site Class D (stiff soils) for structures founded on the native soils at the recommended founding elevations provided in Section 5.1 of this report. For foundations constructed on structural fill, placed in accordance with Section 5.4.2 of this report, the site classification for seismic site response would also be considered Site Class D (stiff soil). The structural engineer responsible for the design of the structure should review the earthquake loads and effects.

## 5.3. Geotechnical Design Parameters

### 5.3.1. Soil Design Parameters

Soil Type	Soil Density (kg/m <sup>3</sup> )	Friction Angle	Coefficient of Active Pressure (K <sub>a</sub> )	Coefficient of Passive Pressure (K <sub>p</sub> )	Coefficient of At-Rest Pressure (K <sub>o</sub> )
Sandy silt	1,900	30°	0.33	3.00	0.50
Silty sand and gravel	2,100	32°	0.31	3.25	0.47
Silt and sand till	1,900	32°	0.31	3.25	0.47

### 5.3.2. Foundation Coefficient of Friction

Footings (Concrete) on soil: 0.30  
Piles (Steel) on soil: 0.40  
Piping (Iron or PVC) on soil: 0.60

### **5.3.3. Design Water Level**

The highest measured groundwater levels were encountered in the following boreholes at the corresponding elevations:

Borehole 3: 395.87 m (local GWT) – January 8/14

Borehole 6: 393.98 m (perched) – June 18/14

### **5.4. Site Preparation**

The extent of the site preparation required will include topsoil stripping and then site grading to achieve the design grades.

#### **5.4.1. Topsoil Stripping**

All topsoil must be removed from within the proposed building, roadway and driveway envelopes to expose approved competent subgrade soils. The topsoil may be used in landscaped areas where some settlement can be tolerated; otherwise it should be properly disposed of off-site.

#### **5.4.2. Site Grading**

Prior to any placement of structural fill, the subgrade for the building envelopes must be prepared large enough to accommodate a 1:1 slope commencing at a distance of 1.0 m beyond the outside edge of the proposed foundation down to approved, competent native founding soils. As the soils underlying the topsoil generally comprise sandy silt or silty sand and gravel soils in a relatively loose, unconsolidated state, compactive effort will be required prior to fill placement. This may be further complicated by the moisture content of the sandy silt, as well as the silty sand and gravel soils. Should the soils become disturbed or unstable, they will have to be subexcavated and replaced with approved soils.

Any fill materials required to achieve the design site grades should be placed according to the following procedures:

- soils approved for use as structural fill must be placed in loose lifts not exceeding 0.3 m (12") in depth for granular soils (recommended fill materials) and 0.2 m (8") in depth for silts and clays, or the capacity of the compactor (whichever is less)
- granular fill materials can be compacted utilizing adequate heavy vibratory smooth drum or padfoot compaction equipment
- fine-grained silt and clay soils (if imported) must be compacted utilizing adequate heavy padfoot vibratory compaction equipment
- approved fill materials must be at suitable moisture contents to achieve the specified compaction
- approved structural fill materials that will support structures (including foundations, interior slab-on-grades, sidewalks and large expansive exterior slabs and stairs) must be compacted to 100% standard Proctor maximum dry density (SPMDD)
- approved bulk fill (exterior foundation wall backfill in landscaped areas, bulk fill for roadway and driveways) must be compacted to a minimum 95% SPMDD
- Granular 'B' subbase and Granular 'A' base materials for the roadway and driveways must be compacted to 100% SPMDD

Based on the moisture content data from the boreholes, the existing soils are generally in a very moist to saturated state. As such, significant air-drying, along with working of the soils, will be required in order to achieve the specified field compaction of 98% SPMDD in the building envelopes (including 1:1 as required) and 95% SPMDD for bulk fill in roadways and driveways. Utilizing the existing native soils during site grading may be more achievable if work is completed during the generally drier summer months. It should be noted, however, that even during drier months, a simple heavy rain could delay further construction for an extended period of time. Positive site drainage during construction could help alleviate this problem.

### **5.5. Foundation Subgrade Preparation**

The native sandy silt as well as the silt and sand till soils encountered in the boreholes are sensitive to change in moisture content and can become loose/soft if the soils are subjected to additional water or precipitation as well as severe drying conditions. The native subgrade soils could also be easily disturbed if traveled on during construction. Once they become disturbed they are no longer considered adequate for the support of shallow foundations. To ensure and protect the integrity of the founding soils during construction operations, the following is recommended:

- the subgrade should be sloped to a sump located outside the building footprints in the excavation to promote surface drainage of the standing water (if present); rainwater or seepage and any collected water should be pumped out of the excavation; it is critical that all water be controlled (not allowed to pond) and that the subgrade and foundation preparation commence in dry conditions
- construction equipment travel and foot traffic on the founding soils should be minimized
- if construction is to be undertaken during subzero weather conditions, the founding native soils and any potential fill materials must be maintained above freezing
- prior to pouring concrete for the footings, the footing area must be cleaned of all disturbed or caved materials
- the foundation formwork and concrete should be installed as soon as practical following the excavation, inspection and approval of the founding soils; the longer that the excavated soils remain open to weather conditions and groundwater seepage, the greater the potential for construction problems to occur
- if it is expected that the founding soils will be left open to exposure for an extended period of time, it is recommended that a 75 mm concrete mud slab be poured in order to protect the structural integrity of the founding soils

### 5.6. Slab-on-Grade / Modulus of Subgrade Reaction

Prior to the placement of the granular base for the slab-on-grade construction, the subgrade should be proof-rolled. Any soft or weak zones, as well as the unsuitable fill in the subgrade, should be subexcavated and backfilled with approved fill materials (see Section 5.4.2 of this report).

The following table provides the modulus of subgrade reaction (k) for the native soils encountered on-site:

Soil Type	Modulus of Subgrade Reaction (k)
Silt and sand till	47,000 kN/m <sup>3</sup> (175 lb/in <sup>3</sup> )
Silty sand and gravel	68,000 kN/m <sup>3</sup> (250 lb/in <sup>3</sup> )
Sandy silt	41,000 kN/m <sup>3</sup> (150 lb/in <sup>3</sup> )

In dry conditions, the floor slab can be founded on a minimum thickness of 100 mm (4") of coarse clean granular material containing not more than 10% of material that will pass a 4 mm sieve in accordance with the current OBC. The clean granular material should be consolidated to prevent future settlement. If the design of the proposed residences results in the foundations being constructed within the zone of saturation identified from the boreholes, a granular drainage layer will be required. The granular drainage layer must conform to the requirements listed in Section 9.14.4 of the Ontario Building Code 2012 (OBC).

