City of Mississauga

Drainage and Stormwater Management Report

Class EA Study of Burnhamthorpe Road West Improvements

January 9, 2020

PRC000387 / B000856

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City of Mississauga

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Class EA Study

Burnhamthorpe Road West Improvements

Project no PRC000387 | File no B000856

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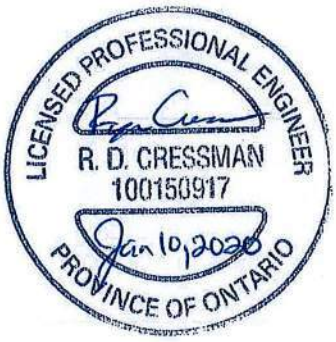
Ryan Cressman, P.Eng.



CIMA+
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January 9, 2020

Version	Date	Revised By	Reviewed By	Revisions
Rev 1	Dec 9, 2019	Kevin Lukawiecki, EIT	Ryan Cressman, P.Eng.	City of Mississauga Comments
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1. Introduction

CIMA+ has been retained by the City of Mississauga to complete a stormwater assessment as part of the Class Environmental Assessment for the improvements of Burnhamthorpe Road West from Loyalist Drive to the West City Limit. The purpose of the Stormwater Management (SWM) Report is to document the SWM plan to mitigate impacts from the proposed Burnhamthorpe Road widening. Based on available background information, applicable design criteria, existing drainage conditions, the Stormwater Management Report will essentially provide an assessment of proposed conditions for the preferred roadway improvements, evaluate and recommend a drainage plan for water quality and quantity including the latest low impact development practices for storm water management.

1.1 Study Area

Within the study area, Burnhamthorpe Road West is a 1.8-kilometre two-lane arterial roadway extending from the intersection of 9th Line in the West to Loyalist Drive in the East as shown in **Figure 1**. The study area includes the existing corridor and external catchments that contribute to the right-of-way (ROW). In the western portion of the study area, from 9th Line to Ridgeway Drive, Burnhamthorpe Road West is a rural cross section with ditches draining the roadway. In the eastern portion of the study area, from Ridgeway Drive to Loyalist Drive, Burnhamthorpe Road West is a semi-rural cross section with a gravel shoulder and ditching which drains to a ditch inlet storm sewer system.

1.2 Background Documents

The following background drawings, studies and guidance documents were obtained as part of the SWM Study:

- Loyalist Creek Watershed Study, CBCL Limited, 1980;
- Collegeway Stormwater Management Facility (#5903) Retrofit Design Brief, Valdor Engineering Inc., October 2013 (revised)
- Erin Mills West Loyalist Creek Drainage Report, Proctor & Redfern Group, 1985;
- Low Impact Development Stormwater Management Planning and Design Guide, CVC, 2010;
- CVC Stormwater Management Criteria, CVC, August 2012;
- City of Mississauga, City of Mississauga Development Requirements Manual, January 2009;
- Guidelines for the Preparation of Stormwater Management Reports in Support of Municipal Class Environmental Assessments; and
- MOE’s Stormwater Management Planning and Design Manual, March 2003.

1.3 Design Criteria

The study area drains to two separate watersheds which can be divided into west and east sections. To the west, stormwater drainage from 9th Line to 175 m west of Ridgeway Drive drains to Joshua's Creek watershed, within the jurisdiction of the Conservation Halton (CH). To the east, stormwater drainage from 175 m west of Ridgeway Drive to Loyalist Drive drains to the Loyalist Creek sub-watershed, within the jurisdiction of the Credit Valley Conservation Authority (CVC). The majority of the study area falls within CVC's jurisdiction with a small portion contributing to CH's jurisdiction.

This section provides an overview of the SWM design criteria for the study area based on City of Mississauga, Credit Valley Conservation Authority (CVC), and Ministry of Environment Conservation and Parks (MECP) guidelines.

1.3.1 City of Mississauga

Generally, the City of Mississauga's design standards for storm sewer capacity assessment was utilized. A brief summary of the key design criteria is provided below:

- Storm sewers shall be designed to convey a 10-year return frequency storm.
- An inlet time of 15 minutes is to be utilized.

1.3.2 Ministry of Environment Conservation and Parks (MECP)

Additional stormwater runoff from new pavement can impact receiving watercourse and flood conditions. Quality and quantity control measures to treat stormwater runoff should be considered for all new impervious areas and, where possible, existing surfaces. A Stormwater Management Plan should be prepared in accordance with the MOECC "Stormwater Management Planning and Design Manual" dated May 2003.

1.3.3 Credit Valley Conservation Authority and Conservation Halton

The following stormwater management design criteria from CVC is applicable to the east side of the study area:

- Quantity control for all storms (2-year to 100-year) is required as per the Loyalist Creek Watershed Study, West of Winston Churchill Boulevard.
- All watercourses within CVC's jurisdiction are classified as requiring an Enhanced level of water quality protection, equivalent to 80% TSS removal on an annual basis as per MOECC's stormwater design manual.
- Erosion control for sites with SWM pond, extended detention of the 25 mm event for a period of 48 hours is required. Otherwise, as a minimum, the CVC requires on-site detention of 5 mm, for the area of widening.

The following stormwater management design criteria from CH is applicable to the west side of the study area:

- Quantity control for all storms (2-year to 100-year and Regional Storm) is required in accordance with target unit area peak flow rates established as per the North Oakville Subwatershed Study, at Dundas Street W.
- All watercourses within North Oakville Creeks Subwatershed Study require enhanced level of water quality protection, equivalent to 80% TSS removal, and pre to post development total phosphorus (TP) loading.
- The erosion control target for Joshua's Creek is not to increase the frequency or duration of flow above existing conditions; a target of 0-5% was established.

The stormwater objectives are expected to be met through a multi-component approach comprising of traditional drainage conveyance methods, conventional stormwater management measures and Low Impact Development (LID) features, where feasible.

1.4 Approach

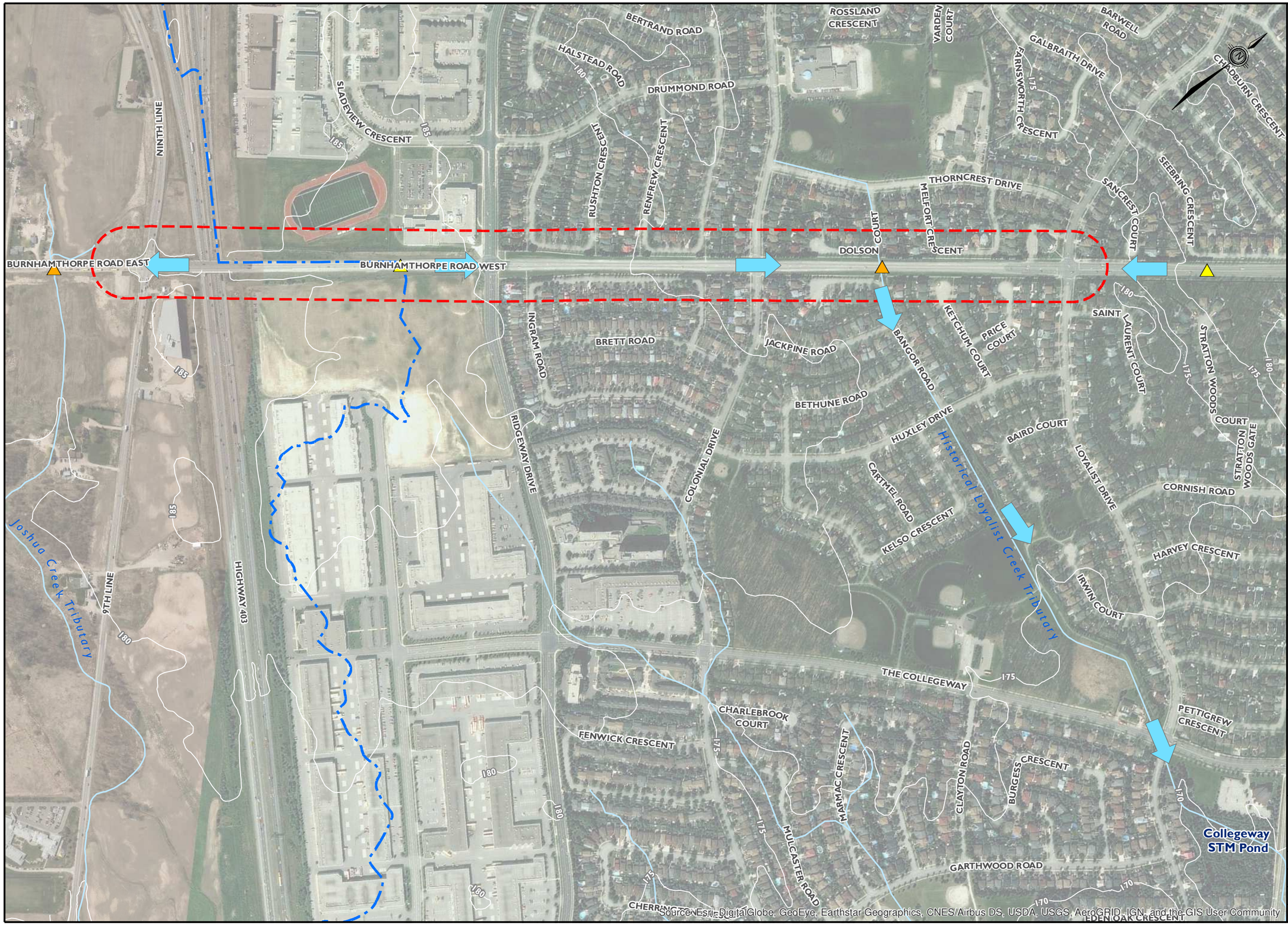
Drainage concerns for the Burnhamthorpe Road West improvements include flooding, erosion, and water quality impacts. Typical impacts are due to increases in impervious area and are characterised by higher flows in the existing roadway or trunk sewer systems and increased water quality degradation at receiving watercourses.

General SWM criteria and mitigation considered by reviewing agencies typically include attenuation of increased flows to existing levels, or erosion control considerations for retention of the 5mm rainfall event; and, collection/treatment of increased roadway runoff for TSS removal with source-based controls and/or end-of-pipe solutions such as SWM Ponds, enhanced swales, or Oil/Grit Separators (OGS).

Challenges in implementing mitigation measures in roadway projects include limitations for implementing aboveground, cost-effective solutions. Also, there is difficulty in identifying and addressing the impacts from an incremental change in imperviousness, since it is difficult to separate or uniquely treat the incremental runoff without including existing runoff.

As a result of these considerations, the approach proposed by CIMA+ adopts a simpler assessment of quality and quantity control, which will leave some of the details to be more appropriately addressed during the detailed design phase of the project. This approach will include:

- Assessing minor storm sewer capacity at outlets and tie-in points to determine design constraints;
- Quantify the impacts on stormwater runoff quantity and quality;
- Evaluate best management practices to meet stormwater objectives; and
- Recommend a stormwater management plan to mitigate the impacts associated with the roadway widening.



LEGEND

ROAD ELEVATION POINTS

- SAG
- HIGH POINT

OTHER FEATURES

- WATERCOURSE
- CREDIT VALLEY CONSERVATION / HALTON CONSERVATION AUTHORITY JURISDICTION BOUNDARY
- STUDY
- DRAINAGE DIRECTION

DATA SOURCES:

WATERBODY, WATERCOURSE, RAILWAY & ROAD NETWORK INFORMATION OBTAINED FROM LAND INFORMATION ONTARIO AND LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

CLIENT

MISSISSAUGA

PROJECT NAME:

NATURAL ENVIRONMENT ASSESSMENT BURNHAMTHORPE ROAD EA

SHEET TITLE:

DRAINAGE MAP

SCALE:

50 25 0 50 100 150 200

meters

1:6,000

PROJECT No: B000856		CLIENT FILE No: ---	
DRAFTER: S. ELLIOTT	DESIGNER ---	DRAWING No:	**FIG. 1**
APPROVER R. CRESSMAN	APPROVER ---		
DATE: 6/15/2018		SHEET No: 1 of 1	

2. Existing Site Conditions Characterization

This section describes the existing conditions drainage and SWM within the study area that will be impacted by the proposed improvements. The drainage characteristics of the site depend on many things, including the topography, local land use and the type of native soil.

2.1 Existing Land Use

Land use from 9th Line to Ridgeway Drive is mixed, which includes the following: industrial, transportation, commercial and school use. From Ridgway Drive to Loyalist Drive consist of primarily residential development. Refer to **Figure 2** for existing land uses.

2.2 Existing Surficial Soils

The soil within the study area consist primarily of clay loam which is classified as hydrologic soil group C. In terms of drainage this type of soil is considered to have a moderate to poor drainage capability, meaning very little rainfall in the open areas will soak into the ground, leaving most of the water as runoff. Refer to **Figure 3** for the existing soils conditions.

2.3 Existing Minor Storm Sewer System

Minor storm systems for Burnhamthorpe Road West generally consist of existing swales and open ditches in the west and existing ditch inlet storm sewer system in the east. Fundamentally, these systems convey flows to four (4) different outlets:

- **Outlet 1 (Highway 403)**: Burnhamthorpe Road West from Ninth Line to approximately 175 m west of Ridgeway Drive, is a rural cross-section with a gravel shoulder and ditching draining to the Highway 403 drainage system, ultimately discharging to Joshua's Creek tributary.
- **Outlet 2 (Ridgeway Drive North)**: Burnhamthorpe Road West from approximately 175 m west of Ridgeway Drive to Ridgeway Drive, is a rural cross-section with a gravel shoulder and ditching draining to a ditch inlet storm sewer. Runoff from the north ditch drains to a 375 mm diameter storm sewer that runs north on Ridgeway Drive.
- **Outlet 3 (Ridgeway Drive South)**: Burnhamthorpe Road West from approximately 175 m west of Ridgeway Drive to Ridgeway Drive, is a rural cross-section with a gravel shoulder and ditching draining to a ditch inlet storm sewer. Runoff from the south ditch drains to a 675 mm diameter storm sewer that runs south on Ridgeway Drive.
- **Outlet 4 (Trunk Sewer at Bangor Road)**: Burnhamthorpe Road West from Ridgway Drive to Loyalist Drive is a semi-rural cross-section with a gravel shoulder and ditching. Roadway runoff drains to a ditch inlet concrete storm sewer system, ranging

in size from 375 mm to 675 mm diameter, that discharges to a 2100 mm diameter trunk sewer running north / south at Bangor Road.

The trunk sewer crossing at Bangor Road ultimately drains to the Collegeway SWM facility. This trunk sewer services an external drainage area of 79.2 ha consisting of 38.35 ha of industrial lands (0.75 coefficient) and 40.85 ha of residential lands (0.5 coefficient). The time of concentration was based on External Drainage Area Plan – G10 by Proctor & Redfern Consulting Engineers plus the travel time from Ridgeway to Bangor Road. The external drainage area is shown on **Figure 6**, attached in **Appendix A**.

A review of the existing storm sewer capacity leading to outlets 1 through 4 was completed utilizing the City of Mississauga Transportation and Works Department's Development Requirements Manual. This assessment was based on runoff coefficients shown on available as-built drawings and storm sewer design sheets, attached in **Appendix B** and as shown in **Table 1** of **Section 3.1.3**. The existing conditions for the transportation corridor were further delineated to allow for an assessment of proposed conditions due to increased hard surface area associated with the roadway improvements. Runoff coefficients are based on City of Mississauga design standards noted on the storm sewer design sheets.

Refer to **Appendix A** for the existing conditions drainage mosaic and **Appendix B** for the detailed storm sewer design sheets. The assessment indicated that sufficient capacity for 10 – year design flows is accommodated for all storm sewer outlets.

2.4 Existing Major Drainage System

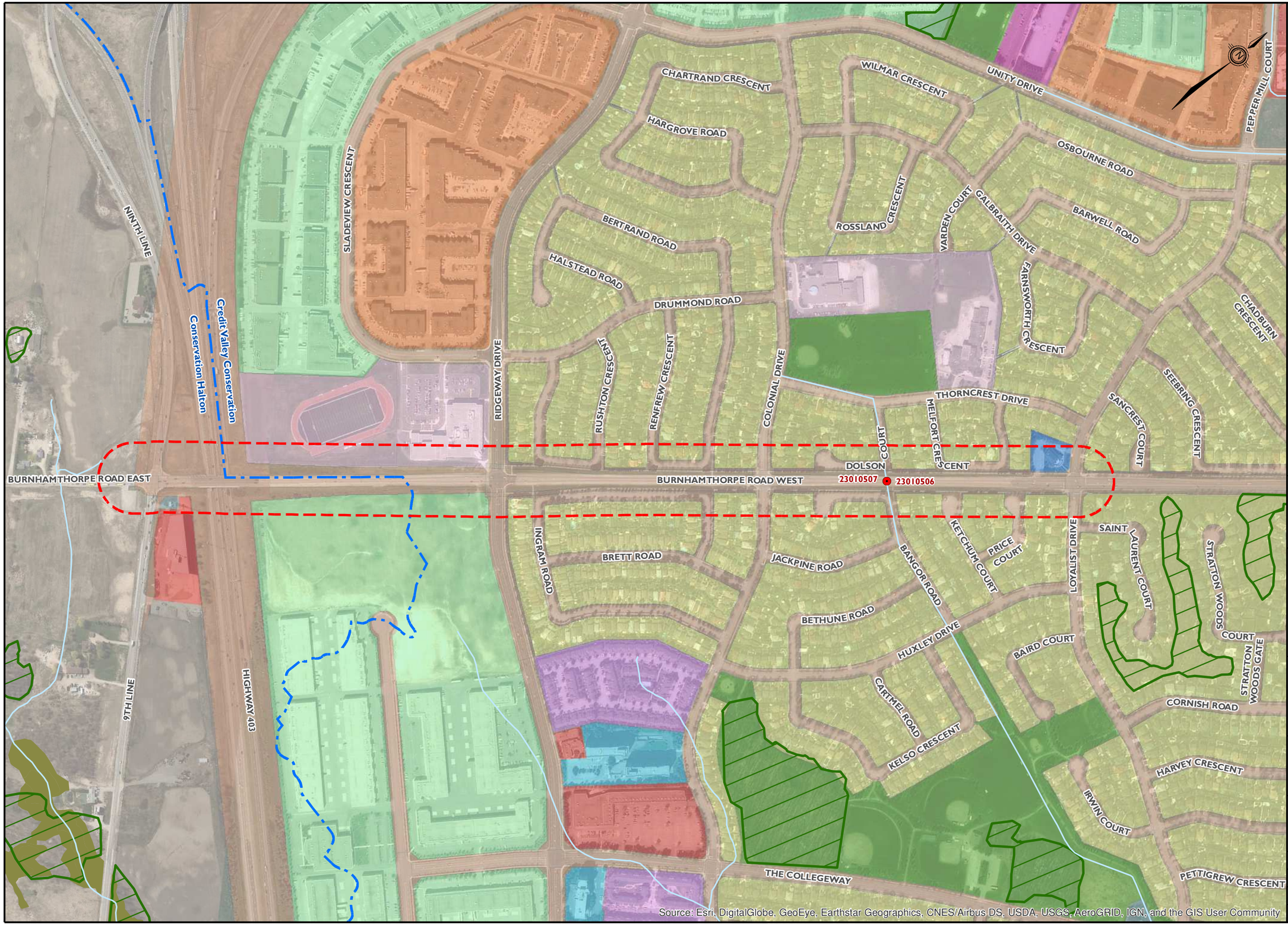
Major drainage systems for Burnhamthorpe Road West generally follow the swales and open ditches to the Highway 403 drainage system in the west section and the path of the existing local and trunk sewer within the existing right of way in the east section. Fundamentally, these systems convey flows to three (3) different outlets:

- **Outlet 1 (Highway 403)**: In the western portion of the study area, from 9th Line to 175 m west of Ridgeway Drive, overland flow is collected along the roadside ditches and conveyed towards the Highway 403 drainage system which ultimately discharges to Joshua's Creek.
- **Outlet 3 (Ridgeway Drive)**: In the western portion of the study area, from 175 m west of Ridgeway Drive to Ridgway Drive, overland flow is conveyed by roadside ditches to Ridgway Drive where it flows south on Ridgeway Drive. The major flows eventually discharge to the Laird Road SWM Facility.
- **Outlet 4 (Trunk Sewer at Bangor Road)**: In the central portion of the study area, overland flow is conveyed by roadside ditches to Bangor Road, at the historical Loyalist Creek headwater tributary that was infilled as part of the Erin Mills Subdivision, where the flows follow an overland flow route eventually discharging to the Collegeway SWM Facility at the southwest corner of the Collegeway and Winston Churchill Boulevard.

2.5 Existing Stormwater Management Facilities

The existing Collegeway SWM facility was originally designed for quantity control for the Erin Mills subdivision in the 1980's and was retrofitted in 2016 to provide additional erosion and water quality controls. The retrofitted SWM Pond provides flow controls for the 2-year through 100-year events, a basic level of water quality treatment (60% TSS removal), and extended detention of 11.6 mm over 24 hours. The Collegeway SWM facility subsequently drains to a Loyalist Creek tributary.

