FUNCTIONAL SERVICING & STORMWATER MANAGEMENT REPORT

LEITH - BAYSHORE ROAD

MUNICIPALITY OF MEAFORD
GREY COUNTY

PREPARED FOR:

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PREPARED BY:

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SEPTEMBER 2022

CFCA FILE NO. 903-3780

CROZIER
&ASSOCIATES
Consulting Engineers

Revision Number	Date	Comments
Rev. 0	July 28, 2020	Issued for Client Review
Rev. 1	September 9, 2020	Issued for 1st Submission
Rev. 2	November 19, 2021	Issued for 2nd Submission
Rev. 3	September 22, 2022	Issued for 3rd Submission

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1.0 INTRODUCTION

C.F. Crozier & Associates Inc. (Crozier) was retained by Don and Daphne McCullough (the proponent) to prepare a Functional Servicing & Stormwater Management Report to support the Severance Application to create five (5) new lots in the Municipality of Meaford, County of Grey. The 4.97 ha property is bound by Bayshore Road to the west, Sideroad 23 to the south, and rural residential land uses to the east and north. Figure 1 illustrates the Site Location.

2.0 BACKGROUND

The proponent owns a parcel of land that fronts onto Bayshore Road north of the Village of Leith (ROLL # 42-10510-004-07110-000); however, there is currently no vehicle access to this property from Bayshore Road. Based on consultations with the Municipality and Grey Sauble Conservation Authority (GSCA) it was deemed to be unreasonable and infeasible to pursue the required approvals and permits for driveway access from Bayshore Road due to the slope feature along the frontage of the Site which takes up approximately 0.58 ha.

To the south and west of the proponent's property, there was an existing unopened municipal road allowance that is connected to 23rd Sideroad. In December 2014 the proponent applied for permission from the Municipality to use this unopened road allowance to access their property, and in the summer of 2015, the Municipality authorized the potential sale of this road allowance through a severance application. The proponent purchased the full 20m road allowance fronting their property (approximately 275m) and a 10m portion from the southern limit of the property to Side Road 23 (approximately 140m) for the potential future construction of a permanent driveway to their property. In support of this application, our office provided input on the required engineering issues associated with this driveway and its associated design constraints.

Following the severance and sale of the road allowance, our office issued a Terms of Reference (TOR) to the Municipality of Meaford to outline the scope of work required to sever the parcel into five (5) lots. The approved TOR included the preparation of a Grading and Drainage Plan for the proposed lots, which detail the on-site services (i.e. well and septic), proposed driveway alignment, high-level grading, and stormwater management (SWM) strategies for the site.

A Scoped Environmental Impact Study (EIS) was prepared by our office to assess the impacts of the proposed development on the natural heritage features and functions and to recommend any warranted mitigation measures. The results of this study was used to prepare the Development Concept, refer to Figure 2.

3.0 EXISTING SITE CONDITIONS

The existing site conditions are outlined in the following sections and provide an overview of the land uses, pre-development drainage conditions, groundwater, and soil conditions affecting stormwater management and septic servicing.

3.1 Pre-Development Drainage Conditions

Based on field reconnaissance conducted by Crozier staff and a review of the topographic survey, the site has been divided into five pre-development catchment areas to characterize the existing drainage conditions and outlets. Please refer to Figure 3 for the Pre-Development Drainage Plan.

Catchment 101 is located at the north end of the site and drains towards the north property line where it outlets down the ridge via a defined channel on the neighbouring property. Catchment 102 drains toward Drainage Feature #1 (DF1). A majority of the site is within Catchment 103, which drains via sheet flow toward Drainage Feature #2 (DF2). A portion of Drainage Feature #3 (DF3) runs through Catchment 104, which then combines with another small watercourse from the neighbouring property before discharging over the ridge through the defined channel south of the Subject Site. Catchment 105 is split by Drainage Feature #4 (DF4), which outlets to the roadside ditch on Sideroad 23.

3.2 Pre-Development Hydrology

The existing topographic survey prepared by Van Harten Surveying and Engineering (dated February 2019) and available aerial photography were used to determine the hydrologic parameters for the site. We have outlined the runoff coefficients and associated catchment areas for pre-development conditions in Table 1 below.

Table 1: Pre-Development Catchment Areas and Runoff Coefficients

Catchment Area	Pervious Area (ha) (RC = 0.25)	Impervious Area (ha) (RC = 0.90)	Total Area (ha)	Weighted Runoff Coefficient
101	0.43	0.00	0.43	0.25
102	0.78	0.00	0.78	0.25
103	2.43	0.00	2.43	0.25
104	0.67	0.00	0.67	0.25
105	0.08	0.00	0.08	0.25
Total	**4.39**	**0.00**	**4.39**	**0.25**

The site is completely pervious under existing conditions with a runoff coefficient of approximately 0.25. The pervious areas consist of meadow vegetation with sparse trees.

3.3 Stormwater / Drainage Infrastructure

All existing surface drainage on the site is conveyed via sheet flow to its respective drainage outlet. To our knowledge, there is currently no existing stormwater management implemented across any of the subject lands.

4.0 PROPOSED SITE CONDITIONS

The following subsections provide an analysis of the servicing strategy for the proposed sanitary sewage system, potable water supply, and utilities for the proposed residential development.

4.1 Servicing Options Statement

Preliminary design concepts for the site have proposed private septic and well for sanitary and water servicing for each lot. A Servicing Options Statement has been prepared per the Ministry of Environment, Conservation and Parks (MECP) guideline, entitled D-5-3 Servicing Options Statement, to justify the type of proposed services.

4.1.1 Proximity to Municipal Services

Full municipal services are typically the preferred method of servicing for new developments. The location of the proposed residential development is in an unserviced area in the Municipality of Meaford and does not have existing Municipal sanitary sewer within a reasonable distance to the development, as the nearest sewage treatment plant is located in the City of Owen Sound.

Existing residential dwellings adjacent to the Subject Site are serviced via private septic and well and there are no communal services in the general area.

The Municipality of Meaford does have existing Municipal sanitary services. However, the Municipality is large and primarily surrounded by agricultural land with dispersed small communities, which do not have Municipal sanitary services. It is not anticipated that Municipal sanitary services will be introduced to the community, or within the surrounding area at an attainable distance to the proposed development in the upcoming future. We do not anticipate a large amount of development in this area in the near future.

4.1.2 Environmental Suitability

GM Blue Plan was retained to complete an initial soils investigation in 2022 for the proposed residential development. In general, the soil stratigraphy observed consisted of a surficial layer of topsoil and organic material (100 mm to 650 mm thick), underlain by stiff, brown clayey silt till with some gravel.

Groundwater monitoring has not been completed for the site at this time and will be required for the individual lot grading plans to establish the maximum elevation of the underside of footing. A Hydrogeological Assessment was completed by C.F. Crozier and Associates, dated June 14th, 2022 to investigate the feasibility of constructing new buildings and individual drinking water wells on each proposed lot. After completing the assessment, Crozier opined that individual wells would be capable of providing water of suitable quality and quantity for normal domestic supply without impacting existing water wells in the area.

The existing topography of the site generally falls from east to west with a ridge at the western limits of the Subject Site. There are three existing drainage channels running from east to west that collect drainage from the site and convey it down the ridge. Proposed grading will direct flows to these existing drainage features.

The development is proposing five (5) lots across the 4.9 ha property. All proposed lots are greater than 7,400 m^2 in area and therefore can support the implementation of private septic and wells for Residential lots with full private services.

4.1.3 Servicing Suitability

Municipal Services

The proposed development is in a relatively undeveloped area consisting of a small residential community and agricultural land. Existing residences in the vicinity of the site are serviced by private septic and wells. There are no active Municipal sewers or watermain within the Leith and the adjacent communities, and large-scale developments near the subject site are not anticipated in the near future. Therefore, municipal services are not a recommended servicing option for this development.

Communal Services

The proposed lots are planned to be developed on an individual basis. Servicing the development with communal services could result in few lots contributing to a septic system sized for the entire development, which is not recommended.

Private Services

The existing residential dwellings near the subject site are serviced via private septic and well. The proposed servicing strategy is consistent with the servicing in the general area and will facilitate a staggered build-out of the five (5) proposed lots. As Municipal services are not readily available and communal services introduce increased maintenance requirements for the Municipality, private services have been proposed as the most feasible approach.

The proposed lots are an acceptable size to host a private septic system and well. Each residence will have individual septic and a well that will be designed and installed on a per-lot basis.

4.2 Post-Development Hydrology

The post-development catchment areas will not alter the pre-development drainage patterns but will include the increased impervious area from the proposed shared private driveway and five (5) proposed homes. Table 2 outlines the runoff coefficients and associated catchment areas for post-development conditions. Refer to the Post-Development Drainage information on Figure 3.

Table 2: Post-Development Catchment Areas and Runoff Coefficients

Catchment Area	Pervious Area (ha) (RC = 0.25)	Impervious Area (ha) (RC = 0.90)	Total Area (ha)	Weighted Runoff Coefficient
201	0.43	0.00	0.43	0.25
202	0.71	0.07	0.78	0.31
203	2.28	0.15	2.43	0.29
204	0.59	0.08	0.67	0.33
205	0.03	0.05	0.08	0.66
Total	**4.04**	**0.35**	**4.39**	**0.30**

4.3 Post-Development Drainage Conditions

The Severance application is for five (5) estate residential homes proposed across the site. The post-development drainage conditions will generally mimic the existing drainage patterns. This development will be constructed with a modified rural road section with roadside ditches on either side of the private roadway.

4.3.1 Culvert Design

The proposed culvert crossings have been designed to convey drainage from external properties to the east of the Subject Site, as well as the increased runoff from the proposed private roadway. Upon review of the Ontario Flow Assessment Tool (OFAT) and aerial imaging, it appears that the Subject Site is located just outside the Waterton Creek watershed which made it possible to estimate the total external drainage area that is conveyed through the Site. Based on the available contour mapping, it was estimated that a total of 50.5 ha drain through the Subject Site via the existing drainage features on site, refer to Appendix A for the estimated external catchment areas.

Based on the delineated external catchments, the 100-year peak flow rate was calculated using the Rational Method. Refer to Table 3 below for the peak flow rates for each catchment.

Table 3: External Catchment - Rational Method Calculations

Catchment	Area (ha)	Runoff Coefficient	100-Year Peak Flow Rate (m^3/s)
Ext. #1	16	0.25	0.88
Ext. #2	13	0.25	0.72
Ext. #3	8.8	0.25	0.49
Ext. #4	8	0.25	0.43
Ext. #5	4.25	0.25	0.22

The proposed culverts have been sized to convey drainage from external catchments and the proposed roadway up to and including the peak flow rates during the 100-year storm event. Since overtopping is not anticipated for any of the culvert crossings, safe access to the proposed lots will be provided via the shared private driveway. Refer to Table 4 below for the culvert sizing summary:

Table 4: Culvert Sizing Summary

Culvert Number	Diameter (mm)	Slope	External Catchment	100-Year Peak Flow Rate (m^3/s)	Headwater (m)	Overtopping Depth (m)
Culvert #1	600 (Twin)	1.0%	Ext. #1	0.92	0.82	0
Culvert #2	600 (Twin)	4.4%	Ext. #2	0.79	0.76	0
*Culvert #3	450	4.3%	Ext. #3	0.53	0.25	0
*Culvert #4	450	2.7%	Ext. #3	0.53	0.88	0.07
Culvert #5	600 (Twin)	5.8%	Ext. #4	0.46	0.54	0
Culvert #6	450	0.5%	Ext. #5	0.22	0.65	0

*Culvert #3 and #4 were conservatively modelled using the entire 100-year peak flow rate from Ext. #3, even though it will be divided between Culvert #3 and #4.

Overtopping may occur at Culvert #4 during the 100-year storm event; however, the depth of flooding is less than 0.3m with the resulting maximum velocity being less than 3.0 m/s. Therefore, safe access is provided based on GSCA Hazard Guidelines. Refer to the Culvert Master output files within Appendix A.

The driveway culverts for the proposed lots will be a 400mm diameter culvert, which is in conformance with the Municipality of Meaford's Engineering Standards for rural residential entrances. A 400mm diameter culvert could not be modelled in CulvertMaster; however, to demonstrate that the culverts are sized sufficiently, a 375mm diameter culvert was modelled at minimal slope with the anticipated 100-year peak flow rate to confirm that the proposed size is sufficient.

Refer to Appendix A for the sizing calculations and Culvert Master model output files.

4.3.2 Roadway Ditches & Overland Drainage Channels

Similar to the proposed culvert crossings, the overland flow routes have been sized to convey up to and including the 100-year peak flow rate. A Flow Master model has been prepared to confirm that the roadside ditches and overland drainage channels on site have sufficient capacity.

Refer to Appendix B for the Flow Master model output files.

4.4 Stormwater Management Criteria and Objectives

Stormwater management (SWM) for the proposed development must comply with the policies and standards of various agencies including the Municipality of Meaford and the Ministry of the Environment, Conservation and Parks (MECP). The site is also located within a regulated area of the Grey Sauble Conservation Authority (GSCA).

The recommended stormwater management strategy for the proposed development is included below:

- Water Quantity Control
  - Control of the post-development peak flow rates up to the 100-year storm to the pre-development peak flow rates

- Water Quality Control
  - Provide an Enhanced Level of Protection (80% TSS removal)

- Erosion Control
  - Capture and retain the quality (25mm) storm event on-site and release over 24 hours

Due to the relatively low density of the development, Low Impact Development (LID) strategies have been considered to meet the quantity and quality control requirements for the site.

4.5 Water Quantity Control

To assess the quantity control requirements for the site, modified rational method calculations were completed to determine the minimum storage volumes required to reduce peak flows to pre-development conditions. IDF parameters for the site were determined using Owen Sound IDF Curve Parameters. The characteristics of the site under pre-and post-development conditions and the storage requirements have been summarized in Table 5. Refer to Appendix C for the modified rational method calculations.

Table 5: Site Drainage Characteristics

Pre-Development					
Characteristic	**101**	**102**	**103**	**104**	**105**
Area (ha)	0.43	0.78	2.43	0.67	0.08
Composite Runoff Coefficient / 100-year Adjusted Runoff Coefficient	0.25/ 0.31	0.25/ 0.31	0.25/ 0.31	0.25/ 0.31	0.25/ 0.31
100-year Peak Flow (m^3/s)	0.07	0.12	0.38	0.11	0.01
Post-Development (Uncontrolled)					
Characteristic	**201**	**202**	**203**	**204**	**205**
Area (ha)	0.43	0.78	2.43	0.67	0.08
Composite Runoff Coefficient / 100-year Adjusted Runoff Coefficient	0.25/ 0.31	0.31/ 0.40	0.29/ 0.36	0.33/ 0.41	0.66/ 0.82
100-year Uncontrolled Peak Flow (m^3/s)	0.07	0.15	0.44	0.14	0.03
Minimum Required Quantity Control Storage Volume (m^3)	0.00	17.1	36.6	19.5	12.5

Per Table 5, approximately 85.7 m^3 of storage is required for Drainage Areas 202 to 205 to control flows to pre-development flow rates.

Based on the Soils Investigation completed by GM BluePlan, date March 2022, the soils on site are not suitable for infiltration. Therefore, sand filters are proposed to provide the required storage based on the modified rational method calculations. Based on the MECP guidelines, sand filters can be implemented for small drainage areas (less than 2 ha) which is consistent with the catchments requiring quantity control.

Table 6 below summarizes the proposed filter dimensions in each catchment and the amount of storage provided. Refer to Appendix D for the filter sizing calculations.

Table 6: Sand Filter Characteristics

	Sand Filters		
Characteristic	**Filter #1**	**Filter #2**	**Filter #3**
Drainage Catchment	202	203	204
Total Length (m)	35.0	75.0	15.0
Width (m)	2.0	3.0	4.0
Depth (m)	1.0	1.0	1.0
Storage Volume (m^3)	28.7	78.8	21.0

Per Table 6 above, a total of 128.5 m^3 of storage is provided which exceeds the minimum requirements to provide quantity control.

4.6 Water Quality Control

Quality control for the site is provided through a treatment train approach consisting of enhanced grass swales and sand filters. Stormwater from the roadways will sheet to the roadside ditches and then be treated via the sand filters before reaching the existing drainage features.

Minimum water quality volumes for the SWM facilities in catchments 202 to 205 were calculated per MOE Table 3.2 for an enhanced level of protection (i.e. 25 cubic meters per hectare). Table 7 below summarizes the volume to draw down in each catchment.

Table 7: Volume to Draw Down for Quality Control

	Post-Development Catchment			
Characteristic	**202**	**203**	**204**	**205**
Catchment Area (ha)	0.78	2.43	0.67	0.08
Storage Volume Required (m^3)	19.5	60.8	16.8	2.8
Storage Volume Provided (m^3)	28.7	78.8	21.0	0
Drawdown Time – Quality (hrs)	9.0	10.0	10.0	N/A

Sand filters will retain the quality event and will draw down the volume within 24 hours, as demonstrated in the sand filter calculations in Appendix D.

As shown in Table 7 above, the proposed sand filters provide more than the minimum storage volumes to meet quality control requirements. Due to the limited space within the 10m Right-of-Way in catchment 205, a sand filter is not practical to install. However, since catchment 205 represents a very small catchment (0.08 ha in size) and has the opportunity to flow over grassed ditches on Side Road 23 and Bayshore Road before reaching the ultimate receiver (Georgian Bay) no further quality control measures are required.

Due to the existing grades within the proposed lots, runoff from the driveways will not drain towards the private roadway and may require separate storage for quality control only. The size and location of the driveways will be determined during the Building Permit stage. Since the proposed lots are large, runoff from the proposed lots will have an opportunity to flow over grassed swales before leaving the site, which should provide sufficient quality controls. If additional quality controls are required at the lot level, these will be addressed in the individual Building Permit applications.

5.0 INDIVIDUAL LOT SERVICING

5.1 Septic System

All lots located within the development will be serviced with private septic systems. The details, size and locations of the septic systems will ultimately be determined once individual house designs and building permit applications are prepared. However, it is assumed that the five (5) lots will be developed into estate homes with the following features:

- 3,500 square feet (325 square meters);
- Five (5) bedrooms;
- Four (4) three-piece bathrooms; and
- 35 total fixture units.

Per the Ontario Building Code (OBC) Table 8.2.1.3.(1) the design flow for each lot would be 3,800 L/day. For residential uses, Section 8.2.2.3.(1)(a.) of the OBC states that a septic tank shall be sized for twice the daily design sewage flow which would require a 7,600 L (minimum) septic tank for each lot. Refer to Appendix E for the full calculations.

GM Blue Plan was retained to complete an initial soils investigation for the proposed residential development. Twelve (12) testholes were excavated across the property on February 18, 2022 to depths of approximately 1.2 to 2.8 meters below ground surface (mbgs). Test holes (TH) #1, #2, #3, #6, and #9 were excavated in the vicinity of the proposed leaching beds; TH #10 and TH#11 were excavated in the vicinity of the proposed overland drainage channels, and the remainder of the test holes were excavated across the property. A copy of the initial soil's investigation report is attached in Appendix E.

In general, the soil stratigraphy observed consisted of a surficial layer of topsoil and organic material (100 mm to 650 mm thick), underlain by stiff, brown clayey silt till with some gravel. The clayey silt till extended from the topsoil to the base of the testhole, with the exception of TH #1, #2, #3, #7, #9, #10, and #12, where a hard, grey, clayey silt was observed between approximately 1 mbgs to 2.6 mbgs. At TH #1, a layer of silty sand and gravel was observed below the clayey silt till between approximately 1 and 2 mbgs, followed by the hard, grey clayey silt.

The clayey silt till is expected to be the receiving soils for the proposed onsite sewage systems based on the observed soil stratigraphy and their relative elevations. According to the particle size analysis charts, the clayey silt till is considered an "SC" soil, which has a T-time ranging from 12 – 50 min/cm per Table 2 of Supplementary Standard SB-6 in the Ontario Building Code. However, GM Blue Plan is recommending that a T-time greater than 50 min/cm should be used for sewage system sizing purposes.

Based on the findings of the Initial Soils Investigation, the individual lot design and preliminary site grading have conservatively allowed a larger footprint area of 950 m^2 for a conventional raised filter bed and minimum setback requirements. Refer to DWG C101 - Master Drainage & Servicing Plan.

5.2 Potable Water Supply

The site is situated in an area that uses individual domestic wells for groundwater supply. Well records indicate that local wells yield sufficient supply for single-family residences. Refer to the Well Record in Appendix G. The record demonstrates that proposed wells will be sustainable and will meet the OBC and MECP requirements.

Further, our office completed a separate Hydrogeological Assessment, dated June 14th, 2022. The assessment concluded that individual wells would be capable of providing water of suitable quality and quantity for normal domestic supply, without impacting existing water wells in the area.

Refer to DWG C101 for the Master Drainage & Servicing Plan. Well locations will be determined at the time of site-specific design. The proposed drilled wells must maintain a 15 m separation from existing and proposed septic systems. Well design will be undertaken during detailed design for each individual lot to support a Building Permit application. If wells are dug, a 30 m separation must be maintained from existing and proposed septic systems.

6.0 ROADWAY AND GRADING

Access to the five (5) lots will be provided via a connection to Sideroad 23 through the unopened Municipal road allowance. The portion of the road allowance is 10m wide south of Lot 5 and then widens to 20m along Lots 1 – 5. The connection at Sideroad 23 will be via a shared private driveway.

The 10 m wide shared private driveway will include the following parameters:

- 4 m super-elevated driveway with 2% cross fall
- 1.0 m granular shoulders
- Ditching on the east side of the driveway
- Pre-cast retaining wall at the entrance from Sideroad 23

Along Lots 1 – 5, where the road allowance widens to 20 m, the shared private driveway will include the following parameters:

- 4.0 m crowned driveway with 2% cross fall
- 1.0 m granular shoulders
- Ditching on either side of the shared private driveway

Detailed grading has been prepared for the proposed shared private driveway on DWG C101.

7.0 UTILITIES

Utility providers will be contacted once the severance application has been approved and building designs are confirmed for the lots. The residences located around the perimeter of the site are serviced by propane tanks and overhead hydro and telephone lines along Bayshore Road.

Our office has reached out to Hydro One and confirmed that the proposed development can be serviced using the available infrastructure located on Side Road 23 and Bayshore Road. At this stage, Hydro One has suggested that an underground utility trench would be extended to the lots via the proposed shared private driveway. A general location for this trench has been shown within the road cross-sections on Drawing C105.

8.0 EROSION & SEDIMENT CONTROLS

Erosion and sediment controls will be installed before beginning any construction activities. They will be maintained until the site is stabilized or as directed by the Site Engineer and/or the Municipality of Meaford. The Preliminary Erosion & Sediment Control Plan (DWG C104) identifies the location of the recommended controls. Controls will be inspected after each significant rainfall event and maintained in proper working condition. The following erosion and sediment controls will be included during construction on the site:

Heavy Duty Silt Fencing

Silt fencing will be installed on the perimeter of the site to intercept sheet flow. Additional silt fence may be added based on field decisions by the Site Engineer and Owner, before, during and after construction.

Rock Mud Mat

A rock mud mat will be installed at the entrance to the construction zone to prevent mud tracking from the site onto surrounding lands and the perimeter roadway network. All construction traffic will be restricted to this access only.

Flow Check Dams

Temporary straw bale and rock check dams will be installed within the onsite swales and overland flow outlets. The check dams are intended to reduce flow velocity thereby reducing the erosion of the outlet channel and promote settling of sediment from the runoff. Locations of the straw bale and rock check dams are shown in DWG C104. The need for additional flow check dams will be based on the field condition at the discretion of the Engineer and Owners and implemented as necessary.

9.0 CONCLUSIONS & RECOMMENDATIONS

It is concluded that the proposed development can readily meet the servicing and stormwater management objectives of the Municipality and the MECP with the proposed servicing, grading and stormwater management scheme as outlined in this report. As such, we support the Severance Application for the subject lands. Should you have any questions regarding the enclosed material, please do not hesitate to contact the undersigned.

Respectfully submitted,

C.F. CROZIER & ASSOCIATES INC.

George Cooper, P.Eng.
Project Engineer

C.F. CROZIER & ASSOCIATES INC.

Rebecca Alexander, P. Eng.
Project Manager

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APPENDIX A

Culvert Sizing Calculations

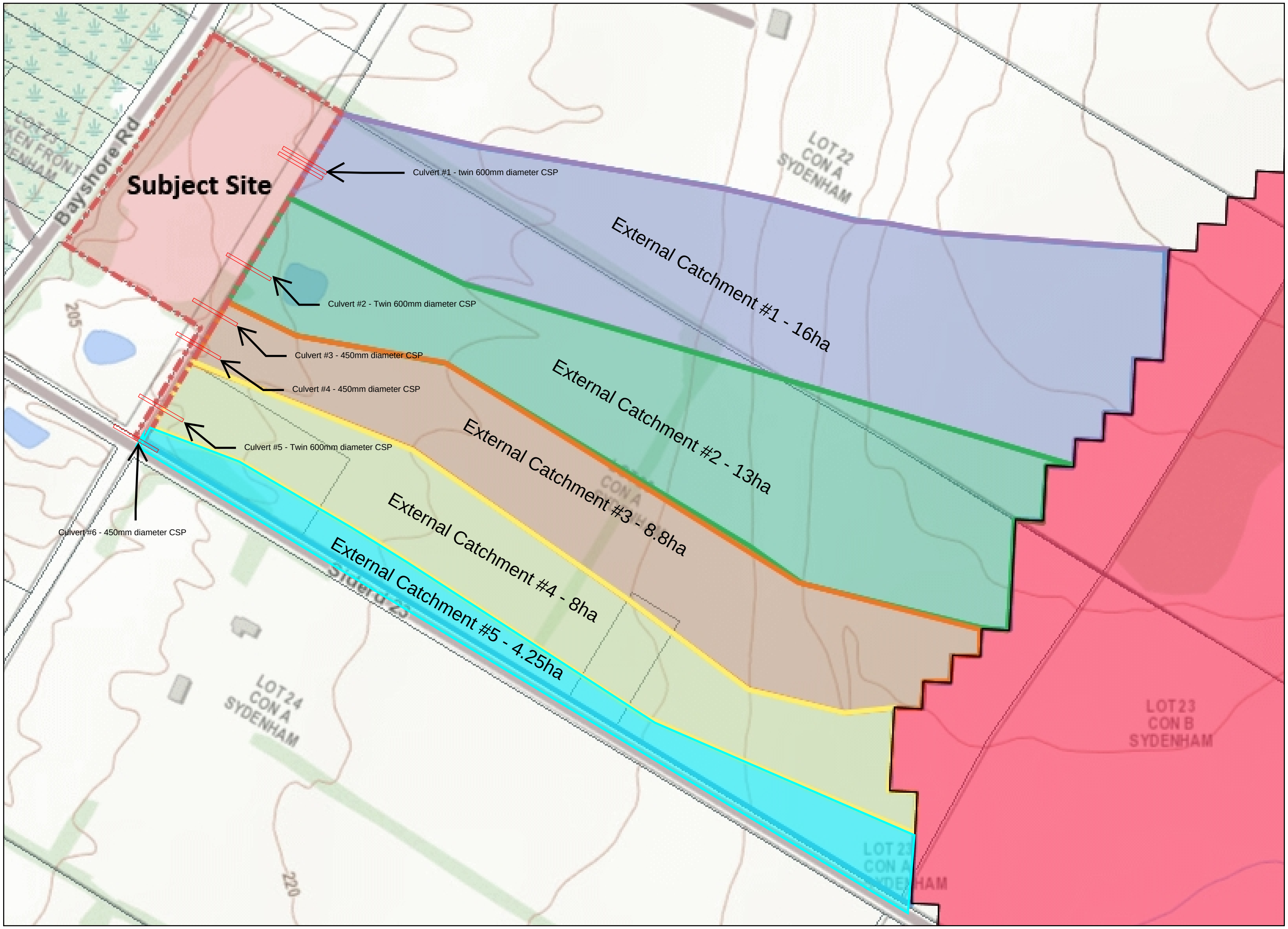
Ontario

MINISTRY OF NATURAL RESOURCES AND FORESTRY

Ontario Flow Assessment Tools

External Drainage Catchments - Topography

Notes:



Legend

- Assessment Parcel
- Secondary Watershed
- Tertiary Watershed
- Quaternary Watershed
- Great Lakes - St. Lawrence Basin
- Hudson - James Bay Basin
- Nelson River Basin
- Diversions
- Waterbody Outlet
- Conservation Authority Dam
- Provincial Dam
- Federal Dam
- OPG Dam
- Other Dam
- HYDAT Gauge
- HYDAT Gauge (RHBN)
- Virtual Flow Segment

Land Cover Compilation

- Other
- Cloud/Shadow
- Clear Open Water
- Turbid Water
- Shoreline
- Mudflats
- Marsh
- Swamp
- Fen
- Bog
- Heath
- Sparse Treed
- Treed Upland
- Deciduous Treed
- Mixed Treed
- Coniferous Treed
- Plantations - Treed Cultivated
- Hedge Rows
- Disturbance
- Open Cliff and Talus
- Alvar
- Sand Barren and Dune
- Open Tallgrass Prairie
- Tallgrass Savannah
- Tallgrass Woodland
- Sand/Gravel/Mine Tailings/Extraction
- Bedrock
- Community/Infrastructure
- Agriculture and Undifferentiated Rural Land Use

0.3 0 km 0.16 0.3

Scale: 1 : 6,422

Projection: Web Mercator

Time of Concentration Calculations

External Catchment - 1

Drainage Area:	16	ha
RC:	0.25	
Upsteam Elevation:	245	
Downsteam Elevation:	212.6	
Distance:	920	m

Time to Peak Inputs				Airport
Flow Path Description	Length (m)	Drop (m)	Slope (%)	Tc (hr)
Sheet	100	3.5	3.52%	0.92
Channel	820	28.9	3.52%	

External Catchment - 4

Drainage Area:	8	ha
RC:	0.25	
Upsteam Elevation:	235	
Downsteam Elevation:	206.6	
Distance:	910	m