It is recommended that areas of extensive exterior slab-on-grade (sidewalks, accessibility ramps and stairs) be constructed with a Granular 'B' subbase (300 mm) and a Granular 'A' base (150 mm), as well as incorporating subdrains, to provide rapid drainage and reduce the effects of frost heaving. Alternatively, a structural frost slab could be designed and constructed at door entrances.

### 5.7. Excavations

All excavations must be carried out in accordance with Ontario Regulation 213/91 (Reg 213/91) of the Occupational Health and Safety Act and Regulations for Construction Projects.

**Type 2 Soils** - In general, the dense silt and sand till encountered in the lower zones of some boreholes, in a drained state (not saturated) would be classified as Type 2 soils under Reg 213/91. The Type 2 soils must be sloped from within 1.2 m of the bottom of the excavation at a minimum gradient of 1 horizontal to 1 vertical. All saturated soils encountered must be treated as Type 4 soils, as described below.

**Type 3 Soils** - In general, the native sandy silt as well as the silty sand and gravel soils encountered in the boreholes, in a drained state (not saturated) would be classified as Type 3 soils under Reg 213/91. The Type 3 soils must be sloped from the bottom of the excavation at a minimum gradient of 1 horizontal to 1 vertical. All saturated soils encountered must be treated as Type 4 soils, as described below.

**Type 4 Soils** - In general, any wet to saturated soils would be classified as Type 4 soils under Reg 213/91. Type 4 soils must be sloped from the bottom of the excavation at a minimum gradient of 3 horizontal to 1 vertical.

If it is not practical to excavate according to the above requirements, then a trench support system (designed in accordance with the Ontario Health and Safety Act Regulations) may be utilized.

Sloughing of soils in the walls of the excavation should be expected when excavating within the zone of saturated soils.

It should be noted that the native sandy silt till soils become very dense with depth (N-values in excess of 50 blows per 0.30 m). If excavations extend into these soils, may prove difficult to excavate with conventional excavating equipment, impacting the production schedule. It is imperative that when the very dense soils are utilized for backfilling of service trenches, the material must be broken down (pulverized) to minimize voids and reduce the potential for settlement.

#### **5.8. Dewatering Considerations**

At the time of the investigation, the proposed finished floor elevations were not known. Therefore it is recommended that the groundwater conditions be confirmed during the initial excavations; at which point recommendations regarding footing size and dampproofing/waterproofing can be made. It should also be noted that it is common for groundwater levels to subside upon installation of service trenches as they can act as drainage pathways through the less permeable soils. Therefore, it may be prudent to inspect the groundwater conditions upon completion of the site servicing.

Moist to saturated soil conditions were encountered at or in close proximity to the assumed founding elevation of the proposed residences. The soils in the upper zone of the boreholes are generally comprised of loose sandy silt or silty sand and gravel soils with an underlying compact to dense sandy silt or sand and silt till layer. This underlying layer of fine-grained, denser material may act as a confining layer, resulting in perched water forming in the overlying relatively loose sandy silt or silty sand and gravel. Seepage control requirements during construction will depend upon the area of work on

the site, the depth of the excavations, the time of year, the amount of precipitation and the control of surface water.

Seepage should be expected when excavating below the groundwater elevations and into saturated zones presented in Section 4.5 of this report. As required, seepage should generally be adequately controlled using conventional dewatering techniques such as the use of sump pits. It is expected that heavy seepage will occur if excavating into the saturated silty sand and gravel deposit and, as such, it may be necessary to increase the number of pumps or utilize a vacuum well point system during construction. Dewatering should be performed in accordance with OPSS 518. If work is being done within this saturated zone, caution should be taken as many of the fine-grained soils may be removed with the dewatering process. Dewatering devices such as sump pumps should be outfitted with filter socks to limit the amount of fine-grained material that is removed with the water. It should still be expected that dewatering equipment may need to be cleared of fine-grained soils regularly during construction. It is the responsibility of the general contractor to propose a suitable dewatering system based on the groundwater conditions at the time of construction.

The proposed founding elevations for the various buildings were not available at the time of preparation of this report. CMT Inc. can provide further recommendations for building drainage once the design drawings are completed and the finished floor elevations have been established. The construction of foundations and slabs-on-grade within or below the zone of saturation or static water levels noted in the boreholes will require design of site-specific waterproofing and dewatering systems constructed in accordance with the 2012 OBC. It is recommended that a waterproofing specialist be consulted to recommend an appropriate product and installation requirements that would be suited to this site.

An exterior perimeter weeping tile system comprising perforated drainage pipe with a factory installed filter sock, bedded in 19 mm clear crushed stone and wrapped in a geotextile filter fabric such as Terrafix 270R (or equivalent) must be installed at an elevation that is below the proposed basement slab-on-grade elevation and provided with positive drainage into a sump pit. The portion of the piping that connects the exterior weeping tile system into the sump pit must comprise solid piping to prevent exterior water from being introduced into the interior subslab stone. It may be prudent to install perforated drainage pipe in the interior of the basement as well to provide an outlet for any water that may collect in the subslab stone. It is also recommended that a capped cleanout port(s) be extended up to the ground surface elevation to provide future access (if required). The rainwater leaders must not be connected to the perimeter weeping tile system.

Depending on the groundwater conditions at the design founding elevations, it may be necessary to install a granular drainage layer to provide a suitable base for the foundations. The granular drainage layer must conform to the requirements listed in Section 9.14.4 of the OBC 2012.

Foundations constructed within or below the zone of saturation noted in the boreholes would be subject to flooding in the event of a power failure or equipment malfunction. Therefore, it would be recommended that a good quality sump pit be utilized and that at a minimum the system be equipped with a battery backup, preferably with a separate functioning sump pump. Each residential unit should be equipped with an individual sump pump system. Groundwater elevations (perched and regional water tables) are dependent on weather and seasonal conditions and should be expected to fluctuate.

#### **5.9. Perimeter Building Drainage, Foundation Wall Backfill and Trench Backfill**

In order to assist in maintaining the buildings dry from surface water seepage, it is recommended that exterior grades around the building be sloped down and away at a 2% gradient or more, for a distance of at least 2.0 m. Any surface discharge rainwater leaders must be constructed with solid piping that discharges with positive drainage at least 1.5 m away from the building foundation to a drainage swale or appropriate storm drainage system.

The exterior foundation backfill should extend a minimum lateral distance of 600 mm out from the foundation walls and should consist of free-draining granular material such as Granular 'B' Type I or Type II (OPSS 1010), with a maximum aggregate size not exceeding 100 mm. It is critical that particles greater than 100 mm in diameter are not in contact with the foundation wall to prevent point loading and overstressing. The backfill material used against the foundation walls must be placed so that the allowable lateral capacities of the foundation walls are not exceeded. Where only one side of a foundation wall will be backfilled and the height of the wall is such that lateral support is required, or where the required concrete strength has not been achieved, the wall must be braced or laterally supported prior to backfilling. In situations where both sides of the wall are backfilled, the backfill should be placed in equal lifts, not exceeding 200 mm differential on each side during backfill operations.