The Laird Road facility is part of a two-pond system on the south branch of the Loyalist Creek and was originally designed to provide quantity control for the 2-year to 100-year storms. In 2014 to 2015 the City of Mississauga undertook a project to retrofit the existing pond, bringing up to current standards. According to as-built drawings for the project, dated August 2015, the pond has a permanent pool which indicates that it provides some level of quality control. Further analysis should be undertaken to determine the level of water quality control.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

LEGEND

EXISTING LAND USE (2018)

- COMMUNITY/CULTURAL
- GENERAL RETAIL COMMERCIAL
- INDUSTRIAL GENERAL
- INDUSTRIAL AND COMMERCIAL MULTIPLES
- OPEN SPACE/GREENLANDS
- PLACE OF RELIGIOUS
- RESIDENTIAL
- RESIDENTIAL DETACHED
- RESIDENTIAL TOWNHOUSES
- SCHOOL
- TRANSPORTATION RIGHT-OF-WAY
- UTILITY/PUBLIC WORK
- VACANT

OTHER FEATURES

- CREDIT VALLEY CONSERVATION FISH SAMPLING LOCATION
- WATERCOURSE (CREDIT VALLEY CONSERVATION DATA)
- CREDIT VALLEY CONSERVATION / HALTON CONSERVATION AUTHORITY JURISDICTION BOUNDARY
- WOODED AREA
- WETLAND
- STUDY AREA

DATA SOURCES:

WOODED AREA, WATERBODY, WATERCOURSE, RAILWAY & ROAD NETWORK INFORMATION OBTAINED FROM LAND INFORMATION ONTARIO AND LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO

CIMA+

CLIENT

MISSISSAUGA

PROJECT NAME:

NATURAL ENVIRONMENT ASSESSMENT BURNHAMTHORPE ROAD EA

SHEET TITLE:

EXISTING LAND USE MAP

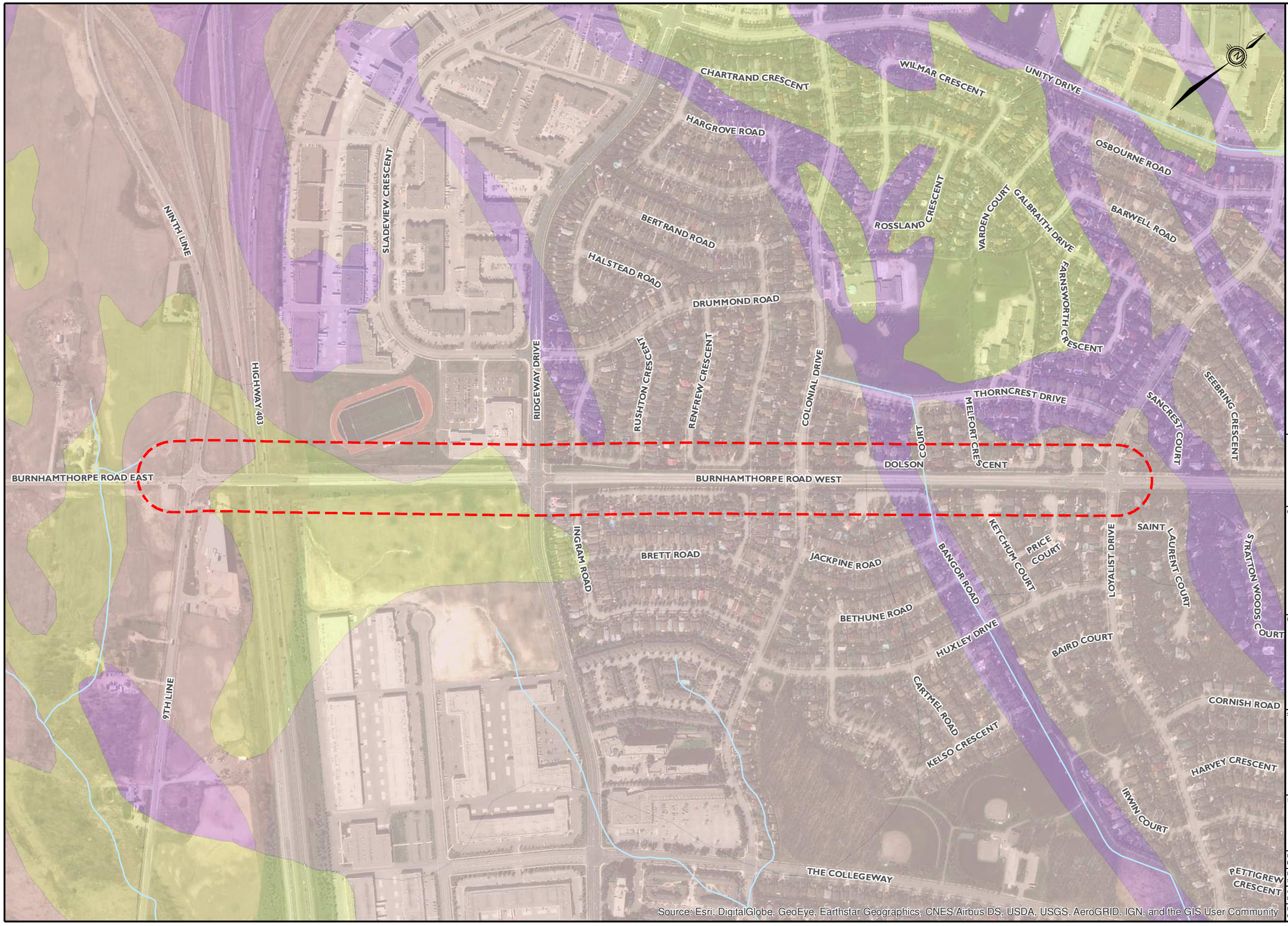
SCALE:

50 25 0 50 100 150 200

meters

1:6,000

PROJECT No: B000856		CLIENT FILE No: ---	
DRAFTER: S. ELLIOTT	DESIGNER ---	DRAWING No:	**FIG. 2**
APPROVER L. CYMBALY	APPROVER ---		
DATE: 6/6/2018		SHEET No: 1 of 1	



LEGEND

SOIL TYPE

- CHINGUACOUSY CLAY LOAM
- JEDDO CLAY LOAM
- ONEIDA CLAY LOAM

OTHER FEATURES

- WATERCOURSE
- STUDY AREA

DATA SOURCES:

WOODED AREA, WATERBODY, WATERCOURSE, RAILWAY & ROAD NETWORK INFORMATION OBTAINED FROM LAND INFORMATION ONTARIO AND LICENSED UNDER THE OPEN GOVERNMENT LICENSE - ONTARIO

CIMA+

CLIENT

MISSISSAUGA

PROJECT NAME:

BURNHAMTHORPE ROAD CLASS EA

SHEET TITLE:

SOILS MAP

SCALE:

50 25 0 50 100 150 200

meters

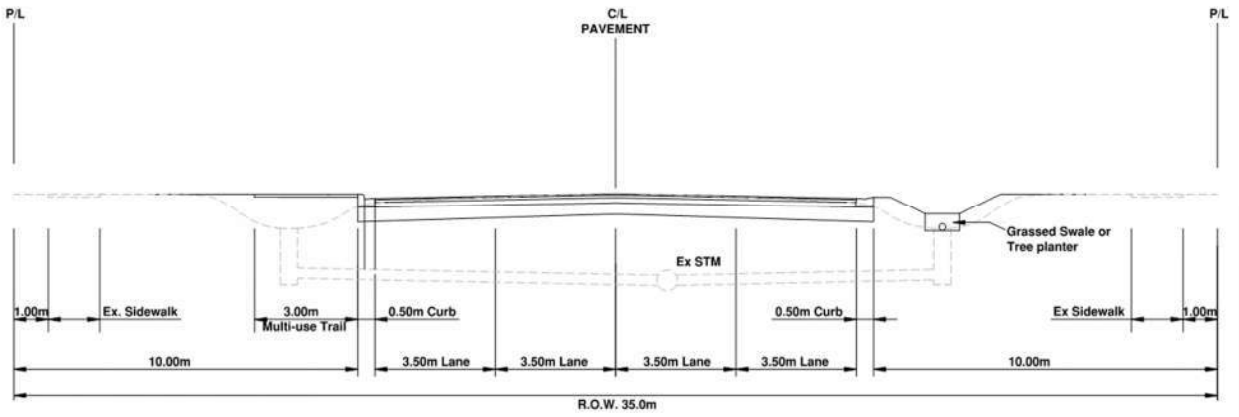
1:6,000

PROJECT No: B000856		CLIENT FILE No: ---
DRAFTER: S. ELLIOTT	DESIGNER ---	DRAWING No: **FIG. 3**
APPROVER R. CRESSMAN	APPROVER ---	
DATE: 6/13/2018		SHEET No: 1 of 1

3. Proposed Conditions

The proposed widening of Burnhamthorpe Road West from 9th Line to Loyalist Drive will include a grassed boulevard ranging in width from 4.5 m on one side of the road and 7.5 m on the other side of the road, a 3.0 m multi-use trail, 0.5 m curb and gutter, a four-lane urban roadway and a grassed ditch as shown in **Figure 4** below. Burnhamthorpe Road will be widened evenly on both sides, maintaining the existing road centerline. Curbs and storm sewers will be used for Burnhamthorpe Road for directing the surface runoff to appropriate outlets. An opportunity exists to utilize LID methods to treat some of the surface runoff before collection by the storm sewer system. Grassed swales, bio-swales and tree planters will be investigated at detailed design. Based on a ROW of 35.0 m, the roadway cross-section will have an approximate proposed imperviousness of 61.4%, which is equivalent to a 0.7 runoff coefficient. This is an increase in impervious area of approximately 25.7% from existing conditions.

Figure 4: Typical Roadway Cross-Section



3.1 Proposed Impact Assessment

The following section provides an assessment of the impacts associated with the proposed widening of Burnhamthorpe Road.

3.1.1 Rainfall Distribution and Data

City of Mississauga IDF rainfall data was used for the 1:10 year storm event to conduct a detailed hydraulic assessment to evaluate the impact of widening Burnhamthorpe Road West from a two lane semi-rural cross section to a four-lane urban cross section.

3.1.2 Runoff Parameters

Based on the City of Mississauga's design standards, 15-minute Tc was applied for each of the Burnhamthorpe Road West segments, the existing and proposed drainage area and runoff coefficients were determined from air-photo interpretation, land use, survey data and typical sections. These are reported in **Table 1**.

Table 1: Hydrologic Parameters of Catchment Areas – Internal Drainage Areas

Catchment	Area (ha)		Runoff Coefficient	
	Existing	Proposed	Existing	Proposed
Outlet 1	1.66	1.12	0.48	0.47
Outlet 2	0.32	0.00	0.49	0.00
Outlet 3	0.34	1.21	0.46	0.78
Outlet 4*	4.22	4.22	0.58	0.75

*The 79.2 ha external drainage area to Outlet 4 remains unchanged for proposed conditions.

3.1.3 Peak Flow Estimates

Peak uncontrolled flows were determined for the 1:2 – 1:100 year storm events using the Rational Method. The minor and major storm events, 1:10 and 1:100-year are summarized in **Table 2**. The complete storm analysis for all storm events can be found in **Appendix B**.

Table 2: Summary of Existing and Proposed Flows by Outlet

Outlet Flow Nodes	10yr (L/s)		% Increase in 10yr Flow	100yr (L/s)		% Increase in 100yr Flow
	Existing	Proposed		Existing	Proposed	
Outlet 1	221	144	-35	463	292	-37
Outlet 2	43	0	-100	96	0	-100
Outlet 3	43	237	451	96	483	403
Outlet 4*	9,655	9,787	1	21,497	21,779	1

*The 79.2 ha external drainage area to Outlet 4 is included in existing and proposed flows.

There will be a reduction in flow to Outlet 1 and no flow to Outlet 2. No analysis into unitary flow rates, erosion control or quantity controls were performed for Outlet 1 due to it's decrease in flow.

Flows going to Outlet 3 increase by 451.2%, which represents the greatest increase in the study area. This is due to a combination of the proposed urban cross section, road widening and re-routing runoff from the entire roadway to discharge south on Ridgeway Drive as opposed the existing conditions where half Burnhamthorpe Road discharges north on Ridgeway Drive and the other half discharges south on Ridgeway Drive. However according to Drainage Plan C-23167 found in **Appendix C**, it has been previously planned for the storm sewer on Ridgeway Drive, south of Burnhamthorpe Road, to accommodate 2 hectares of roadway drainage with a runoff coefficient of 0.9. As shown in **Table 1** above, the proposed drainage area for Outlet 3 is 1.21 hectares with a runoff coefficient of 0.78. As seen in **Table 3** below, the downstream storm sewer has sufficient capacity to handle the increased runoff for a 10-year storm event.

Outlet 4 will experience a 1.4% increase in flows. The flow increases from the road widening are offset by the large external drainage contributing to Outlet 4. As summarized in **Table 3** below, the existing storm sewers on Burnhamthorpe Road between Ridgeway Drive and Loyalist Drive have been adequately sized for 10-year design flows.

Table 3: Summary of Existing and Proposed Storm Sewer Capacity Impacts

Outlet Flow Nodes	Capacity (L/S)	10yr (L/s)		10yr % Capacity	
		Existing	Proposed	Existing	Proposed
Outlet 1	NULL	221	144	NULL	NULL
Outlet 2	94	43	0	45.7	-
Outlet 3	558	43	237	7.7	42.5
Outlet 4	12,261	9,655	9,787	78.7	79.8

Therefore, it can be concluded that the impact for the Four Lane Widening alternative will have negligible impacts on the existing roadway drainage system capacity when compared to existing conditions and design criteria. The detailed storm sewer design sheets can be found in **Appendix B** of this report.

3.2 Proposed Minor Storm Sewer System

The minor system for the proposed conditions will be designed to convey the 1:10 year flow as per City of Mississauga's design standards. The proposed storm sewer system is illustrated on the Proposed Drainage Mosaic found in **Appendix A**, and the proposed storm sewer design sheets are presented in **Appendix B**. At the east and west limits, the existing storm sewer system will be utilized. The assessment confirms that the existing sewers on Burnhamthorpe Road were designed adequately for the 10-year design storm event.

In general, outlets for the proposed minor system will remain the same as the existing conditions. The following provides details for each outlet:

- **Outlet 1 (Highway 403)**: Burnhamthorpe Road West from Ninth Line to approximately 175 m west of Ridgeway Drive, will consist of an urban cross section. The north and south side of the Burnhamthorpe, outside the curb lines, will contribute runoff from the embankments via ditching to Joshua's Creek tributary.
- **Outlet 2 (Ridgeway Drive North)**: Burnhamthorpe Road West from approximately 175 m west of Ridgeway Drive to Ridgeway Drive, will discharge to an existing 675 mm diameter storm sewer in Ridgeway Drive on the south side of Burnhamthorpe. Existing Outlet 2, which discharges to Ridgeway Drive on the north side of Burnhamthorpe will be removed.
- **Outlet 3 (Ridgeway Drive South)**: Burnhamthorpe Road West from approximately 175 m west of Ridgeway Drive to Ridgeway Drive, will consist of an urban cross

section which drains the right-of-way to a proposed storm sewer. This storm sewer will connect to an existing 675 mm diameter storm sewer in Ridgeway Drive south of the intersection of Burnhamthorpe Road and Ridgeway Drive. This existing storm sewer eventually discharges into the Laird Road Stormwater Management Facility where quantity and quality controls are in place.

- **Outlet 4 (Trunk Sewer at Bangor Road)**: Burnhamthorpe Road West from Ridgway Drive to Loyalist Drive, will consist of an urban cross section. On the north side of Burnhamthorpe Road, the existing catchbasins will be relocated to the proposed curb line. On the south side of Burnhamthorpe Road, curb cuts are proposed which will allow runoff to flow through an appropriate LID feature to a system of ditch inlets that drain to the existing storm sewer in Burnhamthorpe Road ranging in size from 375 mm to 675 mm diameter. The roadway drainage storm sewer connects to the 2100 mm diameter trunk sewer running north / south at Bangor Road. The trunk sewer eventually discharges into the Collegeway Stormwater Management Facility where quantity, erosion and quality controls are in place.

Generally, the existing storm sewer will be utilized as part of the proposed system. However, it is anticipated that modifications such as re-locating catch basin inlets and sewer leads will be required to accommodate the widening. A section of new storm sewer will be required from approximately 175 m west of Ridgeway Drive to Ridgeway Drive to Outlet 3.

As demonstrated by the storm sewer design sheets in **Appendix B**, the existing storm sewers have sufficient capacity to handle the additional flows due to the increased impervious areas.

3.3 Proposed Major Drainage System

The proposed major drainage system will be provided by overland flow within Burnhamthorpe's road right-of-way. Generally, the drainage system will remain unchanged, and there are no major changes to the major system drainage patterns as part of the proposed improvements.

3.4 Proposed Stormwater Management System

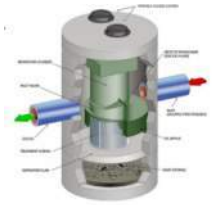
The existing storm sewers discharge to two separate stormwater management facilities which have been retrofitted to meet current design standards as identified by the City of Mississauga and Credit Valley Conservation design criteria. As such, the existing SWM ponds provide Burnhamthorpe Road with a basic level of water quality, quantity and erosion control. The proposed strategy for managing the impacted study area will be to enhance the water quality treatment by implementing a multi-component approach.

Table 4 provides an evaluation of stormwater management alternatives that were considered as part of the stormwater management strategy. The alternative solutions included permeable pavement, curb extension bioretention, traditional SWM facilities, Oil Grit Separators, Enhanced Grass Swale, and underground storage facilities. The evaluation considered relative cost, construction feasibility, and stormwater objectives.

It was concluded, in combination with the existing ponds, that pre-treatment with an Oil Grit Separators (OGS) for Outlet 3 and enhanced grass swales at Outlet 4 would provide the most feasible and effective treatment train approach to achieve the stormwater management objectives. The following is a summary of the recommended SWM plan for each outlet.

Table 4: Evaluation of Alternative SWM Solutions

Stormwater Management Alternative	Relative Cost	Construction Feasibility	Likelihood Of Achieving SWM Objectives	Constraints to Use	Illustration
Permeable pavement in lay-by parking areas	HIGH	LOW	MODERATE	Majority of right-of-way is within high traffic areas that will ultimately reduce the effectiveness of the alternative and limited parking areas are expected to be a feature of the proposed roads. Soils not suitable for infiltration.	 LID SWM Manual, CVC & TRCA, 2010
Curb extension bioretention	MODERATE	LOW	LOW	Will remove lane capacity--suitable in traffic calming areas, but not expected to be a feature of the proposed major roads. Soils not suitable for infiltration.	 LID SWM Manual, CVC & TRCA, 2010
Traditional storm sewer/ curb and gutter design - conveyance to end-of-stormwater management facility	MODERATE	LOW	HIGH	The minor and major systems for the drainage area of Burnhamthorpe Road already have two stormwater management facilities to address water quality and quantity controls. Not required to implement smaller quantity control facilities.	 Ash Creek SWM Pond Town of Whitby

Oil-Grit Separators	LOW	HIGH	MODERATE	The proposed sewer on Burnhamthorpe Road presents an opportunity to install a treatment device at Outlets 3 and 4 as a treatment train approach. No quantity or erosion benefits. **This is the preferred solution for pre-treatment at Outlet 3.**	 CDS Technologies O/G Separator
Enhanced Grass Swale	MODERATE	LOW	HIGH	Requires space in road right-of-way adequate for proper grading of an enhanced grass swale. Soils might require enhancement for proper infiltration rates. **This is the preferred solution for pre-treatment at Outlet 4.**	 LID SWM Manual, CVC & TRCA, 2010
Bio-retention planters	HIGH	LOW	MODERATE	Requires space in boulevard - may be constrained by sidewalk / multiuse pathway and utilities. In 'main street' type setting, requires extensive landscaping and maintenance but can become a signature feature.	 LID SWM Manual, CVC & TRCA, 2010
Underground Storage	HIGH	LOW	LOW	Provides quantity control for roadway outlets. No quantity controls required.	 Sustainable Technologies Evaluation Program, 2019

3.4.1 Water Quality Control

The proposed water quality controls proposed for the different sections of Burnhamthorpe Road are described below by outlet:

- **Outlet 1 (Highway 403)**: For this section, which drains to the west, the impact on the water quality is negligible and no specific Best Management Practice (BMP) is proposed at this location as runoff flows through an existing grass swale providing some quality control.
- **Outlet 3 (Ridgeway Drive)**: For this section, which drains south on Ridgeway Drive, runoff is ultimately discharged to the existing Laird Road SWM facility which provides “Basic” (Level 3) quality control (60% TSS Removal). In order to increase the level of treatment to “Enhanced” (Level 1) quality control (80% TSS Removal) the preferred solution is to implement an OGS unit in a treatment train approach. An Hydroworks HydroStorm 10 or equivalent would be suitable to provide “Enhanced” (Level 1) quality control (80% TSS Removal) for Outlet 3. The OGS sizing report can be found in **Appendix E**.
- **Outlet 4 (Trunk Sewer at Bangor Road)**: For this section, which drains to Bangor Road, runoff is ultimately discharged to the existing Collegeway SWM Pond which provided “Basic” (Level 3) quality control (60% TSS Removal). In order to increase the level of treatment to “Enhanced” (Level 1) quality control (80% TSS Removal) the preferred solution is to implement an enhanced grassed swale. This will provide “Enhanced” (Level 1) quality control (80% TSS Removal) as per the Credit Valley Conservation Authority SWM Criteria, **Appendix D**, for the increased impervious area within Outlet 4. Preliminary design calculations can be seen below.

3.4.2 Water Quantity Control

The proposed water quantity controls for the different sections of Burnhamthorpe Road are described below by outlet:

- **Outlet 1 (Highway 403)**: For this section, which drains to the west, the impact on the water quantity is negligible and no specific quantity controls are proposed at this location.
- **Outlet 3 (Ridgeway Drive)**: For this section, which drains to the sewer at Ridgeway Drive, no specific quantity control is proposed at this location because it ultimately discharges to the existing Laird SWM Facility. The existing minor storm sewer system has been adequately sized for the 10-year proposed flows.
- **Outlet 4 (Trunk Sewer at Bangor Road)**: For this section, which drains to the trunk sewer at Bangor Road, no specific quantity control is proposed at this location because it ultimately discharges to the existing Collegeway SWM Facility. The existing minor storm sewer system has been adequately sized for the 10-year proposed flows.

The existing minor storm sewer system under existing and proposed conditions for the 10-year flows as can be seen in the storm sewer design sheets attached in **Appendix B**.

3.4.3 Water Budget Control

The proposed enhanced swale will provide water erosion/budget controls for the roadway. The preliminary calculations below were performed to assess the required volume capture of the enhanced grass swale to retain 5 mm of runoff from an area equivalent to the new impervious area. The location of the proposed enhanced swale is shown on the proposed drainage mosaic in **Appendix A**.

Calculations were performed to assess the required storage volume and height of the enhanced grass swale for the 5 mm storm event. Capturing this storm runoff will provide an "Enhanced" (Level 1) quality control (80% TSS Removal) as per the Credit Valley Conservation Authority SWM Criteria, **Appendix D** and provide erosion/budget control for the excess runoff created by the proposed increase in impervious area within the drainage area for Outlet 3. **Tables 5-8** below summarize the values used to calculate the required height retention of the enhanced grass swales.