Time to Peak Inputs				Airport
Flow Path Description	Length (m)	Drop (m)	Slope (%)	Tc (hr)
Sheet	100	3.1	3.12%	0.96
Channel	810	25.3	3.12%	

External Catchment - 2

Drainage Area:	13	ha
RC:	0.25	
Upsteam Elevation:	240	
Downsteam Elevation:	209.7	
Distance:	890	m

Time to Peak Inputs				Airport
Flow Path Description	Length (m)	Drop (m)	Slope (%)	Tc (hr)
Sheet	100	3.4	3.40%	0.92
Channel	790	26.9	3.40%	

External Catchment - 5

Drainage Area:	4.25	ha
RC:	0.25	
Upsteam Elevation:	233	
Downsteam Elevation:	205.3	
Distance:	950	m

Time to Peak Inputs				Airport
Flow Path Description	Length (m)	Drop (m)	Slope (%)	Tc (hr)
Sheet	100	2.9	2.92%	1.00
Channel	850	24.8	2.92%	

External Catchment - 3

Drainage Area:	8.8	ha
RC:	0.25	
Upsteam Elevation:	238	
Downsteam Elevation:	208.4	
Distance:	880	m

Time to Peak Inputs				Airport
Flow Path Description	Length (m)	Drop (m)	Slope (%)	Tc (hr)
Sheet	100	3.4	3.36%	0.92
Channel	780	26.2	3.36%	

LEITH - BAYSHORE ROAD - RATIONAL METHOD CALCULATIONS

CROZIER CONSULTING ENGINEERS

FREQUENCY **100 YEARS - Owen Sound IDF**
Coef. A= 47.7 **Coef. B= -0.738**

PROJECT: Leith-Bayshore
PROJECT No.: 903-3780
DATE: 11/19/2021
Design: GC

MANNINGS " 0.024

Culvert #	Catchments	AREA (A) Ha	RUN-OFF COEFF	A x C	Cummul. A x C	TIME OF CONC. min	I mm/hr	Qcummulative L/s
Culvert 1 (Twin)	EXT - 1	16.00	0.31	6.25	6.250	55	50.54	**878.16**
	Road Drainage	0.15	0.56	0.11	0.105	15.00	132.69	**38.91**
	TOTAL							**917.06**
Culvert 2	EXT - 2	13.00	0.31	5.08	5.078	55	50.74	**716.35**
	Road Drainage	0.28	0.56	0.20	0.197	15.00	132.69	**72.62**
	TOTAL							**788.98**
Culvert 3 & Culvert 4	EXT - 3	8.80	0.31	3.44	3.438	55	50.81	**485.51**
	Road Drainage	0.16	0.65	0.13	0.130	15.00	132.69	**47.95**
	TOTAL							**533.47**
Culvert 5	EXT - 4	8.00	0.31	3.13	3.125	57	49.27	**428.07**
	Road Drainage	0.08	0.83	0.08	0.083	15.00	132.69	**30.43**
	TOTAL							**458.50**
Culvert 6	EXT - 5	4.25	0.31	1.66	1.660	60.00	47.70	**220.16**

Culvert Analysis Report
Culvert-1
Culvert #1

Culvert Summary

Computed Headwater Eleva	213.51	m	Discharge	0.9171	m³/s
Inlet Control HW Elev.	213.48	m	Tailwater Elevation	N/A	m
Outlet Control HW Elev.	213.51	m	Control Type	Outlet Control	
Headwater Depth/Height	1.35				

Grades

Upstream Invert	212.69	m	Downstream Invert	212.56	m
Length	11.30	m	Constructed Slope	0.011504	m/m

Hydraulic Profile

Profile	M2		Depth, Downstream	0.44	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.44	m
Velocity Downstream	2.02	m/s	Critical Slope	0.022748	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	2				

Outlet Control Properties

Outlet Control HW Elev.	213.51	m	Upstream Velocity Head	0.13	m
Ke	0.90		Entrance Loss	0.12	m

Inlet Control Properties

Inlet Control HW Elev.	213.48	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Culvert-1
Culvert #2

Culvert Summary

Computed Headwater Eleva	210.89	m	Discharge	0.7900	m³/s
Inlet Control HW Elev.	210.82	m	Tailwater Elevation	N/A	m
Outlet Control HW Elev.	210.89	m	Control Type	Entrance Control	
Headwater Depth/Height	1.24				

Grades

Upstream Invert	210.13	m	Downstream Invert	209.54	m
Length	13.30	m	Constructed Slope	0.044361	m/m

Hydraulic Profile

Profile	S2		Depth, Downstream	0.32	m
Slope Type	Steep		Normal Depth	0.32	m
Flow Regime	Supercritical		Critical Depth	0.41	m
Velocity Downstream	2.55	m/s	Critical Slope	0.020583	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	2				

Outlet Control Properties

Outlet Control HW Elev.	210.89	m	Upstream Velocity Head	0.18	m
Ke	0.90		Entrance Loss	0.16	m

Inlet Control Properties

Inlet Control HW Elev.	210.82	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Culvert-1
Culvert #3

Culvert Summary

Computed Headwater Eleva	N/A	m	Discharge	0.0000	m³/s
Inlet Control HW Elev.	N/A	m	Tailwater Elevation	N/A	m
Outlet Control HW Elev.	N/A	m	Control Type	Inlet Control	
Headwater Depth/Height	0.00				

Grades

Upstream Invert	209.09	m	Downstream Invert	208.57	m
Length	11.80	m	Constructed Slope	0.044068	m/m

Hydraulic Profile

Profile	Dry		Depth, Downstream	0.00	m
Slope Type	Dry		Normal Depth	0.00	m
Flow Regime	Subcritical		Critical Depth	0.00	m
Velocity Downstream	0.00	m/s	Critical Slope	0.000000	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.46	m
Section Size	450 mm		Rise	0.46	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	N/A	m	Upstream Velocity Head	0.00	m
Ke	0.90		Entrance Loss	101.06	m

Inlet Control Properties

Inlet Control HW Elev.	N/A	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Culvert-2
Culvert #4

Culvert Summary

Computed Headwater Eleva	209.08	m	Discharge	0.3083	m³/s
Inlet Control HW Elev.	209.08	m	Tailwater Elevation	N/A	m
Outlet Control HW Elev.	209.02	m	Control Type	Inlet Control	
Headwater Depth/Height	1.93				

Grades

Upstream Invert	208.20	m	Downstream Invert	208.00	m
Length	7.30	m	Constructed Slope	0.027397	m/m

Hydraulic Profile

Profile	CompositeM2PressureProfile		Depth, Downstream	0.39	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.39	m
Velocity Downstream	2.09	m/s	Critical Slope	0.034916	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.46	m
Section Size	450 mm		Rise	0.46	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	209.02	m	Upstream Velocity Head	0.18	m
Ke	0.90		Entrance Loss	0.16	m

Inlet Control Properties

Inlet Control HW Elev.	209.08	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir
Culvert #4 - Overtopping

Hydraulic Component(s): Roadway

Discharge	0.2223	m³/s	Allowable HW Elevation	209.08	m
Roadway Width	6.00	m	Overtopping Coefficient	1.40	SI
Low Point	209.00	m	Headwater Elevation	209.08	m
Discharge Coefficient (Cr)	2.54		Submergence Factor (Kt)	1.00	
Tailwater Elevation	-3,047.70	m			

Sta (m)	Elev. (m)
120.00	209.44
125.00	209.24
130.00	209.10
135.00	209.02
138.13	209.00
140.00	209.01
145.00	209.07
150.00	209.20
154.18	209.32

Culvert Analysis Report
Culvert-1
Culvert #5

Culvert Summary

Computed Headwater Elev:	207.37	m	Discharge	0.4600	m^3/s
Inlet Control HW Elev.	207.29	m	Tailwater Elevation	N/A	m
Outlet Control HW Elev.	207.37	m	Control Type	Entrance Control	
Headwater Depth/Height	0.89				

Grades

Upstream Invert	206.83	m	Downstream Invert	206.14	m
Length	11.90	m	Constructed Slope	0.057983	m/m

Hydraulic Profile

Profile	S2		Depth, Downstream	0.22	m
Slope Type	Steep		Normal Depth	0.22	m
Flow Regime	Supercritical		Critical Depth	0.31	m
Velocity Downstream	2.44	m/s	Critical Slope	0.016718	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	2				

Outlet Control Properties

Outlet Control HW Elev.	207.37	m	Upstream Velocity Head	0.12	m
Ke	0.90		Entrance Loss	0.11	m

Inlet Control Properties

Inlet Control HW Elev.	207.29	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.6	m^2
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Culvert-1
Culvert #6

Culvert Summary

Computed Headwater Eleva	205.93	m	Discharge	0.2200	m³/s
Inlet Control HW Elev.	205.87	m	Tailwater Elevation	N/A	m
Outlet Control HW Elev.	205.93	m	Control Type	Outlet Control	
Headwater Depth/Height	1.42				

Grades

Upstream Invert	205.28	m	Downstream Invert	205.24	m
Length	7.00	m	Constructed Slope	0.005714	m/m

Hydraulic Profile

Profile	CompositeM2PressureProfile		Depth, Downstream	0.33	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.33	m
Velocity Downstream	1.74	m/s	Critical Slope	0.024754	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.46	m
Section Size	450 mm		Rise	0.46	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	205.93	m	Upstream Velocity Head	0.09	m
Ke	0.90		Entrance Loss	0.08	m

Inlet Control Properties

Inlet Control HW Elev.	205.87	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	0.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Culvert-1
Driveway Culvert

Culvert Summary

Computed Headwater Elev	212.98	m	Discharge	0.0300	m³/s
Inlet Control HW Elev.	212.97	m	Tailwater Elevation	N/A	m
Outlet Control HW Elev.	212.98	m	Control Type	Entrance Control	
Headwater Depth/Height	0.47				

Grades

Upstream Invert	212.80	m	Downstream Invert	212.72	m
Length	9.00	m	Constructed Slope	0.008889	m/m

Hydraulic Profile

Profile	S2		Depth, Downstream	0.10	m
Slope Type	Steep		Normal Depth	0.10	m
Flow Regime	Supercritical		Critical Depth	0.12	m
Velocity Downstream	1.20	m/s	Critical Slope	0.004448	m/m

Section

Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	0.38	m
Section Size	375 mm		Rise	0.38	m
Number Sections	1				

Outlet Control Properties

Outlet Control HW Elev.	212.98	m	Upstream Velocity Head	0.04	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties

Inlet Control HW Elev.	212.97	m	Flow Control	Unsubmerged	
Inlet Type	Groove end projecting		Area Full	0.1	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

APPENDIX B

Flow Master Model Reports

Worksheet for Section A-A (new)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.03200	m/m
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Discharge	0.79	m³/s

Results

Normal Depth	0.37	m
Flow Area	0.42	m²
Wetted Perimeter	2.37	m
Hydraulic Radius	0.18	m
Top Width	2.24	m
Critical Depth	0.43	m
Critical Slope	0.01585	m/m
Velocity	1.88	m/s
Velocity Head	0.18	m
Specific Energy	0.55	m
Froude Number	1.39	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.37	m
Critical Depth	0.43	m
Channel Slope	0.03200	m/m
Critical Slope	0.01585	m/m

Worksheet for Section B-B (new)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.00700	m/m
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Discharge	0.92	m³/s

Results

Normal Depth	0.53	m
Flow Area	0.83	m²
Wetted Perimeter	3.33	m
Hydraulic Radius	0.25	m
Top Width	3.16	m
Critical Depth	0.45	m
Critical Slope	0.01553	m/m
Velocity	1.11	m/s
Velocity Head	0.06	m
Specific Energy	0.59	m
Froude Number	0.69	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.53	m
Critical Depth	0.45	m
Channel Slope	0.00700	m/m
Critical Slope	0.01553	m/m

Worksheet for Section C-C (E)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.05600	m/m
Left Side Slope	2.00	m/m (H:V)
Right Side Slope	2.00	m/m (H:V)
Discharge	0.22	m³/s

Results

Normal Depth	0.25	m
Flow Area	0.12	m²
Wetted Perimeter	1.10	m
Hydraulic Radius	0.11	m
Top Width	0.99	m
Critical Depth	0.30	m
Critical Slope	0.01925	m/m
Velocity	1.81	m/s
Velocity Head	0.17	m
Specific Energy	0.41	m
Froude Number	1.65	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.25	m
Critical Depth	0.30	m
Channel Slope	0.05600	m/m
Critical Slope	0.01925	m/m

Worksheet for Section D-D (E)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.05800	m/m
Left Side Slope	2.00	m/m (H:V)
Right Side Slope	2.00	m/m (H:V)
Discharge	0.46	m³/s

Results

Normal Depth	0.32	m
Flow Area	0.21	m²
Wetted Perimeter	1.44	m
Hydraulic Radius	0.14	m
Top Width	1.29	m
Critical Depth	0.40	m
Critical Slope	0.01745	m/m
Velocity	2.21	m/s
Velocity Head	0.25	m
Specific Energy	0.57	m
Froude Number	1.76	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.32	m
Critical Depth	0.40	m
Channel Slope	0.05800	m/m
Critical Slope	0.01745	m/m

Worksheet for Section E-E (E)

Project Description

Friction Method	Manning Formula		
Solve For	Normal Depth		

Input Data

Roughness Coefficient		0.030	
Channel Slope		0.02700	m/m
Left Side Slope		3.00	m/m (H:V)
Right Side Slope		3.00	m/m (H:V)
Discharge		0.79	m³/s

Results

Normal Depth		0.39	m
Flow Area		0.45	m²
Wetted Perimeter		2.44	m
Hydraulic Radius		0.18	m
Top Width		2.32	m
Critical Depth		0.43	m
Critical Slope		0.01585	m/m
Velocity		1.77	m/s
Velocity Head		0.16	m
Specific Energy		0.55	m
Froude Number		1.28	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth		0.00	m
Length		0.00	m
Number Of Steps		0	

GVF Output Data

Upstream Depth		0.00	m
Profile Description			
Profile Headloss		0.00	m
Downstream Velocity		Infinity	m/s
Upstream Velocity		Infinity	m/s
Normal Depth		0.39	m
Critical Depth		0.43	m
Channel Slope		0.02700	m/m
Critical Slope		0.01585	m/m

Worksheet for Section E-E (W)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.04400	m/m
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Discharge	0.03	m^3/s

Results

Normal Depth	0.10	m
Flow Area	0.03	m^2
Wetted Perimeter	0.65	m
Hydraulic Radius	0.05	m
Top Width	0.62	m
Critical Depth	0.12	m
Critical Slope	0.02451	m/m
Velocity	0.94	m/s
Velocity Head	0.04	m
Specific Energy	0.15	m
Froude Number	1.32	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.10	m
Critical Depth	0.12	m
Channel Slope	0.04400	m/m
Critical Slope	0.02451	m/m

Worksheet for Section F-F (E)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.03700	m/m
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	4.00	m/m (H:V)
Discharge	0.92	m^3/s

Results

Normal Depth	0.36	m
Flow Area	0.46	m^2
Wetted Perimeter	2.64	m
Hydraulic Radius	0.17	m
Top Width	2.54	m
Critical Depth	0.43	m
Critical Slope	0.01558	m/m
Velocity	2.00	m/s
Velocity Head	0.20	m
Specific Energy	0.57	m
Froude Number	1.50	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.36	m
Critical Depth	0.43	m
Channel Slope	0.03700	m/m
Critical Slope	0.01558	m/m

Worksheet for Section F-F (W)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.04000	m/m
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Discharge	0.02	m³/s

Results

Normal Depth	0.08	m
Flow Area	0.02	m²
Wetted Perimeter	0.51	m
Hydraulic Radius	0.04	m
Top Width	0.49	m
Critical Depth	0.09	m
Critical Slope	0.02688	m/m
Velocity	0.76	m/s
Velocity Head	0.03	m
Specific Energy	0.11	m
Froude Number	1.20	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.08	m
Critical Depth	0.09	m
Channel Slope	0.04000	m/m
Critical Slope	0.02688	m/m

Worksheet for Section G-G

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.04800	m/m
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Bottom Width	1.50	m
Discharge	0.53	m³/s

Results

Normal Depth	0.15	m
Flow Area	0.30	m²
Wetted Perimeter	2.46	m
Hydraulic Radius	0.12	m
Top Width	2.41	m
Critical Depth	0.20	m
Critical Slope	0.01688	m/m
Velocity	1.78	m/s
Velocity Head	0.16	m
Specific Energy	0.31	m
Froude Number	1.62	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.00	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.15	m
Critical Depth	0.20	m
Channel Slope	0.04800	m/m

Worksheet for Section G-G

GVF Output Data

Critical Slope	0.01688	m/m

APPENDIX C

Modified Rational Method Calculations

CROZIER CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
FILE: Modified Rational Method
DATE: 11/19/2021
DESIGN: GC
CHECK: RA

Owen Sound IDF Curve Parameters		
Storm Event	**A**	**B**
2	22.3	-0.714
5	29.1	-0.724
10	33.6	-0.729
25	39.3	-0.734
50	43.5	-0.736
100	47.7	-0.738

Total Site Area = 0.43 ha

Catchment 101

Surface	**Pre-development**		**Post-development**	
	Area (ha)	**Runoff Coefficient**	**Area (ha)**	**Runoff Coefficient**
Landscapes	0.43	0.25	0.430	0.25
Asphalt	0.00	0.90	0.00	0.90
Building	0.00	0.90	0.00	0.90
Total *	0.43	0.25	0.43	0.25

CROZIER
CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (2-Year Storm)

Peak Flow

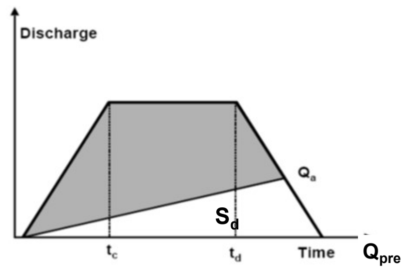
$$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$$

Intensity

$$i_{(T_d)} = A\,(T_d)^{B}$$

Storage

$$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	80.15
Return Period	2 yr		
Time of Concentration (min)	10		
Coeff A	22.3		
Coeff B	-0.714		
Runoff Coeff (Unadjusted)	0.25	Flow (m^3/s)	0.024
Area (ha)	0.43		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	80.15
Return Period	2 yr		
Time of Concentration (min)	10		
Coeff A	22.3		
Coeff B	-0.714		
Runoff Coeff (unadjusted)	0.25	Uncont. Flow (m^3/s)	0.024
Area (ha)	0.43		

Target Flow (m^3/s)	0.024

REQUIRED STORAGE VOLUME:	**0.0**

Storage Volume Determination (Detailed)				
T_d	i	T_d	Q_{Uncont}	S_d
min	mm/hr	sec	m^3/s	m^3
10	80.15	600	0.024	0.0
15	60.00	900	0.018	-1.8
20	48.86	1200	0.015	-4.1
25	41.67	1500	0.013	-6.5
30	36.58	1800	0.011	-9.1
35	32.77	2100	0.010	-11.9
40	29.79	2400	0.009	-14.7
45	27.38	2700	0.008	-17.6
50	25.40	3000	0.008	-20.5
55	23.73	3300	0.007	-23.5
60	22.30	3600	0.007	-26.5
65	21.06	3900	0.006	-29.6
70	19.98	4200	0.006	-32.6
75	19.02	4500	0.006	-35.8
80	18.16	4800	0.005	-38.9
85	17.39	5100	0.005	-42.1

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CONSULTING ENGINEERS

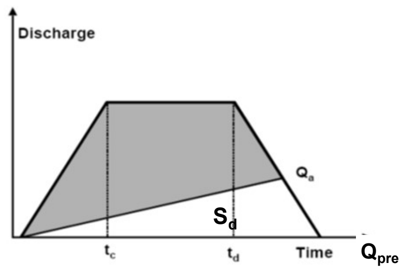
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (5-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^B$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	106.48
Return Period	5 yr		
Time of Concentration (min)	10		
Coeff A	29.1		
Coeff B	-0.724		
Runoff Coeff (Unadjusted)	0.25	Flow (m^3/s)	0.032
Area (ha)	0.43		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	106.48
Return Period	5 yr		
Time of Concentration (min)	10		
Coeff A	29.1		
Coeff B	-0.724		
Runoff Coeff (unadjusted)	0.25	Uncont. Flow (m^3/s)	0.032
Area (ha)	0.43		

Target Flow (m^3/s)	0.032

REQUIRED STORAGE VOLUME:	**0.0**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	106.48	600	0.032	0.0
15	79.39	900	0.024	-2.5
20	64.47	1200	0.019	-5.6
25	54.85	1500	0.017	-8.9
30	48.07	1800	0.014	-12.4
35	42.99	2100	0.013	-16.1
40	39.03	2400	0.012	-19.9
45	35.84	2700	0.011	-23.8
50	33.21	3000	0.010	-27.7
55	30.99	3300	0.009	-31.7
60	29.10	3600	0.009	-35.8
65	27.46	3900	0.008	-39.9
70	26.03	4200	0.008	-44.0
75	24.76	4500	0.007	-48.2
80	23.63	4800	0.007	-52.4
85	22.61	5100	0.007	-56.6

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CONSULTING ENGINEERS

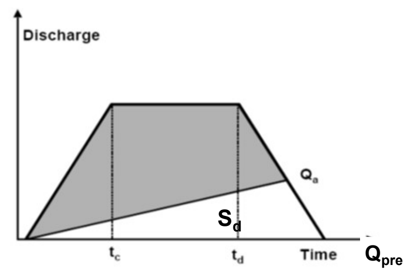
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (10-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \bullet C_{post} \bullet i_{(T_d)} \bullet A$

Intensity
$i_{(T_d)} = A\,(T_d)^{B}$

Storage
$S_d = Q_{post} \bullet T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	124.05
Return Period	10 yr		
Time of Concentration (min)	10		
Coeff A	33.6		
Coeff B	-0.729		
Runoff Coeff (unadjusted)	0.25	Flow (m^3/s)	0.037
Area (ha)	0.43		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	124.05
Return Period	10 yr		
Time of Concentration (min)	10		
Coeff A	33.6		
Coeff B	-0.729		
Runoff Coeff (unadjusted)	0.25	Uncont. Flow (m^3/s)	0.037
Area (ha)	0.43		

Target Flow (m^3/s)	0.037

REQUIRED STORAGE VOLUME:	**0.0**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	124.05	600	0.037	0.0
15	92.31	900	0.028	-3.0
20	74.84	1200	0.023	-6.6
25	63.61	1500	0.019	-10.5
30	55.69	1800	0.017	-14.6
35	49.77	2100	0.015	-18.9
40	45.16	2400	0.014	-23.4
45	41.44	2700	0.012	-27.9
50	38.38	3000	0.012	-32.6
55	35.80	3300	0.011	-37.3
60	33.60	3600	0.010	-42.0
65	31.70	3900	0.010	-46.8
70	30.03	4200	0.009	-51.7
75	28.56	4500	0.009	-56.5
80	27.24	4800	0.008	-61.5
85	26.07	5100	0.008	-66.4

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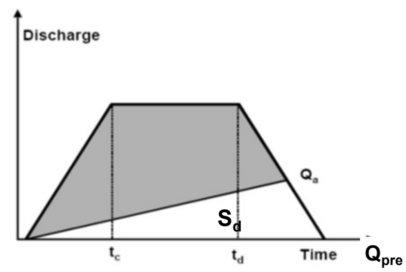
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (25-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^B$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	146.40
Return Period	25 yr		
Time of Concentration (min)	10		
Coeff A	39.3		
Coeff B	-0.734		
Runoff Coeff (Adjusted)	0.28	Flow (m^3/s)	0.048
Area (ha)	0.43		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	146.40
Return Period	25 yr		
Time of Concentration (min)	10		
Coeff A	39.3		
Coeff B	-0.734		
Runoff Coeff (Adjusted)	0.28	Uncont. Flow (m^3/s)	0.048
Area (ha)	0.43		

Target Flow (m^3/s)	0.048

REQUIRED STORAGE VOLUME:	**0.0**

Storage Volume Determination (Detailed)

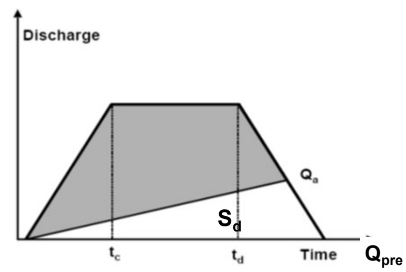
T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	146.40	600	0.048	0.0
15	108.72	900	0.036	-4.0
20	88.02	1200	0.029	-8.7
25	74.73	1500	0.025	-13.8
30	65.37	1800	0.022	-19.2
35	58.37	2100	0.019	-24.9
40	52.92	2400	0.018	-30.7
45	48.54	2700	0.016	-36.6
50	44.93	3000	0.015	-42.6
55	41.89	3300	0.014	-48.8
60	39.30	3600	0.013	-55.0
65	37.06	3900	0.012	-61.2
70	35.10	4200	0.012	-67.5
75	33.36	4500	0.011	-73.9
80	31.82	4800	0.011	-80.3
85	30.43	5100	0.010	-86.8

Modified Rational Method Storage Sizing (50-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^{B}$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	162.63
Return Period	50 yr		
Time of Concentration (min)	10		
Coeff A	43.5		
Coeff B	-0.736		
Runoff Coeff (Adjusted)	0.30	Flow (m^3/s)	0.059
Area (ha)	0.43		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	162.63
Return Period	50 yr		
Time of Concentration (min)	10		
Coeff A	43.5		
Coeff B	-0.736		
Runoff Coeff (Adjusted)	0.30	Uncont. Flow (m^3/s)	0.059
Area (ha)	0.43		

Target Flow (m^3/s)	0.059

REQUIRED STORAGE VOLUME:	**0.0**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	162.63	600	0.059	0.0
15	120.67	900	0.044	-4.8
20	97.65	1200	0.035	-10.5
25	82.86	1500	0.030	-16.8
30	72.45	1800	0.026	-23.4
35	64.68	2100	0.023	-30.2
40	58.63	2400	0.021	-37.3
45	53.76	2700	0.019	-44.5
50	49.75	3000	0.018	-51.8
55	46.38	3300	0.017	-59.3
60	43.50	3600	0.016	-66.8
65	41.01	3900	0.015	-74.4
70	38.83	4200	0.014	-82.1
75	36.91	4500	0.013	-89.8
80	35.20	4800	0.013	-97.6
85	33.66	5100	0.012	-105.4

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CONSULTING ENGINEERS

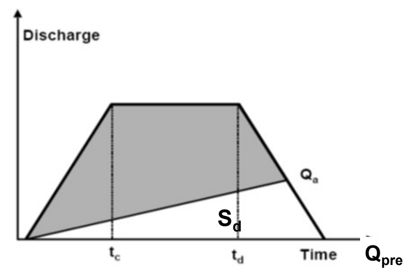
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: GC
CHECK: KM

Modified Rational Method Storage Sizing (100-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^{B}$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	178.98
Return Period	100 yr		
Time of Concentration (min)	10		
Coeff A	47.7		
Coeff B	-0.738		
Runoff Coeff (Adjusted)	0.31	Flow (m^3/s)	0.067
Area (ha)	0.43		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	178.98
Return Period	100 yr		
Time of Concentration (min)	10		
Coeff A	47.7		
Coeff B	-0.738		
Runoff Coeff (Adjusted)	0.31	Uncont. Flow (m^3/s)	0.067
Area (ha)	0.43		

Target Flow (m^3/s)	0.067

REQUIRED STORAGE VOLUME:	**0.0**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	178.98	600	0.067	0.0
15	132.69	900	0.050	-5.6
20	107.31	1200	0.040	-12.2
25	91.02	1500	0.034	-19.3
30	79.56	1800	0.030	-26.9
35	71.00	2100	0.027	-34.8
40	64.34	2400	0.024	-42.9
45	58.98	2700	0.022	-51.2
50	54.57	3000	0.021	-59.6
55	50.86	3300	0.019	-68.2
60	47.70	3600	0.018	-76.8
65	44.96	3900	0.017	-85.5
70	42.57	4200	0.016	-94.3
75	40.46	4500	0.015	-103.2
80	38.58	4800	0.015	-112.1
85	36.89	5100	0.014	-121.1

CROZIER CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
FILE: Modified Rational Method
DATE: 11/19/2021
DESIGN: GC
CHECK: RA

Owen Sound IDF Curve Parameters		
Storm Event	**A**	**B**
2	22.3	-0.714
5	29.1	-0.724
10	33.6	-0.729
25	39.3	-0.734
50	43.5	-0.736
100	47.7	-0.738

Total Site Area = 0.78 ha

Catchment 102

Surface	**Pre-development**		**Post-development**	
	Area (ha)	**Runoff Coefficient**	**Area (ha)**	**Runoff Coefficient**
Landscapes	0.78	0.25	0.71	0.25
Asphalt	0.00	0.90	0.05	0.90
Building	0.00	0.90	0.02	0.90
Total *	0.78	0.25	0.78	0.31

CROZIER CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (2-Year Storm)

Peak Flow

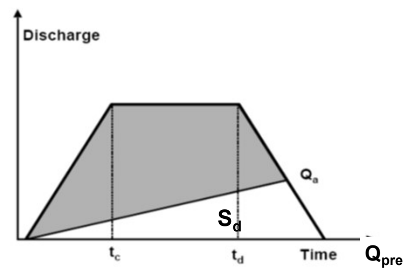
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity

$i_{(T_d)} = A\,(T_d)^{B}$

Storage

$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	80.15
Return Period	2 yr		
Time of Concentration (min)	10		
Coeff A	22.3		
Coeff B	-0.714		
Runoff Coeff (Unadjusted)	0.25	Flow (m^3/s)	0.044
Area (ha)	0.78		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	80.15
Return Period	2 yr		
Time of Concentration (min)	10		
Coeff A	22.3		
Coeff B	-0.714		
Runoff Coeff (unadjusted)	0.31	Uncont. Flow (m^3/s)	0.054
Area (ha)	0.78		