The native mineral soils (non-organic) are generally considered suitable for reuse as trench backfill and bulk fill in the roadway and driveways, however the very moist to saturated soils will require significant air-drying in order to achieve the specified field compaction. Air-drying cannot typically be achieved during winter construction; therefore, depending on the time of year that construction takes place, it may be more feasible to utilize an imported granular fill for this project.

Backfilling operations should be carried out with the following minimum requirements:

- adequate heavy smooth drum or padfoot vibratory compaction equipment should be used for the compaction
- loose lift thicknesses should not exceed 0.3 m (12") for granular soils or 0.2 m (8") for clay and silt soils or the capacity of the compactor (whichever is less)
- the soils must be at suitable moisture contents to achieve compaction to a minimum 95% SPMDD in non-structural areas; service trenches excavated within the zone of influence of footings for the structure must be compacted to a minimum of 100% SPMDD
- it is recommended that inspection and testing be carried out during construction to confirm backfill quality, thickness and to ensure that compaction requirements are achieved
- service trench backfill materials may consist of approved excavated soils with no particles greater than 100 mm and no topsoil or other deleterious materials
- if construction operations are undertaken in the winter, strict consideration should be given to the condition of the backfill material to make certain that frozen material is not used

It should be noted that the native sandy silt till soils become very dense with depth (N-values in excess of 50 blows per 0.30 m) and if excavations extend into these soils, may prove difficult to excavate with conventional excavating equipment, impacting the production schedule. It is imperative that when the very dense soils are utilized for backfilling of service trenches, the material must be broken down (pulverized) to minimize voids and reduce the potential for settlement.

If the buildings will have basements, then a perimeter weeping tile system will be required (see Section 5.8 of this report).

CMT Inc. can provide further recommendations for building drainage once the structural drawings are complete and finished floor elevations have been established.

#### **5.10. Service Pipe Bedding**

The native soils encountered in the geotechnical investigation are generally considered suitable for indirect support of the site service pipes. Where instability due to saturated soil conditions is encountered, it may be necessary to increase the thickness of the granular base and utilize 19 mm clear stone to create an adequate supporting base for the service pipes and manholes. Pipe embedment, cover and backfill for flexible pipes should be in accordance with OPSD-802.010 and as follows:

**Flexible Pipes** - The pipe bedding should be shaped to receive the bottom of the pipe. If necessary, pipe culvert frost treatment should be undertaken in accordance with OPSD-803.030 and OPSD-803.031. The trench excavations should be symmetrical with respect to the centreline of the pipe. The granular material placed under the haunches of the pipe must be compacted to 95% SPMDD prior to the continued placement and compaction of the embedment material. The homogeneous granular material used for embedment should be placed and compacted uniformly around the pipe. Should wet conditions be encountered at the base of the trench, then the pipe bedding should consist of 19 mm clear stone (meeting OPS Specifications) wrapped completely in a geotextile fabric such as Terrafix 270 or equivalent. The general contractor is responsible to protect service piping from damage by heavy equipment.

Pipe embedment, cover and backfill for rigid pipes should be undertaken in accordance with OPSD-802.030 or OPSD-802.031 and as follows:

**Rigid Pipes** - In general, the pipe installation recommendations for rigid pipes are the same as those for flexible pipes, except that the minimum bedding depth below a rigid pipe should be  $0.15D$  (where  $D$  is the pipe diameter). In no case should this dimension be less than 150 mm or greater than 300 mm.

#### **5.11. Pavement Design / Drainage**

All topsoil must be subexcavated from within the roadway and driveway areas. Prior to placement of the granular base, the subgrade must be proof-rolled and any soft or unstable areas should be subexcavated and replaced with suitable drier materials. When service pipes are installed within the roadway, pipe bedding and backfilling should be undertaken as indicated in Sections 5.9 and 5.10 of this report.

Rapid drainage of the pavement structure is critical to ensure long-term performance. As such, it is recommended to install subdrains for this project. It is recommended to install a minimum of 100 mm diameter perforated subdrains to collect and redirect water beneath the pavement surface. Subdrains should be designed and installed in accordance with OPSS 405 and OPSD 216.021. If Granular 'A' bedding (OPSS 1010) is utilized, the

subdrains should be equipped with a factory installed filter sock. If 19 mm clear stone (OPSS 1004) is utilized as bedding for the subdrain, then the bedding must be wrapped completely with geotextile filter fabric such as Terrafix 270R (or equivalent) and a factory installed filter sock is not required. Installation of rigid subdrains allows for better grade control and less potential for damage during installation; however, it would be expected that there would be higher cost implications associated with the installation of rigid subdrains over flexible subdrains. The subdrains will hasten the removal of water, thereby reducing the risk and effects of frost heaving and load transfer in saturated conditions. It is suggested that, at a minimum, subdrains be installed through all low areas of the roadway and ideally along the curb line as well. The subdrains should be installed in a 0.3 m (1.0 ft) by 0.3 m (1.0 ft) trench in the subgrade and bedded approximately 50 mm (2") above the bottom of the trench. The subdrains must be installed with positive drainage into a catch basin structure or other suitable outlet.

The native subgrade soils are sensitive to change in moisture content and can become loose or soft if the soils are subject to inclement weather and seepage or severe drying. Furthermore, the subgrade soils could be easily disturbed if traveled on during construction. As such, where this material will be exposed, it is recommended that the granular subbase be placed immediately upon completion of the subgrade preparation to protect the integrity of the subgrade soils.

Should wet conditions be encountered during construction, site assessments may be required to determine what options can be undertaken to construct a modified pavement base. These options may include subexcavation of wet soils and increasing the thickness of the granular base, the use of reinforcing geotextiles, or a combination of both.

It is expected that the roads will experience mostly light traffic (personal vehicles) and some heavy traffic (moving trucks, delivery trucks, maintenance and emergency vehicles). Based on the anticipated loading, the following pavement design is provided:

<b>Material</b>	<b>Recommended Thickness</b>
Asphaltic Concrete	HL3 - 40 mm (1.5") HL4 or HL8 - 50 mm (2.0")
Granular 'A' Base	150 mm (6.0")
Granular 'B' Subbase	450 mm (18.0")

The granular base and subbase materials must be compacted to 100% SPMDD. Asphaltic concrete should be supplied, placed and compacted to a minimum 92.0% Marshall maximum relative density, in accordance with OPSS 1150 and OPSS 310.