Table 5: Increase in Impervious Area due to Proposed Road Improvements

Increase in Impervious Area				
	Area (ha)	**Runoff Coefficient**	**% Impervious**	**Area Impervious (ha)**
Existing	6.55	0.54	45%	2.95
Proposed	6.55	0.71	71%	4.65
Difference	0	0.17	26%	1.70

Table 6: Increase in Rainfall Volumes due to Impervious Area Increases

	Impervious Area	**Impervious Area (m^2)**	**5 mm Rainfall Volumes (m^3)**
Existing	2.95	29,475	147
Proposed	4.65	46,505	233
Difference	1.70	17,030	86

Table 7: Area of Proposed Enhanced Grass Swales

Area of Enhanced Grass Swale	
	65 m^2
	656 m^2
	444 m^2
	264 m^2
Total =	1,428 m^2

Table 8: Required Retention Height of the Enhanced Grassed Swale

Total Area of Grassed Swale (m^2)	5 mm Retention Volume (m^3)	5 mm Capture Height (m)
1,428.0	86	0.060

Based on a proposed increase in impervious area of 1.70 ha, the 5 mm runoff volumes required is 86 m^3. To capture the 5 mm storm, the height of retention required for the proposed grass swale will be 6.0 cm. By capturing this volume, the enhanced grass swale will provide "Enhanced" (Level 1) quality control (80% TSS Removal).

4. Conclusions and Recommendations

The report has demonstrated the proposed improvement of Burnhamthorpe Road West may proceed in general conformance with the applicable City of Mississauga, MECP, CH and CVC SWM requirements. The findings of this report are summarized as follows:

- Minor and major system flows from the study area will be conveyed to three (3) separate existing outlet locations.
- No existing cross culverts were identified in the study area.
- The existing storm sewers on Burnhamthorpe Road between Ridgeway Drive and Loyalist Drive have been adequately sized for the 10-year proposed design flows.
- The receiving trunk sewer on Ridgeway Drive is adequately sized for the proposed 10-year flows which discharges to the Laird Road SWM facility. Therefore, no quantity controls are proposed.
- The receiving sewer on Bangor Road is adequately sized for the proposed 10-year flows which discharges to the Collegeway SWM facility. Therefore, no quantity controls are proposed.
- Existing end-of-pipe SWM facilities for water quantity control (2-year through 100-year), and erosion control are already in place for the roadway at the Laird SWM and Collegeway SWM facilities. Therefore, no quantity controls are proposed.
- There will be a reduction in flow to Outlet 1, which drains towards the Town of Oakville and the MTO Right of Way, and no flow continuing to Outlet 2. Because of the decrease in flow going to Outlet 1, no analysis into unitary flow rates, erosion control or quantity controls were performed.
- Flows going to Outlet 3 increase by 451.2%, which represents the greatest increase in the study area. However, the receiving storm sewer was designed to receive the 10-year storm drainage from Burnhamthorpe Road.
- The increase in minor flows to the receiving trunk sewer on Bangor Road is representative of a 1.4% increase in flow capacity in the storm sewer which discharges to the Collegeway SWM facility. Therefore, no quantity control is proposed for the minor system at this location.
- Water quality controls for Outlet 3 will be provided by treatment train approach with pre-treatment by an OGS unit, and the existing end-of-pipe Laird SWM Facility.
- Water quality controls for Outlet 4 will be provided by treatment train approach with pre-treatment by an enhanced grassed swale, and the existing end-of-pipe Collegeway SWM Facility.
- The proposed enhanced swale will also mitigate erosion/budget impacts associated with the roadway widening. During detailed design the LID should be designed to retain 5 mm of runoff from an area equivalent to the new impervious area.
- A CCTV inspection of all existing storm sewer systems that the Burnhamthorpe Road storm sewers will utilize should be undertaken at detailed design to verify the condition of the existing storm sewers.

A

Appendix A

Existing Drainage Mosaic

Proposed Drainage Mosaic

External Drainage Mosaic

Burnhamthorpe Rd. E
9th Line
Hwy 403
1 0.9 0.16 ha
2 0.89 0.14 ha
Outlet 1 to Joshua's Creek
Access Storage Building
Road High Point
3 0.41 0.69 ha
Burnhamthorpe Rd.W
4 0.38 0.67 ha
Ditch High Point
5 0.49 0.32 ha
6 0.46 0.34 ha
Ditch High Point
Outlet 2 to the Collegeway SWM Facility
Ridgeway Dr.
375mm @ 0.9%
300mm @ 0.9%
8 0.75 0.55 ha
Rushton Cres.
5 0.49 0.32 ha
6 0.46 0.34 ha
9 0.55 0.3 ha
10 0.49 0.42 ha
MH6
MH7
Burnhamthorpe Rd.W
375mm @ 0.9%
450mm @ 0.9%
11 0.49 0.36 ha
MH8
12 0.51 0.35 ha
525mm @ 0.8%
Renfrew Cres.
MH9
13 0.56 0.2 ha
525mm @ 1%
Colonial Dr.
300mm @ 0.9%
300mm @ 1%
15 0.75 0.16 ha
14 0.76 0.15 ha
MH10
600mm @ 1%
16 0.58 0.39 ha
600mm @ 1.5%
MH11
Ingram Rd.
7 0.7 0.6 ha
675mm @ 0.44%
Outlet 3 to the Laird Road SWM Facility
Dolson Ct.
Melfort Cres.
17 0.2 0.3 ha
600mm @ 1.5%
MH12
600mm @ 1.5%
Road SAG
Ditch SAG
18 0.5 0.06 ha
MH5
675mm @ 0.4%
19 0.49 0.42 ha
MH4
Burnhamthorpe Rd.W
20 0.53 0.41 ha
675mm @ 0.3%
Bangor Rd.
Outlet 4 to the Collegeway SWM Facility
Loyalist Dr.
100mm
450mm @ 0.3%
23 0.78 0.14 ha
21 0.74 0.23 ha
MH3
600mm @ 0.3%
22 0.74 0.12 ha
24 0.79 0.16 ha
MH2
Road SAG
525mm @ 0.3%
25 0.74 0.42 ha
MH1
26 0.74 0.2 ha
Road High Point

CIMA+

CLIENT
MISSISSAUGA

LEGEND
EXISTING STORM INFRASTRUCTURE
CATCHBASIN
DOUBLE CATCHBASIN
MAINT. HOLE
OUTLET NODE
SEWER
CULVERT
DITCH
OVERLAND FLOW DIRECTION ARROW
EXISTING CATCHMENT AREA
CATCHMENT AREA
CATCHMENT ID
RUNOFF COEFFICIENT
CATCHMENT AREA
ROAD/DITCH ELEVATION POINTS
SAG
HIGH POINT
OTHER FEATURES
WATERCOURSE
PROPERTY BOUNDARY
RIPRAP PONDING AREA
ADDITIONAL BUILDING

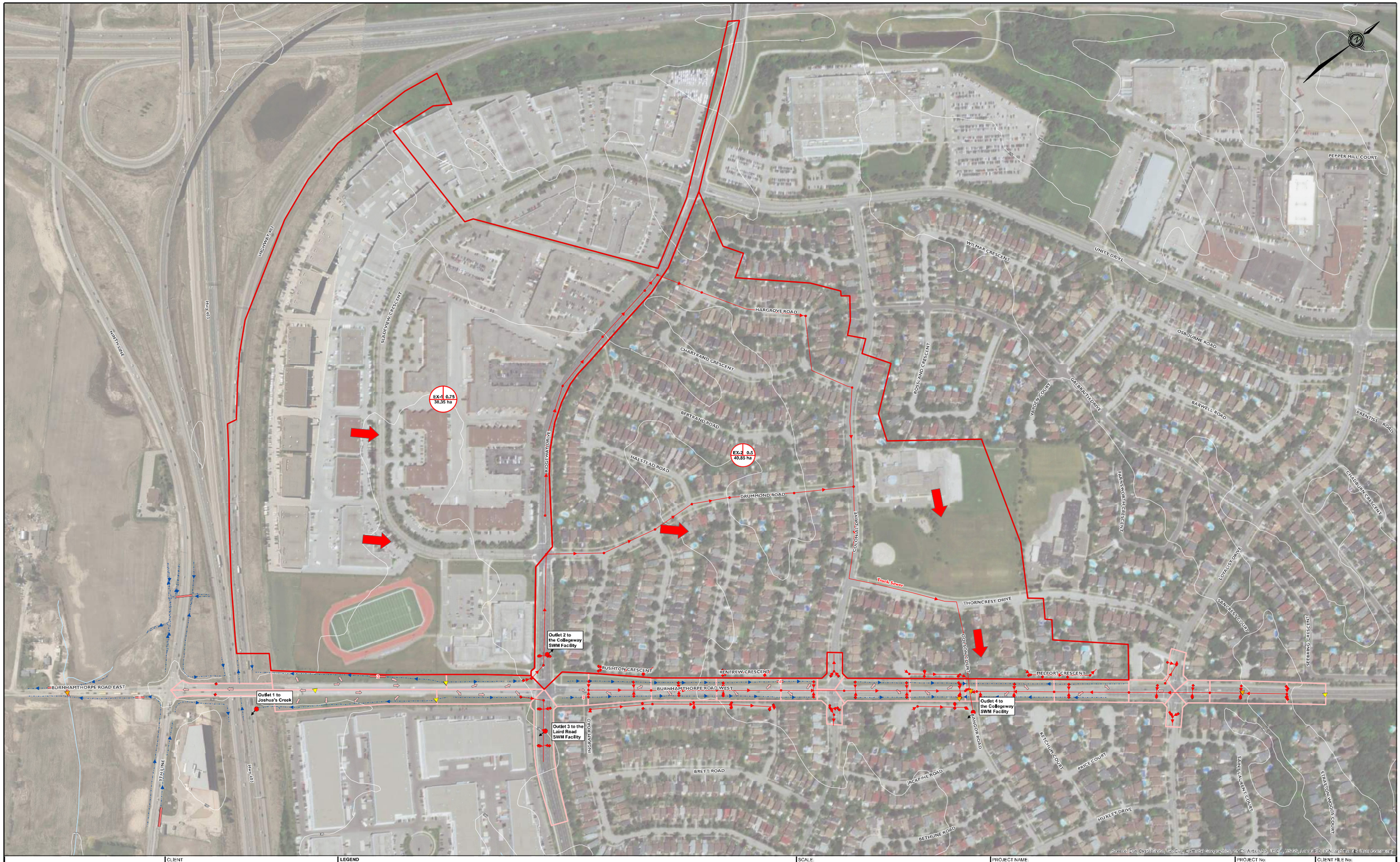
SCALE:
10 5 0 10 20 30 40 50
meters
1:750

PROJECT NAME:
BURNHAMTHORPE ROAD CLASS EA

SHEET TITLE:
EXISTING CONDITIONS - DRAINAGE MOSAIC

PROJECT No: B000656
DRAFTER: S. ELLIOTT
DESIGNER: —
APPROVER: R. CRESSMAN
APPROVER: —
DATE: 12/9/2019

CLIENT FILE No. —
DRAWING No: FIG. 5
SHEET No: 1 of 1



CLIENT

MISSISSAUGA

LEGEND

EXISTING STORM INFRASTRUCTURE

- CATCHBASIN
- DOUBLE CATCHBASIN
- MAINT. HOLE
- OUTLET NODE
- SEWER
- CULVERT
- DITCH
- EXTERNAL OVERLAND FLOW DIRECTION ARROW
- INTERNAL OVERLAND FLOW DIRECTION ARROW
- EXTERNAL CATCHMENT AREA
- EXISTING CATCHMENT AREA
- 210 / 2.2 ha — CATCHMENT ID / RUNOFF COEFFICIENT / CATCHMENT AREA

ROAD/DITCH ELEVATION POINTS

- SAG
- HIGH POINT

NOTE: CONTOURS LINES ARE IN 5M INTERVALS

SCALE:

50 25 0 50 100 150 200

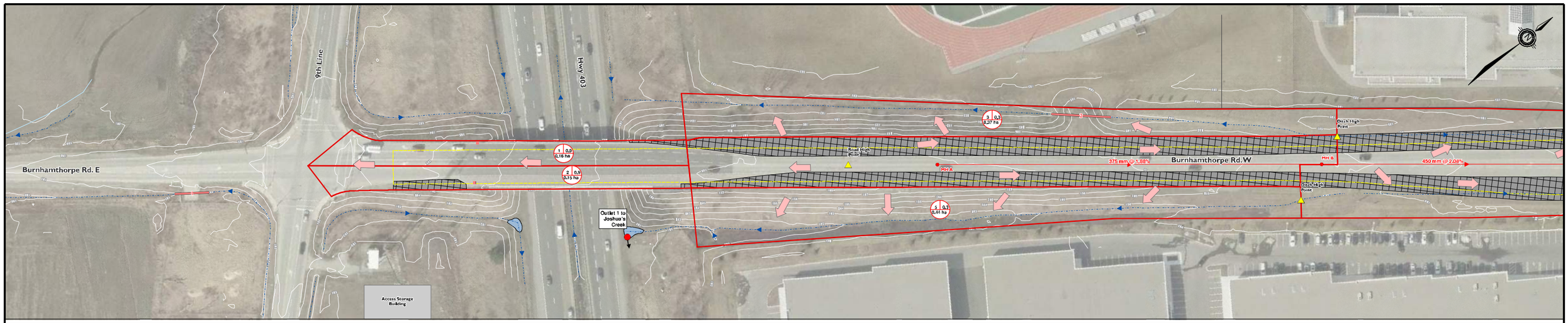
meters

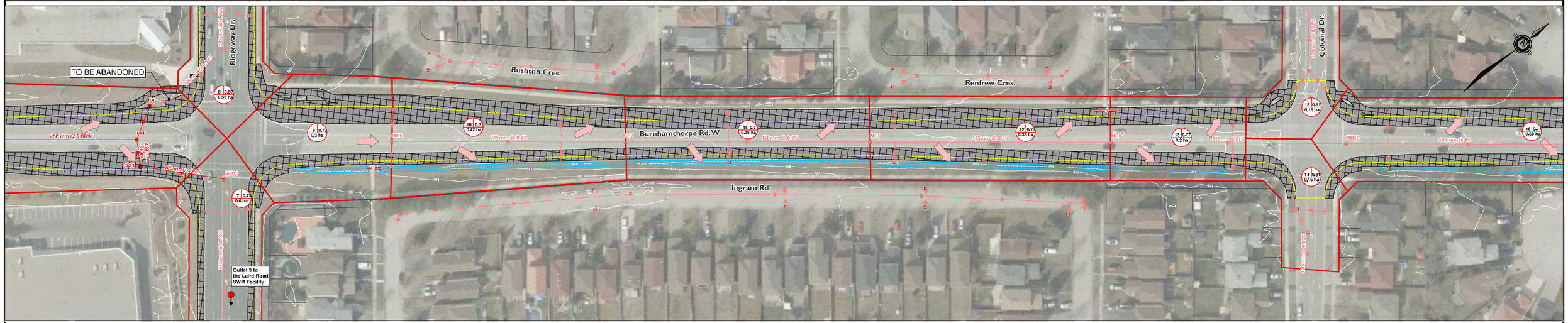
1:2,500

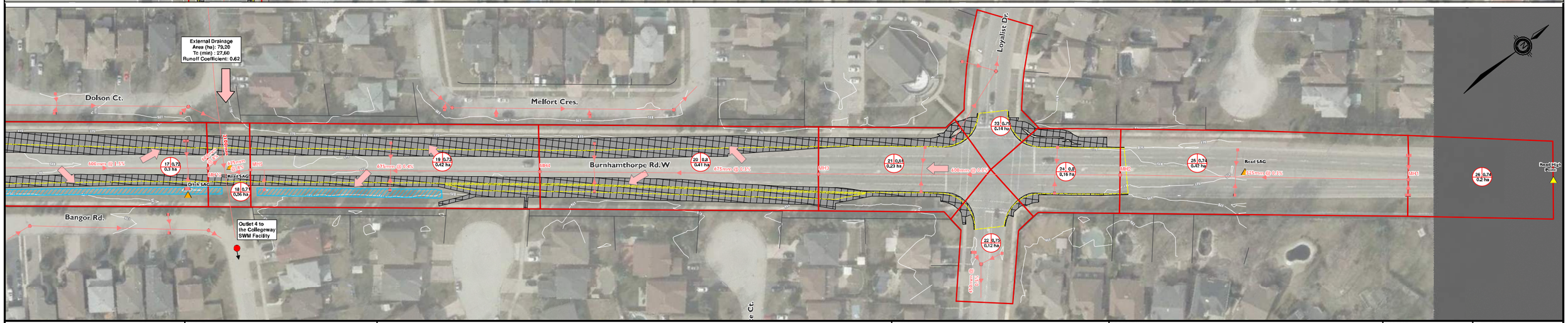
PROJECT NAME: **BURNHAMTHORPE ROAD CLASS EA**

SHEET TITLE: **EXTERNAL DRAINAGE MOSAIC**

PROJECT No: B000856		CLIENT FILE No: —
DRAFTER: S. ELLIOTT	DESIGNER: —	DRAWING No: **FIG. 6**
APPROVER: R. CRESSMAN	APPROVER: —	
DATE: 12/9/2019		SHEET No: 1 of 1







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MISSISSAUGA

LEGEND

EXISTING STORM INFRASTRUCTURE: CATCHBASIN; DOUBLE CATCHBASIN; MAINT. HOLE; SEWER; CULVERT; DITCH; OUTLET NUMB; OVERLAND FLOW DIRECTION ARROW

ROAD/DITCH ELEVATION POINTS: SAG; HIGH POINT; CATCHMENT ID, RUNOFF COEFF, AREA; CATCHMENT AREA

PROPOSED STORM INFRASTRUCTURE: DITCH INLET; MAINT. HOLE; OIL GRIT SEPARATOR; SEWER

BIO-SWALE-GRASSED TREE PLANTER; ROAD WIDENING AREA; EDGE OF PAVEMENT; CATCHMENT AREA

OTHER FEATURES: WATERCOURSE; PROPERTY BOUNDARY; RIPRAP PONDING AREA; ADDITIONAL BUILDING

SCALE:

10 5 0 10 20 30 40 50
meters
1:750

PROJECT NAME:
BURNHAMTHORPE ROAD CLASS EA

SHEET TITLE:
PROPOSED CONDITIONS - DRAINAGE MOSAIC

PROJECT No: B000856		CLIENT FILE No: —
DRAFTER: S. ELLIOTT	DESIGNER: —	DRAWING No: **FIG. 7**
APPROVER: R. CRESSMAN	APPROVER: —	
DATE: 1/10/2020		SHEET No: 1 of 1

B

Appendix B

Storm Sewer Design Sheets

DEVELOPMENT Burnhamthorpe Road Road MCEA

CONSULTANT CIMA+

MAJOR DRAINAGE AREA Joshua's Creek and Loyalist Creek Subwatershed

STORM DRAINAGE DESIGN CHART
FOR CIRCULAR DRAINS FLOWING FULL

EXISTING CONDITIONS (C=0.5) 2 LANE CROSS-SECTION

SHEET No. 1 OF 12

PREPARED BY: Brian O'Dell

CHECKED BY: Ryan Cressman, P.Eng.

Project No. B000856

RETURN PERIOD = 2 YEARS
INLET TIME = 15 minutes
I = A / (t_c + B) ^ C
A = 610; B = 4.6; C = 0.78

2-10 Year Storms - C @ 100%
25 Year Storm - C @ 110%
50 Year Storm - C @ 120%
100 Year Storm - C @ 125%

LOCATION OF SITE	DRAINAGE AREA ID	FROM UPSTEAM	TO DOWNSTREAM	ADJACENT CONTRIBUTING AREA	RUNOFF COEFFICIENT	AREA TIMES RUNOFF COEFFICIENT	ACCUMULATIVE AREA DRAINED BY SECTION	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT FOR SECTION	FLOW TIME TO SECTION FROM EXTREME UPSTREAM INLET	INTIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET	TIME OF CONECENTRATION UPSTREAEM END OF SECTION	INTENSITY OF RAINFALL	QUANTITY OF FLOW TO BE ACCOMMODATED IN SECTION	TYPE OF PIPE	MANNINGS ROUGHNESS COEFFICIENT	SLOPE	DIAMETER	LENGTH OF SECTION	VELOCITY OF FLOW WITH PIPE FLOWING FULL	CAPACITY OF PIPE FLOWING FULL	TIME OF FLOW IN SECTION	PIPE INVERT AT UPSTREAM MH	PIPE INVERT AT DOWNSTREAM MH	PIPE CAPACITY	REMARKS
		MH#	MH#	A_A	C_A	A_A X C_A	Σ A_A	Σ A_A X C_A	tc_f	tc_i	$t_c = tc_f + tc_i$	i	Q=iAC/360		n	s	D	L	V	Q	T = L / VX60				
				ha			ha		min	min	min	mm/hr	m^3/s			%	mm	m	m/s	m^3/s	min	m	m	%	
Burnhamthorpe Road W.	3			0.69	0.40	0.28	0.69	0.28	0.00	15.00	15.00	59.892	0.046	DITCH											
Burnhamthorpe Road W.	1			0.16	0.9	0.14	0.85	0.14	0.00	15.00	15.00	59.892	0.024	DITCH											
Burnhamthorpe Road W.	4			0.67	0.38	0.25	0.67	0.25	0.00	15.00	15.00	59.892	0.042	DITCH											
Burnhamthorpe Road W.	2			0.14	0.9	0.13	0.81	0.13	0.00	15.00	15.00	59.892	0.021	DITCH											
Outlet 1					0.48		1.66	0.80	15.00		15.00	59.892	0.133	DITCH											
Burnhamthorpe Road W.	5			0.32	0.49	0.16	0.32	0.16	0.00	15.00	15.00	59.892	0.026	DITCH											
Outlet 2					0.49		0.32	0.16	15.00		15.00	59.892	0.026	CONC	0.013	0.94	300	28.00	1.33	0.094	0.35	170.16	169.60	28%	
Burnhamthorpe Road W.	6			0.34	0.46	0.16	0.34	0.16	0.00	15.00	15.00	59.892	0.026	DITCH											
Outlet 3					0.46		0.34	0.16	15.00		15.00	59.892	0.026	CONC	0.013	0.44	675	30.00	1.56	0.558	0.32	170.16	169.60	5%	
Burnhamthorpe Road W.	9 & 10	6	7	0.72	0.52	0.37	0.72	0.37	0.00	15.00	15.00	59.892	0.062	CONC	0.013	0.90	375	100.00	1.51	0.166	1.11	178.00	177.10	37%	
Burnhamthorpe Road W.	11	7	8	0.36	0.49	0.18	1.08	0.55	1.11		16.11	57.380	0.088	CONC	0.013	0.90	450	100.00	1.70	0.270	0.98	177.00	176.10	32%	
Burnhamthorpe Road W.	12	8	9	0.35	0.51	0.18	1.43	0.73	0.98		17.09	55.348	0.112	CONC	0.013	0.80	525	100.00	1.78	0.385	0.94	176.00	175.20	29%	
Burnhamthorpe Road W.	13	9	10	0.20	0.56	0.11	1.63	0.84	0.94		18.02	53.550	0.125	CONC	0.013	1.00	525	100.00	1.99	0.430	0.84	174.50	173.50	29%	
Burnhamthorpe Road W.	16	10	11	0.39	0.58	0.23	2.02	1.07	0.84		18.86	52.050	0.154	CONC	0.013	1.00	600	100.00	2.17	0.614	0.77	173.40	172.40	25%	
Burnhamthorpe Road W.	17 & 18	11	12	0.36	0.50	0.18	2.38	1.25	0.77		19.63	50.760	0.176	CONC	0.013	1.50	600	90.00	2.66	0.752	0.56	172.30	170.95	23%	
Burnhamthorpe Road W.		12	Outlet 4	0.00	0.50	0.00	2.38	1.25	0.56		20.20	49.857	0.173	CONC	0.013	8.00	600	7.00	6.14	1.737	0.02	170.16	169.60	10%	
Burnhamthorpe Road W.	25 & 26	1	2	0.62	0.74	0.46	0.62	0.46	0.00	15.00	15.00	59.892	0.076	CONC	0.013	0.30	525	120.00	1.09	0.236	1.84	172.40	172.04	32%	
Burnhamthorpe Road W.	21 & 24	2	3	0.39	0.77	0.30	1.01	0.76	1.84		16.84	55.848	0.118	CONC	0.013	0.30	600	120.00	1.19	0.336	1.68	171.95	171.59	35%	
Burnhamthorpe Road W.	20	3	4	0.41	0.53	0.22	1.42	0.98	1.68		18.52	52.654	0.143	CONC	0.013	0.30	675	120.00	1.29	0.460	1.55	171.50	171.14	31%	
Burnhamthorpe Road W.	19	4	5	0.42	0.49	0.21	1.84	1.18	1.55		20.07	50.048	0.164	CONC	0.013	0.40	675	120.00	1.49	0.532	1.35	171.10	170.62	31%	
Burnhamthorpe Road W.		5	Outlet 4	0.00	0.50	0.00	1.84	1.18	1.35		21.42	48.016	0.158	CONC	0.013	8.00	675	8.00	6.64	2.378	0.02	170.24	169.60	7%	
External Drainage Areas	External			38.35	0.75	28.76	38.35	28.76		21.90	21.90	47.337	3.782												External Drainge Plan by Proctor & Redfern
External Drainage Areas	External		Outlet 4	40.85	0.50	20.43	79.20	49.19			21.90	47.337	6.468	CONC	0.013	0.50	1650	1030.00	3.01		5.70				Consulting Engineers Drawings A1 - 84744 - G10
Outlet 4		5, 12 & External			0.62		83.42	51.62	5.70	21.90	27.60	40.668	5.831	CONC	0.013	0.50	2100	7.00	3.54	12.261	0.03	170.16	169.60	48%	

DEVELOPMENT: Burnhamthorpe Road Road MCEA

CONSULTANT: CIMA+

MAJOR DRAINAGE AREA: Joshua's Creek and Loyalist Creek Subwatershed

STORM DRAINAGE DESIGN CHART
FOR CIRCULAR DRAINS FLOWING FULL

PROPOSED CONDITIONS (C=0.7) 4 LANE CROSS-SECTION

PREPARED BY: Brian O'Dell

CHECKED BY: Ryan Cressman, P.Eng.