Target Flow (m^3/s)	0.044

REQUIRED STORAGE VOLUME:	**6.1**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	80.15	600	0.054	6.1
15	60.00	900	0.040	3.5
20	48.86	1200	0.033	0.1
25	41.67	1500	0.028	-3.9
30	36.58	1800	0.025	-8.2
35	32.77	2100	0.022	-12.7
40	29.79	2400	0.020	-17.5
45	27.38	2700	0.018	-22.4
50	25.40	3000	0.017	-27.5
55	23.73	3300	0.016	-32.6
60	22.30	3600	0.015	-37.8
65	21.06	3900	0.014	-43.2
70	19.98	4200	0.013	-48.5
75	19.02	4500	0.013	-54.0
80	18.16	4800	0.012	-59.5
85	17.39	5100	0.012	-65.0

CROZIER
CONSULTING ENGINEERS

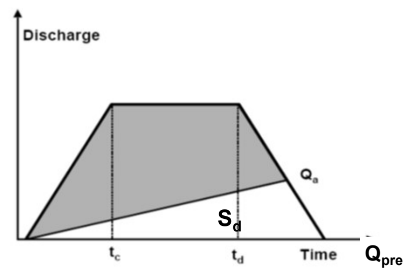
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (5-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^{B}$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	106.48
Return Period	5 yr		
Time of Concentration (min)	10		
Coeff A	29.1		
Coeff B	-0.724		
Runoff Coeff (Unadjusted)	0.25	Flow (m^3/s)	0.058
Area (ha)	0.78		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	106.48
Return Period	5 yr		
Time of Concentration (min)	10		
Coeff A	29.1		
Coeff B	-0.724		
Runoff Coeff (unadjusted)	0.31	Uncont. Flow (m^3/s)	0.072
Area (ha)	0.78		

Target Flow (m^3/s)	0.058

REQUIRED STORAGE VOLUME:	**8.1**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	106.48	600	0.072	8.1
15	79.39	900	0.053	4.5
20	64.47	1200	0.043	-0.2
25	54.85	1500	0.037	-5.6
30	48.07	1800	0.032	-11.5
35	42.99	2100	0.029	-17.7
40	39.03	2400	0.026	-24.1
45	35.84	2700	0.024	-30.8
50	33.21	3000	0.022	-37.6
55	30.99	3300	0.021	-44.5
60	29.10	3600	0.020	-51.5
65	27.46	3900	0.018	-58.7
70	26.03	4200	0.018	-65.9
75	24.76	4500	0.017	-73.2
80	23.63	4800	0.016	-80.6
85	22.61	5100	0.015	-88.0

CROZIER CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (10-Year Storm)

Peak Flow

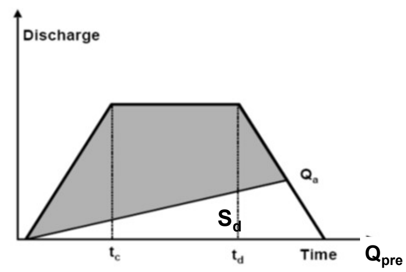
$$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$$

Intensity

$$i_{(T_d)} = A\,(T_d)^{B}$$

Storage

$$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	124.05
Return Period	10 yr		
Time of Concentration (min)	10		
Coeff A	33.6		
Coeff B	-0.729		
Runoff Coeff (unadjusted)	0.25	Flow (m^3/s)	0.068
Area (ha)	0.78		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	124.05
Return Period	10 yr		
Time of Concentration (min)	10		
Coeff A	33.6		
Coeff B	-0.729		
Runoff Coeff (unadjusted)	0.31	Uncont. Flow (m^3/s)	0.084
Area (ha)	0.78		

Target Flow (m^3/s)	0.068

REQUIRED STORAGE VOLUME:	**9.5**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	124.05	600	0.084	9.5
15	92.31	900	0.062	5.1
20	74.84	1200	0.050	-0.5
25	63.61	1500	0.043	-6.9
30	55.69	1800	0.038	-13.8
35	49.77	2100	0.034	-21.1
40	45.16	2400	0.030	-28.6
45	41.44	2700	0.028	-36.4
50	38.38	3000	0.026	-44.4
55	35.80	3300	0.024	-52.5
60	33.60	3600	0.023	-60.8
65	31.70	3900	0.021	-69.2
70	30.03	4200	0.020	-77.6
75	28.56	4500	0.019	-86.2
80	27.24	4800	0.018	-94.8
85	26.07	5100	0.018	-103.5

CROZIER CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (25-Year Storm)

Peak Flow

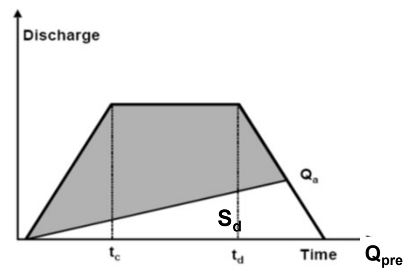
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity

$i_{(T_d)} = A\,(T_d)^{B}$

Storage

$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	146.40
Return Period	25 yr		
Time of Concentration (min)	10		
Coeff A	39.3		
Coeff B	-0.734		
Runoff Coeff (Adjusted)	0.28	Flow (m^3/s)	0.088
Area (ha)	0.78		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	146.40
Return Period	25 yr		
Time of Concentration (min)	10		
Coeff A	39.3		
Coeff B	-0.734		
Runoff Coeff (Adjusted)	0.34	Uncont. Flow (m^3/s)	0.108
Area (ha)	0.78		

Target Flow (m^3/s)	0.088

REQUIRED STORAGE VOLUME:	**12.3**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	146.40	600	0.108	12.3
15	108.72	900	0.081	6.5
20	88.02	1200	0.065	-0.9
25	74.73	1500	0.055	-9.3
30	65.37	1800	0.048	-18.4
35	58.37	2100	0.043	-27.9
40	52.92	2400	0.039	-37.8
45	48.54	2700	0.036	-48.0
50	44.93	3000	0.033	-58.4
55	41.89	3300	0.031	-69.1
60	39.30	3600	0.029	-79.9
65	37.06	3900	0.027	-90.8
70	35.10	4200	0.026	-101.8
75	33.36	4500	0.025	-113.0
80	31.82	4800	0.024	-124.3
85	30.43	5100	0.023	-135.6

CROZIER CONSULTING ENGINEERS

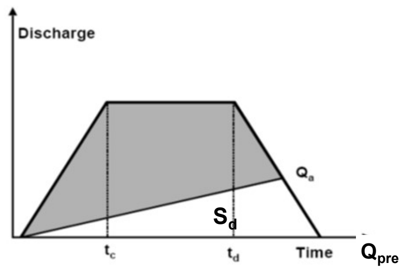
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (50-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^{B}$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	162.63
Return Period	50 yr		
Time of Concentration (min)	10		
Coeff A	43.5		
Coeff B	-0.736		
Runoff Coeff (Adjusted)	0.30	Flow (m^3/s)	0.107
Area (ha)	0.78		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	162.63
Return Period	50 yr		
Time of Concentration (min)	10		
Coeff A	43.5		
Coeff B	-0.736		
Runoff Coeff (Adjusted)	0.37	Uncont. Flow (m^3/s)	0.131
Area (ha)	0.78		

Target Flow (m^3/s)	0.107

REQUIRED STORAGE VOLUME:	**14.9**

Storage Volume Determination (Detailed)				
T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	162.63	600	0.131	14.9
15	120.67	900	0.098	7.8
20	97.65	1200	0.079	-1.2
25	82.86	1500	0.067	-11.5
30	72.45	1800	0.059	-22.5
35	64.68	2100	0.052	-34.1
40	58.63	2400	0.047	-46.1
45	53.76	2700	0.043	-58.5
50	49.75	3000	0.040	-71.2
55	46.38	3300	0.037	-84.1
60	43.50	3600	0.035	-97.2
65	41.01	3900	0.033	-110.5
70	38.83	4200	0.031	-123.9
75	36.91	4500	0.030	-137.5
80	35.20	4800	0.028	-151.2
85	33.66	5100	0.027	-165.0

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CONSULTING ENGINEERS

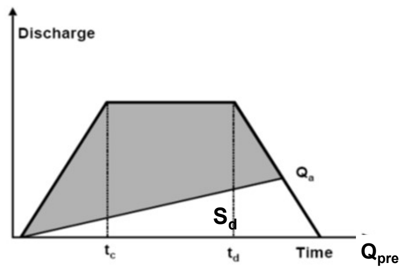
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: GC
CHECK: KM

Modified Rational Method Storage Sizing (100-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^B$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	178.98
Return Period	100 yr		
Time of Concentration (min)	10		
Coeff A	47.7		
Coeff B	-0.738		
Runoff Coeff (Adjusted)	0.31	Flow (m^3/s)	0.122
Area (ha)	0.78		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	178.98
Return Period	100 yr		
Time of Concentration (min)	10		
Coeff A	47.7		
Coeff B	-0.738		
Runoff Coeff (Adjusted)	0.39	Uncont. Flow (m^3/s)	0.151
Area (ha)	0.78		

Target Flow (m^3/s)	0.122

REQUIRED STORAGE VOLUME:	**17.1**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	178.98	600	0.151	17.1
15	132.69	900	0.112	8.9
20	107.31	1200	0.090	-1.5
25	91.02	1500	0.077	-13.3
30	79.56	1800	0.067	-26.0
35	71.00	2100	0.060	-39.4
40	64.34	2400	0.054	-53.2
45	58.98	2700	0.050	-67.5
50	54.57	3000	0.046	-82.1
55	50.86	3300	0.043	-96.9
60	47.70	3600	0.040	-112.0
65	44.96	3900	0.038	-127.2
70	42.57	4200	0.036	-142.7
75	40.46	4500	0.034	-158.2
80	38.58	4800	0.032	-173.9
85	36.89	5100	0.031	-189.8

CROZIER
CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
FILE: Modified Rational Method
DATE: 11/19/2021
DESIGN: GC
CHECK: RA

Owen Sound IDF Curve Parameters		
Storm Event	**A**	**B**
2	22.3	-0.714
5	29.1	-0.724
10	33.6	-0.729
25	39.3	-0.734
50	43.5	-0.736
100	47.7	-0.738

Total Site Area = 2.43 ha

Catchment 103

Surface	Pre-development		Post-development	
	Area (ha)	**Runoff Coefficient**	**Area (ha)**	**Runoff Coefficient**
Landscapes	2.43	0.25	2.28	0.25
Asphalt	0.00	0.90	0.09	0.90
Building	0.00	0.90	0.06	0.90
Total *	2.43	0.25	2.43	0.29

Modified Rational Method Storage Sizing (2-Year Storm)

Peak Flow

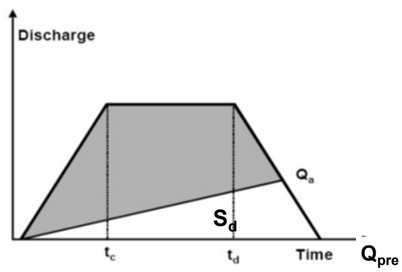
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity

$i_{(T_d)} = A\,(T_d)^{B}$

Storage

$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	80.15
Return Period	2 yr		
Time of Concentration (min)	10		
Coeff A	22.3		
Coeff B	-0.714		
Runoff Coeff (Unadjusted)	0.25	Flow (m^3/s)	0.136
Area (ha)	2.43		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	80.15
Return Period	2 yr		
Time of Concentration (min)	10		
Coeff A	22.3		
Coeff B	-0.714		
Runoff Coeff (unadjusted)	0.29	Uncont. Flow (m^3/s)	0.158
Area (ha)	2.43		

Target Flow (m^3/s)	0.136

REQUIRED STORAGE VOLUME:	**13.1**

Storage Volume Determination (Detailed)

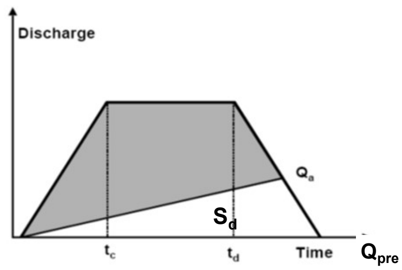
T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	80.15	600	0.158	13.1
15	60.00	900	0.118	4.4
20	48.86	1200	0.096	-7.0
25	41.67	1500	0.082	-19.8
30	36.58	1800	0.072	-33.6
35	32.77	2100	0.065	-48.2
40	29.79	2400	0.059	-63.4
45	27.38	2700	0.054	-79.0
50	25.40	3000	0.050	-95.0
55	23.73	3300	0.047	-111.3
60	22.30	3600	0.044	-127.8
65	21.06	3900	0.042	-144.6
70	19.98	4200	0.039	-161.6
75	19.02	4500	0.038	-178.7
80	18.16	4800	0.036	-196.0
85	17.39	5100	0.034	-213.5

Modified Rational Method Storage Sizing (5-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^{B}$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	106.48
Return Period	5 yr		
Time of Concentration (min)	10		
Coeff A	29.1		
Coeff B	-0.724		
Runoff Coeff (Unadjusted)	0.25	Flow (m^3/s)	0.181
Area (ha)	2.43		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	106.48
Return Period	5 yr		
Time of Concentration (min)	10		
Coeff A	29.1		
Coeff B	-0.724		
Runoff Coeff (unadjusted)	0.29	Uncont. Flow (m^3/s)	0.210
Area (ha)	2.43		

Target Flow (m^3/s)	0.181

REQUIRED STORAGE VOLUME:	**17.4**

Storage Volume Determination (Detailed)				
T_d	i	T_d	Q_{Uncont}	S_d
min	mm/hr	sec	m^3/s	m^3
10	106.48	600	0.210	17.4
15	79.39	900	0.157	5.2
20	64.47	1200	0.127	-10.3
25	54.85	1500	0.108	-27.8
30	48.07	1800	0.095	-46.6
35	42.99	2100	0.085	-66.3
40	39.03	2400	0.077	-86.8
45	35.84	2700	0.071	-107.8
50	33.21	3000	0.066	-129.4
55	30.99	3300	0.061	-151.3
60	29.10	3600	0.057	-173.6
65	27.46	3900	0.054	-196.1
70	26.03	4200	0.051	-218.9
75	24.76	4500	0.049	-241.9
80	23.63	4800	0.047	-265.2
85	22.61	5100	0.045	-288.5

CROZIER CONSULTING ENGINEERS

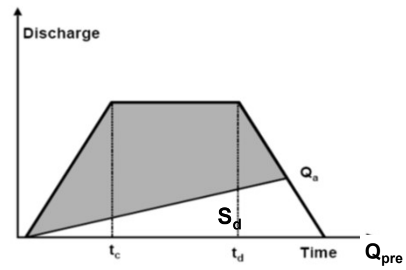
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (10-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^{B}$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	124.05
Return Period	10 yr		
Time of Concentration (min)	10		
Coeff A	33.6		
Coeff B	-0.729		
Runoff Coeff (unadjusted)	0.25	Flow (m^3/s)	0.211
Area (ha)	2.43		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	124.05
Return Period	10 yr		
Time of Concentration (min)	10		
Coeff A	33.6		
Coeff B	-0.729		
Runoff Coeff (unadjusted)	0.29	Uncont. Flow (m^3/s)	0.245
Area (ha)	2.43		

Target Flow (m^3/s)	0.211

REQUIRED STORAGE VOLUME:	**20.3**

Storage Volume Determination (Detailed)				
T_d	i	T_d	Q_{Uncont}	S_d
min	mm/hr	sec	m^3/s	m^3
10	124.05	600	0.245	20.3
15	92.31	900	0.182	5.7
20	74.84	1200	0.148	-12.6
25	63.61	1500	0.126	-33.2
30	55.69	1800	0.110	-55.3
35	49.77	2100	0.098	-78.5
40	45.16	2400	0.089	-102.6
45	41.44	2700	0.082	-127.3
50	38.38	3000	0.076	-152.6
55	35.80	3300	0.071	-178.3
60	33.60	3600	0.066	-204.4
65	31.70	3900	0.063	-230.8
70	30.03	4200	0.059	-257.5
75	28.56	4500	0.056	-284.4
80	27.24	4800	0.054	-311.6
85	26.07	5100	0.051	-339.0

CROZIER CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (25-Year Storm)

Peak Flow

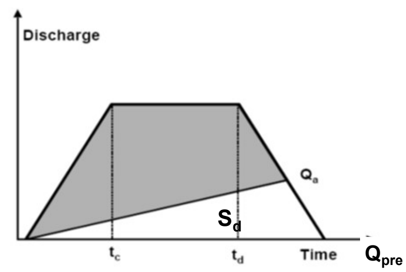
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity

$i_{(T_d)} = A\,(T_d)^B$

Storage

$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	146.40
Return Period	25 yr		
Time of Concentration (min)	10		
Coeff A	39.3		
Coeff B	-0.734		
Runoff Coeff (Adjusted)	0.28	Flow (m^3/s)	0.274
Area (ha)	2.43		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	146.40
Return Period	25 yr		
Time of Concentration (min)	10		
Coeff A	39.3		
Coeff B	-0.734		
Runoff Coeff (Adjusted)	0.32	Uncont. Flow (m^3/s)	0.318
Area (ha)	2.43		

Target Flow (m^3/s)	0.274

REQUIRED STORAGE VOLUME:	**26.4**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	146.40	600	0.318	26.4
15	108.72	900	0.236	7.0
20	88.02	1200	0.191	-17.2
25	74.73	1500	0.162	-44.2
30	65.37	1800	0.142	-73.2
35	58.37	2100	0.127	-103.6
40	52.92	2400	0.115	-135.1
45	48.54	2700	0.105	-167.4
50	44.93	3000	0.098	-200.4
55	41.89	3300	0.091	-234.0
60	39.30	3600	0.085	-268.1
65	37.06	3900	0.080	-302.5
70	35.10	4200	0.076	-337.4
75	33.36	4500	0.072	-372.5
80	31.82	4800	0.069	-408.0
85	30.43	5100	0.066	-443.7

CROZIER CONSULTING ENGINEERS

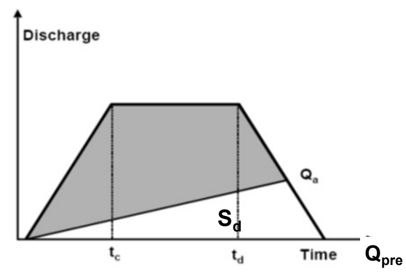
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (50-Year Storm)

Peak Flow
$$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$$

Intensity
$$i_{(T_d)} = A\,(T_d)^B$$

Storage
$$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	162.63
Return Period	50 yr		
Time of Concentration (min)	10		
Coeff A	43.5		
Coeff B	-0.736		
Runoff Coeff (Adjusted)	0.30	Flow (m^3/s)	0.332
Area (ha)	2.43		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	162.63
Return Period	50 yr		
Time of Concentration (min)	10		
Coeff A	43.5		
Coeff B	-0.736		
Runoff Coeff (Adjusted)	0.35	Uncont. Flow (m^3/s)	0.385
Area (ha)	2.43		

Target Flow (m^3/s)	0.332

REQUIRED STORAGE VOLUME:	**32.0**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	162.63	600	0.385	32.0
15	120.67	900	0.286	8.3
20	97.65	1200	0.231	-21.2
25	82.86	1500	0.196	-54.2
30	72.45	1800	0.172	-89.4
35	64.68	2100	0.153	-126.4
40	58.63	2400	0.139	-164.7
45	53.76	2700	0.127	-203.9
50	49.75	3000	0.118	-244.0
55	46.38	3300	0.110	-284.8
60	43.50	3600	0.103	-326.2
65	41.01	3900	0.097	-368.0
70	38.83	4200	0.092	-410.4
75	36.91	4500	0.087	-453.1
80	35.20	4800	0.083	-496.1
85	33.66	5100	0.080	-539.4

CROZIER
CONSULTING ENGINEERS

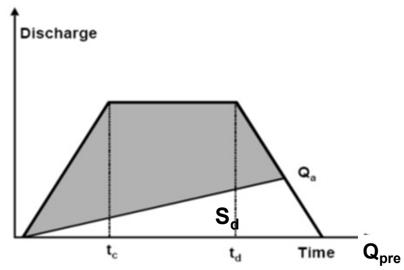
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: GC
CHECK: KM

Modified Rational Method Storage Sizing (100-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^{B}$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	178.98
Return Period	100 yr		
Time of Concentration (min)	10		
Coeff A	47.7		
Coeff B	-0.738		
Runoff Coeff (Adjusted)	0.31	Flow (m^3/s)	0.381
Area (ha)	2.43		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	178.98
Return Period	100 yr		
Time of Concentration (min)	10		
Coeff A	47.7		
Coeff B	-0.738		
Runoff Coeff (Adjusted)	0.36	Uncont. Flow (m^3/s)	0.442
Area (ha)	2.43		

Target Flow (m^3/s)	0.381

REQUIRED STORAGE VOLUME:	**36.6**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	178.98	600	0.442	36.6
15	132.69	900	0.327	9.3
20	107.31	1200	0.265	-24.8
25	91.02	1500	0.225	-62.7
30	79.56	1800	0.196	-103.3
35	71.00	2100	0.175	-145.8
40	64.34	2400	0.159	-189.8
45	58.98	2700	0.146	-234.9
50	54.57	3000	0.135	-281.0
55	50.86	3300	0.126	-327.9
60	47.70	3600	0.118	-375.4
65	44.96	3900	0.111	-423.5
70	42.57	4200	0.105	-472.1
75	40.46	4500	0.100	-521.2
80	38.58	4800	0.095	-570.6
85	36.89	5100	0.091	-620.4

CROZIER CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
FILE: Modified Rational Method
DATE: 11/19/2021
DESIGN: GC
CHECK: RA

Owen Sound IDF Curve Parameters		
Storm Event	**A**	**B**
2	22.3	-0.714
5	29.1	-0.724
10	33.6	-0.729
25	39.3	-0.734
50	43.5	-0.736
100	47.7	-0.738

Total Site Area = 0.67 ha

Catchment 104

Surface	Pre-development		Post-development	
	Area (ha)	**Runoff Coefficient**	**Area (ha)**	**Runoff Coefficient**
Landscapes	0.67	0.25	0.59	0.25
Asphalt	0.00	0.90	0.06	0.90
Building	0.00	0.90	0.02	0.90
Total *	0.67	0.25	0.67	0.33

CROZIER
CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (2-Year Storm)

Peak Flow

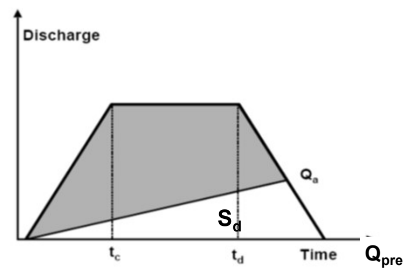
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity

$i_{(T_d)} = A\,(T_d)^{B}$

Storage

$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		Outputs	
IDF Location	Owen Sound	Intensity (mm/hr):	80.15
Return Period	2 yr		
Time of Concentration (min)	10		
Coeff A	22.3		
Coeff B	-0.714		
Runoff Coeff (Unadjusted)	0.25	Flow (m^3/s)	0.038
Area (ha)	0.67		

Post-Development Scenario Data			
Inputs		Outputs	
IDF Location	Owen Sound	Intensity (mm/hr):	80.15
Return Period	2 yr		
Time of Concentration (min)	10		
Coeff A	22.3		
Coeff B	-0.714		
Runoff Coeff (unadjusted)	0.33	Uncont. Flow (m^3/s)	0.049
Area (ha)	0.67		

Target Flow (m^3/s)	0.038

REQUIRED STORAGE VOLUME:	**7.0**

Storage Volume Determination (Detailed)				
T_d	i	T_d	Q_{Uncont}	S_d
min	mm/hr	sec	m^3/s	m^3
10	80.15	600	0.049	7.0
15	60.00	900	0.037	5.0
20	48.86	1200	0.030	2.2
25	41.67	1500	0.026	-1.1
30	36.58	1800	0.022	-4.6
35	32.77	2100	0.020	-8.5
40	29.79	2400	0.018	-12.4
45	27.38	2700	0.017	-16.6
50	25.40	3000	0.016	-20.8
55	23.73	3300	0.015	-25.2
60	22.30	3600	0.014	-29.6
65	21.06	3900	0.013	-34.1
70	19.98	4200	0.012	-38.7
75	19.02	4500	0.012	-43.3
80	18.16	4800	0.011	-47.9
85	17.39	5100	0.011	-52.6

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (5-Year Storm)

Peak Flow

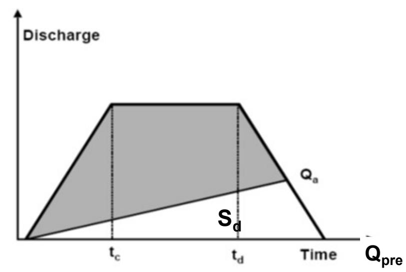
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity

$i_{(T_d)} = A\,(T_d)^B$

Storage

$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	106.48
Return Period	5 yr		
Time of Concentration (min)	10		
Coeff A	29.1		
Coeff B	-0.724		
Runoff Coeff (Unadjusted)	0.25	Flow (m^3/s)	0.050
Area (ha)	0.67		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	106.48
Return Period	5 yr		
Time of Concentration (min)	10		
Coeff A	29.1		
Coeff B	-0.724		
Runoff Coeff (unadjusted)	0.33	Uncont. Flow (m^3/s)	0.065
Area (ha)	0.67		

Target Flow (m^3/s)	0.050
REQUIRED STORAGE VOLUME:	**9.3**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	106.48	600	0.065	9.3
15	79.39	900	0.049	6.5
20	64.47	1200	0.040	2.6
25	54.85	1500	0.034	-1.9
30	48.07	1800	0.030	-6.8
35	42.99	2100	0.026	-11.9
40	39.03	2400	0.024	-17.3
45	35.84	2700	0.022	-22.9
50	33.21	3000	0.020	-28.7
55	30.99	3300	0.019	-34.5
60	29.10	3600	0.018	-40.5
65	27.46	3900	0.017	-46.5
70	26.03	4200	0.016	-52.7
75	24.76	4500	0.015	-58.9
80	23.63	4800	0.015	-65.1
85	22.61	5100	0.014	-71.4

CROZIER CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (10-Year Storm)

Peak Flow

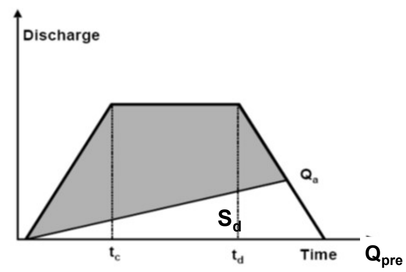
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity

$i_{(T_d)} = A\,(T_d)^{B}$

Storage

$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	124.05
Return Period	10 yr		
Time of Concentration (min)	10		
Coeff A	33.6		
Coeff B	-0.729		
Runoff Coeff (unadjusted)	0.25	Flow (m^3/s)	0.058
Area (ha)	0.67		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	124.05
Return Period	10 yr		
Time of Concentration (min)	10		
Coeff A	33.6		
Coeff B	-0.729		
Runoff Coeff (unadjusted)	0.33	Uncont. Flow (m^3/s)	0.076
Area (ha)	0.67		

Target Flow (m^3/s)	0.058

REQUIRED STORAGE VOLUME:	**10.8**

Storage Volume Determination (Detailed)				
T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	124.05	600	0.076	10.8
15	92.31	900	0.057	7.4
20	74.84	1200	0.046	2.8
25	63.61	1500	0.039	-2.5
30	55.69	1800	0.034	-8.2
35	49.77	2100	0.031	-14.3
40	45.16	2400	0.028	-20.7
45	41.44	2700	0.025	-27.2
50	38.38	3000	0.024	-34.0
55	35.80	3300	0.022	-40.8
60	33.60	3600	0.021	-47.8
65	31.70	3900	0.019	-54.9
70	30.03	4200	0.018	-62.1
75	28.56	4500	0.018	-69.4
80	27.24	4800	0.017	-76.7
85	26.07	5100	0.016	-84.1

CROZIER CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (25-Year Storm)

Peak Flow

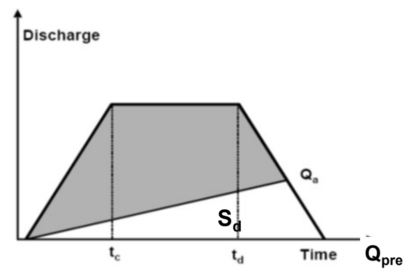
$$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$$

Intensity

$$i_{(T_d)} = A\,(T_d)^{B}$$

Storage

$$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	146.40
Return Period	25 yr		
Time of Concentration (min)	10		
Coeff A	39.3		
Coeff B	-0.734		
Runoff Coeff (Adjusted)	0.28	Flow (m^3/s)	0.076
Area (ha)	0.67		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	146.40
Return Period	25 yr		
Time of Concentration (min)	10		
Coeff A	39.3		
Coeff B	-0.734		
Runoff Coeff (Adjusted)	0.36	Uncont. Flow (m^3/s)	0.099
Area (ha)	0.67		

Target Flow (m^3/s)	0.076

REQUIRED STORAGE VOLUME:	**14.1**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	146.40	600	0.099	14.1
15	108.72	900	0.074	9.5
20	88.02	1200	0.060	3.4
25	74.73	1500	0.051	-3.5
30	65.37	1800	0.044	-11.1
35	58.37	2100	0.039	-19.1
40	52.92	2400	0.036	-27.4
45	48.54	2700	0.033	-36.0
50	44.93	3000	0.030	-44.8
55	41.89	3300	0.028	-53.8
60	39.30	3600	0.027	-63.0
65	37.06	3900	0.025	-72.2
70	35.10	4200	0.024	-81.6
75	33.36	4500	0.023	-91.1
80	31.82	4800	0.022	-100.7
85	30.43	5100	0.021	-110.3