The pavement should be designed to ensure that water will not pond on the pavement surface. If the surface asphalt is not placed within a reasonable time following placement of the binder asphalt, it is recommended that the catch basin lids are set at a lower elevation or apertures provided to allow surface water to drain into the catch basins and not accumulate around the catch basins.

#### **5.12. Infiltration**

Borehole 6 was advanced in the area of the proposed storm water management facility. The native soils in the borehole generally comprised sandy silt overlying silt and sand till to borehole completion. The estimated coefficient of permeability ( $k$ ) is  $2.25 \times 10^{-6}$  cm/sec for the sandy silt, while the estimated coefficient of permeability ( $k$ ) is less than  $1.0 \times 10^{-6}$  cm/sec for the silt and sand till. In general, an acceptable 'k' value for infiltration galleries is  $1.0 \times 10^{-3}$  cm/sec. The groundwater elevation measured on January 8, 2014 was only 0.32 m below the existing ground surface elevation, therefore, the native sandy silt would not be considered suitable to provide infiltration of the runoff water.

#### **5.13. Excess Soil Management**

As requested, a representative sample of the native soils from a depth of 0.76 m to 1.37 m in Borehole 5 was submitted to ALS Laboratory Group for chemical analysis. The soil sample was tested for the following:

- F1-F4, VOC's, BTEX as per O. Reg. 153/04 as amended by R511
- SVOC as per O. Reg. 153/04 as amended by R511
- Metals/Inorganics as per O. Reg. 153/04 amended by R511

The chemical analysis results were compared to Ontario Regulation 153/04 - as amended by O.Reg. 511 – April 15, 2011 Standards = [Suite] – ON-511-T1/T2-SOIL-RPI. Specifically, the results were compared in *T1-Soil-Res/Park/Inst/Ind/Com/Commu Property Use*, *T2-Soil-Res/Park/Inst. Property Use (Coarse)* and *T3-Soil-Res/Park/Inst. Property Use (Fine)*.

It should be noted that none of the Guideline Limits were exceeded in the sample. The results of the chemical analysis are attached in Appendix C of this report.

If soils are transported to a land fill facility, additional chemical testing in accordance with Ontario Regulation 347, Schedule 4, as amended to Ontario Regulation 558/00, dated March 2001, Toxicity Characteristic Leaching Procedure (TCLP) will be required.

When transporting soils off-site, the following is recommended:

- All chemical analyses and environmental assessment reports must be fully disclosed to the receiving site owners/authorities, whom must agree to receive the material;
- An environmental consultant must confirm the land use at the receiving site is compatible to receive the material;
- An environmental consultant must monitor the transportation and placement of the materials to ensure that the material is placed appropriately at the pre-approved site;
- The excess materials may not be transported to a site that has previously had a Record of Site Condition (RSC) filed, unless the material meets the criteria outlined in the RSC.

It should be noted that landfill sites will generally only accept laboratory test results that have been completed within 30 days of exporting. Therefore, it is recommended that provisions for chemical analysis be included in the tender documents. It should also be noted that the laboratory testing generally takes five (5) working days to process with a regular turnaround time.

## **6.0 SITE INSPECTIONS**

Qualified geotechnical personnel should supervise excavation inspections as well as compaction testing for structural filling, site grading and site servicing. This will ensure that footings are founded in the proper strata and that proper material and techniques are used and the specified compaction is achieved. CMT Engineering Inc. would be pleased to review the design drawings and provide an inspection and testing program for the construction of the proposed development.

## **7.0 LIMITATIONS OF THE INVESTIGATION**

This report is intended for the Client named herein and for their Client. The report should be read in its entirety, and no portion of this report may be used as a separate entity. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties.

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review our recommendations when the drawings and specifications are complete, or if the proposed construction should differ from that mentioned in this report.

It is important to emphasize that a soil investigation is, in fact, a random sampling of a site and the comments are based on the results obtained at the test locations only. It is therefore assumed that these results are representative of the subsoil conditions across the site. Should any conditions at the site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations.

It should be noted that this report specifically addresses geotechnical aspects of the project and does not include any investigations or assessments relating to potential subsurface contamination. As such, there should be no assumptions or conclusions derived from this report with respect to potential soil or water contamination. Soil or water contamination is generally caused by the presence of xenobiotic (human-made) chemicals or other alteration processes in the natural soil and groundwater environment. If necessary, the investigation, assessment and rehabilitation of soil and water contaminants should be undertaken by qualified environmental specialists.

The samples obtained during the geotechnical investigation will be stored for a period of three months, after which time they will be disposed of unless alternative arrangements are made.

We trust that this report meets with your present requirements. Should you have any questions, please do not hesitate to contact our office.

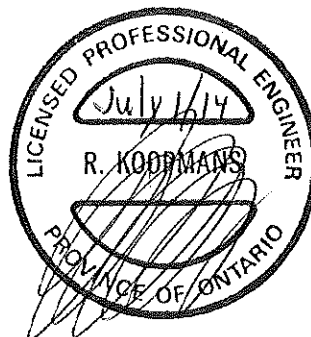
Prepared by:



Mark Vignault  
EIT

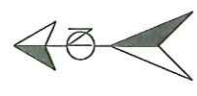
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Reviewed by:



Robert Koopmans, P.Eng.  
Consulting Engineer

NO.	REVISION	DATE

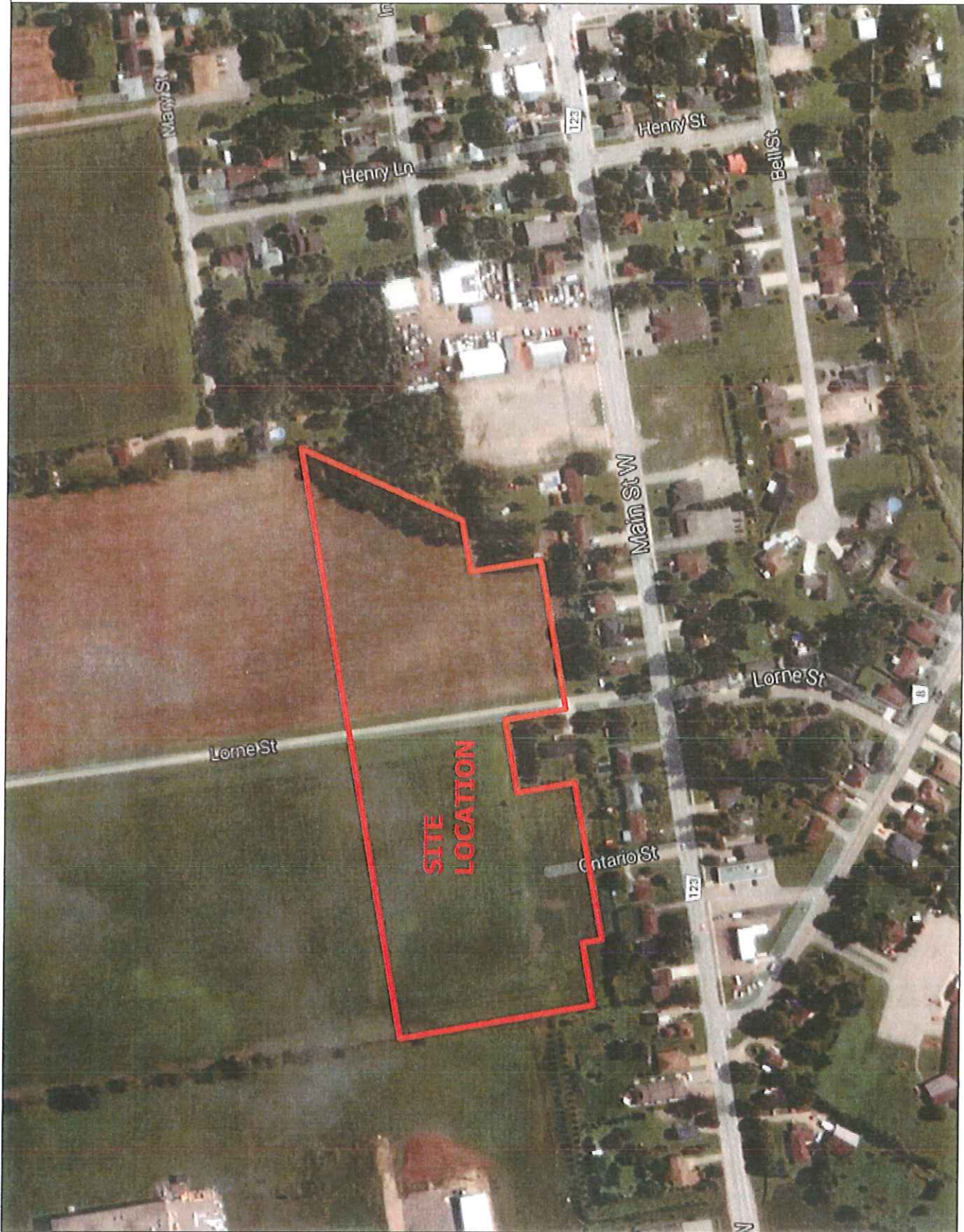


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LOCATION MAP

Clark-Heimiller Subdivision  
 Palmerston, Ontario  
 Town of Minto

Project:	13-603	Drawing:	1
Date:	June 2014	Sheet:	1
Scale:	N.T.S.		



POTENTIAL FUTURE DEVELOPMENT

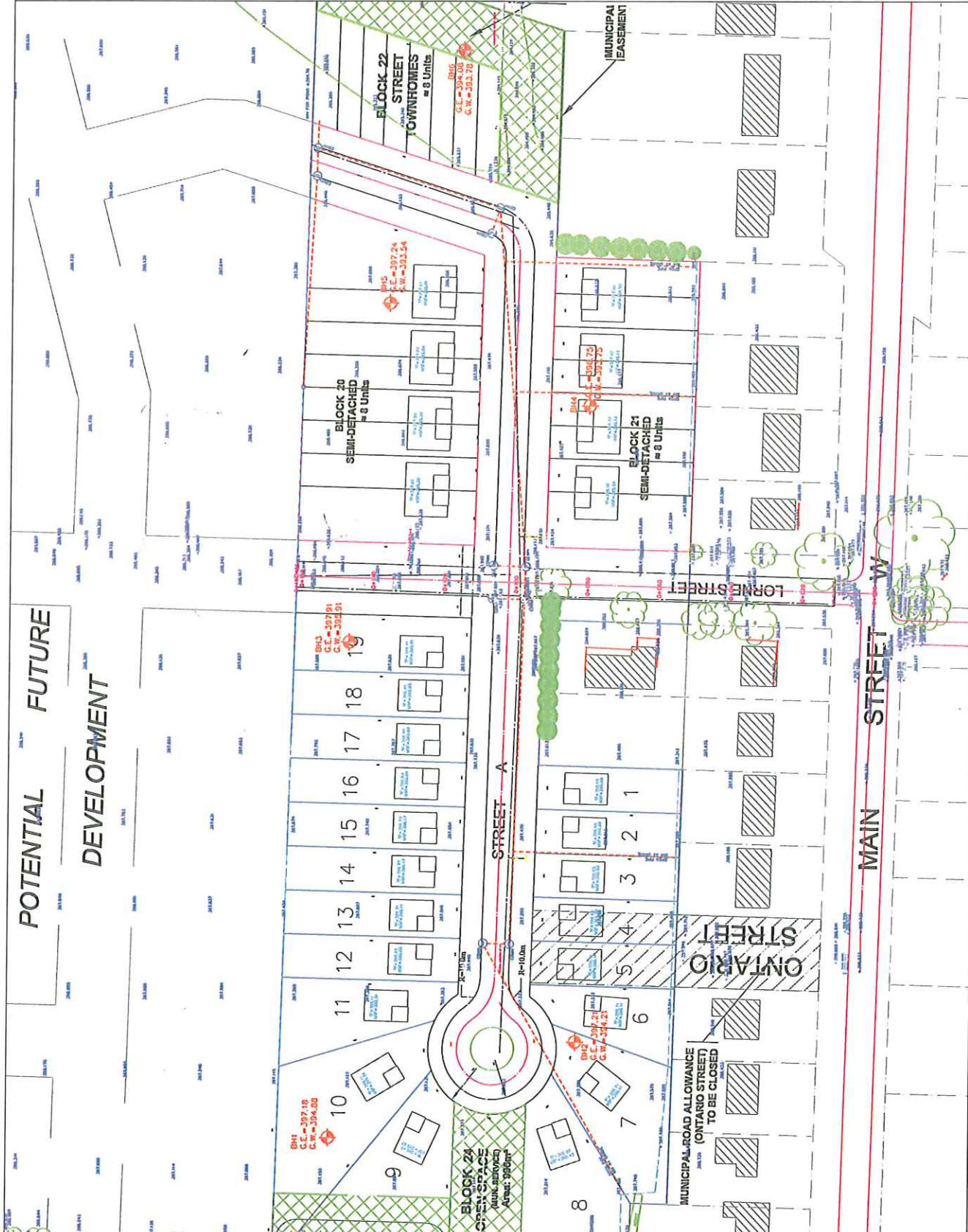
NO.	REVISION	DATE



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PLAN VIEW SHOWING  
 BOREHOLE LOCATIONS  
 Clark-Heinmiller Subdivision  
 Palmerston, Ontario  
 Town of Minto

Project: 13-603	Drawing: 2
Date: June 2014	Sheet: 1
Scale: N.T.S.	