Project No. B000856

RETURN PERIOD = 2 YEARS
INLET TIME = 15 minutes
$I = A / (t_c + B) ^ C$
A = 610; B = 4.6; C = 0.78

2-10 Year Storms - C @ 100%
25 Year Storm - C @ 110%
50 Year Storm - C @ 120%
100 Year Storm - C @ 125%

LOCATION OF SITE	DRAINAGE AREA ID	FROM UPSTEAM	TO DOWNSTREAM	ADJACENT CONTRIBUTING AREA	RUNOFF COEFFICIENT	AREA TIMES RUNOFF COEFFICIENT	ACCUMULATIVE AREA DRAINED BY SECTION	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT FOR SECTION	FLOW TIME TO SECTION FROM EXTREME UPSTREAM INLET	INTIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET	TIME OF CONECENTRATION UPSTREAEM END OF SECTION	INTENSITY OF RAINFALL	QUANTITY OF FLOW TO BE ACCOMMODATED IN SECTION	TYPE OF PIPE	MANNINGS ROUGHNESS COEFFICIENT	SLOPE	DIAMETER	LENGTH OF SECTION	VELOCITY OF FLOW WITH PIPE FLOWING FULL	CAPACITY OF PIPE FLOWING FULL	TIME OF FLOW IN SECTION	PIPE INVERT AT UPSTREAM MH	PIPE INVERT AT DOWNSTREAM MH	PIPE CAPACITY	REMARKS
		MH#	MH#	A_A	C_A	$A_A \times C_A$	ΣA_A	$\Sigma A_A \times C_A$	tc_f	tc_i	$t_c = tc_f + tc_i$	i	$Q=iAC/360$		n	s	D	L	V	Q	T = L / VX60				
				ha			ha		min	min	min	mm/hr	m^3/s			%	mm	m	m/s	m^3/s	min	m	m	%	
Burnhamthorpe Road W.	3			0.37	0.30	0.11	0.37	0.11	0.00	15.00	15.00	59.89	0.018	DITCH											
Burnhamthorpe Road W.	1			0.16	0.90	0.14	0.53	0.14	0.00	15.00	15.00	59.89	0.024	DITCH											
Burnhamthorpe Road W.	5			0.44	0.30	0.13	0.44	0.13	0.00	15.00	15.00	59.89	0.022	DITCH											
Burnhamthorpe Road W.	2			0.15	0.90	0.14	0.59	0.14	0.00	15.00	15.00	59.89	0.022	DITCH											
Outlet 1					0.47		1.12	0.52	15.00		15.00	59.89	0.087	DITCH											
Burnhamthorpe Road W.	4	A	B	0.55	0.90	0.50	0.55	0.50	0.00	15.00	15.00	59.89	0.082	CONC	0.013	1.88	375	160.00	2.18	0.240	1.23	182.22	179.22	34%	
Burnhamthorpe Road W.	6	B	C	0.66	0.68	0.45	1.21	0.94	1.23		16.23	57.13	0.150	CONC	0.013	2.08	450	120.00	2.59	0.411	0.77	179.22	176.72	36%	
Burnhamthorpe Road W. to OGS		C	OGS	0.00	0.00	0.00	1.21	0.94	0.77		17.00	55.52	0.146	CONC	0.013	4.00	450	11.00	3.59	0.570	0.05	176.72	176.28	26%	
Burnhamthorpe Road W.		OGS	13	0.00	0.00	0.00	1.21	0.94	0.05		17.05	55.42	0.145	CONC	0.013	0.50	525	36.00	1.40	0.304	0.43	176.28	176.10	48%	
Outlet 3					0.78		1.21	0.94	0.43	17.05	17.48	54.58	0.143	CONC	0.013	0.44	675	100.00	1.56	0.558	1.07	170.16	169.60	26%	
Burnhamthorpe Road W.	9 & 10	6	7	0.72	0.71	0.51	0.72	0.51	0.00	15.00	15.00	59.89	0.085	CONC	0.013	0.90	375	100.00	1.51	0.166	1.11	178.00	177.10	51%	
Burnhamthorpe Road W.	11	7	8	0.36	0.70	0.25	1.08	0.76	1.11		16.11	57.38	0.122	CONC	0.013	0.90	450	100.00	1.70	0.270	0.98	177.00	176.10	45%	
Burnhamthorpe Road W.	12	8	9	0.35	0.74	0.26	1.43	1.02	0.98		17.09	55.35	0.157	CONC	0.013	0.80	525	100.00	1.78	0.385	0.94	176.00	175.20	41%	
Burnhamthorpe Road W.	13	9	10	0.20	0.77	0.15	1.63	1.18	0.94		18.02	53.55	0.175	CONC	0.013	1.00	525	100.00	1.99	0.430	0.84	174.50	173.50	41%	
Burnhamthorpe Road W.	16	10	11	0.39	0.77	0.30	2.02	1.48	0.84		18.86	52.05	0.213	CONC	0.013	1.00	600	100.00	2.17	0.614	0.77	173.40	172.40	35%	
Burnhamthorpe Road W.	17 & 18	11	12	0.36	0.72	0.26	2.38	1.74	0.77		19.63	50.76	0.245	CONC	0.013	1.50	600	90.00	2.66	0.752	0.56	172.30	170.95	33%	
Burnhamthorpe Road W.		12	Outlet 4				2.38	1.74	0.56		20.20	49.86	0.240	CONC	0.013	8.00	600	7.00	6.14	1.737	0.02	170.16	169.60	14%	
Burnhamthorpe Road W.	25 & 26	1	2	0.62	0.74	0.46	0.62	0.46	0.00	15.00	15.00	59.89	0.076	CONC	0.013	0.30	525	120.00	1.09	0.236	1.84	172.40	172.04	32%	
Burnhamthorpe Road W.	21 & 24	2	3	0.39	0.81	0.32	1.01	0.77	1.84		16.84	55.85	0.120	CONC	0.013	0.30	600	120.00	1.19	0.336	1.68	171.95	171.59	36%	
Burnhamthorpe Road W.	20	3	4	0.41	0.80	0.33	1.42	1.10	1.68		18.52	52.65	0.161	CONC	0.013	0.30	675	120.00	1.29	0.460	1.55	171.50	171.14	35%	
Burnhamthorpe Road W.	19	4	5	0.42	0.73	0.31	1.84	1.41	1.55		20.07	50.05	0.196	CONC	0.013	0.40	675	120.00	1.49	0.532	1.35	171.10	170.62	37%	
Burnhamthorpe Road W.		5	Outlet 4				1.84	1.41	1.35		21.42	48.02	0.188	CONC	0.013	8.00	675	8.00	6.64	2.378	0.02	170.24	169.60	8%	
External Drainage Areas	External			38.35	0.75	28.76	38.35	28.76		21.90	21.90	47.34	3.782												External Drainge Plan by Proctor & Redfern
External Drainage Areas	External		Outlet 4	40.85	0.50	20.43	79.20	49.19			21.90	47.34	6.468	CONC	0.013	0.50	1650	1030.00	3.01		5.70				Consulting Engineers Drawings A1 - 84744 - G10
Outlet 4		5, 12 & External			0.63		83.42	52.33	5.70	21.90	27.60	40.66	5.911	CONC	0.013	0.50	2100	7.00	3.54	12.261	0.03	170.16	169.60	48%	

DEVELOPMENT Burnhamthorpe Road Road MCEA

CONSULTANT CIMA+

MAJOR DRAINAGE AREA Joshua's Creek and Loyalist Creek Subwatershed

STORM DRAINAGE DESIGN CHART
FOR CIRCULAR DRAINS FLOWING FULL

EXISTING CONDITIONS (C=0.5) 2 LANE CROSS-SECTION

SHEET No. 3 OF 12

PREPARED BY: Brian O'Dell

CHECKED BY: Ryan Cressman, P.Eng.

Project No. B000856

RETURN PERIOD = 5 YEARS
INLET TIME = 15 minutes
$I = A / (t_c + B) ^ C$
A = 820; B = 4.6; C = 0.78

2-10 Year Storms - C @ 100%
25 Year Storm - C @ 110%
50 Year Storm - C @ 120%
100 Year Storm - C @ 125%

LOCATION OF SITE	DRAINAGE AREA ID	FROM UPSTEAM	TO DOWNSTREAM	ADJACENT CONTRIBUTING AREA	RUNOFF COEFFICIENT	AREA TIMES RUNOFF COEFFICIENT	ACCUMULATIVE AREA DRAINED BY SECTION	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT FOR SECTION	FLOW TIME TO SECTION FROM EXTREME UPSTREAM INLET	INTIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET	TIME OF CONECENTRATION UPSTREAEM END OF SECTION	INTENSITY OF RAINFALL	QUANTITY OF FLOW TO BE ACCOMMODATED IN SECTION	TYPE OF PIPE	MANNINGS ROUGHNESS COEFFICIENT	SLOPE	DIAMETER	LENGTH OF SECTION	VELOCITY OF FLOW WITH PIPE FLOWING FULL	CAPACITY OF PIPE FLOWING FULL	TIME OF FLOW IN SECTION	PIPE INVERT AT UPSTREAM MH	PIPE INVERT AT DOWNSTREAM MH	PIPE CAPACITY	REMARKS
		MH#	MH#	A_A	C_A	$A_A X C_A$	ΣA_A	$\Sigma A_A X C_A$	tc_f	tc_i	$t_c = tc_f + tc_i$	i	Q=iAC/360		n	s	D	L	V	Q	T = L / VX60				
				ha			ha		min	min	min	mm/hr	m^3/s			%	mm	m	m/s	m^3/s	min	m	m	%	
Burnhamthorpe Road W.	3			0.69	0.40	0.28	0.69	0.28	0.00	15.00	15.00	80.511	0.062	DITCH											
Burnhamthorpe Road W.	1			0.16	0.9	0.14	0.85	0.14	0.00	15.00	15.00	80.511	0.032	DITCH											
Burnhamthorpe Road W.	4			0.67	0.38	0.25	0.67	0.25	0.00	15.00	15.00	80.511	0.057	DITCH											
Burnhamthorpe Road W.	2			0.14	0.9	0.13	0.81	0.13	0.00	15.00	15.00	80.511	0.028	DITCH											
Outlet 1					0.48		1.66	0.80	15.00		15.00	80.511	0.179	DITCH											
Burnhamthorpe Road W.	5			0.32	0.49	0.16	0.32	0.16	0.00	15.00	15.00	80.511	0.035	DITCH											
Outlet 2					0.49		0.32	0.16	15.00		15.00	80.511	0.035	CONC	0.013	0.94	300	28.00	1.33	0.094	0.35	170.16	169.60	37%	
Burnhamthorpe Road W.	6			0.34	0.46	0.16	0.34	0.16	0.00	15.00	15.00	80.511	0.035	DITCH											
Outlet 3					0.46		0.34	0.16	15.00		15.00	80.511	0.035	CONC	0.013	0.44	675	30.00	1.56	0.558	0.32	170.16	169.60	6%	
Burnhamthorpe Road W.	9 & 10	6	7	0.72	0.52	0.37	0.72	0.37	0.00	15.00	15.00	80.511	0.084	CONC	0.013	0.90	375	100.00	1.51	0.166	1.11	178.00	177.10	50%	
Burnhamthorpe Road W.	11	7	8	0.36	0.49	0.18	1.08	0.55	1.11		16.11	77.134	0.118	CONC	0.013	0.90	450	100.00	1.70	0.270	0.98	177.00	176.10	44%	
Burnhamthorpe Road W.	12	8	9	0.35	0.51	0.18	1.43	0.73	0.98		17.09	74.402	0.151	CONC	0.013	0.80	525	100.00	1.78	0.385	0.94	176.00	175.20	39%	
Burnhamthorpe Road W.	13	9	10	0.20	0.56	0.11	1.63	0.84	0.94		18.02	71.985	0.168	CONC	0.013	1.00	525	100.00	1.99	0.430	0.84	174.50	173.50	39%	
Burnhamthorpe Road W.	16	10	11	0.39	0.58	0.23	2.02	1.07	0.84		18.86	69.969	0.207	CONC	0.013	1.00	600	100.00	2.17	0.614	0.77	173.40	172.40	34%	
Burnhamthorpe Road W.	17 & 18	11	12	0.36	0.50	0.18	2.38	1.25	0.77		19.63	68.234	0.236	CONC	0.013	1.50	600	90.00	2.66	0.752	0.56	172.30	170.95	31%	
Burnhamthorpe Road W.		12	Outlet 4	0.00	0.50	0.00	2.38	1.25	0.56		20.20	67.021	0.232	CONC	0.013	8.00	600	7.00	6.14	1.737	0.02	170.16	169.60	13%	
Burnhamthorpe Road W.	25 & 26	1	2	0.62	0.74	0.46	0.62	0.46	0.00	15.00	15.00	80.511	0.103	CONC	0.013	0.30	525	120.00	1.09	0.236	1.84	172.40	172.04	44%	
Burnhamthorpe Road W.	21 & 24	2	3	0.39	0.77	0.30	1.01	0.76	1.84		16.84	75.074	0.158	CONC	0.013	0.30	600	120.00	1.19	0.336	1.68	171.95	171.59	47%	
Burnhamthorpe Road W.	20	3	4	0.41	0.53	0.22	1.42	0.98	1.68		18.52	70.780	0.192	CONC	0.013	0.30	675	120.00	1.29	0.460	1.55	171.50	171.14	42%	
Burnhamthorpe Road W.	19	4	5	0.42	0.49	0.21	1.84	1.18	1.55		20.07	67.277	0.221	CONC	0.013	0.40	675	120.00	1.49	0.532	1.35	171.10	170.62	42%	
Burnhamthorpe Road W.		5	Outlet 4	0.00	0.50	0.00	1.84	1.18	1.35		21.42	64.546	0.212	CONC	0.013	8.00	675	8.00	6.64	2.378	0.02	170.24	169.60	9%	
External Drainage Areas	External			38.35	0.75	28.76	38.35	28.76		21.90	21.90	63.633	5.084												External Drainge Plan by Proctor & Redfern
External Drainage Areas	External		Outlet 4	40.85	0.50	20.43	79.20	49.19			21.90	63.633	8.694	CONC	0.013	0.50	1650	1030.00	3.01		5.70				Consulting Engineers Drawings A1 - 84744 - G10
Outlet 4		5, 12 & External			0.62		83.42	51.62	5.70	21.90	27.60	54.668	7.838	CONC	0.013	0.50	2100	7.00	3.54	12.261	0.03	170.16	169.60	64%	

DEVELOPMENT: Burnhamthorpe Road Road MCEA

CONSULTANT: CIMA+

MAJOR DRAINAGE AREA: Joshua's Creek and Loyalist Creek Subwatershed

STORM DRAINAGE DESIGN CHART
FOR CIRCULAR DRAINS FLOWING FULL

PROPOSED CONDITIONS (C=0.7) 4 LANE CROSS-SECTION

SHEET No. 4 OF 12

PREPARED BY: Brian O'Dell

CHECKED BY: Ryan Cressman, P.Eng.

Project No. B000856

RETURN PERIOD = 5 YEARS
INLET TIME = 15 minutes
$I = A / (t_c + B) ^ C$
A = 820; B = 4.6; C = 0.78

2-10 Year Storms - C @ 100%
25 Year Storm - C @ 110%
50 Year Storm - C @ 120%
100 Year Storm - C @ 125%

LOCATION OF SITE	DRAINAGE AREA ID	FROM UPSTEAM	TO DOWNSTREAM	ADJACENT CONTRIBUTING AREA	RUNOFF COEFFICIENT	AREA TIMES RUNOFF COEFFICIENT	ACCUMULATIVE AREA DRAINED BY SECTION	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT FOR SECTION	FLOW TIME TO SECTION FROM EXTREME UPSTREAM INLET	INTIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET	TIME OF CONECENTRATION UPSTREAEM END OF SECTION	INTENSITY OF RAINFALL	QUANTITY OF FLOW TO BE ACCOMMODATED IN SECTION	TYPE OF PIPE	MANNINGS ROUGHNESS COEFFICIENT	SLOPE	DIAMETER	LENGTH OF SECTION	VELOCITY OF FLOW WITH PIPE FLOWING FULL	CAPACITY OF PIPE FLOWING FULL	TIME OF FLOW IN SECTION	PIPE INVERT AT UPSTREAM MH	PIPE INVERT AT DOWNSTREAM MH	PIPE CAPACITY	REMARKS
		MH#	MH#	A_A	C_A	$A_A \times C_A$	ΣA_A	$\Sigma A_A \times C_A$	tc_f	tc_i	$t_c = tc_f + tc_i$	i	$Q=iAC/360$		n	s	D	L	V	Q	$T = L / VX60$				
				ha			ha		min	min	min	mm/hr	m^3/s			%	mm	m	m/s	m^3/s	min	m	m	%	
Burnhamthorpe Road W.	3			0.37	0.30	0.11	0.37	0.11	0.00	15.00	15.00	80.51	0.025	DITCH											
Burnhamthorpe Road W.	1			0.16	0.90	0.14	0.53	0.14	0.00	15.00	15.00	80.51	0.032	DITCH											
Burnhamthorpe Road W.	5			0.44	0.30	0.13	0.44	0.13	0.00	15.00	15.00	80.51	0.030	DITCH											
Burnhamthorpe Road W.	2			0.15	0.90	0.14	0.59	0.14	0.00	15.00	15.00	80.51	0.030	DITCH											
Outlet 1					0.47		1.12	0.52	15.00		15.00	80.51	0.117	DITCH											
Burnhamthorpe Road W.	4	A	B	0.55	0.90	0.50	0.55	0.50	0.00	15.00	15.00	80.51	0.111	CONC	0.013	1.88	375	160.00	2.18	0.240	1.23	182.22	179.22	46%	
Burnhamthorpe Road W.	6	B	C	0.66	0.68	0.45	1.21	0.94	1.23		16.23	76.79	0.201	CONC	0.013	2.08	450	120.00	2.59	0.411	0.77	179.22	176.72	49%	
Burnhamthorpe Road W. to OGS		C	OGS	0.00	0.00	0.00	1.21	0.94	0.77		17.00	74.64	0.196	CONC	0.013	4.00	450	11.00	3.59	0.570	0.05	176.72	176.28	34%	
Burnhamthorpe Road W.		OGS	13	0.00	0.00	0.00	1.21	0.94	0.05		17.05	74.50	0.195	CONC	0.013	0.50	525	36.00	1.40	0.304	0.43	176.28	176.10	64%	
Outlet 3					0.78		1.21	0.94	0.43	17.05	17.48	73.37	0.192	CONC	0.013	0.44	675	100.00	1.56	0.558	1.07	170.16	169.60	34%	
Burnhamthorpe Road W.	9 & 10	6	7	0.72	0.71	0.51	0.72	0.51	0.00	15.00	15.00	80.51	0.114	CONC	0.013	0.90	375	100.00	1.51	0.166	1.11	178.00	177.10	69%	
Burnhamthorpe Road W.	11	7	8	0.36	0.70	0.25	1.08	0.76	1.11		16.11	77.13	0.164	CONC	0.013	0.90	450	100.00	1.70	0.270	0.98	177.00	176.10	60%	
Burnhamthorpe Road W.	12	8	9	0.35	0.74	0.26	1.43	1.02	0.98		17.09	74.40	0.211	CONC	0.013	0.80	525	100.00	1.78	0.385	0.94	176.00	175.20	55%	
Burnhamthorpe Road W.	13	9	10	0.20	0.77	0.15	1.63	1.18	0.94		18.02	71.98	0.235	CONC	0.013	1.00	525	100.00	1.99	0.430	0.84	174.50	173.50	55%	
Burnhamthorpe Road W.	16	10	11	0.39	0.77	0.30	2.02	1.48	0.84		18.86	69.97	0.287	CONC	0.013	1.00	600	100.00	2.17	0.614	0.77	173.40	172.40	47%	
Burnhamthorpe Road W.	17 & 18	11	12	0.36	0.72	0.26	2.38	1.74	0.77		19.63	68.23	0.329	CONC	0.013	1.50	600	90.00	2.66	0.752	0.56	172.30	170.95	44%	
Burnhamthorpe Road W.		12	Outlet 4				2.38	1.74	0.56		20.20	67.02	0.323	CONC	0.013	8.00	600	7.00	6.14	1.737	0.02	170.16	169.60	19%	
Burnhamthorpe Road W.	25 & 26	1	2	0.62	0.74	0.46	0.62	0.46	0.00	15.00	15.00	80.51	0.103	CONC	0.013	0.30	525	120.00	1.09	0.236	1.84	172.40	172.04	44%	
Burnhamthorpe Road W.	21 & 24	2	3	0.39	0.81	0.32	1.01	0.77	1.84		16.84	75.07	0.162	CONC	0.013	0.30	600	120.00	1.19	0.336	1.68	171.95	171.59	48%	
Burnhamthorpe Road W.	20	3	4	0.41	0.80	0.33	1.42	1.10	1.68		18.52	70.78	0.217	CONC	0.013	0.30	675	120.00	1.29	0.460	1.55	171.50	171.14	47%	
Burnhamthorpe Road W.	19	4	5	0.42	0.73	0.31	1.84	1.41	1.55		20.07	67.28	0.263	CONC	0.013	0.40	675	120.00	1.49	0.532	1.35	171.10	170.62	50%	
Burnhamthorpe Road W.		5	Outlet 4				1.84	1.41	1.35		21.42	64.55	0.253	CONC	0.013	8.00	675	8.00	6.64	2.378	0.02	170.24	169.60	11%	
External Drainage Areas	External			38.35	0.75	28.76	38.35	28.76		21.90	21.90	63.63	5.084												External Drainge Plan by Proctor & Redfern
External Drainage Areas	External		Outlet 4	40.85	0.50	20.43	79.20	49.19			21.90	63.63	8.694	CONC	0.013	0.50	1650	1030.00	3.01		5.70				Consulting Engineers Drawings A1 - 84744 - G10
Outlet 4		5, 12 & External			0.63		83.42	52.33	5.70	21.90	27.60	54.66	7.946	CONC	0.013	0.50	2100	7.00	3.54	12.261	0.03	170.16	169.60	65%	

DEVELOPMENT Burnhamthorpe Road Road MCEA

CONSULTANT CIMA+

MAJOR DRAINAGE AREA Joshua's Creek and Loyalist Creek Subwatershed

STORM DRAINAGE DESIGN CHART
FOR CIRCULAR DRAINS FLOWING FULL

EXISTING CONDITIONS (C=0.5) 2 LANE CROSS-SECTION

SHEET No. 5 OF 12

PREPARED BY: Brian O'Dell

CHECKED BY: Ryan Cressman, P.Eng.