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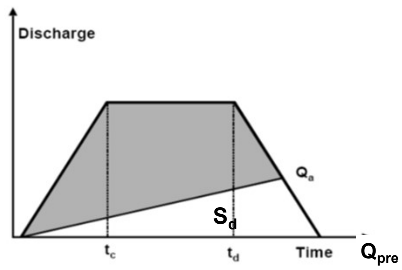
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (50-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^{B}$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	162.63
Return Period	50 yr		
Time of Concentration (min)	10		
Coeff A	43.5		
Coeff B	-0.736		
Runoff Coeff (Adjusted)	0.30	Flow (m^3/s)	0.092
Area (ha)	0.67		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	162.63
Return Period	50 yr		
Time of Concentration (min)	10		
Coeff A	43.5		
Coeff B	-0.736		
Runoff Coeff (Adjusted)	0.39	Uncont. Flow (m^3/s)	0.120
Area (ha)	0.67		

Target Flow (m^3/s)	0.092

REQUIRED STORAGE VOLUME:	**17.0**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	162.63	600	0.120	17.0
15	120.67	900	0.089	11.5
20	97.65	1200	0.072	4.0
25	82.86	1500	0.061	-4.4
30	72.45	1800	0.053	-13.7
35	64.68	2100	0.048	-23.4
40	58.63	2400	0.043	-33.5
45	53.76	2700	0.040	-44.0
50	49.75	3000	0.037	-54.7
55	46.38	3300	0.034	-65.6
60	43.50	3600	0.032	-76.7
65	41.01	3900	0.030	-88.0
70	38.83	4200	0.029	-99.4
75	36.91	4500	0.027	-110.9
80	35.20	4800	0.026	-122.5
85	33.66	5100	0.025	-134.2

CROZIER CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: GC
CHECK: KM

Modified Rational Method Storage Sizing (100-Year Storm)

Peak Flow

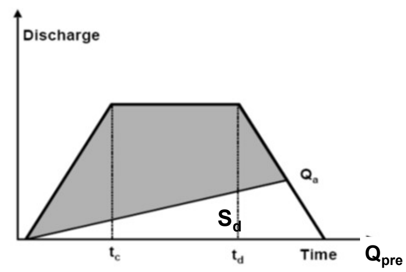
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity

$i_{(T_d)} = A\,(T_d)^{B}$

Storage

$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	178.98
Return Period	100 yr		
Time of Concentration (min)	10		
Coeff A	47.7		
Coeff B	-0.738		
Runoff Coeff (Adjusted)	0.31	Flow (m^3/s)	0.105
Area (ha)	0.67		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	178.98
Return Period	100 yr		
Time of Concentration (min)	10		
Coeff A	47.7		
Coeff B	-0.738		
Runoff Coeff (Adjusted)	0.41	Uncont. Flow (m^3/s)	0.137
Area (ha)	0.67		

Target Flow (m^3/s)	0.105
REQUIRED STORAGE VOLUME:	**19.5**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	178.98	600	0.137	19.5
15	132.69	900	0.102	13.1
20	107.31	1200	0.082	4.5
25	91.02	1500	0.070	-5.3
30	79.56	1800	0.061	-15.9
35	71.00	2100	0.055	-27.1
40	64.34	2400	0.049	-38.8
45	58.98	2700	0.045	-50.8
50	54.57	3000	0.042	-63.1
55	50.86	3300	0.039	-75.7
60	47.70	3600	0.037	-88.4
65	44.96	3900	0.035	-101.4
70	42.57	4200	0.033	-114.5
75	40.46	4500	0.031	-127.7
80	38.58	4800	0.030	-141.0
85	36.89	5100	0.028	-154.5

CROZIER
CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
FILE: Modified Rational Method
DATE: 11/19/2021
DESIGN: GC
CHECK: RA

Owen Sound IDF Curve Parameters		
Storm Event	**A**	**B**
2	22.3	-0.714
5	29.1	-0.724
10	33.6	-0.729
25	39.3	-0.734
50	43.5	-0.736
100	47.7	-0.738

Total Site Area = 0.08 ha

Catchment 105

Surface	**Pre-development**		**Post-development**	
	Area (ha)	**Runoff Coefficient**	**Area (ha)**	**Runoff Coefficient**
Landscapes	0.08	0.25	0.03	0.25
Asphalt	0.00	0.90	0.05	0.90
Building	0.00	0.90	0.00	0.90
Total *	0.08	0.25	0.08	0.66

CROZIER
CONSULTING ENGINEERS

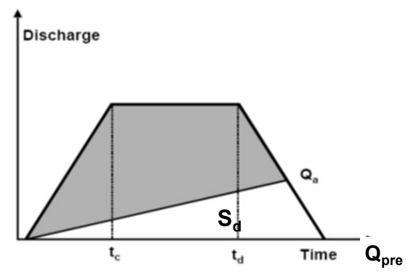
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (2-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^B$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	80.15
Return Period	2 yr		
Time of Concentration (min)	10		
Coeff A	22.3		
Coeff B	-0.714		
Runoff Coeff (Unadjusted)	0.25	Flow (m^3/s)	0.004
Area (ha)	0.08		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	80.15
Return Period	2 yr		
Time of Concentration (min)	10		
Coeff A	22.3		
Coeff B	-0.714		
Runoff Coeff (unadjusted)	0.66	Uncont. Flow (m^3/s)	0.012
Area (ha)	0.08		

Target Flow (m^3/s)	0.004

REQUIRED STORAGE VOLUME:	**4.6**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	80.15	600	0.012	4.4
15	60.00	900	0.009	4.6
20	48.86	1200	0.007	4.6
25	41.67	1500	0.006	4.5
30	36.58	1800	0.005	4.3
35	32.77	2100	0.005	4.1
40	29.79	2400	0.004	3.8
45	27.38	2700	0.004	3.5
50	25.40	3000	0.004	3.1
55	23.73	3300	0.003	2.8
60	22.30	3600	0.003	2.4
65	21.06	3900	0.003	2.0
70	19.98	4200	0.003	1.6
75	19.02	4500	0.003	1.1
80	18.16	4800	0.003	0.7
85	17.39	5100	0.003	0.2

CROZIER
CONSULTING ENGINEERS

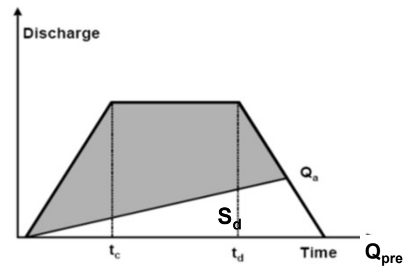
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (5-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^{B}$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	106.48
Return Period	5 yr		
Time of Concentration (min)	10		
Coeff A	29.1		
Coeff B	-0.724		
Runoff Coeff (Unadjusted)	0.25	Flow (m^3/s)	0.006
Area (ha)	0.08		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	106.48
Return Period	5 yr		
Time of Concentration (min)	10		
Coeff A	29.1		
Coeff B	-0.724		
Runoff Coeff (unadjusted)	0.66	Uncont. Flow (m^3/s)	0.016
Area (ha)	0.08		

Target Flow (m^3/s)	0.006

REQUIRED STORAGE VOLUME:	**6.0**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	106.48	600	0.016	5.8
15	79.39	900	0.012	6.0
20	64.47	1200	0.009	6.0
25	54.85	1500	0.008	5.8
30	48.07	1800	0.007	5.6
35	42.99	2100	0.006	5.2
40	39.03	2400	0.006	4.8
45	35.84	2700	0.005	4.4
50	33.21	3000	0.005	3.9
55	30.99	3300	0.005	3.4
60	29.10	3600	0.004	2.9
65	27.46	3900	0.004	2.3
70	26.03	4200	0.004	1.8
75	24.76	4500	0.004	1.2
80	23.63	4800	0.003	0.6
85	22.61	5100	0.003	0.0

CROZIER CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (10-Year Storm)

Peak Flow

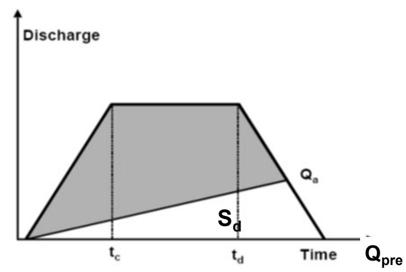
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity

$i_{(T_d)} = A\,(T_d)^{B}$

Storage

$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		Outputs	
IDF Location	Owen Sound	Intensity (mm/hr):	124.05
Return Period	10 yr		
Time of Concentration (min)	10		
Coeff A	33.6		
Coeff B	-0.729		
Runoff Coeff (unadjusted)	0.25	Flow (m^3/s)	0.007
Area (ha)	0.08		

Post-Development Scenario Data			
Inputs		Outputs	
IDF Location	Owen Sound	Intensity (mm/hr):	124.05
Return Period	10 yr		
Time of Concentration (min)	10		
Coeff A	33.6		
Coeff B	-0.729		
Runoff Coeff (unadjusted)	0.66	Uncont. Flow (m^3/s)	0.018
Area (ha)	0.08		

Target Flow (m^3/s)	0.007

REQUIRED STORAGE VOLUME:	**7.0**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	124.05	600	0.018	6.8
15	92.31	900	0.014	7.0
20	74.84	1200	0.011	7.0
25	63.61	1500	0.009	6.7
30	55.69	1800	0.008	6.4
35	49.77	2100	0.007	6.0
40	45.16	2400	0.007	5.5
45	41.44	2700	0.006	5.0
50	38.38	3000	0.006	4.4
55	35.80	3300	0.005	3.8
60	33.60	3600	0.005	3.2
65	31.70	3900	0.005	2.5
70	30.03	4200	0.004	1.9
75	28.56	4500	0.004	1.2
80	27.24	4800	0.004	0.5
85	26.07	5100	0.004	-0.3

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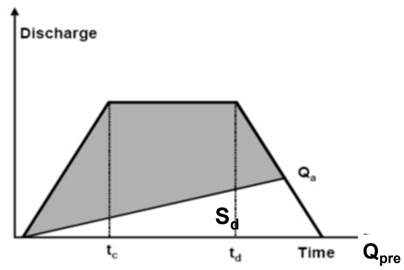
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (25-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^{B}$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	146.40
Return Period	25 yr		
Time of Concentration (min)	10		
Coeff A	39.3		
Coeff B	-0.734		
Runoff Coeff (Adjusted)	0.28	Flow (m^3/s)	0.009
Area (ha)	0.08		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	146.40
Return Period	25 yr		
Time of Concentration (min)	10		
Coeff A	39.3		
Coeff B	-0.734		
Runoff Coeff (Adjusted)	0.72	Uncont. Flow (m^3/s)	0.024
Area (ha)	0.08		

Target Flow (m^3/s)	0.009

REQUIRED STORAGE VOLUME:	**9.1**

Storage Volume Determination (Detailed)				
T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	146.40	600	0.024	8.8
15	108.72	900	0.018	9.1
20	88.02	1200	0.014	9.0
25	74.73	1500	0.012	8.7
30	65.37	1800	0.011	8.2
35	58.37	2100	0.009	7.6
40	52.92	2400	0.009	7.0
45	48.54	2700	0.008	6.3
50	44.93	3000	0.007	5.6
55	41.89	3300	0.007	4.8
60	39.30	3600	0.006	3.9
65	37.06	3900	0.006	3.1
70	35.10	4200	0.006	2.2
75	33.36	4500	0.005	1.3
80	31.82	4800	0.005	0.3
85	30.43	5100	0.005	-0.6

CROZIER CONSULTING ENGINEERS

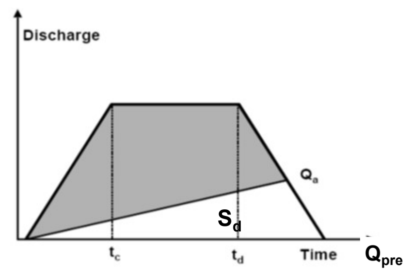
PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: AN
CHECK: GC

Modified Rational Method Storage Sizing (50-Year Storm)

Peak Flow
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity
$i_{(T_d)} = A\,(T_d)^{B}$

Storage
$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	162.63
Return Period	50 yr		
Time of Concentration (min)	10		
Coeff A	43.5		
Coeff B	-0.736		
Runoff Coeff (Adjusted)	0.30	Flow (m^3/s)	0.011
Area (ha)	0.08		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	162.63
Return Period	50 yr		
Time of Concentration (min)	10		
Coeff A	43.5		
Coeff B	-0.736		
Runoff Coeff (Adjusted)	0.79	Uncont. Flow (m^3/s)	0.029
Area (ha)	0.08		

Target Flow (m^3/s)	0.011

REQUIRED STORAGE VOLUME:	**11.0**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	162.63	600	0.029	10.7
15	120.67	900	0.021	11.0
20	97.65	1200	0.017	10.8
25	82.86	1500	0.015	10.4
30	72.45	1800	0.013	9.9
35	64.68	2100	0.011	9.2
40	58.63	2400	0.010	8.4
45	53.76	2700	0.009	7.6
50	49.75	3000	0.009	6.7
55	46.38	3300	0.008	5.7
60	43.50	3600	0.008	4.7
65	41.01	3900	0.007	3.6
70	38.83	4200	0.007	2.5
75	36.91	4500	0.007	1.4
80	35.20	4800	0.006	0.3
85	33.66	5100	0.006	-0.9

CROZIER
CONSULTING ENGINEERS

PROJECT: McCULLOUGH
PROJECT No.: 903-3780
DATE: 11/19/2021
DESIGN: GC
CHECK: KM

Modified Rational Method Storage Sizing (100-Year Storm)

Peak Flow

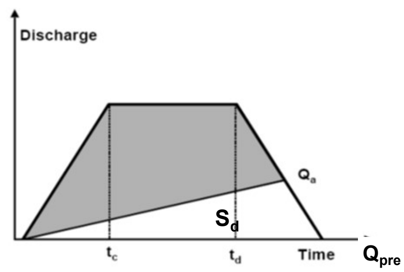
$Q_{post} = 0.0028 \cdot C_{post} \cdot i_{(T_d)} \cdot A$

Intensity

$i_{(T_d)} = A\,(T_d)^{B}$

Storage

$S_d = Q_{post} \cdot T_d - Q_{pre}\,(T_d + T_c) / 2$



Pre-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	178.98
Return Period	100 yr		
Time of Concentration (min)	10		
Coeff A	47.7		
Coeff B	-0.738		
Runoff Coeff (Adjusted)	0.31	Flow (m^3/s)	0.013
Area (ha)	0.08		

Post-Development Scenario Data			
Inputs		**Outputs**	
IDF Location	Owen Sound	Intensity (mm/hr):	178.98
Return Period	100 yr		
Time of Concentration (min)	10		
Coeff A	47.7		
Coeff B	-0.738		
Runoff Coeff (Adjusted)	0.82	Uncont. Flow (m^3/s)	0.033
Area (ha)	0.08		

Target Flow (m^3/s)	0.013

REQUIRED STORAGE VOLUME:	**12.5**

Storage Volume Determination (Detailed)

T_d	i	T_d	Q_{Uncont}	S_d
min	*mm/hr*	*sec*	*m^3/s*	*m^3*
10	178.98	600	0.033	12.2
15	132.69	900	0.024	12.5
20	107.31	1200	0.020	12.4
25	91.02	1500	0.017	11.9
30	79.56	1800	0.015	11.3
35	71.00	2100	0.013	10.5
40	64.34	2400	0.012	9.6
45	58.98	2700	0.011	8.6
50	54.57	3000	0.010	7.5
55	50.86	3300	0.009	6.4
60	47.70	3600	0.009	5.2
65	44.96	3900	0.008	4.0
70	42.57	4200	0.008	2.8
75	40.46	4500	0.007	1.5
80	38.58	4800	0.007	0.2
85	36.89	5100	0.007	-1.1

APPENDIX D

Sand Filter Sizing Calculations

CROZIER CONSULTING ENGINEERS

Project: McCullough **Created By:** JK **Date:** March 2022
Project No.: 0903-3780 **Checked By:** GC **Updated:** 7/13/2022

Sand Filter Calculations - Catchment 202 (Sand Filter #1)

Notes & References

Assume: Full Filtration

A. Maximum Infiltration Depth

Total Controlled Area	0.78	ha	
P = Percolation Rate (native soils)	12	mm/hr	Percolation rate for sand
T = Drawdown Time	24	hours	
d = Maximum allowable depth of infiltration	**0.288**	**m**	MECP SWMP Manual, Equation 4.2

$$d = \frac{PT}{1000}$$

B. Minimum Footprint Surface Area

Catchment 202 Sand Filter

V = Runoff Volume to be Infiltrated (Quality)	**20**	m^3	per MOE Table 3.2 ($25m^3$/ha)
V = Runoff Volume to be Infiltrated (100-year)	**17**	m^3	
d = depth of sand	1.00	m	MOE SWMP Manual, Equation 4.12
k = coefficient of permeability of filter media	35	mm/hr	
h = operating head of water on filter	0.2	m	
T = Drawdown Time	24	hours	
Minimum footprint area	**36**	m^2	

$$A = \frac{1{,}000Vd}{k(h + d)t}$$

C. Design Sizing

Catchment 202 Sand Filter

Provided Footprint Area:	70.0	m^2	35m Length x 2m Width
Void Ratio	0.35		
Provided Storage Volume:	28.7	$\mathbf{m^3}$	

Sand Filter:

Surface Storage Depth:	0.30	m	Basin will be lined with a sand filter to promote filtration. A perforated subdrain will be located at the bottom of the filter to drain out runoff.
Depth of Sand Layer:	1.00	m	
Total Depth of Sand Filter:	**1.30**	**m**	

D. Provided Design and Detention Time

Catchment 202 Sand Filter	**9.0**	**hr**	

$$A = \frac{1{,}000Vd}{k(h + d)t}$$

CROZIER CONSULTING ENGINEERS	**Project:** McCullough	**Created By:** JK	**Date:** March 2022
	Project No.: 0903-3780	**Checked By:** GC	**Updated:** 7/13/2022

Sand Filter Calculations - Catchment 203 (Sand Filter #2)

Notes & References

Assume: Full Filtration

A. Maximum Infiltration Depth

Total Controlled Area	2.43	ha	
P = Percolation Rate (native soils)	12	mm/hr	Percolation rate for sand
T = Drawdown Time	24	hours	
d = Maximum allowable depth of infiltration	**0.288**	**m**	MECP SWMP Manual, Equation 4.2 $d = \frac{PT}{1000}$

B. Minimum Footprint Surface Area

Catchment 202 Sand Filter

V = Runoff Volume to be Infiltrated (Quality)	**61**	m^3	per MOE Table 3.2 ($25m^3$/ha)
V = Runoff Volume to be Infiltrated (100-year)	**37**	m^3	
d = depth of sand	1.00	m	MOE SWMP Manual, Equation 4.12
k = coefficient of permeability of filter media	35	mm/hr	$A = \frac{1{,}000Vd}{k(h+d)t}$
h = operating head of water on filter	0	m	
T = Drawdown Time	24	hours	
Minimum footprint area	**116**	m^2	

C. Design Sizing

Catchment 202 Sand Filter

Provided Footprint Area:	225.0	m^2	75m Length x 3m Width
Void Ration	0.35		
Provided Storage Volume:	78.8	$\mathbf{m^3}$	

Sand Filter:

Depth of Sand Layer:	1.00	m	Basin will be lined with a sand filter to promote filtration. A perforated subdrain will be located at the bottom of the filter to drain out runoff.
Total Depth of Sand Filter:	**1.00**	**m**	

D. Provided Design and Detention Time

Catchment 202 Sand Filter	**10.0**	**hr**	$A = \frac{1{,}000Vd}{k(h+d)t}$

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CONSULTING ENGINEERS

Project: McCullough	**Created By:** JK	**Date:** March 2022
Project No.: 0903-3780	**Checked By:** GC	**Updated:** 7/13/2022

Sand Filter Calculations - Catchment 204 (Sand Filter #3)

Notes & References

Assume: Full Filtration

A. Maximum Infiltration Depth

Total Controlled Area	0.67	ha	
P = Percolation Rate (native soils)	12	mm/hr	Percolation rate for sand
T = Drawdown Time	24	hours	
d = Maximum allowable depth of infiltration	**0.288**	**m**	MECP SWMP Manual, Equation 4.2

$$d = \frac{PT}{1000}$$

B. Minimum Footprint Surface Area

Catchment 202 Sand Filter

V = Runoff Volume to be Infiltrated (Quality)	**17**	m^3	per MOE Table 3.2 ($25m^3$/ha)
V = Runoff Volume to be Infiltrated (100-year)	**20**	m^3	
d = depth of sand	1.00	m	MOE SWMP Manual, Equation 4.12
k = coefficient of permeability of filter media	35	mm/hr	
h = operating head of water on filter	0	m	
T = Drawdown Time	24	hours	
Minimum footprint area	**43**	m^2	

$$A = \frac{1{,}000Vd}{k(h + d)t}$$

C. Design Sizing

Catchment 202 Sand Filter

Provided Footprint Area:	60.0	m^2	15m Length x 4m Width
Void Ration	0.35		
Provided Storage Volume:	21.0	**m^3**	

Sand Filter:

Depth of Sand Layer:	1.00	m	
Total Depth of Sand Filter:	**1.00**	**m**	

Basin will be lined with a sand filter to promote filtration. A perforated subdrain will be located at the bottom of the filter to drain out runoff.

D. Provided Design and Detention Time

Catchment 202 Sand Filter	**10.0**	**hr**

$$A = \frac{1{,}000Vd}{k(h + d)t}$$

APPENDIX E

Septic Calculations

CROZIER & ASSOCIATES Consulting Engineers

ONSITE SEWAGE SYSTEM RESIDENTIAL CALCULATION SHEET

Project Name: McCullough
Project Number: 903-3780
Date: 29-Apr-22
Designed By: GC/JD
Checked By: KR

House Details: 5 bedroom, 325 m2

References

Description		Number of Units	Additional Flow per Unit (L)	Total Flow (L/day)
Base Flow				2500
Additional Flow				
i) Each bedroom over 5		0	500	0
ii) Area over $200m^2$,				
A) Each $10m^2$ over $200m^2$ to $400m^2$		13	100	1300
B) Each $10m^2$ over $400m^2$ to $600m^2$		0	75	0
C) Each $10m^2$ over $600m^2$		0	50	0
	Total Additional Sewage Flow from Area			1300
iii) Fixture Units over 20		15	50	750
Addition flow (greatest of i,ii,iii)				**1300**
Total Daily Design Sanitary Sewage Flow (L/day):				**3800**

Pre-Treatment Options

Required septic tank size = 7600 L minimum

Propose Level IV Treatment (Y/N):* N

*Y if Type A dispersal bed selected

Native Percolation time, T = 50 min/cm

Imported Sand Percolation time = 10 min/cm

Option #1 - In Ground Absorption Trench

Length of distribution pipe required = 950.0 m   1520 m^2

Length of runs = 50 m
Number of runs = 19 runs
Length of distribution pipe provided = 950 m

Option #2 -Raised Absorption Trench

Length of distribution pipe required = 190.0 m

Length of runs = 50 m
Number of runs = 4 runs
Length of distribution pipe provided = 200 m

Maximum loading rate = 4 $L/m^2/day$

Minimum loading area = 950 m^2

Option #3 - Filter Bed

Minimum required contact area = 76 m^2

Required extended contact area = 224 m^2

Maximum loading rate = 4 $L/m^2/day$

Minimum loading area = 950 m^2

APPENDIX F

Initial Soils Investigation (GM BluePlan, March 2022)

March 17, 2022
Our File: 222042

Via Email: gcooper@cfcrozier.ca

Don McCullough
53 Georgian Meadows Drive
Collingwood, ON L9y 5H4

C/o George Cooper – Crozier Consulting Engineers

Re: Initial Soils Investigation
Proposed Severances – Sideroad 23
343019 Side Road 23
Municipality of Meaford

Dear Mr. McCullough,

It is understood that you are proposing a residential development within the Municipality of Meaford. The site is located along Bayshore Road, north of the community of Leith.

The conceptual drawings provided from Crozier Consulting Engineers indicate the development will be comprised of five lots with individual drilled wells and sewage systems. The lots will be accessed by an internal street (McCullough Way) from Sideroad 23.

This letter report is to provide a summary of the soil conditions observed during the testhole excavation and recommendations with regards to the soil conditions for septic and infiltration features and the roadway construction and general comments on the foundation construction for the proposed residential development.

Site Setting

The site is located along Bayshore Road and will be accessed from Sideroad 23. An existing easement from Sideroad 23 exists and runs along the east side of 343011 Sideroad 23. Bayshore Road is considered to run in a north-south direction. Currently, the site is undeveloped and features a rolling terrain within the development area. Generally, the site slopes from east to west, from the open fields upgradient down towards Bayshore Road. The west side of the property is bordered with a treed area between the proposed development and Bayshore Road. Within the treed area there is a "bluff" and the grade changes rapidly towards Bayshore Road. There are four (4) existing drainage features that drain surface water from the upgradient lands to the east, through the site and west to the ditch that runs along the east side of Bayshore Road.

Site Investigation

A initial site visit was conducted on February 4, 2022 to layout the testholes and verify the access of the excavator to the site from the neighboring property. This testhole layout was provided to Crozier for review prior to conducting the site investigation. The excavation of the testholes was undertaken on February 18, 2022 and included twelve (12) testholes across the development area. A CAT 350 excavator provided and operated by R.F. King Excavating was utilized for the excavation of the testholes. The locations were selected to cover the general area of each proposed septic bed area, infiltration feature and for general spatial coverage. The testhole locations were surveyed and tied into the site datum provided by Crozier and the locations are shown on the appended Figure No. 1.

The soil stratigraphy was observed, the overburden soils probed to infer the relative density, and the groundwater observations were noted. The testhole logs describing the soil stratigraphy are appended to this letter.

In general, the subsurface consisted of a surficial layer of topsoil and organic material, underlain by clayey silt till with some gravel. Some of the testholes intercepted a hard grey clay layer. In the area of TH-1, a sand with a little silt and gravel was encountered.

Foundation Loading

Since the proposed development is still in a conceptual phase, final floor elevations for the houses have not been finalized. Frost protected foundations are to be extended down to suitable inorganic bearing soil. For the Owen Sound area, frost penetration is considered to be 1.2 mbgs. Based on the anticipated lot grading, the houses are expected to be founded on the native undisturbed clayey silt till with sand and some gravel.

Conventional foundations governed by the Ontario Building Code are expected. Therefore, recommended design bearing capacities are 75 kPa at SLS and 100 kPa at ULS. The maximum total and differential settlements of footings which are designed based on the above noted capacities are expected to be less than 25mm and 15mm respectively

Slab-on-Grade Construction

Where a conventional slab-on-grade construction element is proposed, all topsoil and organics must be removed down to suitable underlying inorganic subgrade soils. The underlying clayey silt soils would generally be considered suitable. A proof-roll with compaction equipment can be performed to confirm suitability. A minimum 150mm lift of compacted Granular A, meeting the OPSS 1010 specifications and compacted to 100% of the material's SPMDD, is to be placed below the proposed concrete slab-on-grade. Where greater depth of backfill is required, imported sand or Granular "B" is recommended with a minimum compaction of 95% SPMDD.

Excavations and Dewatering

Excavations for the foundations will terminate in the native clayey silt soil. Temporary excavations must comply with Ontario Occupational Health and Safety Act for Construction Projects (O.Reg. 213/91). The overburden soils fall into the Type 2 as defined in the regulation and therefore, temporary side slopes in Type 2 soils must be sloped to 1.2 metres or less from its bottom at an inclination of 1 horizontal to 1 vertical (exclusive to groundwater effects).

During the excavation of the testholes, minor shallow groundwater infiltration was noted at some of the locations. The water was found to infiltrate between 1.0m to 1.6m below ground surface. These shallow ground water conditions can be attributed to the recent fluctuations in temperature causing snow melt. At the location of TH-10, towards the west end of infiltration trench #3, significant groundwater infiltration was noted at a depth of 1.4m.

Since there are predominately fine-grained soils located across the site, perched groundwater conditions are likely to develop during the wetter seasons. Temporary dewatering with conventional sump pumps at excavated low points may be necessary to control the seepage of water from the layers of till during construction.

Septic Design

The five lots are proposed to have their own individual septic systems located to the rear of the lots (west side) and typically downgradient of the dwelling. A testhole was excavated within each proposed septic bed area, with a subgrade soil being generally consistent for 4 of the 5 septic areas. For Lots 1, 2, 3, and 5, the encountered subgrade soils in the area of the septic bed was clayey silt till with sand and some to trace gravel. A representative sample collected from TH-6 was selected for grain-size analysis and yielded 21.4% gravel, 35.5% sand, 33.6% silt and 17.5% clay. Therefore, the estimated coefficient of permeability for this material is 1.6 x 10^{-7} cm/sec which translates to a "T" Time for the bed greater than 50 mins/cm. Based on this result, it is not feasible to construct "in-ground" septic beds for these lots, and the design should feature a raised bed constructed of approved imported material.

The excavation of TH-1, located within the proposed septic area for Lot 4, encountered below the till and at a depth of 1.0 m, a sandier soil with silt, gravel, and clay still present. A sample collected from TH-1 was analyzed for grain-size distribution and yielded 15.0% gravel, 63.9% sand, 16.6% silt and 4.5% clay. The estimated coefficient of permeability for this sample is 1.6 x 10^{-3} cm/sec and a "T" Time of 12 to 15 mins/cm. While this soil would be somewhat more conducive to a "in-ground" septic bed, the consistent clay and silt subgrade findings above and below the minor sandy layer in this testhole and the clay and silt from the other testholes would impact the performance of the septic bed and therefore raised beds are recommended. In addition, diverting surface water away from the raised system will be critical to reduce potential saturation of the imported sand, utilized to construct the onsite systems.

Stormwater Management

As shown on the conceptual design for the development, several infiltration trenches are included to manage the stormwater on site. There are four (4) existing drainage features identified on the site that drain surface water from the upgradient lands to the east, through the site west to the ditch that runs along the east side of Bayshore Road.

The proposed construction includes ditches on either side of McCullough Way, that direct the surface water towards infiltration trenches located along the existing drainage features. TH-4 was excavated within the area of infiltration trench #4 near drainage feature 1, located on Lot 2. TH-10 and TH-11 were located along the area of infiltration trench #3 located between Lots 4 and 5. TH-12 is located near infiltration trenches #1 and #2, near drainage feature 3. The fourth drainage feature is located towards the south end of McCullough Way.