**APPENDIX A**

**BOREHOLE LOGS**

# BOREHOLE 1

**Date Drilled:** December 23, 2013  
**Rig:** Geoprobe 7822DT  
**Contractor:** CMT Engineering Inc.  
**Drilling Method:** SPT

**Elevation:** 397.18 m  
**Logged by:** SS

**Project No.:** 13-603  
**Project:** Clark-Heinmiller Subdivision  
 Clark Street  
**Location:** Palmerston, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Well Installation	Moisture Content % Wp [---X---] Wl	Pocket Penetrometer kPa SPT (N) Blows/0.3 m
0					Ground Surface (m) 397.18			
0					0.00			
0-1	SS		1		<b>TOPSOIL</b> Loose, dark brown silty topsoil, moist (200mm)		24.2	5
1-2					<b>SANDY SILT</b> Loose, mottled light brown sandy silt, some clay and gravel, wet and slightly dilatant			
2-3								
3-4	SS		2		becoming compact		18.7	9
4-5								
5-6								
6-7	SS		3				12.3	22
7-8					becoming grey, moist			
8-9								
9-10	SS		4				11.0	35
10-11								
11-12	SS		5				12.4	16
12-13								
13-14								
14-15	SS		6				11.8	26
15-16								
15					End of Borehole			
15					392.76			
15					4.42			
16-17					Wet cave at 2.3 m upon completion			



# BOREHOLE 2

**Date Drilled:** December 23, 2013  
**Rig:** Geoprobe 7822DT  
**Contractor:** CMT Engineering Inc.  
**Drilling Method:** SPT

**Elevation:** 397.21 m  
**Logged by:** SS

**Project No.:** 13-603  
**Project:** Clark-Heinmiller Subdivision  
 Clark Street  
**Location:** Palmerston, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Well Installation	Moisture Content % Wp [---X---] Wl 10 20 30 40	Pocket Penetrometer kPa 100 300 SPT (N) Blows/0.3 m 10 30 50 70 90
					Ground Surface (m) 397.21			
0					<b>TOPSOIL</b> Loose, dark brown silty topsoil, moist (150mm)			
1	SS		1		<b>SANDY SILT</b> Loose, mottled light brown sandy silt, some clay and gravel, very moist		20.6	4
2								
3								
4	SS		2				14.5	8
5					395.69			
6					becoming compact			
7	SS		3				13.9	10
8					394.92			
9	SS		4		<b>SILT AND SAND TILL</b> Very dense, grey silt and sand till, some clay and gravel, moist		7.9	55
10					394.16			
11	SS		5		becoming compact		11.8	23
12								
13								
14	SS		6				12.6	23
15					392.79			
16					End of Borehole			
17					4.42			
					Wet cave at 3.0 m upon completion			

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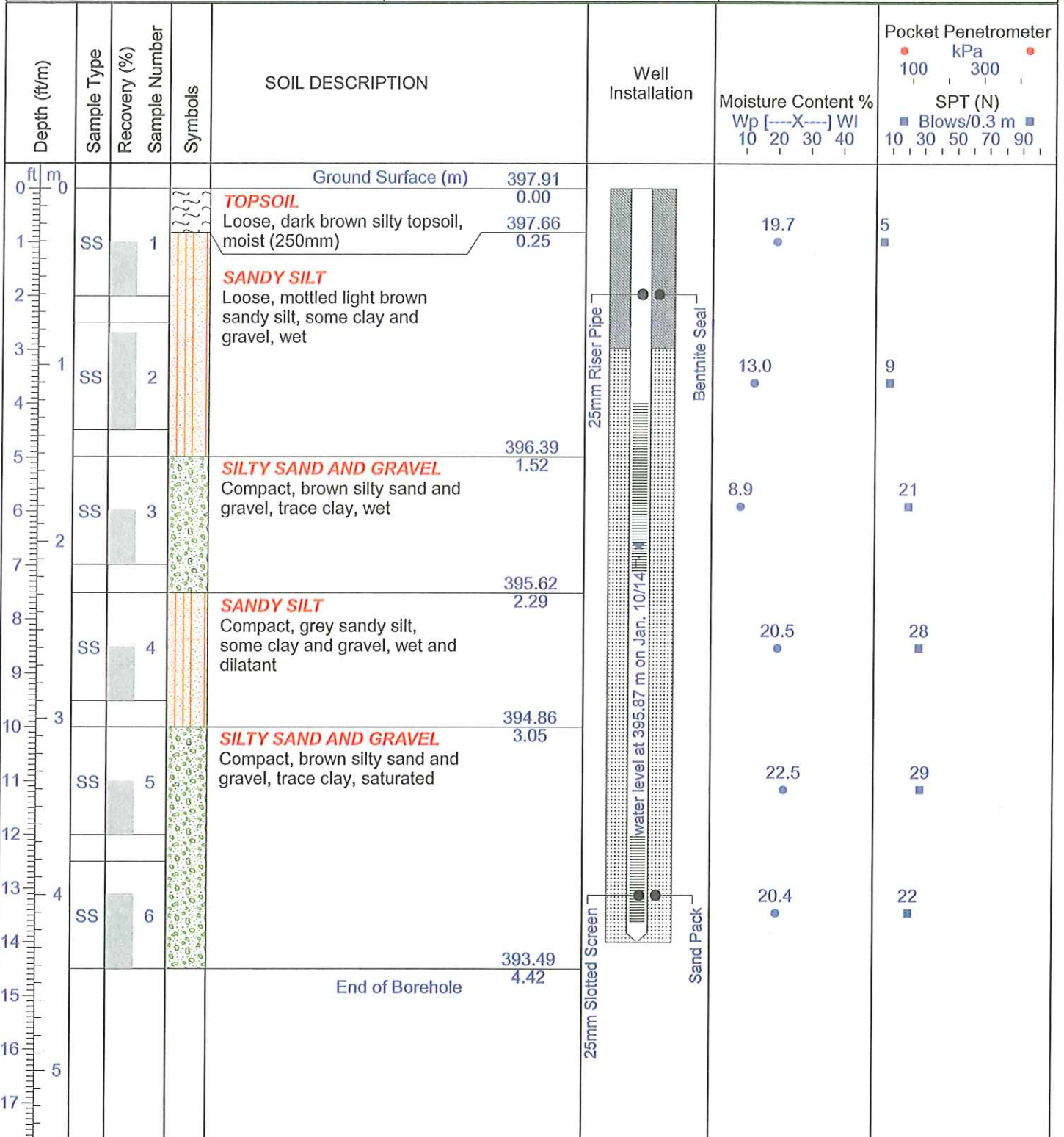