Project No. B000856

RETURN PERIOD = 10 YEARS
INLET TIME = 15 minutes
$I = A / (t_c + B) ^ C$
A = 1010; B = 4.6; C = 0.78

2-10 Year Storms - C @ 100%
25 Year Storm - C @ 110%
50 Year Storm - C @ 120%
100 Year Storm - C @ 125%

LOCATION OF SITE	DRAINAGE AREA ID	FROM UPSTEAM	TO DOWNSTREAM	ADJACENT CONTRIBUTING AREA	RUNOFF COEFFICIENT	AREA TIMES RUNOFF COEFFICIENT	ACCUMULATIVE AREA DRAINED BY SECTION	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT FOR SECTION	FLOW TIME TO SECTION FROM EXTREME UPSTREAM INLET	INTIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET	TIME OF CONECENTRATION UPSTREAEM END OF SECTION	INTENSITY OF RAINFALL	QUANTITY OF FLOW TO BE ACCOMMODATED IN SECTION	TYPE OF PIPE	MANNINGS ROUGHNESS COEFFICIENT	SLOPE	DIAMETER	LENGTH OF SECTION	VELOCITY OF FLOW WITH PIPE FLOWING FULL	CAPACITY OF PIPE FLOWING FULL	TIME OF FLOW IN SECTION	PIPE INVERT AT UPSTREAM MH	PIPE INVERT AT DOWNSTREAM MH	PIPE CAPACITY	REMARKS
		MH#	MH#	A_A	C_A	$A_A X C_A$	ΣA_A	$\Sigma A_A X C_A$	tc_f	tc_i	$t_c = tc_f + tc_i$	i	Q=iAC/360		n	s	D	L	V	Q	T = L / VX60				
				ha			ha		min	min	min	mm/hr	m^3/s			%	mm	m	m/s	m^3/s	min	m	m	%	
Burnhamthorpe Road W.	3			0.69	0.40	0.28	0.69	0.28	0.00	15.00	15.00	99.17	0.076	DITCH											
Burnhamthorpe Road W.	1			0.16	0.90	0.14	0.85	0.14	0.00	15.00	15.00	99.17	0.040	DITCH											
Burnhamthorpe Road W.	4			0.67	0.38	0.25	0.67	0.25	0.00	15.00	15.00	99.17	0.070	DITCH											
Burnhamthorpe Road W.	2			0.14	0.90	0.13	0.81	0.13	0.00	15.00	15.00	99.17	0.035	DITCH											
Outlet 1					0.48		1.66	0.80	15.00		15.00	99.17	0.221	DITCH											
Burnhamthorpe Road W.	5			0.32	0.49	0.16	0.32	0.16	0.00	15.00	15.00	99.17	0.043	DITCH											
Outlet 2					0.49		0.32	0.16	15.00		15.00	99.17	0.043	CONC	0.013	0.94	300	28.00	1.33	0.094	0.35	170.16	169.60	46%	
Burnhamthorpe Road W.	6			0.34	0.46	0.16	0.34	0.16	0.00	15.00	15.00	99.17	0.043	DITCH											
Outlet 3					0.46		0.34	0.16	15.00		15.00	99.17	0.043	CONC	0.013	0.44	675	30.00	1.56	0.558	0.32	170.16	169.60	8%	
Burnhamthorpe Road W.	9 & 10	6	7	0.72	0.52	0.37	0.72	0.37	0.00	15.00	15.00	99.17	0.103	CONC	0.013	0.90	375	100.00	1.51	0.166	1.11	178.00	177.10	62%	
Burnhamthorpe Road W.	11	7	8	0.36	0.49	0.18	1.08	0.55	1.11		16.11	95.01	0.145	CONC	0.013	0.90	450	100.00	1.70	0.270	0.98	177.00	176.10	54%	
Burnhamthorpe Road W.	12	8	9	0.35	0.51	0.18	1.43	0.73	0.98		17.09	91.64	0.186	CONC	0.013	0.80	525	100.00	1.78	0.385	0.94	176.00	175.20	48%	
Burnhamthorpe Road W.	13	9	10	0.20	0.56	0.11	1.63	0.84	0.94		18.02	88.66	0.207	CONC	0.013	1.00	525	100.00	1.99	0.430	0.84	174.50	173.50	48%	
Burnhamthorpe Road W.	16	10	11	0.39	0.58	0.23	2.02	1.07	0.84		18.86	86.18	0.256	CONC	0.013	1.00	600	100.00	2.17	0.614	0.77	173.40	172.40	42%	
Burnhamthorpe Road W.	17 & 18	11	12	0.36	0.50	0.18	2.38	1.25	0.77		19.63	84.04	0.291	CONC	0.013	1.50	600	90.00	2.66	0.752	0.56	172.30	170.95	39%	
Burnhamthorpe Road W.		12	Outlet 4	0.00	0.50	0.00	2.38	1.25	0.56		20.20	82.55	0.286	CONC	0.013	8.00	600	7.00	6.14	1.737	0.02	170.16	169.60	16%	
Burnhamthorpe Road W.	25 & 26	1	2	0.62	0.74	0.46	0.62	0.46	0.00	15.00	15.00	99.17	0.126	CONC	0.013	0.30	525	120.00	1.09	0.236	1.84	172.40	172.04	54%	
Burnhamthorpe Road W.	21 & 24	2	3	0.39	0.77	0.30	1.01	0.76	1.84		16.84	92.47	0.195	CONC	0.013	0.30	600	120.00	1.19	0.336	1.68	171.95	171.59	58%	
Burnhamthorpe Road W.	20	3	4	0.41	0.53	0.22	1.42	0.98	1.68		18.52	87.18	0.236	CONC	0.013	0.30	675	120.00	1.29	0.460	1.55	171.50	171.14	51%	
Burnhamthorpe Road W.	19	4	5	0.42	0.49	0.21	1.84	1.18	1.55		20.07	82.87	0.272	CONC	0.013	0.40	675	120.00	1.49	0.532	1.35	171.10	170.62	51%	
Burnhamthorpe Road W.		5	Outlet 4	0.00	0.50	0.00	1.84	1.18	1.35		21.42	79.50	0.261	CONC	0.013	8.00	675	8.00	6.64	2.378	0.02	170.24	169.60	11%	
External Drainage Areas	External			38.35	0.75	28.76	38.35	28.76		21.90	21.90	78.38	6.262												External Drainge Plan by Proctor & Redfern
External Drainage Areas	External		Outlet 4	40.85	0.50	20.43	79.20	49.19			21.90	78.38	10.709	CONC	0.013	0.50	1650	1030.00	3.01		5.70				Consulting Engineers Drawings A1 - 84744 - G10
Outlet 4		5, 12 & External			0.62		83.42	51.62	5.70	21.90	27.60	67.34	9.655	CONC	0.013	0.50	2100	7.00	3.54	12.261	0.03	170.16	169.60	79%	

DEVELOPMENT: Burnhamthorpe Road Road MCEA

CONSULTANT: CIMA+

MAJOR DRAINAGE AREA: Joshua's Creek and Loyalist Creek Subwatershed

STORM DRAINAGE DESIGN CHART
FOR CIRCULAR DRAINS FLOWING FULL

PROPOSED CONDITIONS (C=0.7) 4 LANE CROSS-SECTION

SHEET No. 6 OF 12

PREPARED BY: Brian O'Dell

CHECKED BY: Ryan Cressman, P.Eng.

Project No. B000856

RETURN PERIOD = 10 YEARS
INLET TIME = 15 minutes
$I = A / (t_c + B) ^ C$
A = 1010; B = 4.6; C = 0.78

2-10 Year Storms - C @ 100%
25 Year Storm - C @ 110%
50 Year Storm - C @ 120%
100 Year Storm - C @ 125%

LOCATION OF SITE	DRAINAGE AREA ID	FROM UPSTEAM	TO DOWNSTREAM	ADJACENT CONTRIBUTING AREA	RUNOFF COEFFICIENT	AREA TIMES RUNOFF COEFFICIENT	ACCUMULATIVE AREA DRAINED BY SECTION	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT FOR SECTION	FLOW TIME TO SECTION FROM EXTREME UPSTREAM INLET	INTIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET	TIME OF CONECENTRATION UPSTREAEM END OF SECTION	INTENSITY OF RAINFALL	QUANTITY OF FLOW TO BE ACCOMMODATED IN SECTION	TYPE OF PIPE	MANNINGS ROUGHNESS COEFFICIENT	SLOPE	DIAMETER	LENGTH OF SECTION	VELOCITY OF FLOW WITH PIPE FLOWING FULL	CAPACITY OF PIPE FLOWING FULL	TIME OF FLOW IN SECTION	PIPE INVERT AT UPSTREAM MH	PIPE INVERT AT DOWNSTREAM MH	PIPE CAPACITY	REMARKS
		MH#	MH#	A_A	C_A	$A_A \times C_A$	ΣA_A	$\Sigma A_A \times C_A$	tc_f	tc_i	$t_c = tc_f + tc_i$	i	$Q=iAC/360$		n	s	D	L	V	Q	T = L / VX60				
				ha			ha		min	min	min	mm/hr	m^3/s			%	mm	m	m/s	m^3/s	min	m	m	%	
Burnhamthorpe Road W.	3			0.37	0.30	0.11	0.37	0.11	0.00	15.00	15.00	99.17	0.031	DITCH											
Burnhamthorpe Road W.	1			0.16	0.90	0.14	0.53	0.14	0.00	15.00	15.00	99.17	0.040	DITCH											
Burnhamthorpe Road W.	5			0.44	0.30	0.13	0.44	0.13	0.00	15.00	15.00	99.17	0.036	DITCH											
Burnhamthorpe Road W.	2			0.15	0.90	0.14	0.59	0.14	0.00	15.00	15.00	99.17	0.037	DITCH											
Outlet 1					0.47		1.12	0.52	15.00		15.00	99.17	0.144	DITCH											
Burnhamthorpe Road W.	4	A	B	0.55	0.90	0.50	0.55	0.50	0.00	15.00	15.00	99.17	0.136	CONC	0.013	1.88	375	160.00	2.18	0.240	1.23	182.22	179.22	57%	
Burnhamthorpe Road W.	6	B	C	0.66	0.68	0.45	1.21	0.94	1.23		16.23	94.59	0.248	CONC	0.013	2.08	450	120.00	2.59	0.411	0.77	179.22	176.72	60%	
Burnhamthorpe Road W. to OGS		C	OGS	0.00	0.00	0.00	1.21	0.94	0.77		17.00	91.93	0.241	CONC	0.013	4.00	450	11.00	3.59	0.570	0.05	176.72	176.28	42%	
Burnhamthorpe Road W.		OGS	13	0.00	0.00	0.00	1.21	0.94	0.05		17.05	91.76	0.241	CONC	0.013	0.50	525	36.00	1.40	0.304	0.43	176.28	176.10	79%	
Outlet 3					0.78		1.21	0.94	0.43	17.05	17.48	90.38	0.237	CONC	0.013	0.44	675	100.00	1.56	0.558	1.07	170.16	169.60	42%	
Burnhamthorpe Road W.	9 & 10	6	7	0.72	0.71	0.51	0.72	0.51	0.00	15.00	15.00	99.17	0.141	CONC	0.013	0.90	375	100.00	1.51	0.166	1.11	178.00	177.10	85%	
Burnhamthorpe Road W.	11	7	8	0.36	0.70	0.25	1.08	0.76	1.11		16.11	95.01	0.201	CONC	0.013	0.90	450	100.00	1.70	0.270	0.98	177.00	176.10	74%	
Burnhamthorpe Road W.	12	8	9	0.35	0.74	0.26	1.43	1.02	0.98		17.09	91.64	0.260	CONC	0.013	0.80	525	100.00	1.78	0.385	0.94	176.00	175.20	68%	
Burnhamthorpe Road W.	13	9	10	0.20	0.77	0.15	1.63	1.18	0.94		18.02	88.66	0.290	CONC	0.013	1.00	525	100.00	1.99	0.430	0.84	174.50	173.50	67%	
Burnhamthorpe Road W.	16	10	11	0.39	0.77	0.30	2.02	1.48	0.84		18.86	86.18	0.353	CONC	0.013	1.00	600	100.00	2.17	0.614	0.77	173.40	172.40	58%	
Burnhamthorpe Road W.	17 & 18	11	12	0.36	0.72	0.26	2.38	1.74	0.77		19.63	84.04	0.405	CONC	0.013	1.50	600	90.00	2.66	0.752	0.56	172.30	170.95	54%	
Burnhamthorpe Road W.		12	Outlet 4				2.38	1.74	0.56		20.20	82.55	0.398	CONC	0.013	8.00	600	7.00	6.14	1.737	0.02	170.16	169.60	23%	
Burnhamthorpe Road W.	25 & 26	1	2	0.62	0.74	0.46	0.62	0.46	0.00	15.00	15.00	99.17	0.126	CONC	0.013	0.30	525	120.00	1.09	0.236	1.84	172.40	172.04	54%	
Burnhamthorpe Road W.	21 & 24	2	3	0.39	0.81	0.32	1.01	0.77	1.84		16.84	92.47	0.199	CONC	0.013	0.30	600	120.00	1.19	0.336	1.68	171.95	171.59	59%	
Burnhamthorpe Road W.	20	3	4	0.41	0.80	0.33	1.42	1.10	1.68		18.52	87.18	0.267	CONC	0.013	0.30	675	120.00	1.29	0.460	1.55	171.50	171.14	58%	
Burnhamthorpe Road W.	19	4	5	0.42	0.73	0.31	1.84	1.41	1.55		20.07	82.87	0.324	CONC	0.013	0.40	675	120.00	1.49	0.532	1.35	171.10	170.62	61%	
Burnhamthorpe Road W.		5	Outlet 4				1.84	1.41	1.35		21.42	79.50	0.311	CONC	0.013	8.00	675	8.00	6.64	2.378	0.02	170.24	169.60	13%	
External Drainage Areas	External			38.35	0.75	28.76	38.35	28.76		21.90	21.90	78.38	6.262												External Drainge Plan by Proctor & Redfern
External Drainage Areas	External		Outlet 4	40.85	0.50	20.43	79.20	49.19			21.90	78.38	10.709	CONC	0.013	0.50	1650	1030.00	3.01		5.70				Consulting Engineers Drawings A1 - 84744 - G10
Outlet 4		5, 12 & External			0.63		83.42	52.33	5.70	21.90	27.60	67.33	9.787	CONC	0.013	0.50	2100	7.00	3.54	12.261	0.03	170.16	169.60	80%	

DEVELOPMENT: Burnhamthorpe Road Road MCEA

CONSULTANT: CIMA+

MAJOR DRAINAGE AREA: Joshua's Creek and Loyalist Creek Subwatershed

STORM DRAINAGE DESIGN CHART
FOR CIRCULAR DRAINS FLOWING FULL

EXISTING CONDITIONS (C=0.5) 2 LANE CROSS-SECTION

SHEET No. 7 OF 12

PREPARED BY: Brian O'Dell

CHECKED BY: Ryan Cressman, P.Eng.

Project No. B000856

RETURN PERIOD = 25 YEARS
INLET TIME = 15 minutes
$I = A / (t_c + B) ^ C$
A = 1160; B = 4.6; C = 0.78

2-10 Year Storms - C @ 100%
25 Year Storm - C @ 110%
50 Year Storm - C @ 120%
100 Year Storm - C @ 125%

LOCATION OF SITE	DRAINAGE AREA ID	FROM UPSTEAM	TO DOWNSTREAM	ADJACENT CONTRIBUTING AREA	RUNOFF COEFFICIENT	AREA TIMES RUNOFF COEFFICIENT	ACCUMULATIVE AREA DRAINED BY SECTION	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT FOR SECTION	FLOW TIME TO SECTION FROM EXTREME UPSTREAM INLET	INTIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET	TIME OF CONECENTRATION UPSTREAEM END OF SECTION	INTENSITY OF RAINFALL	QUANTITY OF FLOW TO BE ACCOMMODATED IN SECTION	TYPE OF PIPE	MANNINGS ROUGHNESS COEFFICIENT	SLOPE	DIAMETER	LENGTH OF SECTION	VELOCITY OF FLOW WITH PIPE FLOWING FULL	CAPACITY OF PIPE FLOWING FULL	TIME OF FLOW IN SECTION	PIPE INVERT AT UPSTREAM MH	PIPE INVERT AT DOWNSTREAM MH	PIPE CAPACITY	REMARKS
		MH#	MH#	A_A	C_A	$A_A \times C_A$	ΣA_A	$\Sigma A_A \times C_A$	tc_f	tc_i	$t_c = tc_f + tc_i$	i	Q=iAC/360		n	s	D	L	V	Q	T = L / VX60				
				ha			ha		min	min	min	mm/hr	m^3/s			%	mm	m	m/s	m^3/s	min	m	m	%	
Burnhamthorpe Road W.	3			0.69	0.44	0.30	0.69	0.30	0.00	15.00	15.00	113.893	0.096	DITCH											
Burnhamthorpe Road W.	1			0.16	0.95	0.15	0.85	0.15	0.00	15.00	15.00	113.893	0.048	DITCH											
Burnhamthorpe Road W.	4			0.67	0.42	0.28	0.67	0.28	0.00	15.00	15.00	113.893	0.089	DITCH											
Burnhamthorpe Road W.	2			0.14	0.95	0.13	0.81	0.13	0.00	15.00	15.00	113.893	0.042	DITCH											
Outlet 1					0.52		1.66	0.87	15.00		15.00	113.893	0.275	DITCH											
Burnhamthorpe Road W.	5			0.32	0.54	0.17	0.32	0.17	0.00	15.00	15.00	113.893	0.055	DITCH											
Outlet 2					0.54		0.32	0.17	15.00		15.00	113.893	0.055	CONC	0.013	0.94	300	28.00	1.33	0.094	0.35	170.16	169.60	58%	
Burnhamthorpe Road W.	6			0.34	0.51	0.17	0.34	0.17	0.00	15.00	15.00	113.893	0.054	DITCH											
Outlet 3					0.51		0.34	0.17	15.00		15.00	113.893	0.054	CONC	0.013	0.44	675	30.00	1.56	0.558	0.32	170.16	169.60	10%	
Burnhamthorpe Road W.	9 & 10	6	7	0.72	0.57	0.41	0.72	0.41	0.00	15.00	15.00	113.893	0.130	CONC	0.013	0.90	375	100.00	1.51	0.166	1.11	178.00	177.10	78%	
Burnhamthorpe Road W.	11	7	8	0.36	0.54	0.19	1.08	0.61	1.11		16.11	109.117	0.184	CONC	0.013	0.90	450	100.00	1.70	0.270	0.98	177.00	176.10	68%	
Burnhamthorpe Road W.	12	8	9	0.35	0.56	0.20	1.43	0.80	0.98		17.09	105.251	0.235	CONC	0.013	0.80	525	100.00	1.78	0.385	0.94	176.00	175.20	61%	
Burnhamthorpe Road W.	13	9	10	0.20	0.62	0.12	1.63	0.93	0.94		18.02	101.832	0.262	CONC	0.013	1.00	525	100.00	1.99	0.430	0.84	174.50	173.50	61%	
Burnhamthorpe Road W.	16	10	11	0.39	0.64	0.25	2.02	1.17	0.84		18.86	98.981	0.323	CONC	0.013	1.00	600	100.00	2.17	0.614	0.77	173.40	172.40	53%	
Burnhamthorpe Road W.	17 & 18	11	12	0.36	0.55	0.20	2.38	1.37	0.77		19.63	96.527	0.368	CONC	0.013	1.50	600	90.00	2.66	0.752	0.56	172.30	170.95	49%	
Burnhamthorpe Road W.		12	Outlet 4	0.00	0.55	0.00	2.38	1.37	0.56		20.20	94.810	0.361	CONC	0.013	8.00	600	7.00	6.14	1.737	0.02	170.16	169.60	21%	
Burnhamthorpe Road W.	25 & 26	1	2	0.62	0.81	0.50	0.62	0.50	0.00	15.00	15.00	113.893	0.160	CONC	0.013	0.30	525	120.00	1.09	0.236	1.84	172.40	172.04	68%	
Burnhamthorpe Road W.	21 & 24	2	3	0.39	0.85	0.33	1.01	0.84	1.84		16.84	106.202	0.246	CONC	0.013	0.30	600	120.00	1.19	0.336	1.68	171.95	171.59	73%	
Burnhamthorpe Road W.	20	3	4	0.41	0.58	0.24	1.42	1.07	1.68		18.52	100.128	0.299	CONC	0.013	0.30	675	120.00	1.29	0.460	1.55	171.50	171.14	65%	
Burnhamthorpe Road W.	19	4	5	0.42	0.54	0.23	1.84	1.30	1.55		20.07	95.173	0.344	CONC	0.013	0.40	675	120.00	1.49	0.532	1.35	171.10	170.62	65%	
Burnhamthorpe Road W.		5	Outlet 4	0.00	0.55	0.00	1.84	1.30	1.35		21.42	91.310	0.330	CONC	0.013	8.00	675	8.00	6.64	2.378	0.02	170.24	169.60	14%	
External Drainage Areas	External			38.35	0.83	31.64	38.35	31.64		21.90	21.90	90.017	7.911												External Drainge Plan by Proctor & Redfern
External Drainage Areas	External		Outlet 4	40.85	0.55	22.47	79.20	54.11			21.90	90.017	13.529	CONC	0.013	0.50	1650	1030.00	3.01		5.70				Consulting Engineers Drawings A1 - 84744 - G10
Outlet 4		5, 12 & External			0.68		83.42	56.78	5.70	21.90	27.60	77.335	12.197	CONC	0.013	0.50	2100	7.00	3.54	12.261	0.03	170.16	169.60	99%	

DEVELOPMENT: Burnhamthorpe Road Road MCEA

CONSULTANT: CIMA+

MAJOR DRAINAGE AREA: Joshua's Creek and Loyalist Creek Subwatershed

SHEET No. 8 OF 12

PREPARED BY: Brian O'Dell

CHECKED BY: Ryan Cressman, P.Eng.