The findings of the testholes at these areas was relatively consistent, with surficial topsoil and organics underlain by the clayey silt till with sand and some gravel. Samples from TH-4, TH-10 were selected for grain-size analysis to determine estimated infiltration rates of the soil. The sample collected from TH-4 yielded a grain-size distribution of 11.8% gravel, 37.1% sand, 33.6% silt and 17.5% clay. The sample collected from TH-10 yielded a grain-size distribution of 5.0% gravel, 41.5% sand, 40.4% silt and 13.1% clay. The estimated coefficient of permeability for the samples from TH-4 and TH-10 are 1.0 x 10^{-8} cm/sec and 1.6 x 10^{-7} cm/sec respectively.

During the excavation of the testholes, the inferred density of the material was estimated from probing the soils with a steel rod. The clayey silt till was noted to be stiff to very stiff when probed. Combining this with the low estimated coefficient of permeability and low infiltration rates, it is interpreted that the infiltration of stormwater would be very low and should be considered negligible as part of the stormwater design.

Roadway Construction

The five lots will front on McCullough Way, which will be a private roadway which is proposed to be constructed to connect the lots to Sideroad 23. The subgrade for the roadway will likely be the clayey silt till with sand and some gravel. Depending on the time of year, the moisture conditions at the time of construction, and the quality of the soils, surplus harvested materials may be able to be used as subgrade material.

It is recommended the final subgrade surface be proof rolled to determine any loose, soft, or unstable areas of the subgrade. Any areas which reveal unsuitable conditions should be sub-excavated and backfilled using suitable materials such as imported Granular "B" which must be compacted to at least 95% of the material's SPMDD at the subgrade level. The recommended road structure is outlined in the table below.

Internal Roadways	Component Thickness (mm)	Specified Compaction (%)
OPSS Granular "A"	200	100% SPMDD
OPSS Granular "B"	350	100% SPMDD
Subgrade Fill	Varies	95 to 98% SPMDD

STATEMENT OF LIMITATIONS

The discussion and recommendations in this report are based upon information gathered at the testhole locations and available geological and physiographical information of general nature for the area. Sub-surface and groundwater conditions are variable and will differ in area beyond the investigated testholes. As a result, conditions may become apparent during further investigation or construction, which would not be detected or anticipated at the time the site investigation was performed and when this report was prepared.

The information in this report is intended for the sole use of Mr. Don McCullough and his agents. GM BluePlan Engineering Limited accepts no liability for use of this information by third parties on the basis of the interpretation of the information provided in this preliminary report are made at the sole risk of the third parties.

The final shape and location of the proposed site developments have not been confirmed and therefore, comments made within this report are made in general only to assist the owner and designers involved with the project in question. Furthermore, the number of testholes may not be sufficient to determine all the factors that may affect the design, construction methods and costs. Additional investigation would be necessary to increase the confidence level. For this reason, Contractors bidding on this project or undertaking the construction should make their own interpretation of the factual information presented within this report and then draw their own conclusion on the sub-surface conditions and how it will affect the methods and cost of construction.

We recommend that we be retained to provide comment for the selected roadway design and during construction to ensure that all the necessary stripping, sub-grade preparation, and compaction requirements are met, and to be available to confirm that the soil conditions do not deviate from those presented within this report

Yours truly,

GM BLUEPLAN ENGINEERING LIMITED

Per:

Ethan C.J. Webb, P.Eng.
EW/md

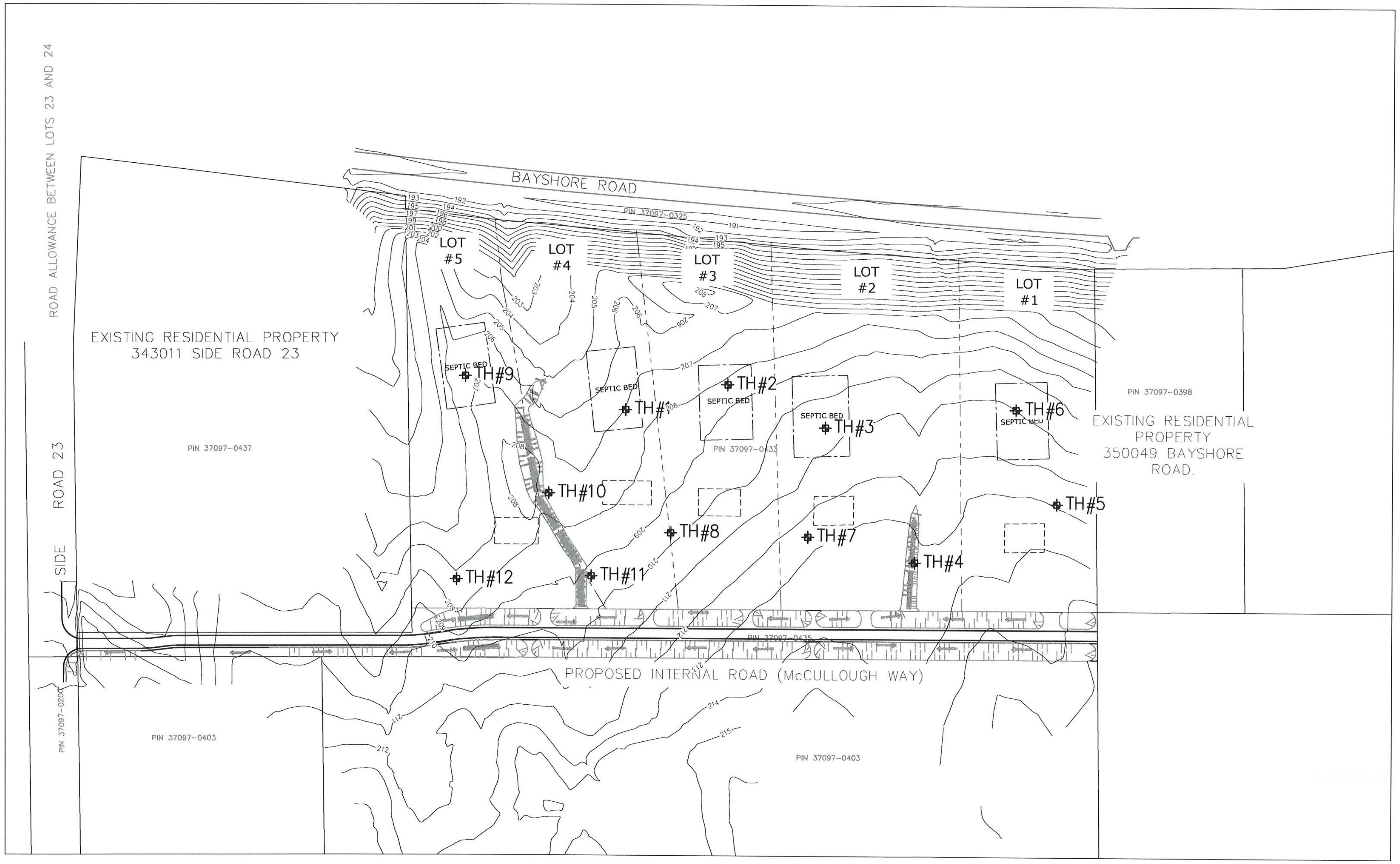
Reviewed by:

Wm. E. Dubeau, P.Eng.

LICENSED PROFESSIONAL ENGINEER
Mar 17/22
W. E. DUBEAU
PROVINCE OF ONTARIO

Encl.

cc: File No. 222042



222042
SOILS INVESTIGATION
PROPOSED SEVERANCE
SIDEROAD 23, MEAFORD

LEGEND

PROPOSED TESTHOLE

CONCEPTUAL LOCATION OF RESIDENCE

CONCEPTUAL LOCATION OF SEPTIC BED

SCALE = 1:2000
FEBRUARY 2022

TESTHOLE LOCATIONS

Mr. Don McCullough

Municipality of Meaford

Figure No. 1

GM BluePlan ENGINEERING

FILE:W:\OwenSound\Owen Sound\022-2022\222042 Soils Investigation - Proposed Severance - Sideroad 23, Meaford\Survey Data\Temp\222042b.dwg LAYOUT:11X17
LAST SAVED BY:Tjahnke, 3/9/2022 4:20:16 PM PLOTTED BY:Tyler Jahnke - GM BluePlan 3/10/2022 9:44:46 AM

Log of Testhole: 1

Project No: 222042

Project: Sideroad 23 - Severences

Client: Mr. Don McCullough

Location: Municipality of Meaford

Excavation Date: February 18, 2022

Field Technician: E. Webb.

Excavation Company: R.F. King Excavating

Depth (m)	Elevation	Description	% Moisture (5 / 15 / 25)	Ground Water and Sampling Details
0	206.96	Ground Surface		
0 – 0.4	206.96 – 206.56	Black topsoil and organics.		
0.4 – 1.0	206.56 – 205.96	Brown Clayey Silt Till with a some Gravel. Grey Mottled. Moist and Stiff when probed with a steel rod.		
1.0 – 2.0	205.96 – 204.96	Silty Sand and Gravel. Moist and Compact when probed with a steel rod.		Minor Infiltration @ 1.1m Sample Collected @ 1.4m Minor Infiltration @ 1.6m
2.0 – 2.2	204.96 – 204.76	Grey Clayey Silt Till. Moist and Hard from resistence in excavation.		

Notes:

Equipment: CAT 350 Excavator

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Log of Testhole: 2

Project No: 222042

Project: Sideroad 23 - Severences

Client: Mr. Don McCullough

Location: Municipality of Meaford

Excavation Date: February 18, 2022

Field Technician: E. Webb.

Excavation Company: R.F. King Excavating

SUBSURFACE PROFILE				PROPERTIES	HYDROLOGY
Depth (ft / m)	Elevation	Symbol	Description	% Moisture (5, 15, 25)	Ground Water and Sampling Details
0 ft / 0 m	208.22		Ground Surface		
	208.02		Black topsoil and organics.		
			Brown Clayey Silt Till with a some Gravel. Grey Mottled. Moist and Stiff when probed with a steel rod.		
	206.12				
	205.92		Grey Clayey Silt Till. Moist and Hard from resistence in excavation.		

Depth scale: ft 0–16; m 0–4

Notes:

Equipment: CAT 350 Excavator

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Log of Testhole: 3

Project No: 222042

Project: Sideroad 23 - Severences

Client: Mr. Don McCullough

Location: Municipality of Meaford

Excavation Date: February 18, 2022

Field Technician: E. Webb.

Excavation Company: R.F. King Excavating

SUBSURFACE PROFILE				PROPERTIES	HYDROLOGY
Depth (ft / m)	Elevation	Symbol	Description	% Moisture 5 15 25	Ground Water and Sampling Details
0 / 0	210.52		Ground Surface		
	210.32		Black topsoil and organics.		
			Brown Clayey Silt Till with a some Gravel. Grey Mottled. Moist and Stiff when probed with a steel rod.		Minor Infiltration @ 1.1m
	208.42		Grey Clayey Silt Till. Moist and Hard from resistence in excavation.		
	208.22				

Depth scale: ft 0–16; m 0–4

Notes:

Equipment: CAT 350 Excavator

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Project No: 222042	**Log of Testhole: 4**
Project: Sideroad 23 - Severences	*Excavation Date:* February 18, 2022
Client: Mr. Don McCullough	*Field Technician:* E. Webb.
Location: Municipality of Meaford	*Excavation Company:* R.F. King Excavating

SUBSURFACE PROFILE				PROPERTIES	HYDROLOGY
Depth (ft / m)	Elevation	Symbol	Description	% Moisture (5, 15, 25)	Ground Water and Sampling Details
0 ft / 0 m	213.27		Ground Surface		
	213.07		Black topsoil and organics.		
			Brown Clayey Silt Till with a some Gravel. Grey Mottled. Moist and Stiff when probed with a steel rod.		Sample Collected @ 1.2m
	210.97				

Notes:

Equipment: CAT 350 Excavator

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Log of Testhole: 5

Project No: 222042	
Project: Sideroad 23 - Severences	*Excavation Date:* February 18, 2022
Client: Mr. Don McCullough	*Field Technician:* E. Webb.
Location: Municipality of Meaford	*Excavation Company:* R.F. King Excavating

SUBSURFACE PROFILE				PROPERTIES	HYDROLOGY
Depth (ft / m)	Elevation	Symbol	Description	% Moisture (5, 15, 25)	Ground Water and Sampling Details
0 ft / 0 m	217.87		Ground Surface		
	217.67		Black topsoil and organics.		
			Brown Clayey Silt Till with a some Gravel. Grey Mottled. Moist and Stiff when probed with a steel rod.		Minor Infiltration @ 1.0m
6 ft	215.97				

Depth scale: 0–16 ft; 0–4 m.

Notes:

Equipment: CAT 350 Excavator

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Project No: 222042

Log of Testhole: 6

Project: Sideroad 23 - Severences

Excavation Date: February 18, 2022

Client: Mr. Don McCullough

Field Technician: E. Webb.

Location: Municipality of Meaford

Excavation Company: R.F. King Excavating

SUBSURFACE PROFILE				PROPERTIES	HYDROLOGY
Depth (ft / m)	Elevation	Symbol	Description	% Moisture (5, 15, 25)	Ground Water and Sampling Details
0 ft / 0 m	210.97		Ground Surface		
	210.77		Black topsoil and organics.		
			Brown Clayey Silt Till with a some Gravel. Grey Mottled. Moist and Stiff when probed with a steel rod.		Sample Collected @ 1.2m
	208.67				

Depth scale: ft 0–16; m 0–4

Notes:

Equipment: CAT 350 Excavator

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Log of Testhole: 7

Project No: 222042
Project: Sideroad 23 - Severences
Client: Mr. Don McCullough
Location: Municipality of Meaford

Excavation Date: February 18, 2022
Field Technician: E. Webb.
Excavation Company: R.F. King Excavating

SUBSURFACE PROFILE				PROPERTIES	HYDROLOGY
Depth (ft / m)	Elevation	Symbol	Description	% Moisture (5, 15, 25)	Ground Water and Sampling Details
0 ft / 0 m	210.97		Ground Surface		
	210.82		Black topsoil and organics.		
	208.47		Brown Clayey Silt Till with a some Gravel. Grey Mottled. Moist and Stiff when probed with a steel rod.		
	208.17		Grey Clayey Silt Till. Moist and Hard from resistence in excavation.		

Notes:

Equipment: CAT 350 Excavator

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Log of Testhole: 8

Project No: 222042

Project: Sideroad 23 - Severences

Client: Mr. Don McCullough

Location: Municipality of Meaford

Excavation Date: February 18, 2022

Field Technician: E. Webb.

Excavation Company: R.F. King Excavating

SUBSURFACE PROFILE				PROPERTIES	HYDROLOGY
Depth (ft / m)	Elevation	Symbol	Description	% Moisture (5, 15, 25)	Ground Water and Sampling Details
0 / 0	209.62		Ground Surface		
			Black topsoil and organics.		
	209.32		Brown Clayey Silt Till with a some Gravel. Grey Mottled. Moist and Stiff when probed with a steel rod.		
	207.32				

Depth scale: ft 0–16; m 0–4

Notes:

Equipment: CAT 350 Excavator

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Log of Testhole: 9

Project No: 222042

Project: Sideroad 23 - Severences

Client: Mr. Don McCullough

Location: Municipality of Meaford

Excavation Date: February 18, 2022

Field Technician: E. Webb.

Excavation Company: R.F. King Excavating

SUBSURFACE PROFILE				PROPERTIES	HYDROLOGY
Depth (ft / m)	Elevation	Symbol	Description	% Moisture 5 15 25	Ground Water and Sampling Details
0 / 0	206.81		Ground Surface		
	206.66		Black topsoil and organics.		
	204.11		Brown Clayey Silt Till with a some Gravel. Grey Mottled. Moist and Stiff when probed with a steel rod.		
	203.91		Grey Clayey Silt Till. Moist and Hard from resistence in excavation.		

Depth scale: ft 0–16; m 0–4

Notes:

Equipment: CAT 350 Excavator

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Log of Testhole: 10

Project No: 222042

Project: Sideroad 23 - Severences

Client: Mr. Don McCullough

Location: Municipality of Meaford

Excavation Date: February 18, 2022

Field Technician: E. Webb.

Excavation Company: R.F. King Excavating

SUBSURFACE PROFILE				PROPERTIES	HYDROLOGY
Depth (ft / m)	Elevation	Symbol	Description	% Moisture (5, 15, 25)	Ground Water and Sampling Details
0 ft / 0 m	207.80		Ground Surface		
0–1.3 ft	207.40		Black topsoil and organics.		
1.3–6.9 ft	205.70		Sandy Silt with a little Clay. Moist and Loose to Compact when probed with a steel rod.		Sample Collected @ 1.0m Major Infiltration @ 1.4m
6.9–7.9 ft	205.40		Grey Clayey Silt Till. Moist and Hard from resistence in excavation.		

Notes:

Equipment: CAT 350 Excavator

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Log of Testhole: 11

Project No: 222042	
Project: Sideroad 23 - Severences	*Excavation Date:* February 18, 2022
Client: Mr. Don McCullough	*Field Technician:* E. Webb.
Location: Municipality of Meaford	*Excavation Company:* R.F. King Excavating

SUBSURFACE PROFILE				PROPERTIES	HYDROLOGY
Depth (ft / m)	Elevation	Symbol	Description	% Moisture (5, 15, 25)	Ground Water and Sampling Details
0 ft / 0 m	209.17		Ground Surface		
0			Black topsoil and organics.		
			Brown Clayey Silt Till with a some Gravel. Grey Mottled. Moist and Stiff when probed with a steel rod.		
1.4 m					Major Infiltration @ 1.4m
2 m	207.07				

Depth scale: ft 0–16; m 0–4

Notes:

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Equipment: CAT 350 Excavator

Project No: 222042

Log of Testhole: 12

Project: Sideroad 23 - Severences

Excavation Date: February 18, 2022

Client: Mr. Don McCullough

Field Technician: E. Webb.

Location: Municipality of Meaford

Excavation Company: R.F. King Excavating

SUBSURFACE PROFILE				PROPERTIES	HYDROLOGY
Depth (ft / m)	Elevation	Symbol	Description	% Moisture 5 15 25	Ground Water and Sampling Details
0	207.20		Ground Surface		
0 – 1 ft	206.85		Black topsoil and organics.		
1 – 3.4 ft (1 m)	206.10		Brown Clayey Silt Till with a some Gravel. Grey Mottled. Moist and Stiff when probed with a steel rod.		Minor Infiltration @ 1.0m
3.4 – 4.3 ft	205.90		Grey Clayey Silt Till. Moist and Hard from resistence in excavation.		

Notes:

Equipment: CAT 350 Excavator

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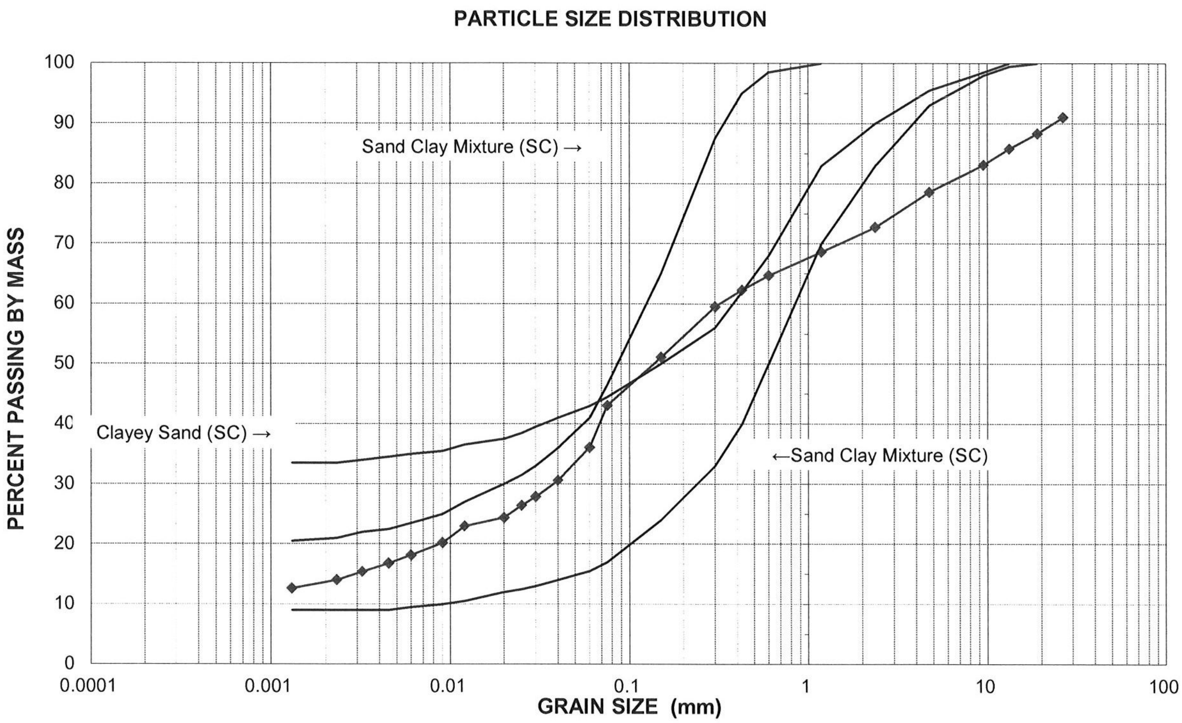
PARTICLE SIZE ANALYSIS

PROJECT:	Soils Investigation - Proposed Severance - Sideroad 23	FILE NO.:	222042
LOCATION:	Municipality of Meaford	LAB SAMPLE NO.:	S-4445 (RCVD Feb 18)
CLIENT :	Don McCullough	SAMPLE DATE:	February 18, 2022
SOIL TYPE:	Clayey Silt with Sand and some Gravel	SAMPLED BY:	EW
GRAPH # :	8 - Clayey Sands, Sand-Clay Mixtures	SOURCE:	TH-6 @ 1.2m



← CLAY	SILT	SAND (FINE)	SAND (MEDIUM)	SAND (COARSE)	GRAVEL (FINE)	GRAVEL (COARSE)

SIEVE SIZE PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE	HYDROMETER PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE
26.5	91.0	0.0600	36.1
19	88.4	0.0400	30.6
13.2	85.8	0.0300	27.8
9.5	83.1	0.0250	26.4
4.75	78.6	0.0200	24.4
2.36	72.7	0.0120	23.0
1.180	68.6	0.0090	20.2
0.600	64.7	0.0060	18.2
0.425	62.4	0.0045	16.8
0.300	59.5	0.0032	15.4
0.150	51.1	0.0023	14.0
0.075	43.1	0.0013	12.6

D_{10} : **0.0004 mm** **D_{60} : 0.32 mm** **Cu : 800**

Coefficient of Permeability: 1.6×10^{-7} cm/sec **"T" Time : > 50 mins/cm**

Comments: D10 is extrapolated.

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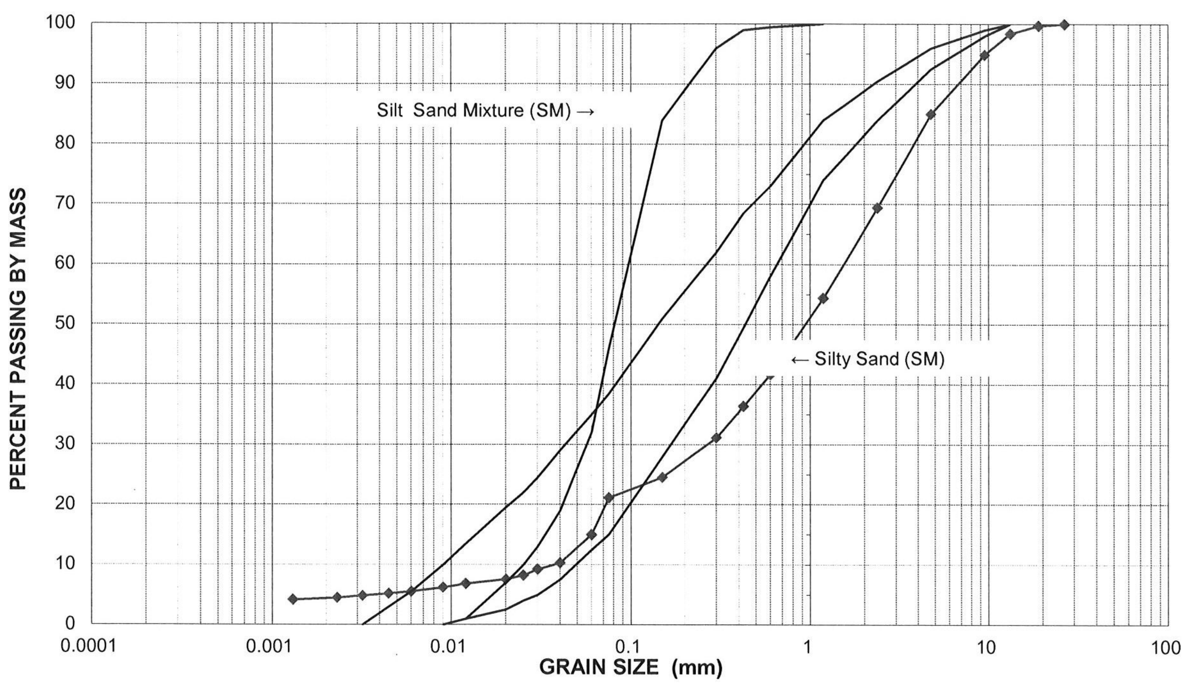
PARTICLE SIZE ANALYSIS

PROJECT:	Soils Investigation - Propose Severance - Sideroad 23	FILE NO.:	222042
LOCATION:	Municipality of Meaford	LAB SAMPLE NO.:	S-4446 (RCVD Feb 18)
CLIENT :	Don McCullough	SAMPLE DATE:	February 18, 2022
SOIL TYPE:	Sand with a little Silt and Gravel and a trace of Clay	SAMPLED BY:	EW
GRAPH # :	7 - Silty Sands, Sand-Silt Mixture	SOURCE:	TH-1 @ 1.4m

PARTICLE SIZE DISTRIBUTION



←		FINE	MEDIUM	COARSE	FINE	COARSE
CLAY	SILT	SAND			GRAVEL	

SIEVE SIZE PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE	HYDROMETER PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE
26.5	100.0	0.0600	15.0
19	99.7	0.0400	10.3
13.2	98.4	0.0300	9.2
9.5	94.9	0.0250	8.2
4.75	85.0	0.0200	7.6
2.36	69.4	0.0120	6.9
1.180	54.4	0.0090	6.2
0.600	41.7	0.0060	5.5
0.425	36.4	0.0045	5.2
0.300	31.1	0.0032	4.8
0.150	24.6	0.0023	4.5
0.075	21.1	0.0013	4.2

D_{10} : 0.04 mm **D_{60} : 1.62 mm** **Cu : 40.5**

Coefficient of Permeability: 1.6×10^{-3} cm/sec **"T" Time : 12 to 15 mins/cm**

Comments:

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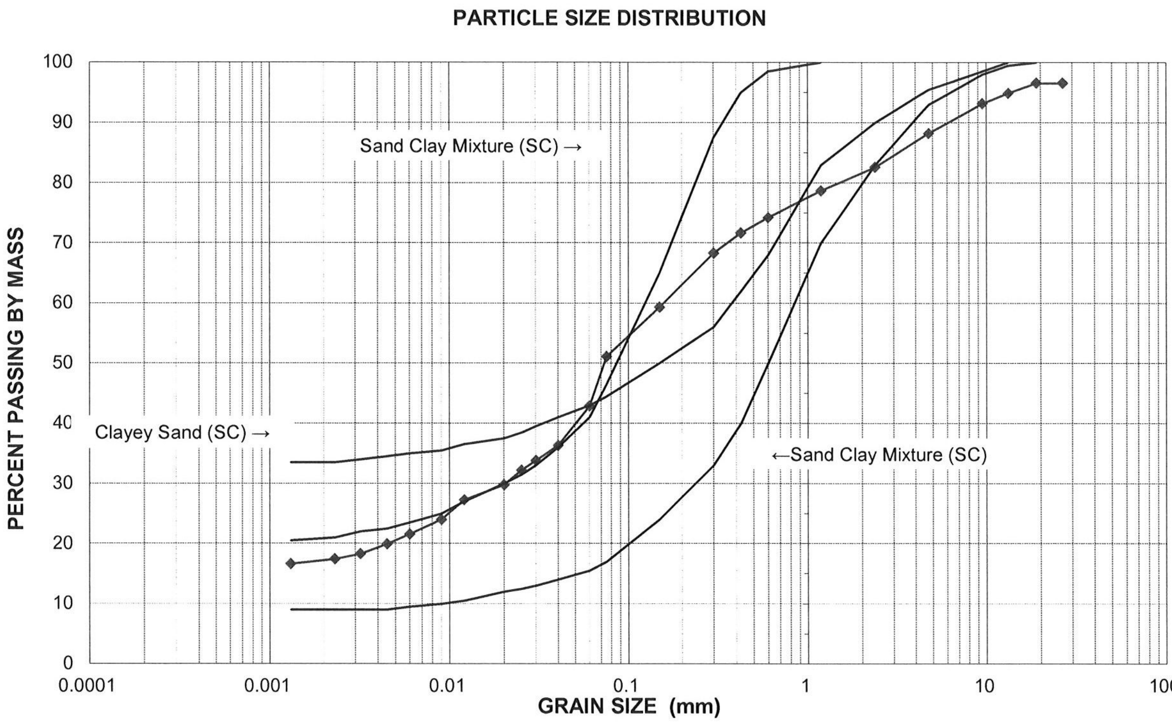
PARTICLE SIZE ANALYSIS

PROJECT:	Soils Investigation - Proposed Severance - Sideroad 23	FILE NO.:	222042
LOCATION:	Municipality of Meaford	LAB SAMPLE NO.:	S-4447 (RCVD Feb 18)
CLIENT :	Don McCullough	SAMPLE DATE:	February 18, 2022
SOIL TYPE:	Clayey Silt with Sand and a little Gravel	SAMPLED BY:	EW
GRAPH # :	8 - Clayey Sands, Sand-Clay Mixtures	SOURCE:	TH-4 @ 1.2m



CLAY	SILT	SAND (FINE / MEDIUM / COARSE)	GRAVEL (FINE / COARSE)

SIEVE SIZE PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE	HYDROMETER PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE
26.5	96.6	0.0600	42.9
19	96.6	0.0400	36.3
13.2	94.9	0.0300	33.9
9.5	93.2	0.0250	32.2
4.75	88.2	0.0200	29.8
2.36	82.6	0.0120	27.3
1.180	78.7	0.0090	24.0
0.600	74.2	0.0060	21.6
0.425	71.7	0.0045	19.9
0.300	68.3	0.0032	18.3
0.150	59.3	0.0023	17.5
0.075	51.1	0.0013	16.6

D_{10} : **0.0001 mm** **D_{60} : 0.16 mm** **Cu : 1600**

Coefficient of Permeability: 1.0×10^{-8} cm/sec **"T" Time : > 50 mins/cm**

Comments: D10 is extrapolated.