# BOREHOLE 3

**Date Drilled:** December 23, 2013  
**Rig:** Geoprobe 7822DT  
**Contractor:** CMT Engineering Inc.  
**Drilling Method:** SPT

**Elevation:** 397.91 m  
**Logged by:** SS

**Project No.:** 13-603  
**Project:** Clark-Heinmiller Subdivision  
 Clark Street  
**Location:** Palmerston, Ontario



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# BOREHOLE 4

Date Drilled: December 23, 2013  
 Rig: Geoprobe 7822DT  
 Contractor: CMT Engineering Inc.  
 Drilling Method: SPT

Elevation: 396.75 m  
 Logged by: SS

Project No.: 13-603  
 Project: Clark-Heinmiller Subdivision  
 Clark Street  
 Location: Palmerston, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Well Installation	Moisture Content % Wp [---X---] Wl	Pocket Penetrometer kPa SPT (N) Blows/0.3 m
0					Ground Surface (m) 396.75			
0					0.00			
1	SS		1		<b>TOPSOIL</b> Loose, dark brown silty topsoil, moist (150mm)		10.5	5
2					<b>SILTY SAND AND GRAVEL</b> Loose to compact, brown silty sand and gravel, trace clay, wet			
3								
4	SS		2				9.9	20
5								
6	SS		3				11.7	10
7								
8					394.46			
8					2.29			
9	SS		4		<b>SANDY SILT</b> Compact, brown sandy silt, some clay and gravel, very moist		14.0	11
10								
11	SS		5				12.6	10
12								
13								
14	SS		6				11.9	9
15					392.33			
15					4.42			
15					End of Borehole			
16					Wet cave at 3.0m upon completion			
17								



# BOREHOLE 5

**Date Drilled:** December 23, 2013  
**Rig:** Geoprobe 7822DT  
**Contractor:** CMT Engineering Inc.  
**Drilling Method:** SPT

**Elevation:** 397.24 m  
**Logged by:** SS

**Project No.:** 13-603  
**Project:** Clark-Heinmiller Subdivision  
 Clark Street  
**Location:** Palmerston, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Well Installation	Moisture Content % Wp [---X---] Wl	Pocket Penetrometer kPa SPT (N) Blows/0.3 m
0					Ground Surface (m) 397.24			
0					0.00			
1	SS		1		<b>TOPSOIL</b> Loose, dark brown silty topsoil, moist (150mm)		14.0	3
2					396.48			
2					0.76			
3	SS		2		<b>SANDY SILT</b> Loose, mottled light brown sandy silt, some clay and gravel, very moist becoming compact		12.0	14
4								
5								
6	SS		3				9.8	11
7								
8					394.80			
8					2.44			
9	SS		4		<b>SILT AND SAND TILL</b> Compact, brown silt and sand till, some clay and gravel, moist		9.3	31
10								
11	SS		5				10.4	18
12					393.58			
12					3.66			
13					becoming dense			
14	SS		6				11.3	40
15					392.82			
15					4.42			
15					End of Borehole			
16					Wet cave at 3.7 m upon completion			
17								

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# BOREHOLE 6

Date Drilled: December 23, 2013  
 Rig: Geoprobe 7822DT  
 Contractor: CMT Engineering Inc.  
 Drilling Method: SPT

Elevation: 394.08 m  
 Logged by: SS

Project No.: 13-603  
 Project: Clark-Heinmiller Subdivision  
 Clark Street  
 Location: Palmerston, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Well Installation	Moisture Content %		Pocket Penetrometer	
							Wp [---X---] Wl	SPT (N)	kPa	Blows/0.3 m
0					Ground Surface (m) 394.08					
0					<b>TOPSOIL</b> Loose, dark brown silty topsoil, moist (410mm)					
1	SS		1		393.67 0.41					
2				<b>SANDY SILT</b> Very loose, mottled light brown sandy silt, some clay and gravel, wet						
3										
4	SS		2							
5										
6	SS		3							
7										
8					becoming loose and moist					
9	SS		4		391.79 2.29					
10										
11	SS		5		<b>SILT AND SAND TILL</b> Dense to very dense, grey silt and sand till, some clay and gravel, moist					
12					390.73 3.35					
13										
14	SS		6							
15					389.66 4.42					
16					End of Borehole					
17										

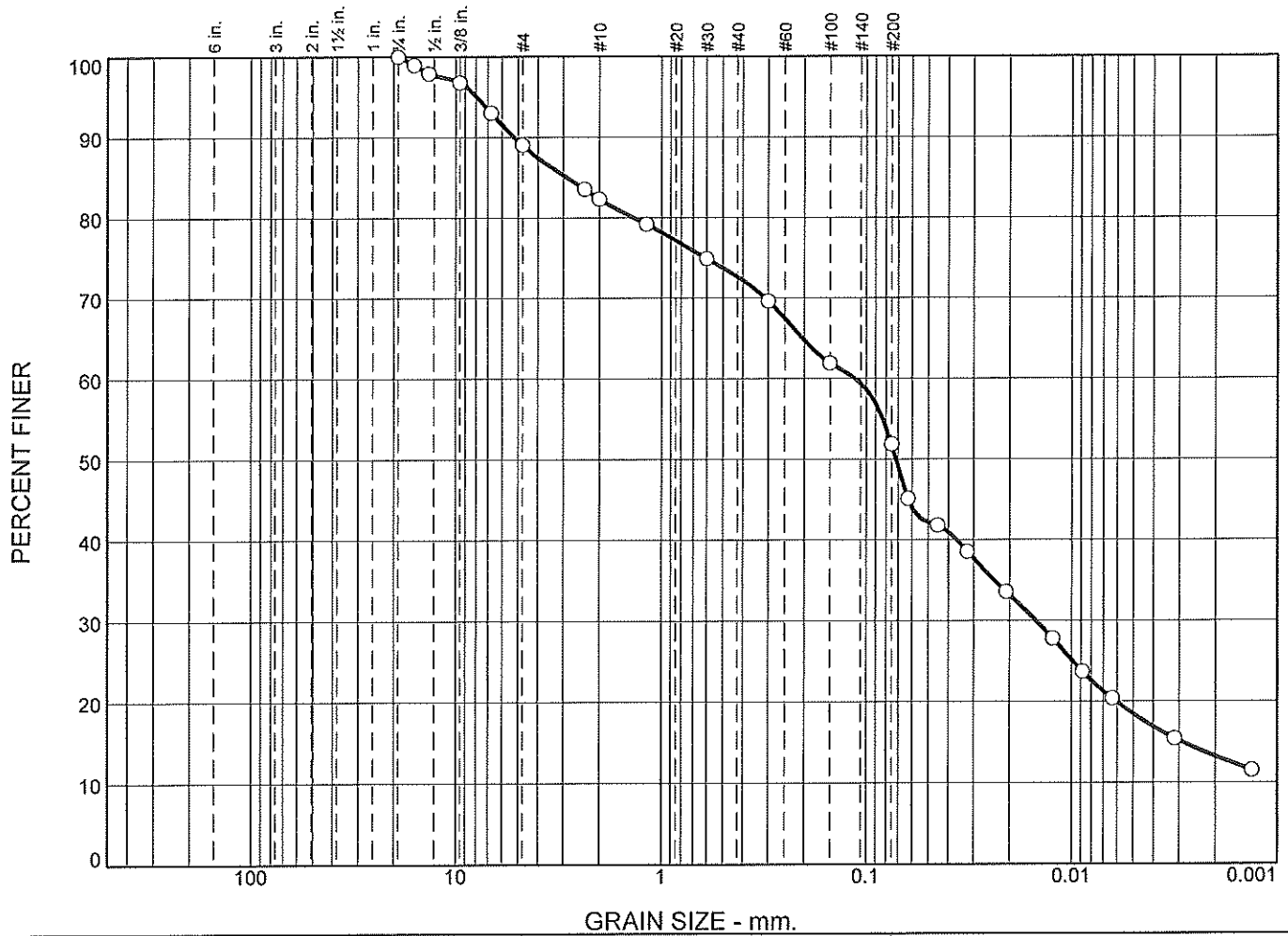
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**APPENDIX B**