Project No. B000856

STORM DRAINAGE DESIGN CHART
FOR CIRCULAR DRAINS FLOWING FULL

PROPOSED CONDITIONS (C=0.7) 4 LANE CROSS-SECTION

RETURN PERIOD = 25 YEARS
INLET TIME = 15 minutes
$I = A / (t_c + B) ^ C$
A = 1160; B = 4.6; C = 0.78

2-10 Year Storms - C @ 100%
25 Year Storm - C @ 110%
50 Year Storm - C @ 120%
100 Year Storm - C @ 125%

LOCATION OF SITE	DRAINAGE AREA ID	FROM UPSTEAM	TO DOWNSTREAM	ADJACENT CONTRIBUTING AREA	RUNOFF COEFFICIENT	AREA TIMES RUNOFF COEFFICIENT	ACCUMULATIVE AREA DRAINED BY SECTION	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT FOR SECTION	FLOW TIME TO SECTION FROM EXTREME UPSTREAM INLET	INTIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET	TIME OF CONECENTRATION UPSTREAEM END OF SECTION	INTENSITY OF RAINFALL	QUANTITY OF FLOW TO BE ACCOMMODATED IN SECTION	TYPE OF PIPE	MANNINGS ROUGHNESS COEFFICIENT	SLOPE	DIAMETER	LENGTH OF SECTION	VELOCITY OF FLOW WITH PIPE FLOWING FULL	CAPACITY OF PIPE FLOWING FULL	TIME OF FLOW IN SECTION	PIPE INVERT AT UPSTREAM MH	PIPE INVERT AT DOWNSTREAM MH	TOP OF GRATE AT UPSTREAM MH	DEPTH OF COVER AT UPSTREAM MH	PIPE CAPACITY	REMARKS
		MH#	MH#	A_A	C_A	$A_A \times C_A$	ΣA_A	$\Sigma A_A \times C_A$	tc_f	tc_i	$t_c = tc_f + tc_i$	i	Q=iAC/360		n	s	D	L	V	Q	T = L / VX60						
				ha			ha		min	min	min	mm/hr	m^3/s			%	mm	m	m/s	m^3/s	min	m	m	m	m	%	
Burnhamthorpe Road W.	3			0.37	0.33	0.12	0.37	0.12	0.00	15.00	15.00	113.89	0.039	DITCH													
Burnhamthorpe Road W.	1			0.16	0.95	0.15	0.53	0.15	0.00	15.00	15.00	113.89	0.048	DITCH													
Burnhamthorpe Road W.	5			0.44	0.33	0.15	0.44	0.15	0.00	15.00	15.00	113.89	0.046	DITCH													
Burnhamthorpe Road W.	2			0.15	0.95	0.14	0.59	0.14	0.00	15.00	15.00	113.89	0.045	DITCH													
Outlet 1					0.50		1.12	0.56	15.00		15.00	113.89	0.178	DITCH													
Burnhamthorpe Road W.	4	A	B	0.55	0.95	0.52	0.55	0.52	0.00	15.00	15.00	113.89	0.165	CONC	0.013	1.88	375	160.00	2.18	0.240	1.23	182.22	179.22			69%	
Burnhamthorpe Road W.	6	B	C	0.66	0.75	0.49	1.21	1.02	1.23		16.23	108.63	0.307	CONC	0.013	2.08	450	120.00	2.59	0.411	0.77	179.22	176.72			75%	
Burnhamthorpe Road W. to OGS		C	OGS	0.00	0.00	0.00	1.21	1.02	0.77		17.00	105.59	0.298	CONC	0.013	4.00	450	11.00	3.59	0.570	0.05	176.72	176.28			52%	
Burnhamthorpe Road W.		OGS	13	0.00	0.00	0.00	1.21	1.02	0.05		17.05	105.39	0.297	CONC	0.013	0.50	525	36.00	1.40	0.304	0.43	176.28	176.10			98%	
Outlet 3					0.84		1.21	1.02	0.43	17.05	17.48	103.80	0.293	CONC	0.013	0.44	675	100.00	1.56	0.558	1.07	170.16	169.60			53%	
Burnhamthorpe Road W.	9 & 10	6	7	0.72	0.78	0.56	0.72	0.56	0.00	15.00	15.00	113.89	0.178	CONC	0.013	0.90	375	100.00	1.51	0.166	1.11	178.00	177.10			107%	
Burnhamthorpe Road W.	11	7	8	0.36	0.77	0.28	1.08	0.84	1.11		16.11	109.12	0.254	CONC	0.013	0.90	450	100.00	1.70	0.270	0.98	177.00	176.10			94%	
Burnhamthorpe Road W.	12	8	9	0.35	0.81	0.28	1.43	1.12	0.98		17.09	105.25	0.329	CONC	0.013	0.80	525	100.00	1.78	0.385	0.94	176.00	175.20			85%	
Burnhamthorpe Road W.	13	9	10	0.20	0.85	0.17	1.63	1.29	0.94		18.02	101.83	0.366	CONC	0.013	1.00	525	100.00	1.99	0.430	0.84	174.50	173.50			85%	
Burnhamthorpe Road W.	16	10	11	0.39	0.85	0.33	2.02	1.62	0.84		18.86	98.98	0.447	CONC	0.013	1.00	600	100.00	2.17	0.614	0.77	173.40	172.40			73%	
Burnhamthorpe Road W.	17 & 18	11	12	0.36	0.79	0.29	2.38	1.91	0.77		19.63	96.53	0.512	CONC	0.013	1.50	600	90.00	2.66	0.752	0.56	172.30	170.95			68%	
Burnhamthorpe Road W.		12	Outlet 4				2.38	1.91	0.56		20.20	94.81	0.503	CONC	0.013	8.00	600	7.00	6.14	1.737	0.02	170.16	169.60			29%	
Burnhamthorpe Road W.	25 & 26	1	2	0.62	0.81	0.50	0.62	0.50	0.00	15.00	15.00	113.89	0.160	CONC	0.013	0.30	525	120.00	1.09	0.236	1.84	172.40	172.04			68%	
Burnhamthorpe Road W.	21 & 24	2	3	0.39	0.89	0.35	1.01	0.85	1.84		16.84	106.20	0.251	CONC	0.013	0.30	600	120.00	1.19	0.336	1.68	171.95	171.59			75%	
Burnhamthorpe Road W.	20	3	4	0.41	0.88	0.36	1.42	1.21	1.68		18.52	100.13	0.337	CONC	0.013	0.30	675	120.00	1.29	0.460	1.55	171.50	171.14			73%	
Burnhamthorpe Road W.	19	4	5	0.42	0.80	0.34	1.84	1.55	1.55		20.07	95.17	0.410	CONC	0.013	0.40	675	120.00	1.49	0.532	1.35	171.10	170.62			77%	
Burnhamthorpe Road W.		5	Outlet 4				1.84	1.55	1.35		21.42	91.31	0.393	CONC	0.013	8.00	675	8.00	6.64	2.378	0.02	170.24	169.60			17%	
External Drainage Areas	External			38.35	0.83	31.64	38.35	31.64		21.90	21.90	90.02	7.911														External Drainge Plan by Proctor & Redfern
External Drainage Areas	External		Outlet 4	40.85	0.55	22.47	79.20	54.11			21.90	90.02	13.529	CONC	0.013	0.50	1650	1030.00	3.01		5.70						Consulting Engineers Drawings A1 - 84744 - G10
Outlet 4		5, 12 & External			0.69		83.42	57.57	5.70	21.90	27.60	77.33	12.365	CONC	0.013	0.50	2100	7.00	3.54	12.261	0.03	170.16	169.60			101%	

DEVELOPMENT: Burnhamthorpe Road Road MCEA

CONSULTANT: CIMA+

MAJOR DRAINAGE AREA: Joshua's Creek and Loyalist Creek Subwatershed

STORM DRAINAGE DESIGN CHART
FOR CIRCULAR DRAINS FLOWING FULL

EXISTING CONDITIONS (C=0.5) 2 LANE CROSS-SECTION

SHEET No. 9 OF 12

PREPARED BY: Brian O'Dell

CHECKED BY: Ryan Cressman, P.Eng.

Project No. B000856

RETURN PERIOD = 50 YEARS
INLET TIME = 15 minutes
I = A / (t_c + B) ^ C
A = 1300; B = 4.7; C = 0.78

2-10 Year Storms - C @ 100%
25 Year Storm - C @ 110%
50 Year Storm - C @ 120%
100 Year Storm - C @ 125%

LOCATION OF SITE	DRAINAGE AREA ID	FROM UPSTEAM	TO DOWNSTREAM	ADJACENT CONTRIBUTING AREA	RUNOFF COEFFICIENT	AREA TIMES RUNOFF COEFFICIENT	ACCUMULATIVE AREA DRAINED BY SECTION	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT FOR SECTION	FLOW TIME TO SECTION FROM EXTREME UPSTREAM INLET	INTIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET	TIME OF CONECENTRATION UPSTREAEM END OF SECTION	INTENSITY OF RAINFALL	QUANTITY OF FLOW TO BE ACCOMMODATED IN SECTION	TYPE OF PIPE	MANNINGS ROUGHNESS COEFFICIENT	SLOPE	DIAMETER	LENGTH OF SECTION	VELOCITY OF FLOW WITH PIPE FLOWING FULL	CAPACITY OF PIPE FLOWING FULL	TIME OF FLOW IN SECTION	PIPE INVERT AT UPSTREAM MH	PIPE INVERT AT DOWNSTREAM MH	PIPE CAPACITY	REMARKS
		MH#	MH#	A_A	C_A	A_A X C_A	Σ A_A	Σ A_A X C_A	tc_f	tc_i	$t_c = tc_f + tc_i$	i	Q=iAC/360		n	s	D	L	V	Q	T = L / VX60				
				ha			ha		min	min	min	mm/hr	m^3/s			%	mm	m	m/s	m^3/s	min	m	m	%	
Burnhamthorpe Road W.	3			0.69	0.48	0.33	0.69	0.33	0.00	15.00	15.00	127.133	0.117	DITCH											
Burnhamthorpe Road W.	1			0.16	0.95	0.15	0.85	0.15	0.00	15.00	15.00	127.133	0.054	DITCH											
Burnhamthorpe Road W.	4			0.67	0.46	0.31	0.67	0.31	0.00	15.00	15.00	127.133	0.108	DITCH											
Burnhamthorpe Road W.	2			0.14	0.95	0.13	0.81	0.13	0.00	15.00	15.00	127.133	0.047	DITCH											
Outlet 1					0.56		1.66	0.92	15.00		15.00	127.133	0.326	DITCH											
Burnhamthorpe Road W.	5			0.32	0.59	0.19	0.32	0.19	0.00	15.00	15.00	127.133	0.066	DITCH											
Outlet 2					0.59		0.32	0.19	15.00		15.00	127.133	0.066	CONC	0.013	0.94	300	28.00	1.33	0.094	0.35	170.16	169.60	71%	
Burnhamthorpe Road W.	6			0.34	0.55	0.19	0.34	0.19	0.00	15.00	15.00	127.133	0.066	DITCH											
Outlet 3					0.55		0.34	0.19	15.00		15.00	127.133	0.066	CONC	0.013	0.44	675	30.00	1.56	0.558	0.32	170.16	169.60	12%	
Burnhamthorpe Road W.	9 & 10	6	7	0.72	0.62	0.45	0.72	0.45	0.00	15.00	15.00	127.133	0.159	CONC	0.013	0.90	375	100.00	1.51	0.166	1.11	178.00	177.10	95%	
Burnhamthorpe Road W.	11	7	8	0.36	0.59	0.21	1.08	0.66	1.11		16.11	121.827	0.224	CONC	0.013	0.90	450	100.00	1.70	0.270	0.98	177.00	176.10	83%	
Burnhamthorpe Road W.	12	8	9	0.35	0.61	0.21	1.43	0.88	0.98		17.09	117.531	0.286	CONC	0.013	0.80	525	100.00	1.78	0.385	0.94	176.00	175.20	74%	
Burnhamthorpe Road W.	13	9	10	0.20	0.67	0.13	1.63	1.01	0.94		18.02	113.730	0.319	CONC	0.013	1.00	525	100.00	1.99	0.430	0.84	174.50	173.50	74%	
Burnhamthorpe Road W.	16	10	11	0.39	0.70	0.27	2.02	1.28	0.84		18.86	110.559	0.393	CONC	0.013	1.00	600	100.00	2.17	0.614	0.77	173.40	172.40	64%	
Burnhamthorpe Road W.	17 & 18	11	12	0.36	0.60	0.22	2.38	1.50	0.77		19.63	107.830	0.448	CONC	0.013	1.50	600	90.00	2.66	0.752	0.56	172.30	170.95	60%	
Burnhamthorpe Road W.		12	Outlet 4	0.00	0.60	0.00	2.38	1.50	0.56		20.20	105.919	0.440	CONC	0.013	8.00	600	7.00	6.14	1.737	0.02	170.16	169.60	25%	
Burnhamthorpe Road W.	25 & 26	1	2	0.62	0.89	0.55	0.62	0.55	0.00	15.00	15.00	127.133	0.194	CONC	0.013	0.30	525	120.00	1.09	0.236	1.84	172.40	172.04	83%	
Burnhamthorpe Road W.	21 & 24	2	3	0.39	0.92	0.36	1.01	0.91	1.84		16.84	118.589	0.300	CONC	0.013	0.30	600	120.00	1.19	0.336	1.68	171.95	171.59	89%	
Burnhamthorpe Road W.	20	3	4	0.41	0.64	0.26	1.42	1.17	1.68		18.52	111.835	0.364	CONC	0.013	0.30	675	120.00	1.29	0.460	1.55	171.50	171.14	79%	
Burnhamthorpe Road W.	19	4	5	0.42	0.59	0.25	1.84	1.42	1.55		20.07	106.323	0.419	CONC	0.013	0.40	675	120.00	1.49	0.532	1.35	171.10	170.62	79%	
Burnhamthorpe Road W.		5	Outlet 4	0.00	0.60	0.00	1.84	1.42	1.35		21.42	102.024	0.402	CONC	0.013	8.00	675	8.00	6.64	2.378	0.02	170.24	169.60	17%	
External Drainage Areas	External			38.35	0.90	34.52	38.35	34.52		21.90	21.90	100.586	9.644												External Drainge Plan by Proctor & Redfern
External Drainage Areas	External		Outlet 4	40.85	0.60	24.51	79.20	59.03			21.90	100.586	16.492	CONC	0.013	0.50	1650	1030.00	3.01		5.70				Consulting Engineers Drawings A1 - 84744 - G10
Outlet 4		5, 12 & External			0.74		83.42	61.94	5.70	21.90	27.60	86.460	14.876	CONC	0.013	0.50	2100	7.00	3.54	12.261	0.03	170.16	169.60	121%	

DEVELOPMENT: Burnhamthorpe Road Road MCEA

CONSULTANT: CIMA+

MAJOR DRAINAGE AREA: Joshua's Creek and Loyalist Creek Subwatershed

STORM DRAINAGE DESIGN CHART
FOR CIRCULAR DRAINS FLOWING FULL

PROPOSED CONDITIONS (C=0.7) 4 LANE CROSS-SECTION

SHEET No. 10 OF 12

PREPARED BY: Brian O'Dell

CHECKED BY: Ryan Cressman, P.Eng.

Project No. B000856

RETURN PERIOD = 50 YEARS
INLET TIME = 15 minutes
$I = A / (t_c + B) ^ C$
A = 1300; B = 4.7; C = 0.78

2-10 Year Storms - C @ 100%
25 Year Storm - C @ 110%
50 Year Storm - C @ 120%
100 Year Storm - C @ 125%

LOCATION OF SITE	DRAINAGE AREA ID	FROM UPSTEAM	TO DOWNSTREAM	ADJACENT CONTRIBUTING AREA	RUNOFF COEFFICIENT	AREA TIMES RUNOFF COEFFICIENT	ACCUMULATIVE AREA DRAINED BY SECTION	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT FOR SECTION	FLOW TIME TO SECTION FROM EXTREME UPSTREAM INLET	INTIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET	TIME OF CONECENTRATION UPSTREAEM END OF SECTION	INTENSITY OF RAINFALL	QUANTITY OF FLOW TO BE ACCOMMODATED IN SECTION	TYPE OF PIPE	MANNINGS ROUGHNESS COEFFICIENT	SLOPE	DIAMETER	LENGTH OF SECTION	VELOCITY OF FLOW WITH PIPE FLOWING FULL	CAPACITY OF PIPE FLOWING FULL	TIME OF FLOW IN SECTION	PIPE INVERT AT UPSTREAM MH	PIPE INVERT AT DOWNSTREAM MH	PIPE CAPACITY	REMARKS
		MH#	MH#	A_A	C_A	$A_A \times C_A$	ΣA_A	$\Sigma A_A \times C_A$	tc_f	tc_i	$t_c = tc_f + tc_i$	i	$Q=iAC/360$		n	s	D	L	V	Q	T = L / VX60				
				ha			ha		min	min	min	mm/hr	m^3/s			%	mm	m	m/s	m^3/s	min	m	m	%	
Burnhamthorpe Road W.	3			0.37	0.36	0.13	0.37	0.13	0.00	15.00	15.00	127.13	0.047	DITCH											
Burnhamthorpe Road W.	1			0.16	0.95	0.15	0.53	0.15	0.00	15.00	15.00	127.13	0.054	DITCH											
Burnhamthorpe Road W.	5			0.44	0.36	0.16	0.44	0.16	0.00	15.00	15.00	127.13	0.056	DITCH											
Burnhamthorpe Road W.	2			0.15	0.95	0.14	0.59	0.14	0.00	15.00	15.00	127.13	0.050	DITCH											
Outlet 1					0.52		1.12	0.59	15.00		15.00	127.13	0.207	DITCH											
Burnhamthorpe Road W.	4	A	B	0.55	0.95	0.52	0.55	0.52	0.00	15.00	15.00	127.13	0.185	CONC	0.013	1.88	375	160.00	2.18	0.240	1.23	182.22	179.22	77%	
Burnhamthorpe Road W.	6	B	C	0.66	0.82	0.54	1.21	1.06	1.23		16.23	121.29	0.357	CONC	0.013	2.08	450	120.00	2.59	0.411	0.77	179.22	176.72	87%	
Burnhamthorpe Road W. to OGS		C	OGS	0.00	0.00	0.00	1.21	1.06	0.77		17.00	117.90	0.348	CONC	0.013	4.00	450	11.00	3.59	0.570	0.05	176.72	176.28	61%	
Burnhamthorpe Road W.		OGS	13	0.00	0.00	0.00	1.21	1.06	0.05		17.05	117.69	0.347	CONC	0.013	0.50	525	36.00	1.40	0.304	0.43	176.28	176.10	114%	
Outlet 3					0.88		1.21	1.06	0.43	17.05	17.48	115.91	0.342	CONC	0.013	0.44	675	100.00	1.56	0.558	1.07	170.16	169.60	61%	
Burnhamthorpe Road W.	9 & 10	6	7	0.72	0.85	0.61	0.72	0.61	0.00	15.00	15.00	127.13	0.217	CONC	0.013	0.90	375	100.00	1.51	0.166	1.11	178.00	177.10	130%	
Burnhamthorpe Road W.	11	7	8	0.36	0.84	0.30	1.08	0.92	1.11		16.11	121.83	0.310	CONC	0.013	0.90	450	100.00	1.70	0.270	0.98	177.00	176.10	115%	
Burnhamthorpe Road W.	12	8	9	0.35	0.89	0.31	1.43	1.23	0.98		17.09	117.53	0.400	CONC	0.013	0.80	525	100.00	1.78	0.385	0.94	176.00	175.20	104%	
Burnhamthorpe Road W.	13	9	10	0.20	0.92	0.18	1.63	1.41	0.94		18.02	113.73	0.446	CONC	0.013	1.00	525	100.00	1.99	0.430	0.84	174.50	173.50	104%	
Burnhamthorpe Road W.	16	10	11	0.39	0.92	0.36	2.02	1.77	0.84		18.86	110.56	0.544	CONC	0.013	1.00	600	100.00	2.17	0.614	0.77	173.40	172.40	89%	
Burnhamthorpe Road W.	17 & 18	11	12	0.36	0.86	0.31	2.38	2.08	0.77		19.63	107.83	0.624	CONC	0.013	1.50	600	90.00	2.66	0.752	0.56	172.30	170.95	83%	
Burnhamthorpe Road W.		12	Outlet 4				2.38	2.08	0.56		20.20	105.92	0.613	CONC	0.013	8.00	600	7.00	6.14	1.737	0.02	170.16	169.60	35%	
Burnhamthorpe Road W.	25 & 26	1	2	0.62	0.89	0.55	0.62	0.55	0.00	15.00	15.00	127.13	0.194	CONC	0.013	0.30	525	120.00	1.09	0.236	1.84	172.40	172.04	83%	
Burnhamthorpe Road W.	21 & 24	2	3	0.39	0.95	0.37	1.01	0.92	1.84		16.84	118.59	0.303	CONC	0.013	0.30	600	120.00	1.19	0.336	1.68	171.95	171.59	90%	
Burnhamthorpe Road W.	20	3	4	0.41	0.95	0.39	1.42	1.31	1.68		18.52	111.84	0.407	CONC	0.013	0.30	675	120.00	1.29	0.460	1.55	171.50	171.14	88%	
Burnhamthorpe Road W.	19	4	5	0.42	0.88	0.37	1.84	1.68	1.55		20.07	106.32	0.496	CONC	0.013	0.40	675	120.00	1.49	0.532	1.35	171.10	170.62	93%	
Burnhamthorpe Road W.		5	Outlet 4				1.84	1.68	1.35		21.42	102.02	0.476	CONC	0.013	8.00	675	8.00	6.64	2.378	0.02	170.24	169.60	20%	
External Drainage Areas	External			38.35	0.90	34.52	38.35	34.52		21.90	21.90	100.59	9.644												External Drainge Plan by Proctor & Redfern
External Drainage Areas	External		Outlet 4	40.85	0.60	24.51	79.20	59.03			21.90	100.59	16.492	CONC	0.013	0.50	1650	1030.00	3.01		5.70				Consulting Engineers Drawings A1 - 84744 - G10
Outlet 4		5, 12 & External			0.75		83.42	62.79	5.70	21.90	27.60	86.45	15.077	CONC	0.013	0.50	2100	7.00	3.54	12.261	0.03	170.16	169.60	123%	

DEVELOPMENT: Burnhamthorpe Road Road MCEA

CONSULTANT: CIMA+

MAJOR DRAINAGE AREA: Joshua's Creek and Loyalist Creek Subwatershed

STORM DRAINAGE DESIGN CHART
FOR CIRCULAR DRAINS FLOWING FULL

EXISTING CONDITIONS (C=0.5) 2 LANE CROSS-SECTION

SHEET No. 11 OF 12

PREPARED BY: Brian O'Dell

CHECKED BY: Ryan Cressman, P.Eng.