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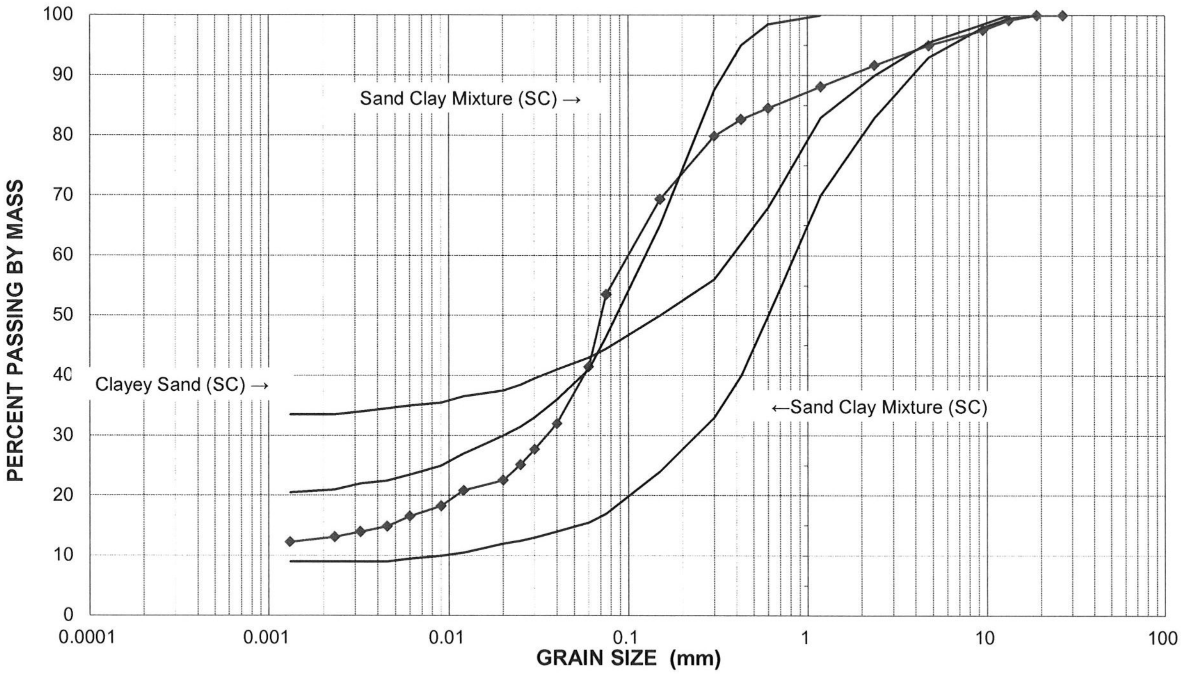
PARTICLE SIZE ANALYSIS

PROJECT:	Soils Investigation - Proposed Severance - Sideroad 23	FILE NO.:	222042
LOCATION:	Municipality of Meaford	LAB SAMPLE NO.:	S-4448 (RCVD Feb 18)
CLIENT :	Don McCullough	SAMPLE DATE:	February 18, 2022
SOIL TYPE:	Silty Sand with a little Clay and trace of Gravel	SAMPLED BY:	EW
GRAPH # :	8 - Clayey Sands, Sand-Clay Mixtures	SOURCE:	TH-10 @ 1.0m



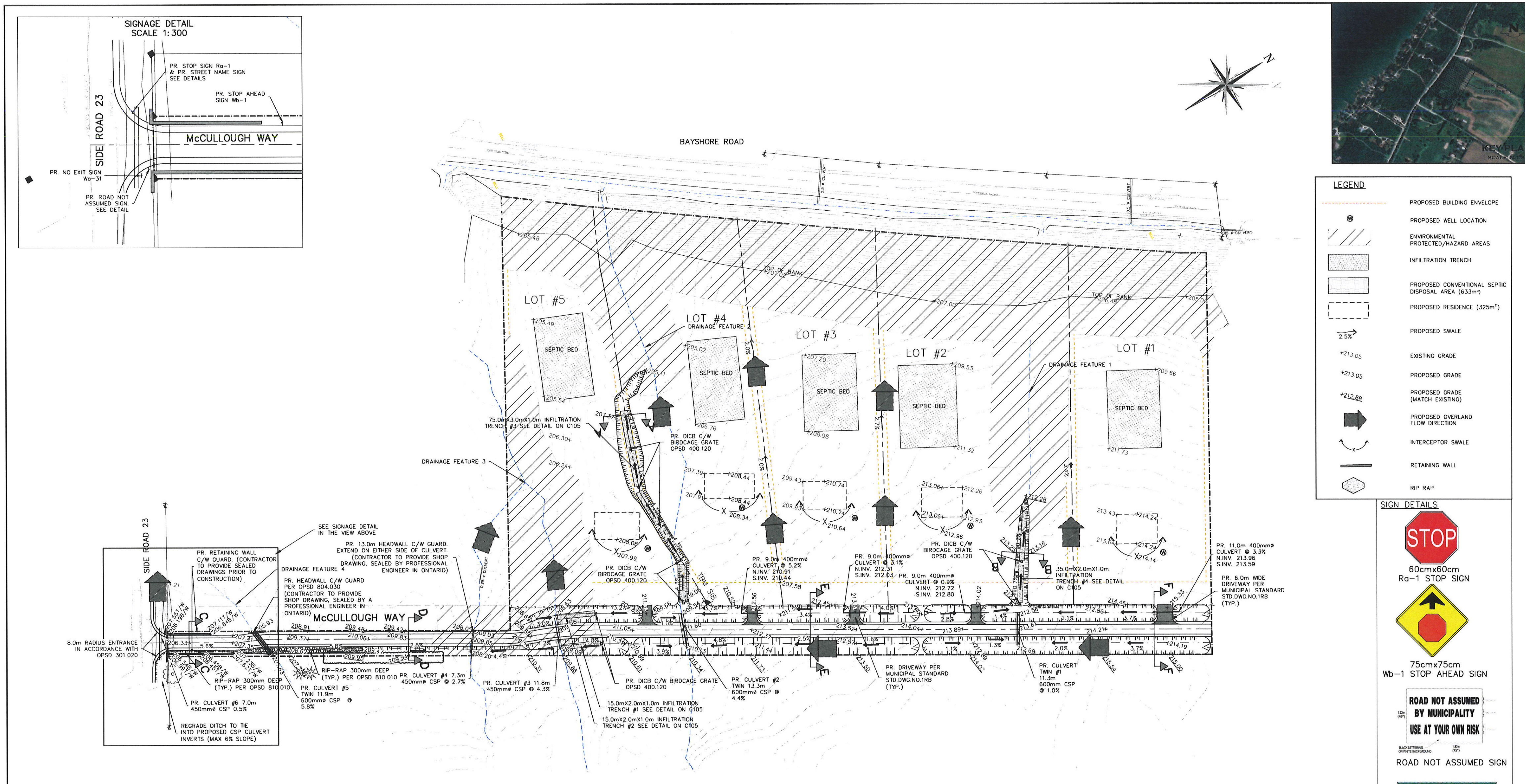
CLAY	SILT	SAND (FINE / MEDIUM / COARSE)	GRAVEL (FINE / COARSE)

SIEVE SIZE PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE	HYDROMETER PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE
26.5	100.0	0.0600	41.5
19	100.0	0.0400	32.0
13.2	99.2	0.0300	27.7
9.5	97.5	0.0250	25.1
4.75	95.0	0.0200	22.6
2.36	91.7	0.0120	20.9
1.180	88.2	0.0090	18.3
0.600	84.6	0.0060	16.6
0.425	82.7	0.0045	14.8
0.300	79.9	0.0032	14.0
0.150	69.4	0.0023	13.1
0.075	53.5	0.0013	12.3

D_{10} : 0.0004 mm **D_{60} :** 0.11 mm **Cu :** 275

Coefficient of Permeability: 1.6×10^{-7} cm/sec **"T" Time :** > 50 mins/cm

Comments: D10 is extrapolated.



GENERAL GRADING NOTES:

1. REFER TO DRAWING C102 FOR CROSS-SECTION DETAILS
2. PROPOSED INFILTRATION TRENCHES HAVE BEEN DESIGNED TO PROVIDE THE REQUIRED QUANTITY CONTROLS FOR FULL BUILD-OUT OF THE DEVELOPMENT AND QUALITY FOR THE PROPOSED ROADWAY. QUALITY CONTROLS FOR INDIVIDUAL LOTS TO BE DESIGNED BY OTHERS AT BUILDING PERMIT STAGE (IF REQUIRED)
3. 150mmø RIP RAP (300mm DEEP) TO BE PROVIDED IN DITCHES THAT EXCEED A SLOPE OF 5.0%

GENERAL SERVICING NOTES:

1. DETAILED SEPTIC DESIGN AND LOCATION, AND WELL LOCATION TO BE CONFIRMED AT TIME OF DETAILED LOT DESIGN/BUILDING PERMIT.
2. SEPTIC BEDS TO MAINTAIN MINIMUM 15m SEPARATION FROM PROPOSED WELLS AND INFILTRATION FACILITIES.
3. SEPTIC BEDS TO MAINTAIN MINIMUM 3m SEPARATION FROM PROPERTY LINES.

15 0m 15 30 45 60
SCALE: 1:750

1. THIS DRAWING IS THE EXCLUSIVE PROPERTY OF C.F. CROZIER & ASSOCIATES INC. AND THE REPRODUCTION OF ANY PART WITHOUT PRIOR WRITTEN CONSENT OF THIS OFFICE IS STRICTLY PROHIBITED.
2. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS, LEVELS, AND DATUMS ON SITE AND REPORT ANY DISCREPANCIES OR OMISSIONS TO THIS OFFICE PRIOR TO CONSTRUCTION.
3. THIS DRAWING IS TO BE READ AND UNDERSTOOD IN CONJUNCTION WITH ALL OTHER PLANS AND DOCUMENTS APPLICABLE TO THIS PROJECT.
4. DO NOT SCALE THE DRAWINGS.
5. ALL EXISTING UNDERGROUND UTILITIES TO BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

TEMPORARY BENCHMARKS

TBM#1- SQUARE IRON BAR (SIB), ELEVATION = 210.299
SURVEY COMPLETED BY VAN HARTEN ON JANUARY 29TH 2019

Town

No.	ISSUE	DATE: MM/DD/YYYY
0	ISSUED FOR CLIENT REVIEW	07/28/2020
1	RE-ISSUED FOR CLIENT REVIEW	08/18/2021
2	ISSUED FOR SECOND SUBMISSION	11/18/2021

Engineer

Engineer

Project

LEITH-BAYSHORE ROAD
MUNICIPALITY OF MEAFORD

Drawing

MASTER SERVICING & GRADING PLAN

CROZIER
CONSULTING ENGINEERS

ADMIRAL BUILDING
1 FIRST STREET, SUITE 200
COLLINGWOOD, ON, L9Y 1A1
705-446-3510 T
705-446-3520 F
WWW.CFCROZIER.CA
INFO@CFCROZIER.CA

Drawn By N.L.	Design By N.L./G.C.	Project 903-3780	
Check By G.C.	Check By R.A.	Scale 1:750	Drawing C101

J:\900\903 - McCullough\3780 - Leith Bayshore Rd\CAD\C3D\SHEETS\3780_C100-C103_(With Retaining Wall).dwg, 2021-11-18 4:43:14 PM, _AutoCAD PDF (General Documentation).pc3

APPENDIX G

Well Records

MINISTRY OF THE ENVIRONMENT
The Ontario Water Resources Act

WATER WELL RECORD

Ontario ✓ 41A/10 West

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2505270 | MUNICIP 25016 | CON CON | BF

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT 25-27
[redacted]	Sydenham	CON BF	023

[redacted] Annan, Ontario

DATE COMPLETED 48-53: DAY 11 MO. 06 YR. 75

RC. ELEVATION RC. BASIN CODE

2505270 17 512088 4944754 4 650 5 22 AUG 16, 1976 19

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
	Blue	Shale		0	90

Plastic Liner 50 ft. - 40 - 90

31 0090317

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
0080	4 ☒ MINERAL (1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY)
15-18	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
20-23	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
25-28	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL
30-33	1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL

51 CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
05 3/16	1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE	.188	0	0050
05 4 1/2	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE #5 PLASTIC	1/10 IN	50	0090
24-25	1 ☐ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE			27-30

SCREEN

SIZE(S) OF OPENING (SLOT NO.) 31-33	DIAMETER 34-38 INCHES	LENGTH 39-40 FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN 41-44 FEET	

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
10-13	14-17	
18-21	22-25	
26-29	30-33	

71 PUMPING TEST

PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
1 ☐ PUMP 2 ☒ BAILER	0005 GPM	02 HOURS 00 MINS

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING (1 ☒ PUMPING 2 ☐ RECOVERY) 15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
020 FEET	070 FEET	070 FEET	FEET	FEET	FEET

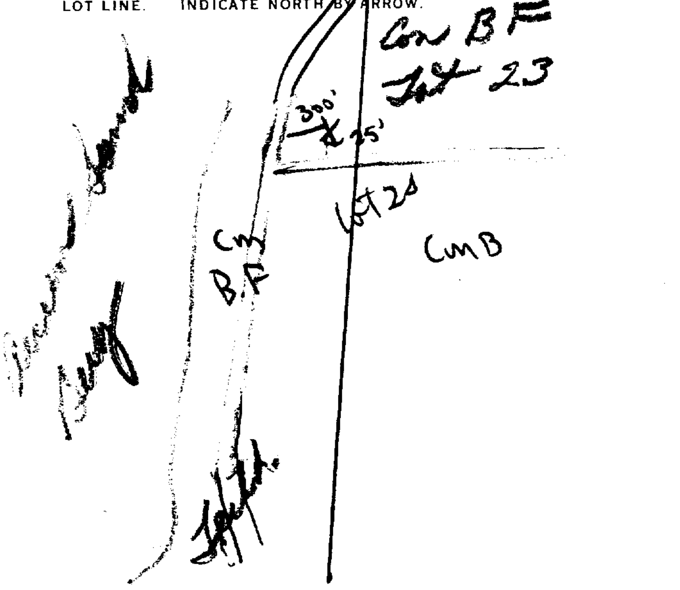
IF FLOWING, GIVE RATE: GPM | PUMP INTAKE SET AT: 60 FEET | WATER AT END OF TEST: 1 ☒ CLEAR 2 ☐ CLOUDY

RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP | RECOMMENDED PUMP SETTING: 060 FEET | RECOMMENDED PUMPING RATE: 0003 GPM

50-53 000.1 GPM./FT. SPECIFIC CAPACITY

LOCATION OF WELL 1244

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS:

FINAL STATUS OF WELL 1
1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED

WATER USE 01
1 ☒ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL ☐ OTHER 5 ☐ COMMERCIAL 6 ☐ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED

METHOD OF DRILLING 4
1 ☐ CABLE TOOL 2 ☐ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☒ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING

CONTRACTOR

NAME OF WELL CONTRACTOR: Wm. Wright Well Drillers — LICENCE NUMBER 5507
ADDRESS: Hepworth, Ont.
NAME OF DRILLER OR BORER: Herb Wright — LICENCE NUMBER 5503
SIGNATURE OF CONTRACTOR: William Wright
SUBMISSION DATE: DAY. MO. YR.

OFFICE USE ONLY

DATA SOURCE 1 | CONTRACTOR 5507 | DATE RECEIVED 290975
DATE OF INSPECTION 6/11/75 | INSPECTOR
REMARKS: P.B, N.V | P 1D | WKD

MINISTRY OF THE ENVIRONMENT COPY

FORM 7 MOE 07-091

Ministry of the Environment
Ontario

The Ontario Water Resources Act
WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11 | 2512914 | MUNICIP 25016 | CON. B.F.

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
[redacted]		Broken front Con.	22

[redacted] R. 2, Annan, Ont. N0H 1B0

DATE COMPLETED: DAY 13 MO 07 YR 95

ELEVATION | RC | BASIN CODE

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	DEPTH - FEET TO
	top soil			0	1
brown	sandy clay			1	45
gray	clay	sand & gravel		45	57

31
32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERALS ☐ GAS
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERALS ☐ GAS
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERALS ☐ GAS
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERALS ☐ GAS
	☐ FRESH ☐ SALTY ☐ SULPHUR ☐ MINERALS ☐ GAS

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	DEPTH - FEET TO
6¼	☒ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE ☐ PLASTIC	1.88	0	54'7"
6¼	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE ☒ PLASTIC		54'7"	57
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE ☐ PLASTIC			

SCREEN

SIZE(S) OF OPENING (SLOT NO.) | DIAMETER INCHES | LENGTH FEET
MATERIAL AND TYPE | DEPTH TO TOP OF SCREEN FEET

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
		WELL CAPPED ALUMINUM CAP

71 PUMPING TEST

PUMPING TEST METHOD: ☐ PUMP ☐ BAILER | PUMPING RATE GPM | DURATION OF PUMPING HOURS MINS

STATIC LEVEL | WATER LEVEL END OF PUMPING | WATER LEVELS DURING ☐ PUMPING ☐ RECOVERY: 15 MINUTES FEET | 30 MINUTES FEET | 45 MINUTES FEET | 60 MINUTES FEET

IF FLOWING GIVE RATE GPM | PUMP INTAKE SET AT FEET | WATER AT END OF TEST ☐ CLEAR ☐ CLOUDY

RECOMMENDED PUMP TYPE ☐ SHALLOW ☐ DEEP | RECOMMENDED PUMP SETTING FEET | RECOMMENDED PUMPING RATE GPM

FINAL STATUS OF WELL

☐ WATER SUPPLY ☐ OBSERVATION WELL ☐ TEST HOLE ☐ RECHARGE WELL ☐ ABANDONED, INSUFFICIENT SUPPLY ☐ ABANDONED, POOR QUALITY ☒ UNFINISHED ☐ DEWATERING

WATER USE

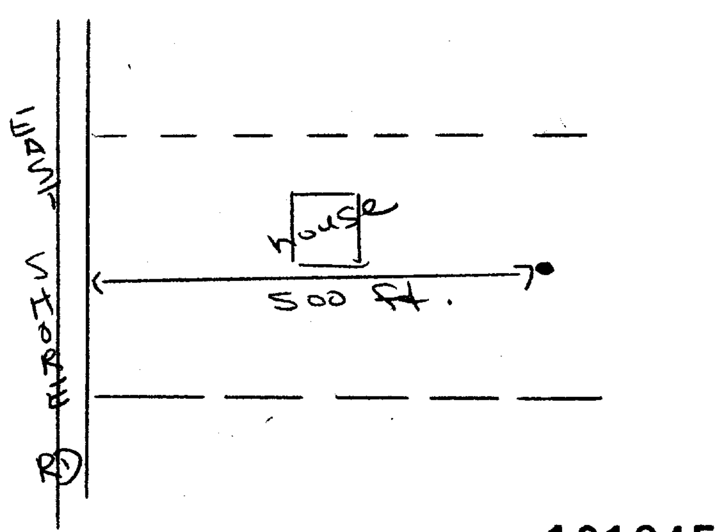
☐ DOMESTIC ☐ STOCK ☐ IRRIGATION ☐ INDUSTRIAL ☐ OTHER ☐ COMMERCIAL ☐ MUNICIPAL ☐ PUBLIC SUPPLY ☐ COOLING OR AIR CONDITIONING ☐ NOT USED

METHOD OF CONSTRUCTION

☒ CABLE TOOL ☐ ROTARY (CONVENTIONAL) ☐ ROTARY (REVERSE) ☐ ROTARY (AIR) ☐ AIR PERCUSSION ☐ BORING ☐ DIAMOND ☐ JETTING ☐ DRIVING ☐ DIGGING ☐ OTHER

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS

131945

CONTRACTOR

NAME OF WELL CONTRACTOR: JIM CLARKE WELL DRILLING LIMITED | WELL CONTRACTOR'S LICENCE NUMBER: 1565
ADDRESS: R. R. 2, Meaford, Ont. N4L 1W6
NAME OF WELL TECHNICIAN: Jim Clarke | WELL TECHNICIAN'S LICENCE NUMBER: T-0104
SIGNATURE OF TECHNICIAN/CONTRACTOR: [signature] | SUBMISSION DATE: DAY 17 MO 07 YR 95

OFFICE USE ONLY

DATA SOURCE | CONTRACTOR 1565 | DATE RECEIVED SEP 29 1995
DATE OF INSPECTION | INSPECTOR
REMARKS
CSS.ES

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506 (11/86) FORM 9

LIST OF FIGURES & DRAWINGS

Legend

= SUBJECT LANDS

Project

LEITH BAYSHORE ROAD
THE COUNTY OF GREY

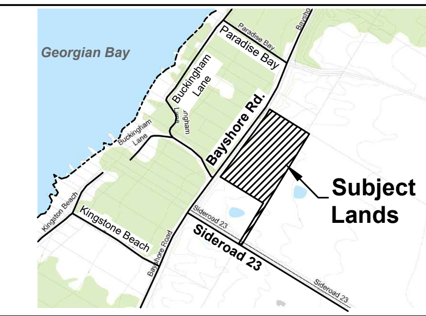
Drawing

SITE LOCATION

CROZIER CONSULTING ENGINEERS

Admiral Building
1 First Street, Suite 200
Collingwood, ON, L9Y 1A1
705-446-3510 T
705-446-3520 F
www.cfcrozier.ca
info@cfcrozier.ca

Drawn By	N.L.	Design By	N.L./G.C.	Project	903–3780
Scale N.T.S.	Date 06/30/2020	Check By	G.C.	Drawing	FIG. 1



KEY PLAN
SCALE: N.T.S.

LEGEND

- SUBJECT LANDS BOUNDARY (Ref: July 30,2016 Survey)
- ENVIRONMENTAL PROTECTED / HAZARD AREAS (Ref: 15m Setback from Surveyed Top of Bank and Surveyed Swales)
- DEVELOPMENT ENVELOPE AREAS (Ref: 9m Front Lot Line Setback / 2m Interior Side Lot Line Setback)
- UNEVALUATED WETLANDS
- INTERMITTENT / EPHEMERAL SWALES
- PROPOSED LOT LINES

Total Lot Area / Lot Development Envelope Area:

Lot 1
7999.8m² / 5111.9m²

Lot 2
11282.9m² / 4801.5m²

Lot 3
7482.7m² / 4639.7m²

Lot 4
8102m² / 4454m²

Lot 5
8159.7m² / 3814m²

N

0 10 20 40 60 80 m

1 : 2000

Project

CON BF PT LOT 23
COUNTY OF GREY, ONTARIO

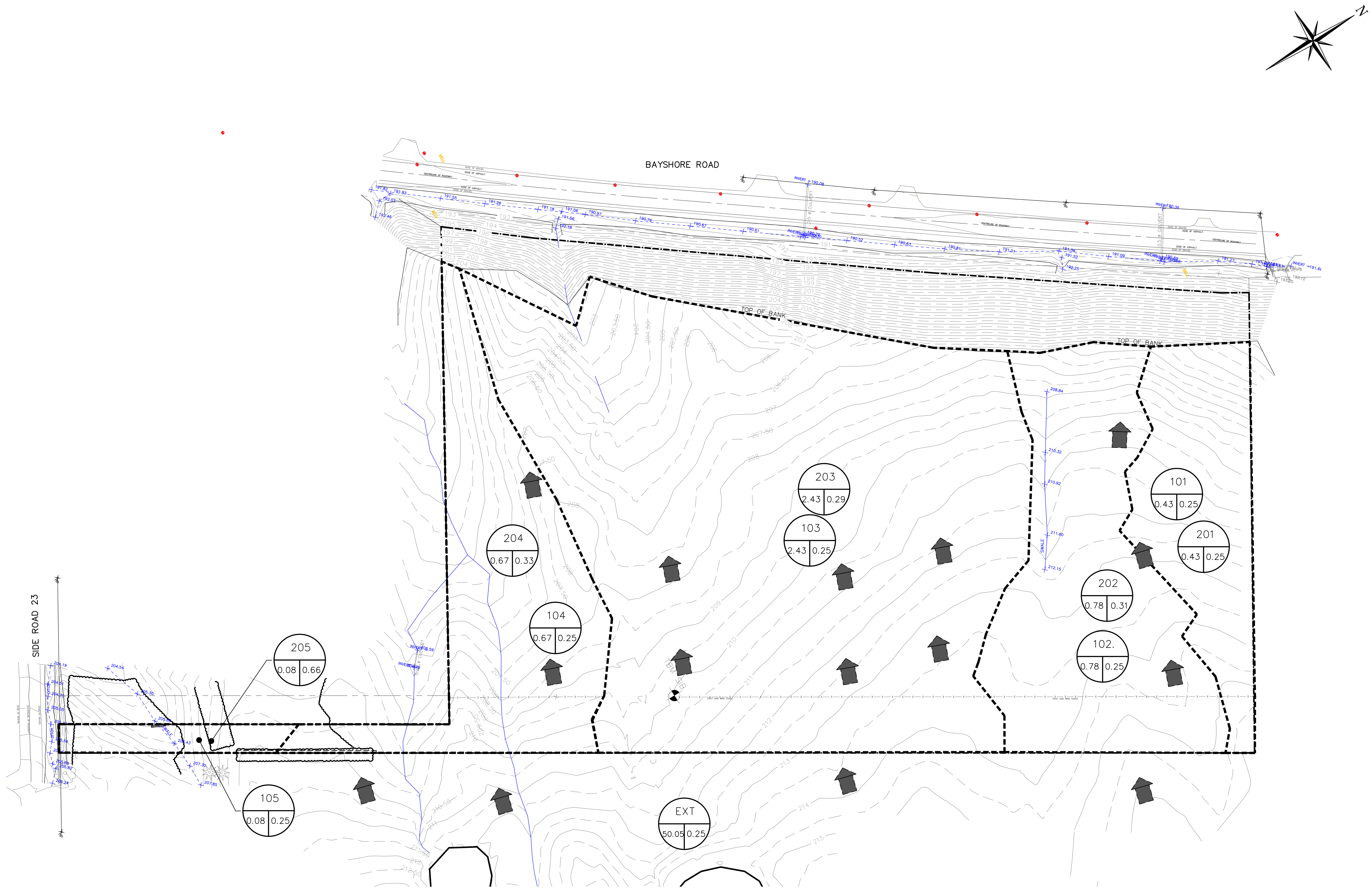
Title

DEVELOPMENT OPPORTUNITIES AND CONSTRAINTS

CROZIER CONSULTING ENGINEERS
The HarbourEdge Building, 40 Huron Street, Suite 301, Collingwood, ON L9Y 4R3
705 446 3510 T
705 446 3520 F
www.cfcrozier.ca
info@cfcrozier.ca

Drawn By	Design By	Project	
D.C.	M.H.	CR-EIS-McC	
Date	Check By	Scale	Drawing
2020/02/20	M.H.	1: 2000	Figure 5

Date Plotted: February 20, 2020



LEGEND

198 X-ELEVATION
PROPERTY BOUNDARY
OVERLAND FLOW ARROW
CATCHMENT ID (PRE-DEVELOPMENT)
RUN OFF COEFFICIENT
CATCHMENT AREA (ha)
CATCHMENT ID (POST-DEVELOPMENT)
RUN OFF COEFFICIENT
CATCHMENT AREA (ha)
DRAINAGE CATCHMENT AREA
EXISTING DRAINAGE FEATURE

15 0m 15 30 45 60
SCALE: 1:750

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TEMPORARY BENCHMARKS

TBM#1– SQUARE IRON BAR (SIB), ELEVATION = 210.299
SURVEY COMPLETED BY VAN HARTEN ON JANUARY 29TH 2019

Town

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3	ISSUED FOR THIRD SUBMISSION	07/08/2022