**GRAIN SIZE ANALYSES**

# Particle Size Distribution Report



GRAIN SIZE - mm.

	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	10.9	6.8	9.6	20.8	38.6	13.3

## SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH 2	4	2.3-2.9 m	silt and sand, some clay and gravel	ML
				Tested by BF of CMT Engineering Inc. January 3, 2014	
				Estimated Coefficient of Permeability; $k < 1.0 \times 10^{-6}$ cm/sec	

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**St. Clements, ON**

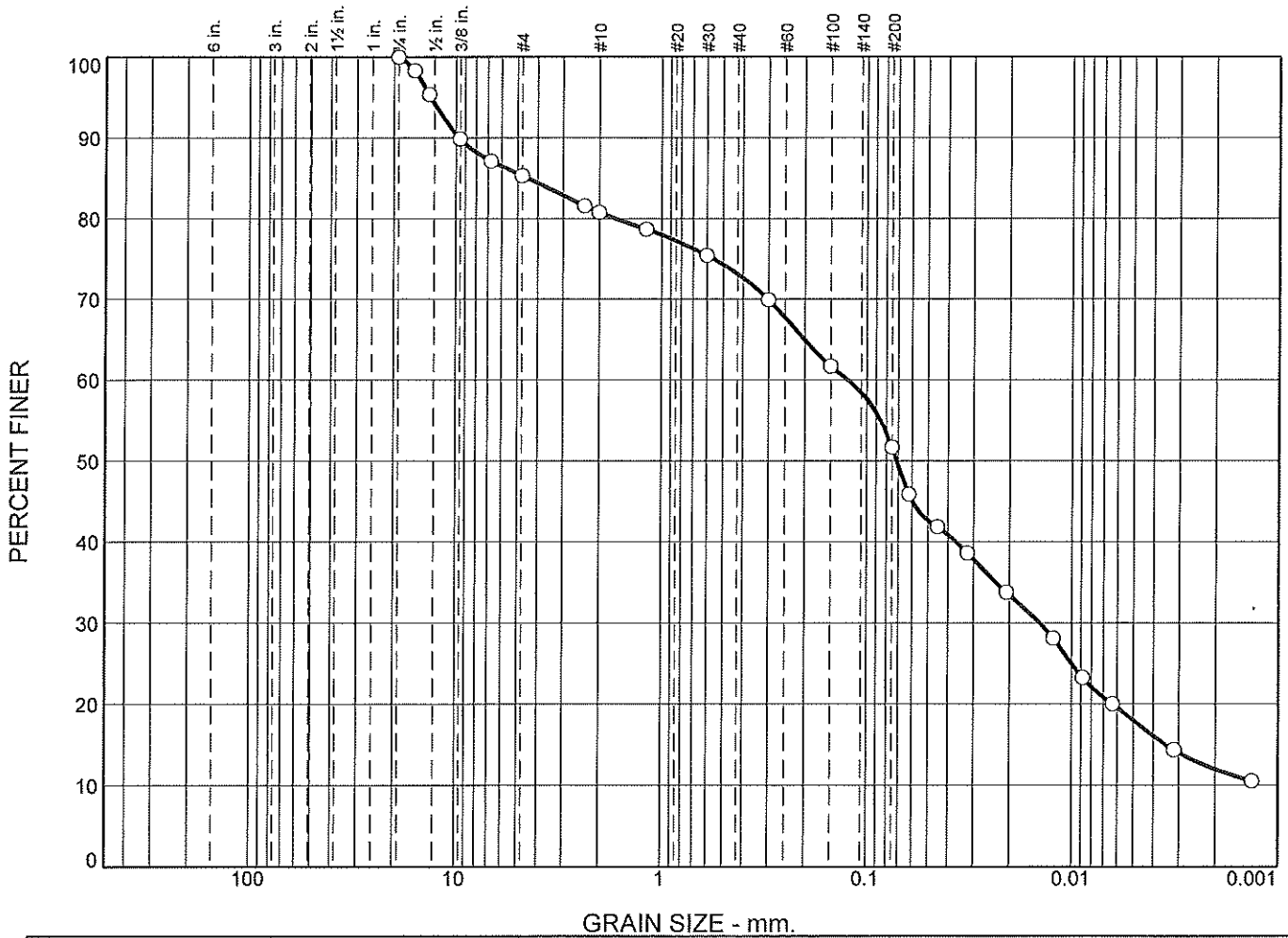
**Client:** Triton Engineering Services

**Project:** Clark-Heinmiller Subdivision, Palmerston, Ontario

**Project No.:** 13-603

**Figure 1**

# Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	14.7	4.5	7.6	21.5	39.7	12.0

SOIL DATA					
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH 3	2	0.8-1.4 m	sandy, silt, some gravel and clay	ML
				Tested by BF of CMT Engineering Inc. January 3, 2014	
				Estimated Coefficient of Permeability; $k = 2.25 \times 10^{-6}$ cm/sec	



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