Project No. B000856

RETURN PERIOD = 100 YEARS
INLET TIME = 15 minutes
$I = A / (t_c + B) ^ C$
A = 1450; B = 4.9; C = 0.78

2-10 Year Storms - C @ 100%
25 Year Storm - C @ 110%
50 Year Storm - C @ 120%
100 Year Storm - C @ 125%

LOCATION OF SITE	DRAINAGE AREA ID	FROM UPSTEAM	TO DOWNSTREAM	ADJACENT CONTRIBUTING AREA	RUNOFF COEFFICIENT	AREA TIMES RUNOFF COEFFICIENT	ACCUMULATIVE AREA DRAINED BY SECTION	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT FOR SECTION	FLOW TIME TO SECTION FROM EXTREME UPSTREAM INLET	INTIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET	TIME OF CONECENTRATION UPSTREAEM END OF SECTION	INTENSITY OF RAINFALL	QUANTITY OF FLOW TO BE ACCOMMODATED IN SECTION	TYPE OF PIPE	MANNINGS ROUGHNESS COEFFICIENT	SLOPE	DIAMETER	LENGTH OF SECTION	VELOCITY OF FLOW WITH PIPE FLOWING FULL	CAPACITY OF PIPE FLOWING FULL	TIME OF FLOW IN SECTION	PIPE INVERT AT UPSTREAM MH	PIPE INVERT AT DOWNSTREAM MH	PIPE CAPACITY	REMARKS
		MH#	MH#	A_A	C_A	$A_A X C_A$	ΣA_A	$\Sigma A_A X C_A$	tc_f	tc_i	$t_c = tc_f + tc_i$	i	Q=iAC/360		n	s	D	L	V	Q	T = L / VX60				
				ha			ha		min	min	min	mm/hr	m^3/s			%	mm	m	m/s	m^3/s	min	m	m	%	
Burnhamthorpe Road W.	3			0.69	0.50	0.35	0.69	0.35	0.00	15.00	15.00	175.86	0.169	DITCH											
Burnhamthorpe Road W.	1			0.16	0.95	0.15	0.85	0.15	0.00	15.00	15.00	99.17	0.042	DITCH											
Burnhamthorpe Road W.	4			0.67	0.48	0.32	0.67	0.32	0.00	15.00	15.00	175.86	0.155	DITCH											
Burnhamthorpe Road W.	2			0.14	0.95	0.13	0.81	0.13	0.00	15.00	15.00	99.17	0.037	DITCH											
Outlet 1					0.57		1.66	0.95	15.00		15.00	175.86	0.463	DITCH											
Burnhamthorpe Road W.	5			0.32	0.61	0.20	0.32	0.20	0.00	15.00	15.00	175.86	0.096	DITCH											
Outlet 2					0.61		0.32	0.20	15.00		15.00	175.86	0.096	CONC	0.013	0.94	300	28.00	1.33	0.094	0.35	170.16	169.60	102%	
Burnhamthorpe Road W.	6			0.34	0.58	0.20	0.34	0.20	0.00	15.00	15.00	175.86	0.096	DITCH											
Outlet 3				0.00	0.46	0.00	0.34	0.20	15.00		15.00	175.86	0.096	CONC	0.013	0.44	675	30.00	1.56	0.558	0.32	170.16	169.60	17%	
Burnhamthorpe Road W.	9 & 10	6	7	0.72	0.65	0.47	0.72	0.47	0.00	15.00	15.00	175.86	0.229	CONC	0.013	0.90	375	100.00	1.51	0.166	1.11	178.00	177.10	137%	
Burnhamthorpe Road W.	11	7	8	0.36	0.61	0.22	1.08	0.69	1.11		16.11	168.59	0.322	CONC	0.013	0.90	450	100.00	1.70	0.270	0.98	177.00	176.10	119%	
Burnhamthorpe Road W.	12	8	9	0.35	0.64	0.22	1.43	0.91	0.98		17.09	162.70	0.412	CONC	0.013	0.80	525	100.00	1.78	0.385	0.94	176.00	175.20	107%	
Burnhamthorpe Road W.	13	9	10	0.20	0.70	0.14	1.63	1.05	0.94		18.02	157.49	0.460	CONC	0.013	1.00	525	100.00	1.99	0.430	0.84	174.50	173.50	107%	
Burnhamthorpe Road W.	16	10	11	0.39	0.73	0.28	2.02	1.33	0.84		18.86	153.13	0.568	CONC	0.013	1.00	600	100.00	2.17	0.614	0.77	173.40	172.40	92%	
Burnhamthorpe Road W.	17 & 18	11	12	0.36	0.63	0.23	2.38	1.56	0.77		19.63	149.38	0.647	CONC	0.013	1.50	600	90.00	2.66	0.752	0.56	172.30	170.95	86%	
Burnhamthorpe Road W.		12	Outlet 4	0.00	0.63	0.00	2.38	1.56	0.56		20.20	146.76	0.636	CONC	0.013	8.00	600	7.00	6.14	1.737	0.02	170.16	169.60	37%	
Burnhamthorpe Road W.	25 & 26	1	2	0.62	0.93	0.57	0.62	0.57	0.00	15.00	15.00	175.86	0.280	CONC	0.013	0.30	525	120.00	1.09	0.236	1.84	172.40	172.04	119%	
Burnhamthorpe Road W.	21 & 24	2	3	0.39	0.95	0.37	1.01	0.94	1.84		16.84	164.15	0.430	CONC	0.013	0.30	600	120.00	1.19	0.336	1.68	171.95	171.59	128%	
Burnhamthorpe Road W.	20	3	4	0.41	0.66	0.27	1.42	1.22	1.68		18.52	154.88	0.523	CONC	0.013	0.30	675	120.00	1.29	0.460	1.55	171.50	171.14	114%	
Burnhamthorpe Road W.	19	4	5	0.42	0.61	0.26	1.84	1.47	1.55		20.07	147.31	0.603	CONC	0.013	0.40	675	120.00	1.49	0.532	1.35	171.10	170.62	113%	
Burnhamthorpe Road W.		5	Outlet 4	0.00	0.63	0.00	1.84	1.47	1.35		21.42	141.40	0.579	CONC	0.013	8.00	675	8.00	6.64	2.378	0.02	170.24	169.60	24%	
External Drainage Areas	External			38.35	0.94	35.95	38.35	35.95		21.90	21.90	139.42	13.924												External Drainge Plan by Proctor & Redfern
External Drainage Areas	External		Outlet 4	40.85	0.63	25.53	79.20	61.48			21.90	139.42	23.812	CONC	0.013	0.50	1650	1030.00	3.01		5.70				Consulting Engineers Drawings A1 - 84744 - G10
Outlet 4		5, 12 & External			0.77		83.42	64.52	5.70	21.90	27.60	119.95	21.497	CONC	0.013	0.50	2100	7.00	3.54	12.261	0.03	170.16	169.60	175%	

DEVELOPMENT: Burnhamthorpe Road Road MCEA

CONSULTANT: CIMA+

MAJOR DRAINAGE AREA: Joshua's Creek and Loyalist Creek Subwatershed

STORM DRAINAGE DESIGN CHART
FOR CIRCULAR DRAINS FLOWING FULL

PROPOSED CONDITIONS (C=0.7) 4 LANE CROSS-SECTION

SHEET No. 12 OF 12

PREPARED BY: Brian O'Dell

CHECKED BY: Ryan Cressman, P.Eng.

Project No. B000856

RETURN PERIOD = 100 YEARS
INLET TIME = 15 minutes
$I = A / (t_c + B) ^ C$
A = 1450; B = 4.9; C = 0.78

2-10 Year Storms - C @ 100%
25 Year Storm - C @ 110%
50 Year Storm - C @ 120%
100 Year Storm - C @ 125%

LOCATION OF SITE	DRAINAGE AREA ID	FROM UPSTEAM	TO DOWNSTREAM	ADJACENT CONTRIBUTING AREA	RUNOFF COEFFICIENT	AREA TIMES RUNOFF COEFFICIENT	ACCUMULATIVE AREA DRAINED BY SECTION	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT FOR SECTION	FLOW TIME TO SECTION FROM EXTREME UPSTREAM INLET	INTIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET	TIME OF CONECENTRATION UPSTREAEM END OF SECTION	INTENSITY OF RAINFALL	QUANTITY OF FLOW TO BE ACCOMMODATED IN SECTION	TYPE OF PIPE	MANNINGS ROUGHNESS COEFFICIENT	SLOPE	DIAMETER	LENGTH OF SECTION	VELOCITY OF FLOW WITH PIPE FLOWING FULL	CAPACITY OF PIPE FLOWING FULL	TIME OF FLOW IN SECTION	PIPE INVERT AT UPSTREAM MH	PIPE INVERT AT DOWNSTREAM MH	PIPE CAPACITY	REMARKS
		MH#	MH#	A_A	C_A	A_A X C_A	Σ A_A	Σ A_A X C_A	tc_f	tc_i	$t_c = tc_f + tc_i$	i	Q=iAC/360		n	s	D	L	V	Q	T = L / VX60				
				ha			ha		min	min	min	mm/hr	m^3/s			%	mm	m	m/s	m^3/s	min	m	m	%	
Burnhamthorpe Road W.	3			0.37	0.38	0.14	0.37	0.14	0.00	15.00	15.00	175.86	0.068	DITCH											
Burnhamthorpe Road W.	1			0.16	0.95	0.15	0.53	0.15	0.00	15.00	15.00	99.17	0.042	DITCH											
Burnhamthorpe Road W.	5			0.44	0.38	0.17	0.44	0.17	0.00	15.00	15.00	175.86	0.081	DITCH											
Burnhamthorpe Road W.	2			0.15	0.95	0.14	0.59	0.14	0.00	15.00	15.00	99.17	0.039	DITCH											
Outlet 1					0.53		1.12	0.60	15.00		15.00	175.86	0.292	DITCH											
Burnhamthorpe Road W.	4	A	B	0.55	0.95	0.52	0.55	0.52	0.00	15.00	15.00	175.86	0.255	CONC	0.013	1.88	375	160.00	2.18	0.240	1.23	182.22	179.22	106%	
Burnhamthorpe Road W.	6	B	C	0.66	0.85	0.56	1.21	1.08	1.23		16.23	167.86	0.505	CONC	0.013	2.08	450	120.00	2.59	0.411	0.77	179.22	176.72	123%	
Burnhamthorpe Road W. to OGS		C	OGS	0.00	0.00	0.00	1.21	1.08	0.77		17.00	163.21	0.491	CONC	0.013	4.00	450	11.00	3.59	0.570	0.05	176.72	176.28	86%	
Burnhamthorpe Road W.		OGS	13	0.00	0.00	0.00	1.21	1.08	0.05		17.05	162.92	0.490	CONC	0.013	0.50	525	36.00	1.40	0.304	0.43	176.28	176.10	161%	
Outlet 3					0.90		1.21	1.08	0.43	17.05	17.48	160.48	0.483	CONC	0.013	0.44	675	100.00	1.56	0.558	1.07	170.16	169.60	87%	
Burnhamthorpe Road W.	9 & 10	6	7	0.72	0.89	0.64	0.72	0.64	0.00	15.00	15.00	175.86	0.312	CONC	0.013	0.90	375	100.00	1.51	0.166	1.11	178.00	177.10	188%	
Burnhamthorpe Road W.	11	7	8	0.36	0.88	0.32	1.08	0.95	1.11		16.11	168.59	0.447	CONC	0.013	0.90	450	100.00	1.70	0.270	0.98	177.00	176.10	165%	
Burnhamthorpe Road W.	12	8	9	0.35	0.93	0.32	1.43	1.28	0.98		17.09	162.70	0.577	CONC	0.013	0.80	525	100.00	1.78	0.385	0.94	176.00	175.20	150%	
Burnhamthorpe Road W.	13	9	10	0.20	0.95	0.19	1.63	1.47	0.94		18.02	157.49	0.642	CONC	0.013	1.00	525	100.00	1.99	0.430	0.84	174.50	173.50	149%	
Burnhamthorpe Road W.	16	10	11	0.39	0.95	0.37	2.02	1.84	0.84		18.86	153.13	0.782	CONC	0.013	1.00	600	100.00	2.17	0.614	0.77	173.40	172.40	127%	
Burnhamthorpe Road W.	17 & 18	11	12	0.36	0.90	0.32	2.38	2.16	0.77		19.63	149.38	0.897	CONC	0.013	1.50	600	90.00	2.66	0.752	0.56	172.30	170.95	119%	
Burnhamthorpe Road W.		12	Outlet 4			0.00	2.38	2.16	0.56		20.20	146.76	0.881	CONC	0.013	8.00	600	7.00	6.14	1.737	0.02	170.16	169.60	51%	
Burnhamthorpe Road W.	25 & 26	1	2	0.62	0.93	0.57	0.62	0.57	0.00	15.00	15.00	175.86	0.280	CONC	0.013	0.30	525	120.00	1.09	0.236	1.84	172.40	172.04	119%	
Burnhamthorpe Road W.	21 & 24	2	3	0.39	0.95	0.37	1.01	0.94	1.84		16.84	164.15	0.430	CONC	0.013	0.30	600	120.00	1.19	0.336	1.68	171.95	171.59	128%	
Burnhamthorpe Road W.	20	3	4	0.41	0.95	0.39	1.42	1.33	1.68		18.52	154.88	0.574	CONC	0.013	0.30	675	120.00	1.29	0.460	1.55	171.50	171.14	125%	
Burnhamthorpe Road W.	19	4	5	0.42	0.91	0.38	1.84	1.72	1.55		20.07	147.31	0.702	CONC	0.013	0.40	675	120.00	1.49	0.532	1.35	171.10	170.62	132%	
Burnhamthorpe Road W.		5	Outlet 4			0.00	1.84	1.72	1.35		21.42	141.40	0.674	CONC	0.013	8.00	675	8.00	6.64	2.378	0.02	170.24	169.60	28%	
External Drainage Areas	External			38.35	0.94	35.95	38.35	35.95		21.90	21.90	139.42	13.924												External Drainge Plan by Proctor & Redfern
External Drainage Areas	External		Outlet 4	40.85	0.63	25.53	79.20	61.48			21.90	139.42	23.812	CONC	0.013	0.50	1650	1030.00	3.01		5.70				Consulting Engineers Drawings A1 - 84744 - G10
Outlet 4		5, 12 & External			0.78		83.42	65.36	5.70	21.90	27.60	119.95	21.779	CONC	0.013	0.50	2100	7.00	3.54	12.261	0.03	170.16	169.60	178%	

Flow Change Summary - Existing to Proposed

	Outlet 1 Flow L/s		
	Existing	Proposed	Change
2 Year	133	87	-46
5 Year	179	117	-62
10 Year	221	144	-77
25 Year	275	178	-97
50 Year	326	207	-119
100 Year	463	292	-171

	Outlet 2 Flow L/s		
	Existing	Proposed	Change
2 Year	26	0	-26
5 Year	35	0	-35
10 Year	43	0	-43
25 Year	55	0	-55
50 Year	66	0	-66
100 Year	96	0	-96

	Outlet 3 Flow L/s		
	Existing	Proposed	Change
2 Year	26	143	117
5 Year	35	192	157
10 Year	43	237	194
25 Year	54	293	239
50 Year	66	342	275
100 Year	96	483	388

	Outlet 4 Flow L/s		
	Existing	Proposed	Change
2 Year	5,831	5,911	80
5 Year	7,838	7,946	108
10 Year	9,655	9,787	133
25 Year	12,197	12,365	168
50 Year	14,876	15,077	201
100 Year	21,497	21,779	282

C

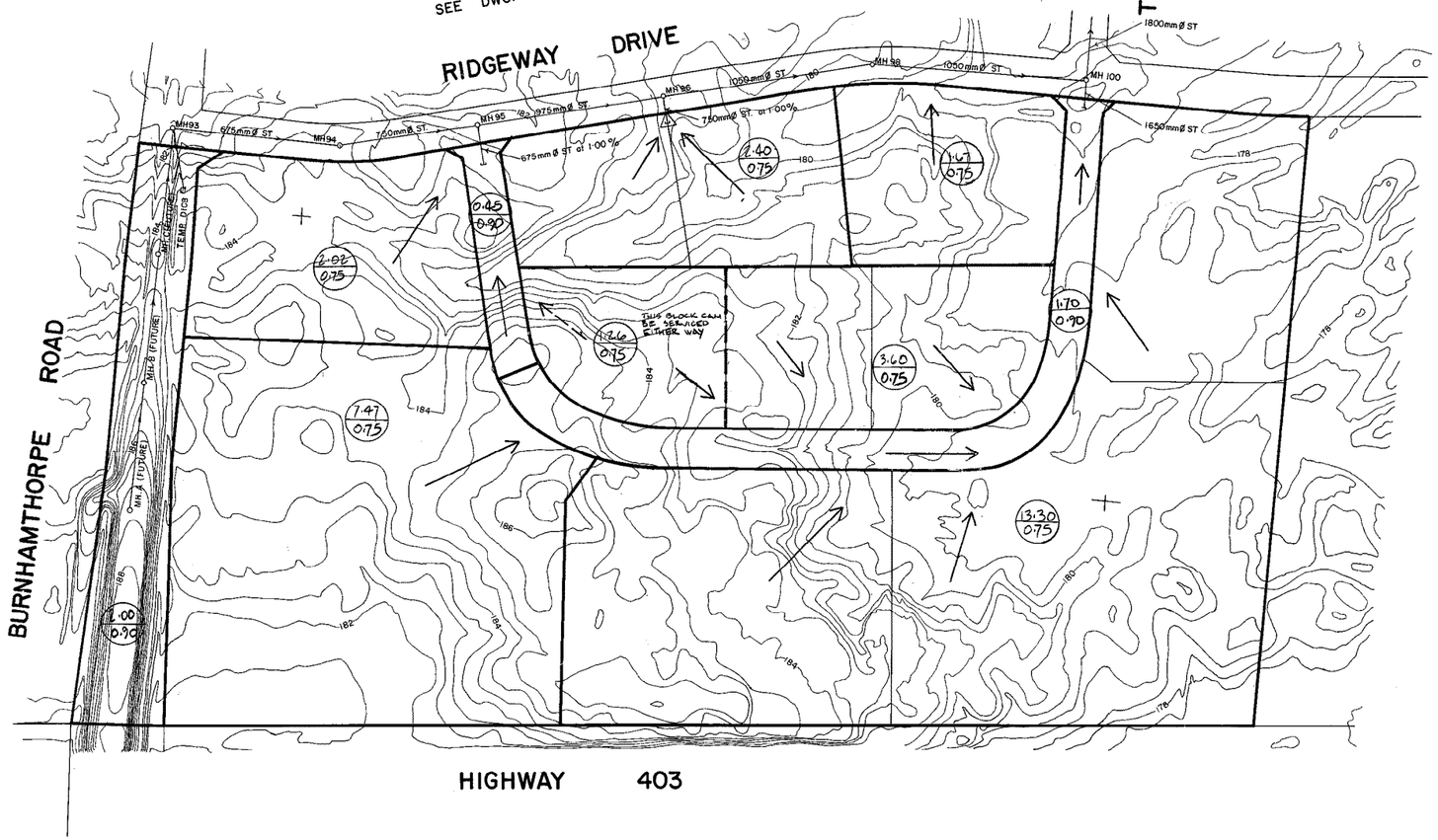
Appendix C

Drainage Plan C-23167 &

Ridgeway South Drawing C-23210

External Storm Drainage Plan – Proctor & Redfern

Collegeway SWM Facility Retrofit



ERIN MILLS

METRIC
ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE SHOWN

Revisions

Date	No.	Details	Int.