Engineer

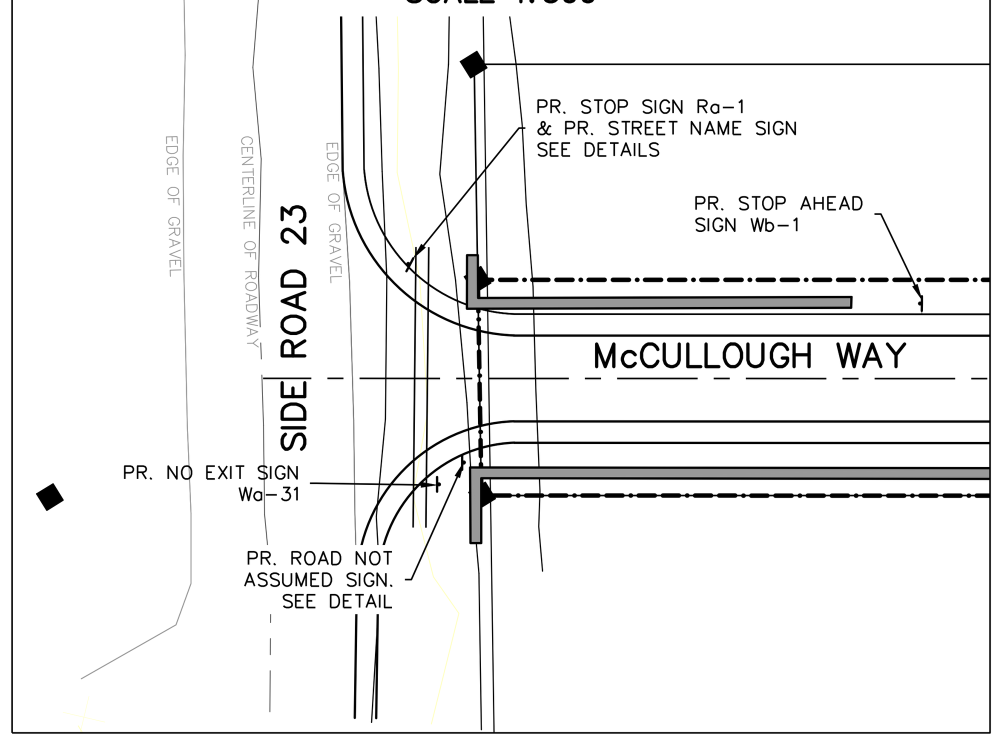
Engineer

Project
LEITH–BAYSHORE ROAD
MUNICIPALITY OF MEAFORD

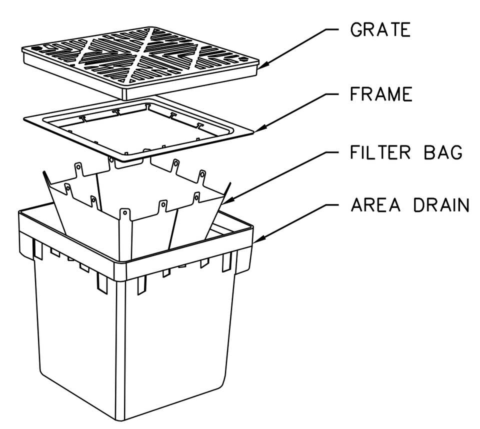
Drawing
PRE AND POST–DEVELOPMENT DRAINAGE PLAN

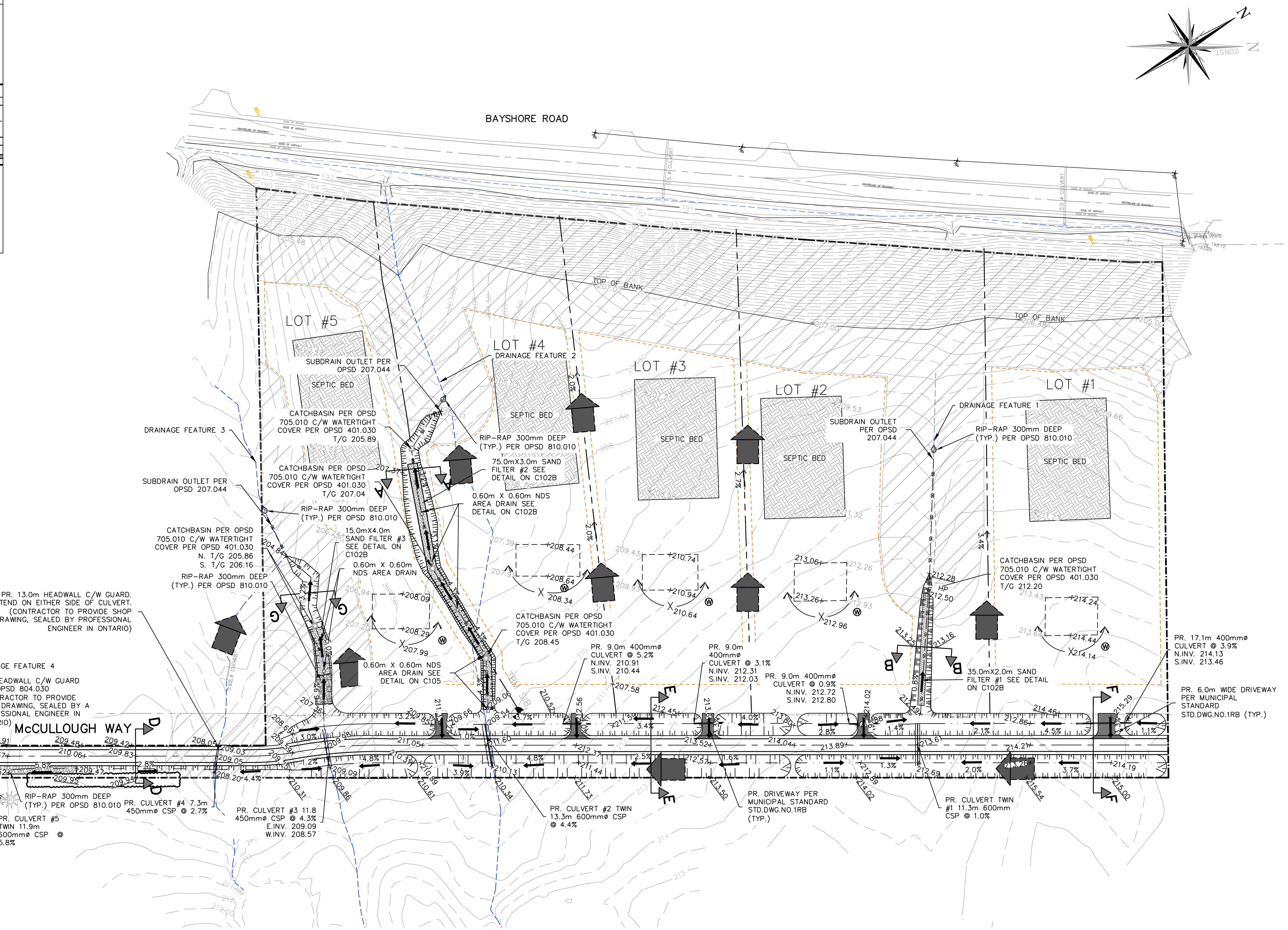
CROZIER
CONSULTING ENGINEERS
ADMIRAL BUILDING
1 FIRST STREET, SUITE 200
COLLINGWOOD, ON, L9Y 1A1
705-446-3510 T
705-446-3520 F
WWW.CFCROZIER.CA
INFO@CFCROZIER.CA

Drawn By N.L.	Design By N.L./G.C.	Project	903–3780
Check By G.C.	Check By R.A.	Scale 1:750	Drawing FIG . 3



TYPICAL AREA DRAIN

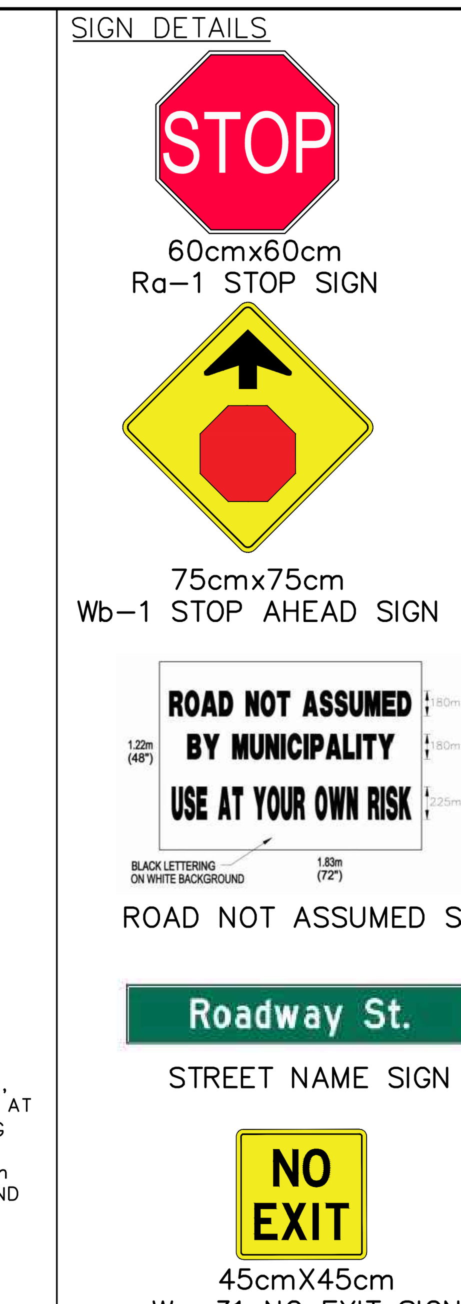




LEGEND

- PROPOSED BUILDING ENVELOPE
- PROPOSED SUBDRAIN
- PROPOSED WELL LOCATION
- ENVIRONMENTAL PROTECTED/HAZARD AREAS
- SAND FILTER
- PROPOSED CONVENTIONAL SEPTIC DISPOSAL AREA (950m²)
- PROPOSED RESIDENCE (325m²)
- PROPOSED SWALE
- EXISTING GRADE
- PROPOSED GRADE
- PROPOSED GRADE (MATCH EXISTING)
- PROPOSED OVERLAND FLOW DIRECTION
- INTERCEPTOR SWALE
- RETAINING WALL
- RIP RAP
- PROPOSED DRIPLINE

SIGN DETAILS



SCALE: 1:750

GENERAL GRADING NOTES:

1. REFER TO DRAWING C102 FOR CROSS-SECTION DETAILS
2. PROPOSED SAND FILTER HAVE BEEN DESIGNED TO PROVIDE THE REQUIRED QUANTITY CONTROLS FOR FULL BUILD-OUT OF THE DEVELOPMENT AND QUALITY FOR THE PROPOSED ROADWAY. QUALITY CONTROLS FOR INDIVIDUAL LOTS TO BE DESIGNED BY OTHERS AT BUILDING PERMIT STAGE (IF REQUIRED)
3. 150mmø RIP RAP (300mm DEEP) TO BE PROVIDED IN DITCHES THAT EXCEED A SLOPE OF 5.0%

GENERAL SERVICING NOTES:

1. DETAILED SEPTIC DESIGN AND LOCATION, AND WELL LOCATION TO BE CONFIRMED AT TIME OF DETAILED LOT DESIGN/BUILDING PERMIT.
2. SEPTIC BEDS TO MAINTAIN MINIMUM 15m SEPARATION FROM PROPOSED WELLS AND SAND FILTERS.
3. SEPTIC BEDS TO MAINTAIN MINIMUM 3m SEPARATION FROM PROPERTY LINES.

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SURVEY COMPLETED BY VAN HARTEN ON JANUARY 29TH 2019

Town

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3	ISSUED FOR THIRD SUBMISSION	09/19/2022

Engineer: LICENSED PROFESSIONAL ENGINEER R.A. ALEXANDER 100213093 PROVINCE OF ONTARIO

Engineer: LICENSED PROFESSIONAL ENGINEER G.F. COOPER 100532614 PROVINCE OF ONTARIO

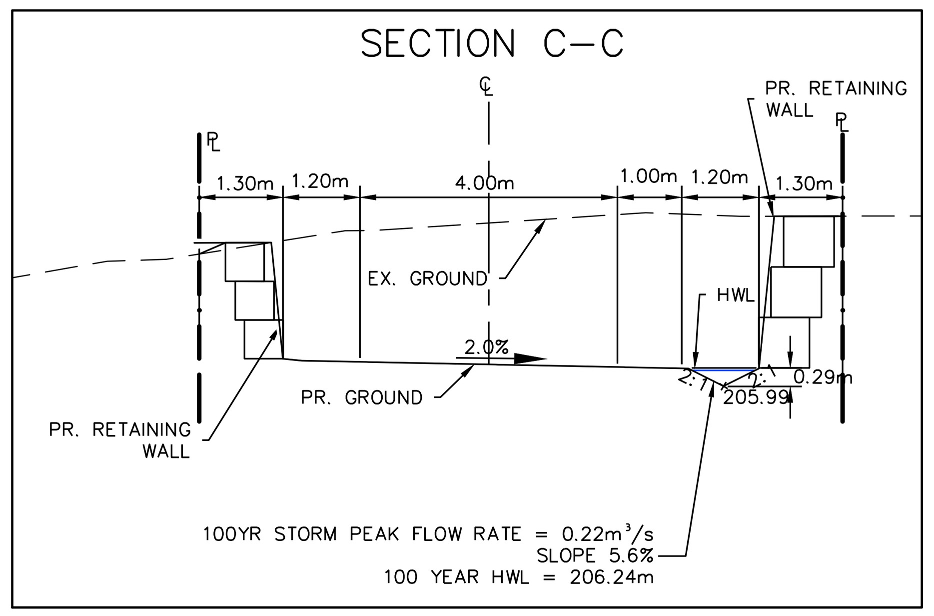
Project: LEITH-BAYSHORE ROAD
MUNICIPALITY OF MEAFORD

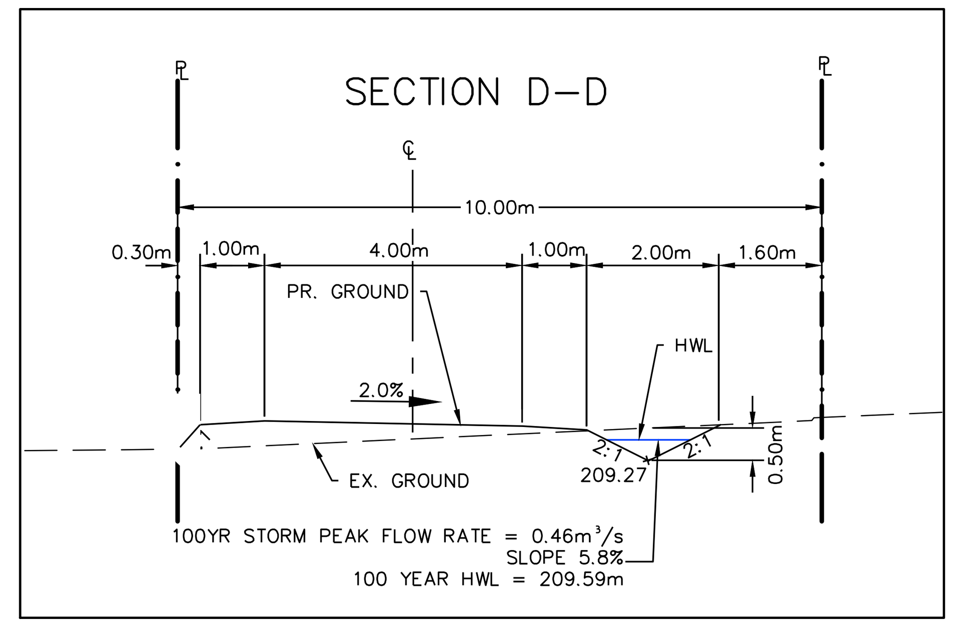
Drawing: MASTER SERVICING & GRADING PLAN

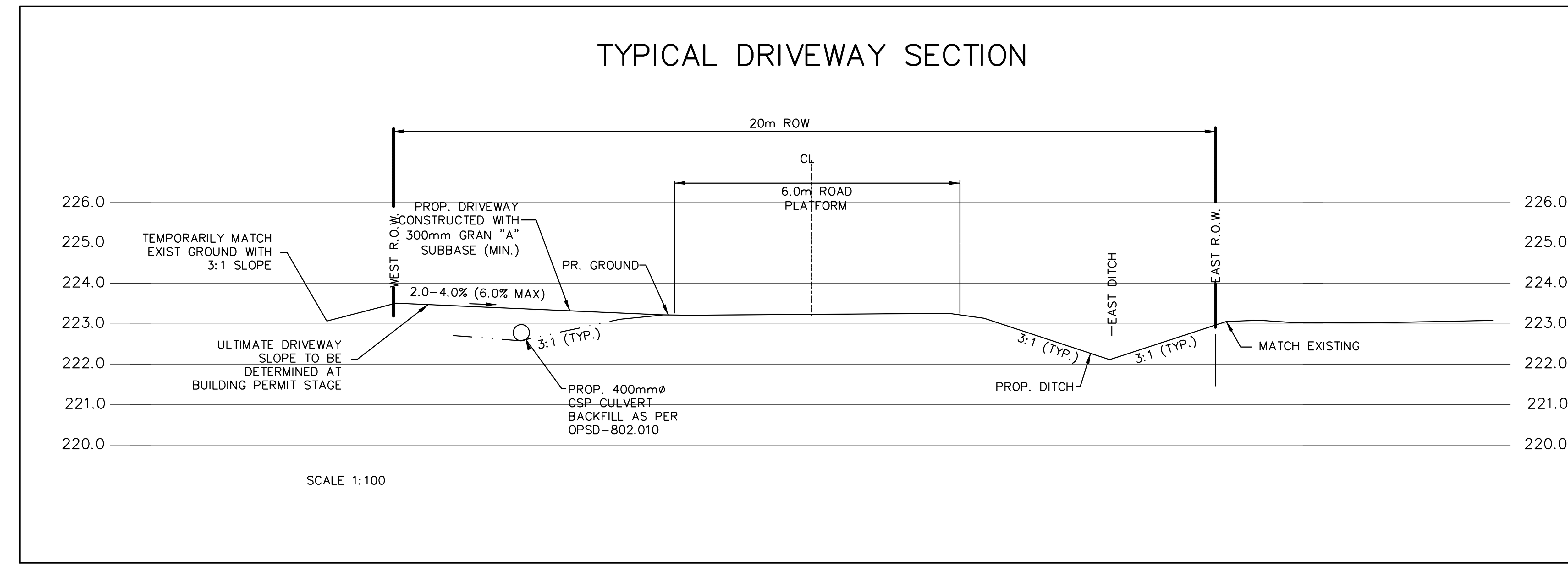
CROZIER CONSULTING ENGINEERS
ADMIRAL BUILDING
1 FIRST STREET, SUITE 200
COLLINGWOOD, ON, L9Y 1A1
705-446-3510 T
705-446-3520 F
WWW.CFCROZIER.CA
INFO@CFCROZIER.CA

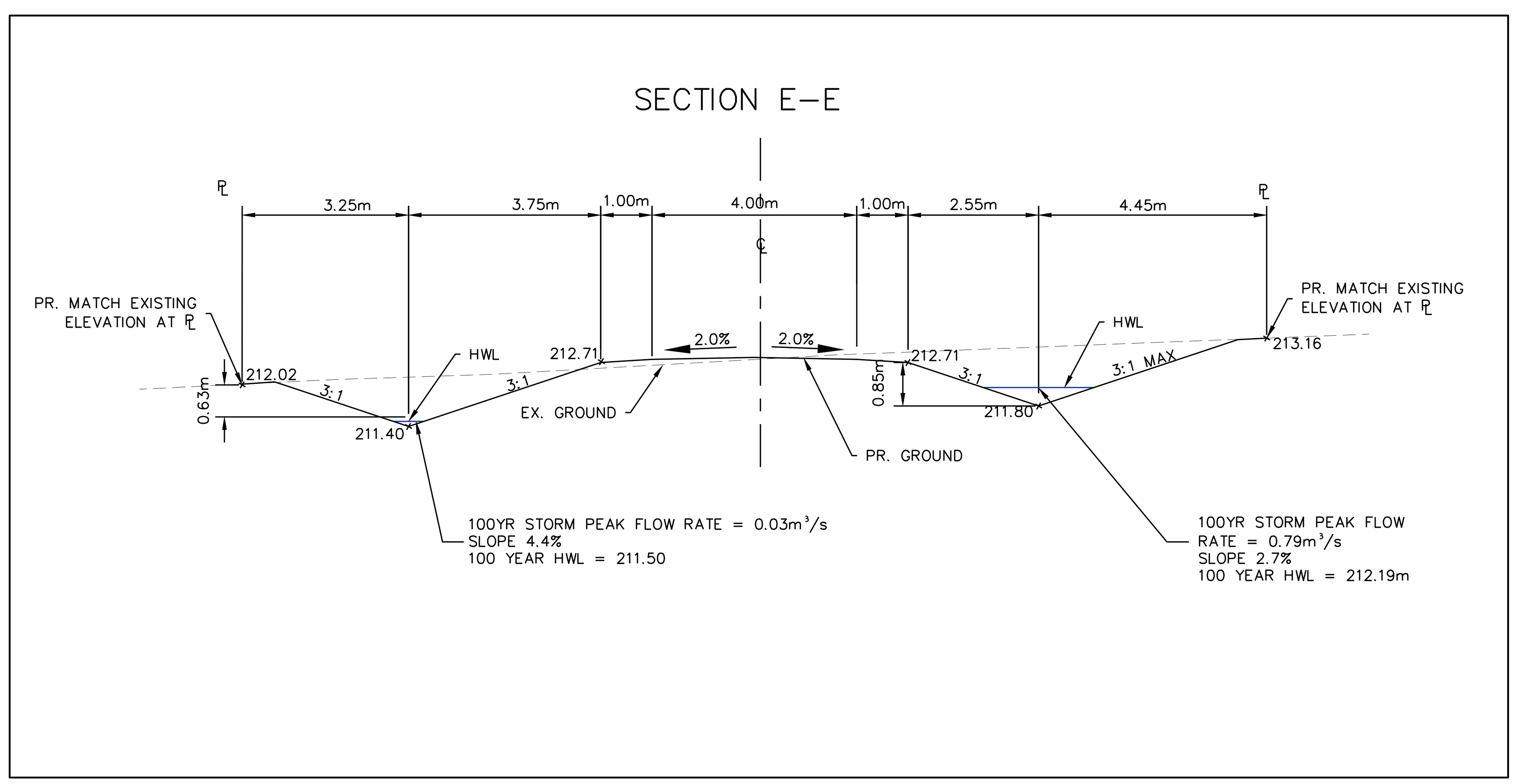
Drawn By	Design By	Project
N.L.	N.L./G.C.	903-3780

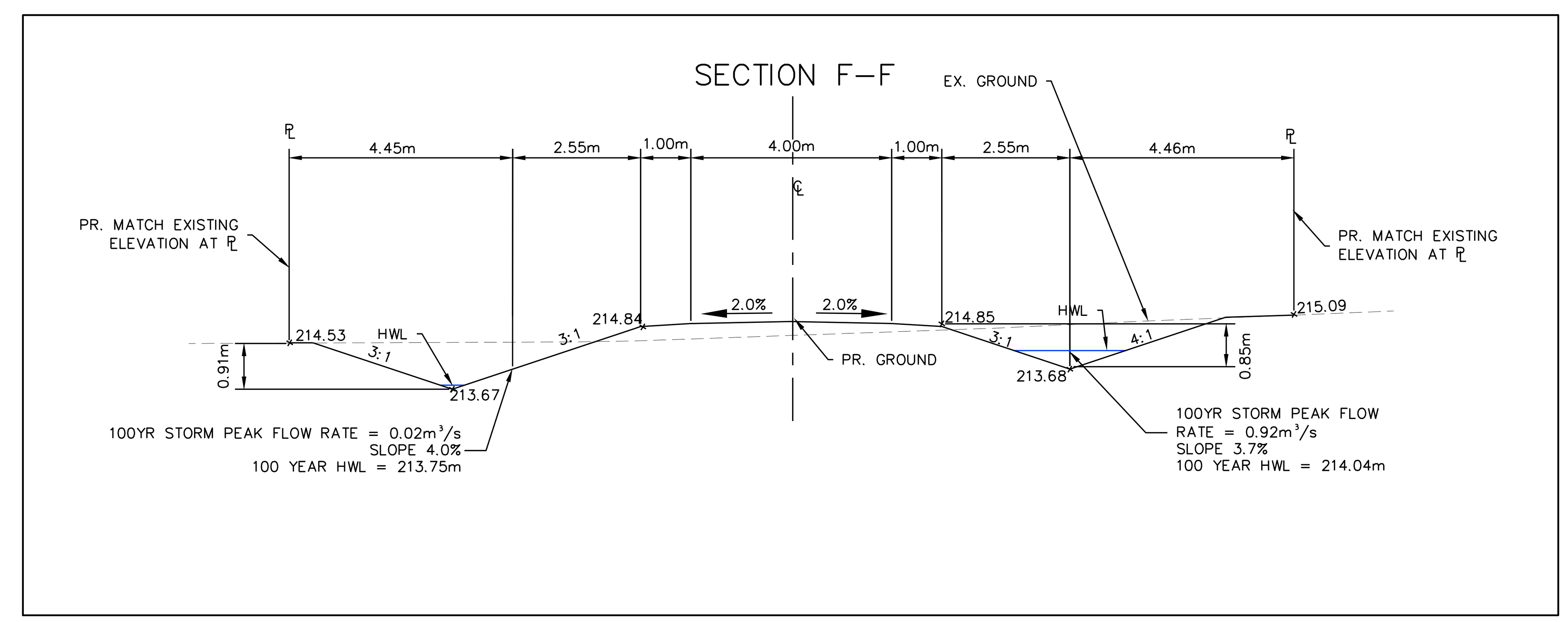
Check By	Check By	Scale	Drawing
G.C.	R.A.	1:750	C101











SCALE: 1:100

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Engineer: LICENSED PROFESSIONAL ENGINEER R.A. ALEXANDER 100213093 September 19, 2022 PROVINCE OF ONTARIO

Engineer: LICENSED PROFESSIONAL ENGINEER G.F. COOPER 100532614 Sept. 19, 2022 PROVINCE OF ONTARIO

Project: LEITH–BAYSHORE ROAD
MUNICIPALITY OF MEAFORD

Drawing: CROSS SECTIONS

CROZIER CONSULTING ENGINEERS
ADMIRAL BUILDING
1 FIRST STREET, SUITE 200
COLLINGWOOD, ON, L9Y 1A1
705-446-3510 T
705-446-3520 F
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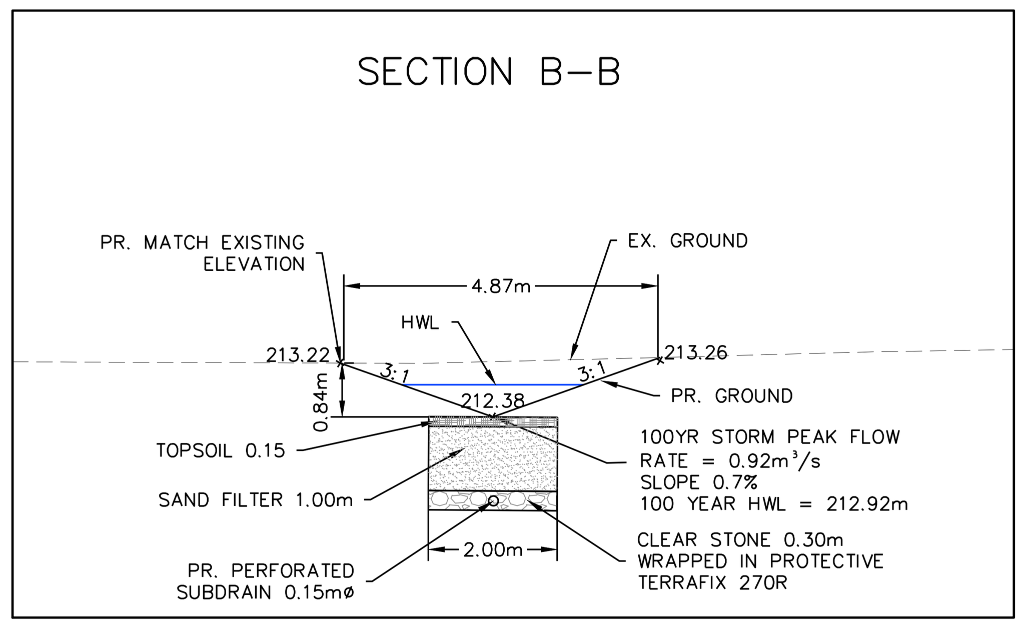
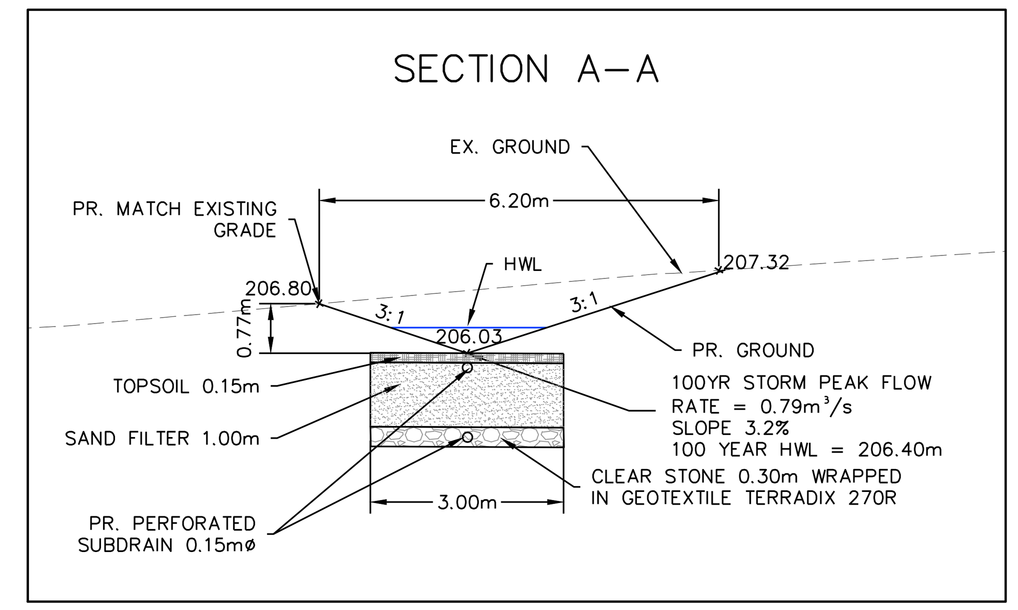
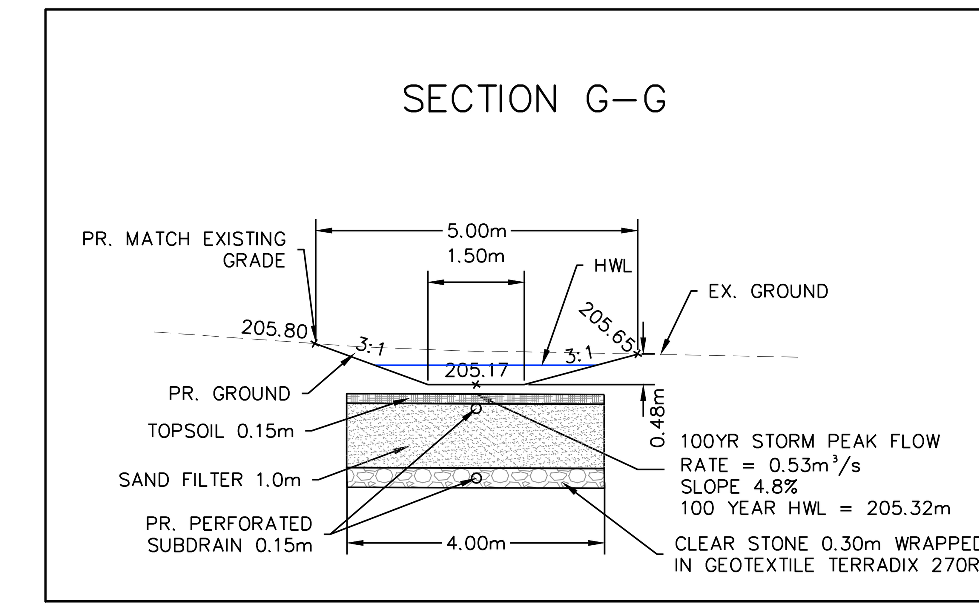
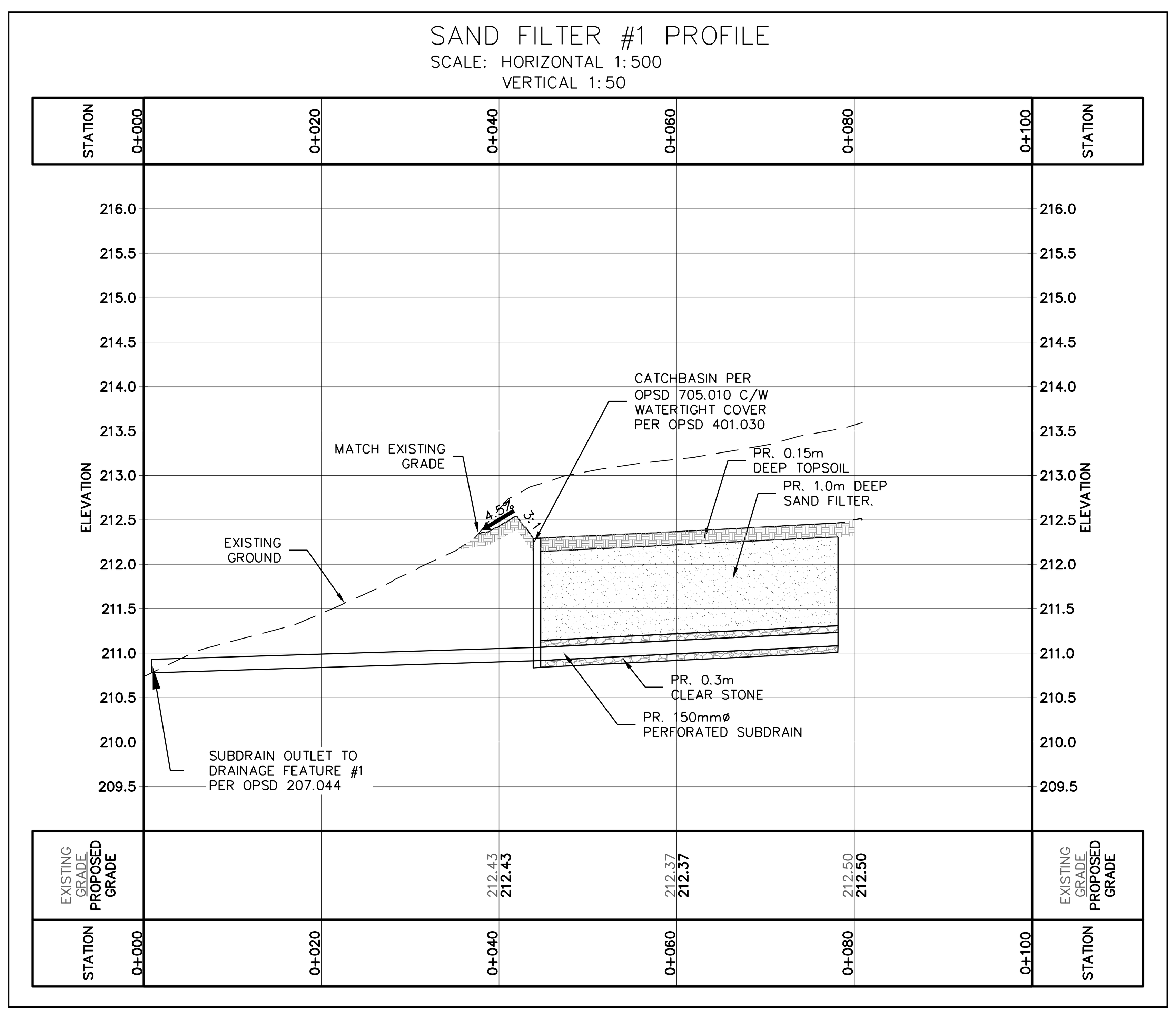
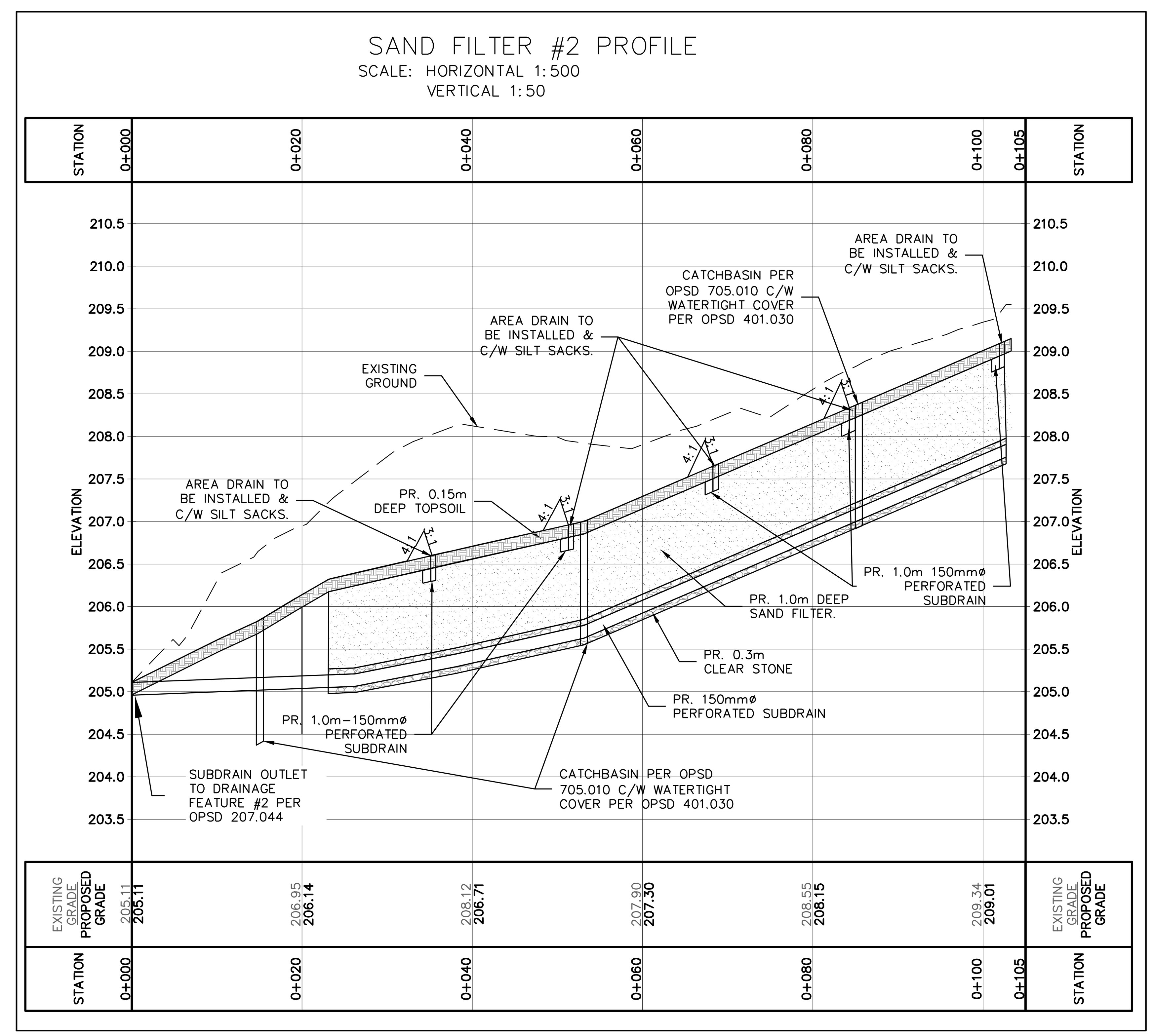
Drawn By	N.L.	Design By	N.L./G.C.	Project	903–3780
Check By	G.C.	Check By	R.A.	Scale 1:100	Drawing C102A

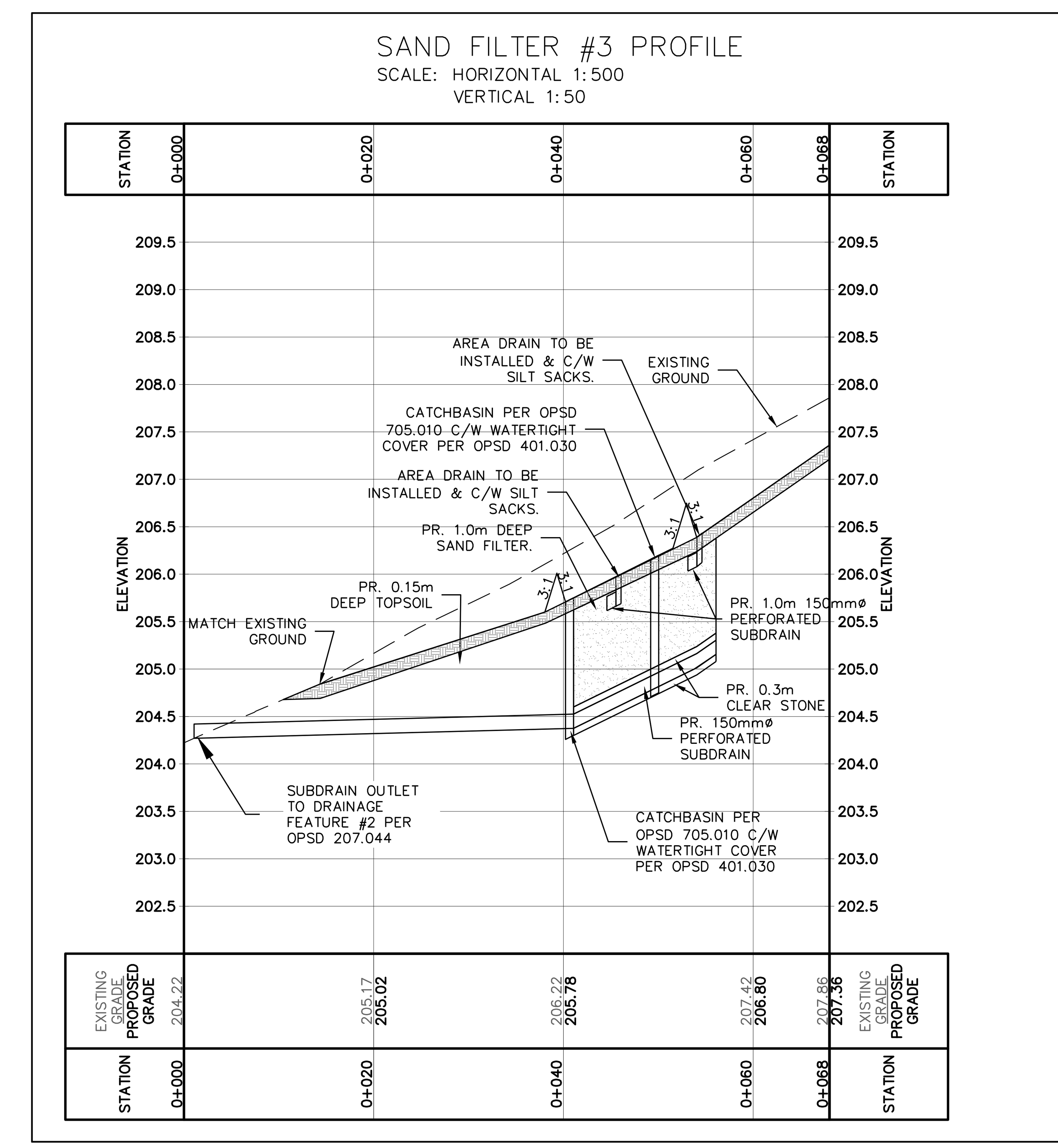












2 0m 2 4 6 8
SCALE: 1:100

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TEMPORARY BENCHMARKS

TBM#1– SQUARE IRON BAR (SIB), ELEVATION = 210.299
SURVEY COMPLETED BY VAN HARTEN ON JANUARY 29TH 2019

Town

No.	ISSUE	DATE: MM/DD/YYYY
0	ISSUED FOR CLIENT REVIEW	07/28/2020
1	RE-ISSUED FOR CLIENT REVIEW	08/18/2021
2	ISSUED FOR SECOND SUBMISSION	11/18/2021
3	ISSUED FOR THIRD SUBMISSION	09/19/2022

Engineer: LICENSED PROFESSIONAL ENGINEER R.A. ALEXANDER 100213093 September 19, 2022 PROVINCE OF ONTARIO

Engineer: LICENSED PROFESSIONAL ENGINEER G.F. COOPER 100532614 Sept. 19, 2022 PROVINCE OF ONTARIO

Project: LEITH–BAYSHORE ROAD MUNICIPALITY OF MEAFORD

Drawing: CROSS SECTIONS & PROFILES FOR SAND FILTER

CROZIER CONSULTING ENGINEERS

ADMIRAL BUILDING
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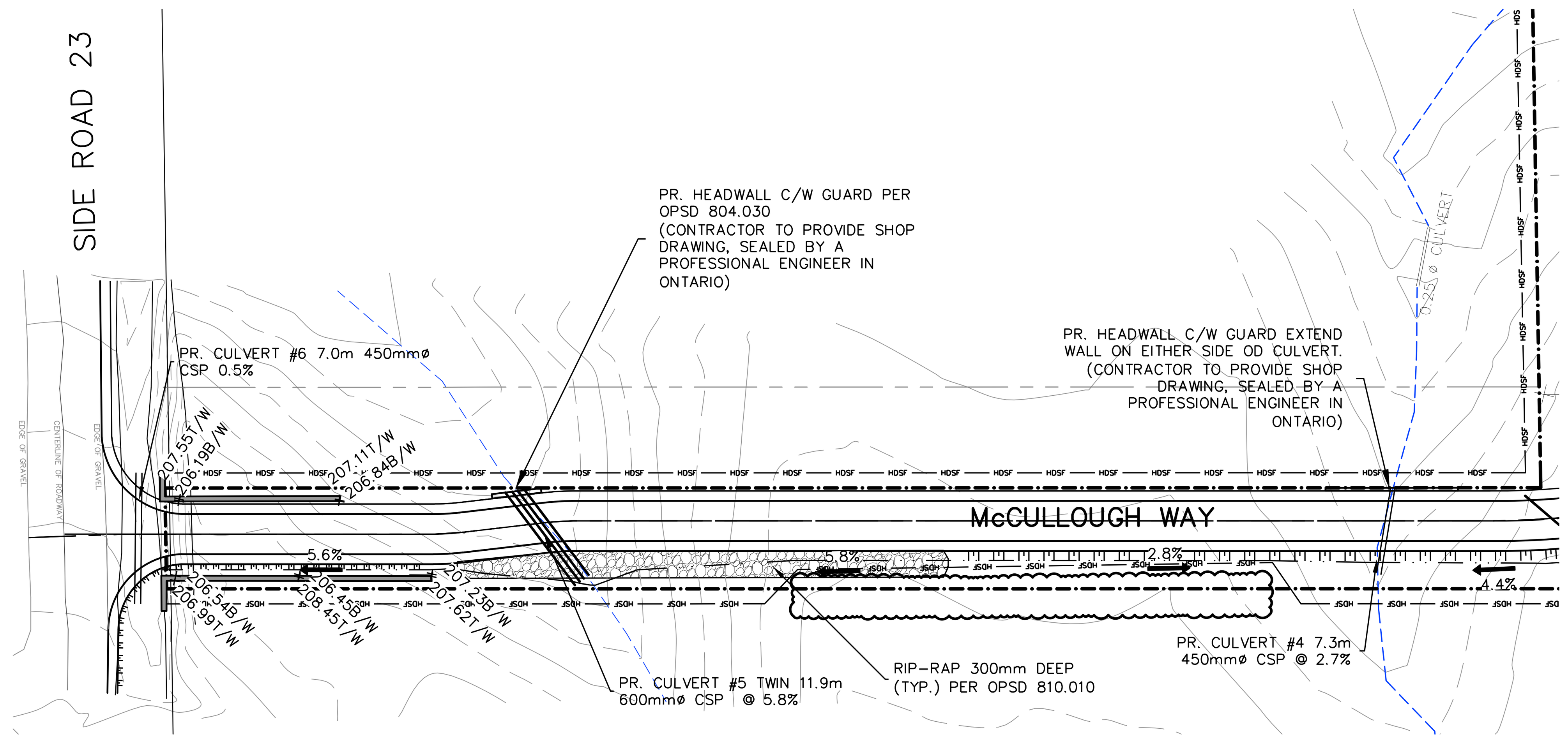
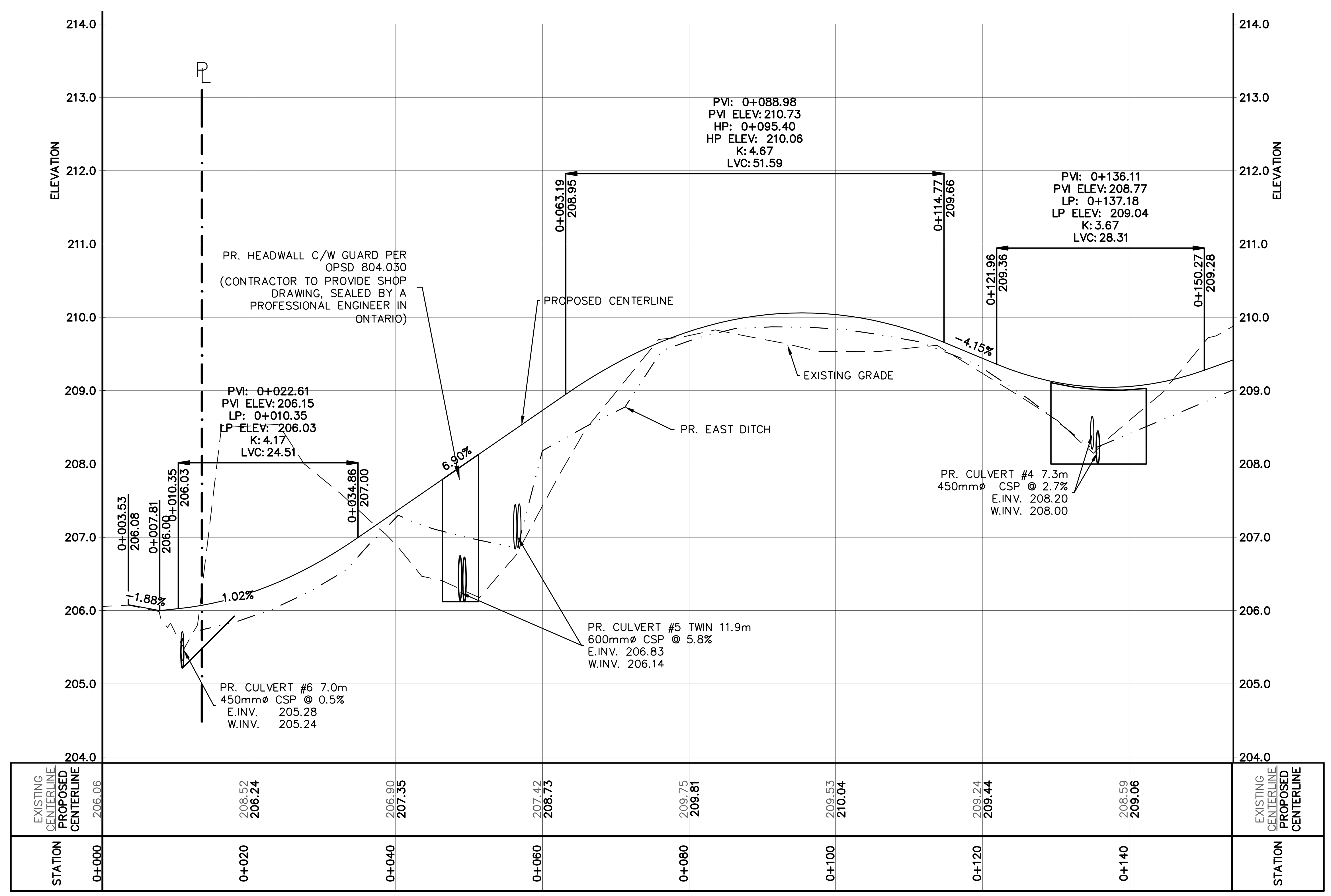
Drawn By	N.L.	Design By	N.L./G.C.	Project	903–3780
Check By	G.C.	Check By	R.A.	Scale 1:100	Drawing C102B



LEGEND

	PROPOSED WEST DITCH
	PROPOSED EAST DITCH
	PROPOSED CENTER LINE
	TOP SLOPE
	EXISTING GRADE
	PROPOSED DRIPLINE
	PROPERTY BOUNDARY
	PR. HEAVY DUTY SILT FENCE
X.X%	PR. SLOPE & DIRECTION
	PR. RIP-RAP



EXISTING CENTERLINE	206.06	208.52	206.90	207.42	209.75	209.53	209.24	208.59
PROPOSED CENTERLINE		206.24	207.35	208.73	209.81	210.04	209.44	209.06
STATION	0+000	0+020	0+040	0+060	0+080	0+100	0+120	0+140

SCALE: 1:500

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TEMPORARY BENCHMARKS

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Engineer: LICENSED PROFESSIONAL ENGINEER G.F. COOPER 100532614 Sept. 19, 2022 PROVINCE OF ONTARIO

Project: LEITH–BAYSHORE ROAD
MUNICIPALITY OF MEAFORD

Drawing: PLAN & PROFILE (STA. 0+000 TO 0+154)

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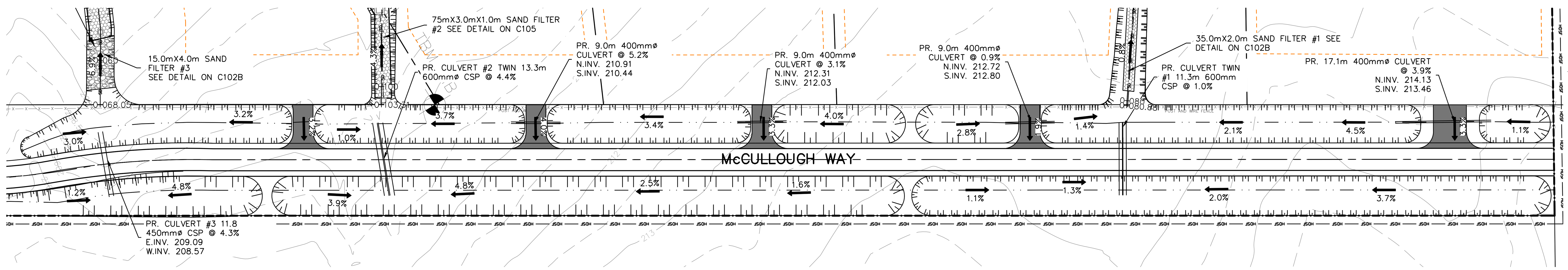
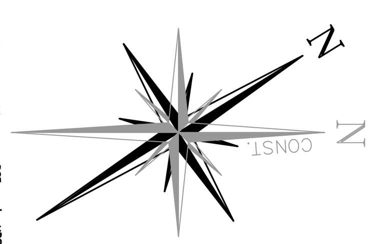
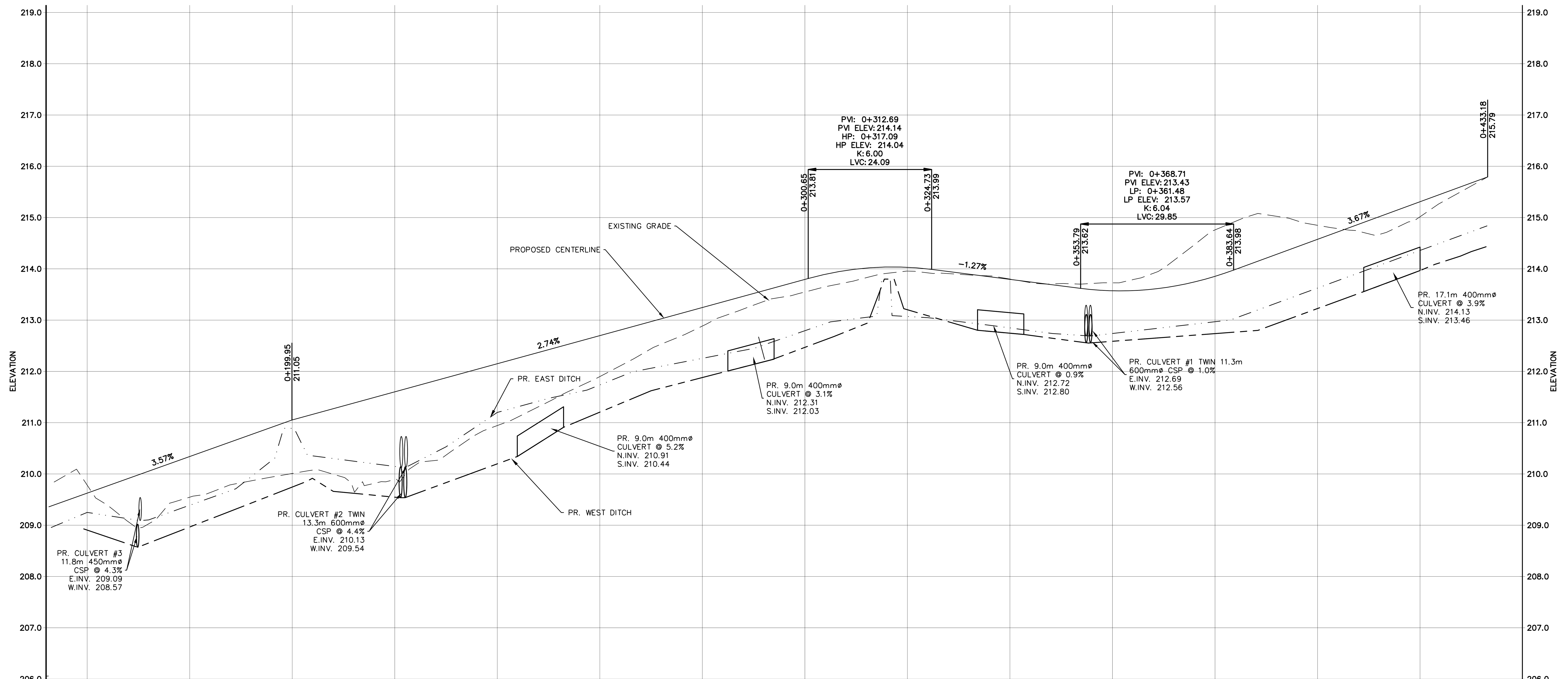
Drawn By	Design By	Project
N.L.	N.L./G.C.	903–3780
Check By: G.C.	Check By: R.A.	Scale: 1:500 — Drawing: C103 A





LEGEND

— — —	PROPOSED WEST DITCH
— · · —	PROPOSED EAST DITCH
— — · —	PROPOSED CENTER LINE
┴┴┴┴	TOP SLOPE
- - - -	EXISTING GRADE
(cloud outline)	PROPOSED DRIPLINE
— · —	PROPERTY BOUNDARY
—HDSF—	PR. HEAVY DUTY SILT FENCE
X.X% →	PR. SLOPE & DIRECTION



STATION	EXISTING CENTERLINE	PROPOSED CENTERLINE
0+160	209.78	209.63
0+180	210.55	210.34
0+200	211.01	211.05
0+220	209.89	211.60
0+240	210.94	212.15
0+260	211.90	212.70
0+280	212.88	213.25
0+300	213.55	213.79
0+320	213.96	214.03
0+340	213.80	213.79
0+360	213.73	213.57
0+380	214.76	213.85
0+400	214.85	214.58
0+420	215.02	215.31
0+440		

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TEMPORARY BENCHMARKS

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Engineer: LICENSED PROFESSIONAL ENGINEER R.A. ALEXANDER 100213093 September 19, 2022 PROVINCE OF ONTARIO

Engineer: LICENSED PROFESSIONAL ENGINEER G.F. COOPER 100532614 Sept. 19, 2022 PROVINCE OF ONTARIO

Project: LEITH–BAYSHORE ROAD
MUNICIPALITY OF MEAFORD

Drawing: PLAN & PROFILE (STA. 0+154 TO 0+440)

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Drawn By	Design By	Project
N.L.	N.L./G.C.	903–3780
Check By: G.C.	Check By: R.A.	Scale: 1:500 · Drawing: C103 B

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TEMPORARY BENCHMARKS

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Engineer: LICENSED PROFESSIONAL ENGINEER R.A. ALEXANDER 100213093 September 19, 2022 PROVINCE OF ONTARIO

Engineer: LICENSED PROFESSIONAL ENGINEER G.F. COOPER 100532614 Sept. 19, 2022 PROVINCE OF ONTARIO

Project: LEITH–BAYSHORE ROAD MUNICIPALITY OF MEAFORD

Drawing: EROSION & SEDIMENT CONTROL PLAN

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Drawn By	N.L.	Design By	N.L./G.C.	Project	903–3780
Check By	G.C.	Check By	R.A.	Scale 1:750	Drawing C104