Bench Mark

B. S. WILSON
REGISTERED PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO

Designed By | Approved By

Proctor & Redfern
Consulting Engineers
Toronto

Drawn C.A.D. Chk'd B.S.W Rev.
Dw'g No. A1-85721-G25
Appr. J.R.G.

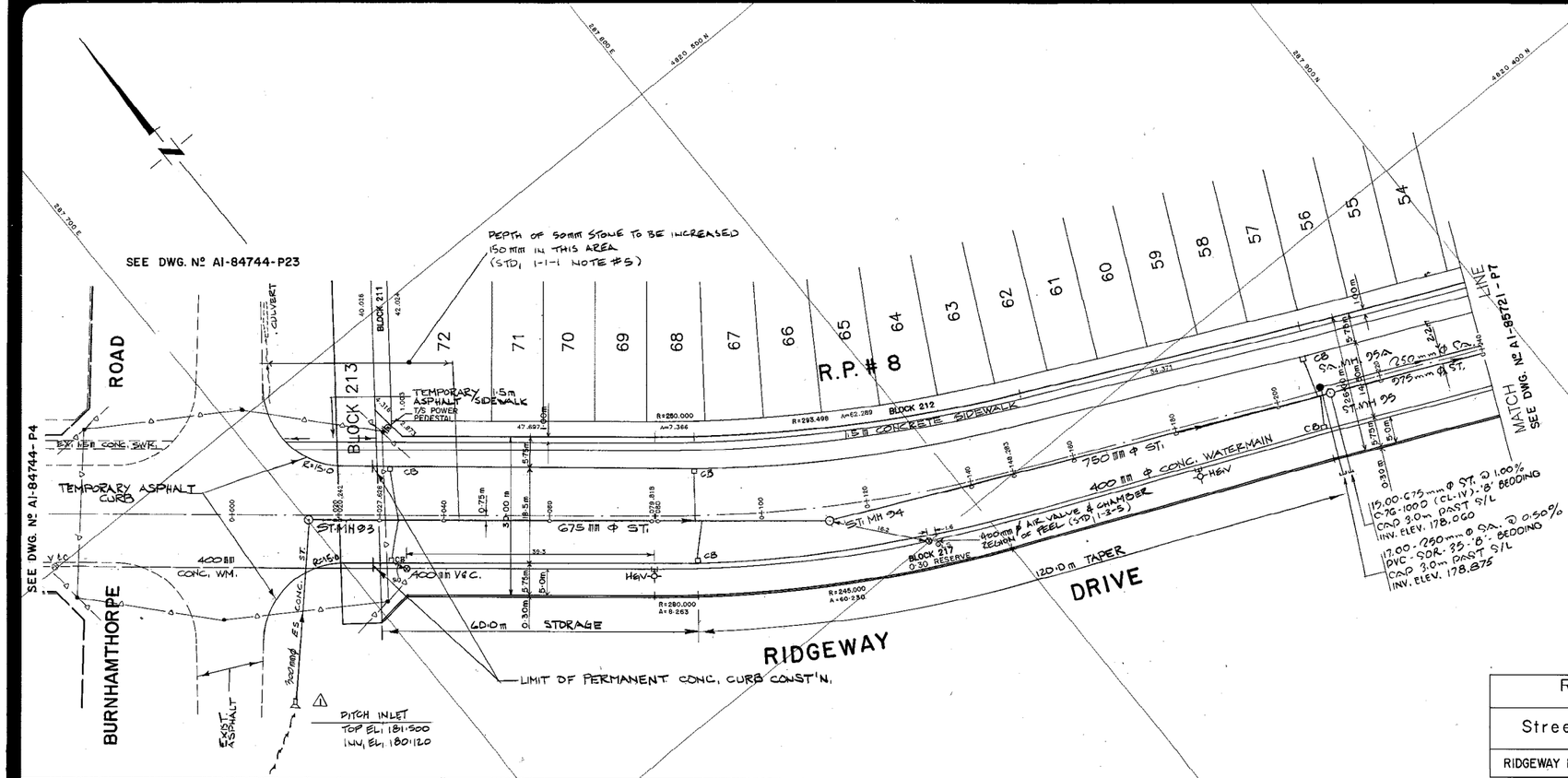
City of Mississauga
Region of Peel
Engineering Department

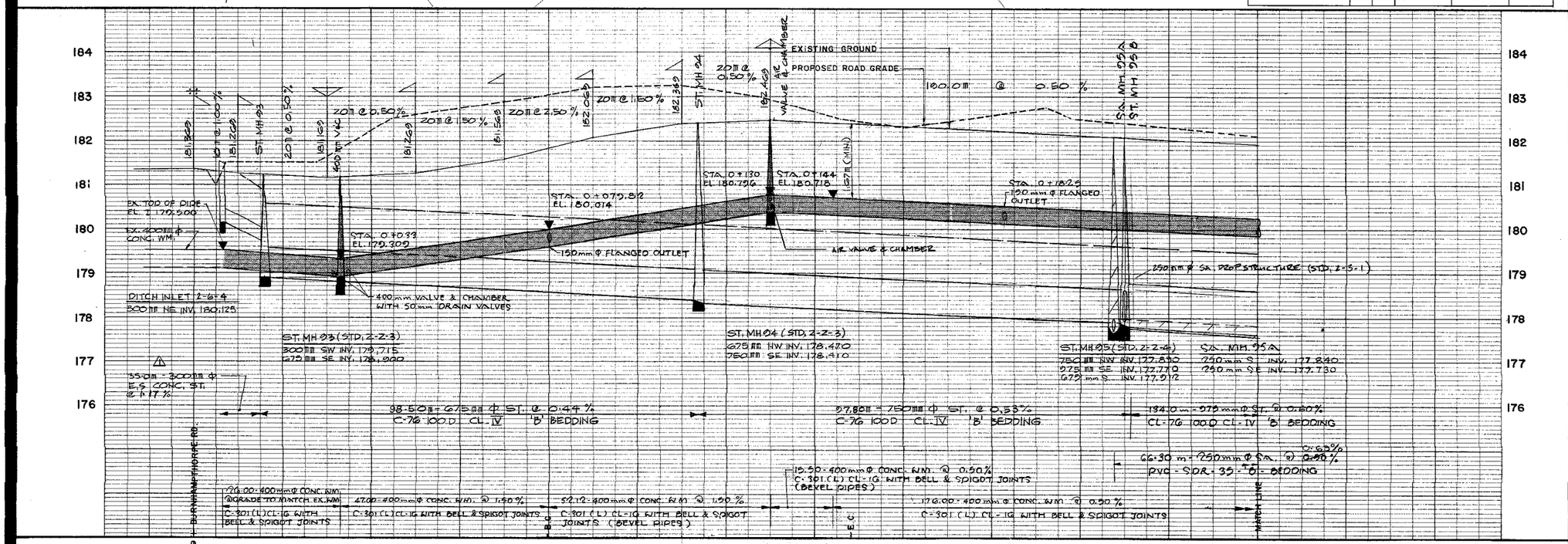
General Plan
External Storm
Drainage Plan
Sheet 1 of 1

Scale 1:2000
Horizontal
Drawn
Chk'd
Date
T-83021M

Vertical
Project No.
Area
Plan No.
C-23167

C-23167





NOTE

1. NO LARGE PIECES OF SHALE ARE TO BE USED AS TRENCH BACKFILL, ONLY APPROVED NATIVE MATERIAL COMPACTED IN ACCORDANCE WITH DRAWING D-75178-02.
2. ALL MANHOLES SHALL BE 1200mm ø PRECAST UNLESS SHOWN OTHERWISE.
3. LATEST STANDARDS FOR THE CITY OF MISSISSAUGA & REGION OF PEEL SHALL BE USED.
4. BOREHOLE DATA SHOWN IS FOR INFORMATION ONLY. NO RESPONSIBILITY IS ASSUMED THEREBY.
5. BACKFILL LIFT THICKNESS SHALL BE NO GREATER THAN 200mm.
6. ANY UTILITY RELOCATIONS REQUIRED DUE TO THE DEVELOPMENT OF THE SUBJECT LANDS TO BE UNDERTAKEN AT THE EXPENSE OF THE DEVELOPER.
7. ALL FILL WITHIN ROAD ALLOWANCE TO BE COMPACTED TO MIN. 95% STANDARD PROCTOR DENSITY. THE SUITABILITY AND COMPACTION OF ALL FILL MATERIAL IS TO BE CONFIRMED BY A RECOGNIZED SOIL CONSULTANT TO THE CITY ENGINEER PRIOR TO THE INSTALLATION OF ANY ROAD BASE MATERIAL.
8. SANITARY CONNECTIONS MUST BE LOWER THAN THE STORM CONNECTIONS AT THE STREET LINE.

MATERIAL NOTES (AS CONSTRUCTED)
HYDRANTS : McAVITY
VALVES : CRANE McAVITY

ROAD DESIGN TABLE
all dimensions in millimetres

Street	HL3	HL8	GRANULAR A	GRANULAR B	Total Thickness
RIDGEWAY DRIVE	40	100	150	375	665

ERIN MILLS

METRIC
ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE SHOWN

Revisions

Date	No.	Details	Int.
MAY 1, 86	1	RELOCATED TEMP. DITCH INLET.	ASM.
JUNE, 1990	2	AS CONSTRUCTED	I.M.

General Notes

1. Water services to single lots to be located at mid-point of lot.
2. Waterservice to semi-detached lots to be 3.5 m either side of centre of lot.
3. The minimum lateral distance between water services and other utilities shall be 1.2 m.
4. Curb radii at intersections shall be 8.0 m unless otherwise shown.
5. Sewer bedding types refer to drawing 2-1-31.
6. All non-reinforced concrete pipe and reinforced concrete pipe shall conform with A.S.T.M. specifications C-14 and C-76 respectively and shall be of the strengths indicated.
7. SUB-DRAINS TO BE INSTALLED BEHIND THE CURB AS PER DETAIL DWG. Nº AI-85721-G57.
8. All sanitary sewers shall have premium rubber gasket joints.
9. All storm sewers shall have standard rubber gasket joints.

Legend

S Denotes a semi-detached lot
--- 20 mm dia. water service (type 'K' soft copper)
(172.30) Proposed finished ground elevation at house
Min. Basement Floor Elevation
▼ Single house service
▽ Double house service
(All services located on lot lines are double services)

Bench Mark
BM.# 643 – On the S. face at the E. corner of S. end of a concrete box culvert across Burnhamthorpe Rd. W., 2600' W. of Winston Churchill Blvd. EL 174.162

B. S. WILSON — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

Designed By | Approved By

Proctor & Redfern Consulting Engineers Toronto

Drawn C.A.D. Chk'd B.S.W Rev.
Dw'g No. AI-85721-P6
Appr. J.R.G.

City of Mississauga
Region of Peel
Engineering Department

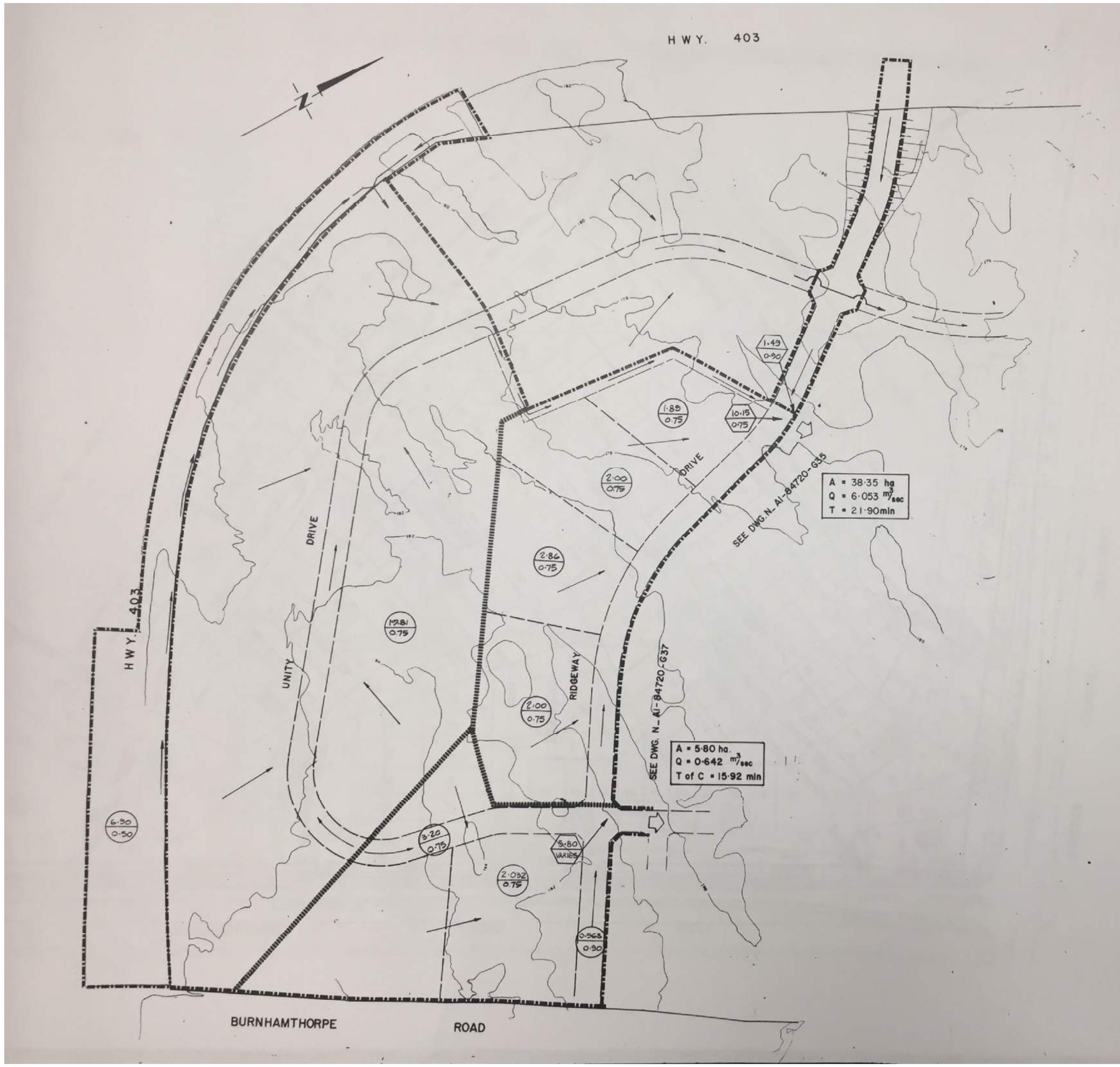
Ridgeway Drive

Sheet 1 of 3

From Sta. 0+000
To Sta. 0+240

Scale
Horizontal 1:500 Vertical 1:50
Drawn Project No.
Chk'd Area
Date Plan No.
T-83021M C-23210

C-23210



ERIN MILLS

METRIC
ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE SHOWN

Revisions

ile	No.	Details	int

LEGEND

- DRAINAGE BOUNDARY
- INTERNAL BOUNDARY
- DIRECTION OF FLOW
- 10.15 / 0.75 — AREA IN HECTARES / RUN-OFF COEFFICIENT

Bench Mark

S. S. S. YAO — Designed By

G. T. GIFFEY — Approved By

Proctor & Redfern
Consulting Engineers
Toronto

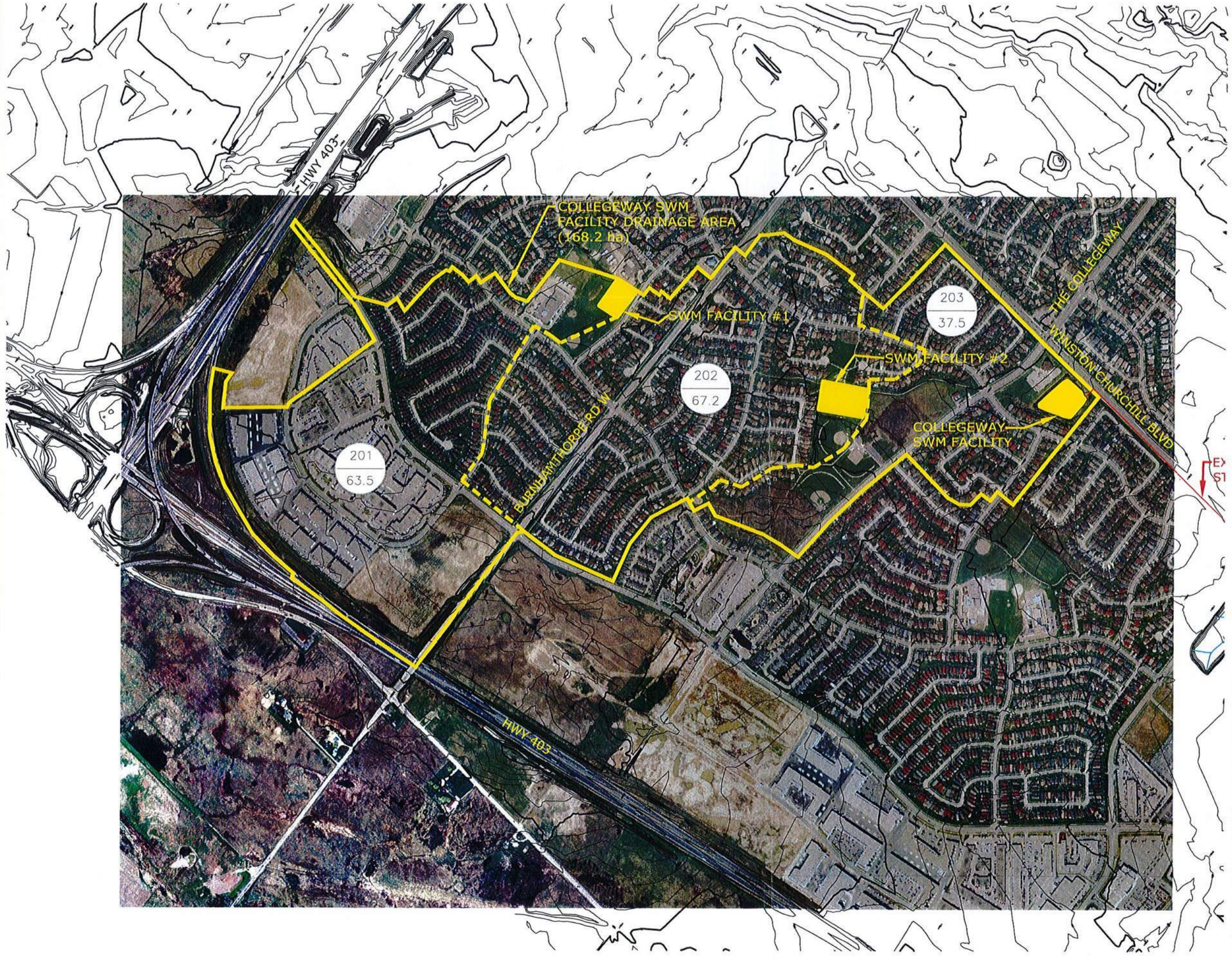
Drawn P.L.C. Chk'd S.S.Y. Rev
Dwg No AI-84744-G10
Appr

City of Mississauga
Region of Peel
Engineering Department

External Storm Drainage Plan

Scale 1:2000
Horizontal
Drawn
Chk'd
Date

Vertical
Project No
Area
Plan No T-83022'(A) C-23109



201
63.5
VO2 CATCHMENT ID#
DRAINAGE AREA (HA)

MISSISSAUGA
Leading today for tomorrow

PROJECT
COLLEGEWAY SWM FACILITY RETROFIT, CITY OF MISSISSISAUGA

TITLE
EXISTING DRAINAGE PLAN

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

PREPARED BY	CKD. BY
P.A.	B.C.
SCALE	DATE
NTS	JUNE 2012
PROJECT	
09136	FIGURE 2

D

Appendix D

CVC SWM Criteria / LID Guide

City of Missisauga SWM Criteria

fully consistent with NJDEP protocol, a blanket approval of 50% removal for all OGS tested under their program was issued. Further testing is currently underway for the Toronto Guidelines for OGS application which may result in an update to the TSS removal efficiency rating indicate above; please ensure that you are using the latest version of this document which can be downloaded from www.trca.on.ca and www.sustainabletechnologies.ca.

7.4 Low Impact Development Practices

There is increasing recognition that Low Impact Development (LID) can mitigate the impacts of increased runoff volume and stormwater pollution (including temperature) by managing stormwater as close to its source as possible. Therefore LID practices can address criteria associated with water quantity (for frequent storm events), quality, erosion, and water balance. In addition to having the advantage of meeting multiple criteria goals, LID can be integrated into the urban form (bioretention in landscaping areas and parking islands, soakaways and rain gardens in back yards, and permeable pavement and subsurface infiltration in parking areas) and thereby allow for more developable space. Furthermore, the use of LID in a treatment train approach reduces the maintenance on end-of-pipe facilities. The CVC/TRCA Low Impact Development Planning and Design Guide (LID Guide, 2011) provides planning and design guidance on a wide range of LID practices.

As described in Chapter 2 of the LID Guide, the LID design process begins with a landscape-based approach to planning. The approach involves understanding regional and watershed-scale contexts, management objectives, and targets relevant to the site. Opportunities for LID practices are identified at the neighbourhood or subwatershed scales and refined at more detailed planning stages. Inventories of the natural resources and drainage features present on the site are used as the integrating framework for SWM system planning.

In order to achieve the CVC SWM criteria with LID, the following conditions must be met:

- The local municipality must endorse the use of LID SWM practices. Some practices may not be acceptable within a municipality, if LID is being proposed in lieu of conventional SWM, it is the applicant's responsibility to ensure that the local municipality has accepted the use of these practices and has considered long term operations and maintenance.
- Designs are undertaken in accordance with the recommendations of the LID Guide. As a minimum, to achieve the enhance level of water quality control, the LID practice must be sized to provide storage for a minimum 5mm of rainfall.
- For rainwater harvesting and green roof systems, calculations of runoff reduction must consider winter operation, where designs focused on warm weather functionality may yield a negligible reduction in runoff during cold weather periods.
- For infiltration practices, the depth to water table, existing soil infiltration rates, and proximity to vulnerable groundwater resources must be considered as part of the planning and design processes. Infiltration facilities may be considered in areas with infiltration rates of less than 15mm per hour, provided these are designed with effective overflow or underdrain mechanisms.
- Pre-treatment for infiltration facilities (e.g. via OGS, filter strip, forebay, etc.) may also be required depending on the source of water to be infiltrated.

4.8 Enhanced Grass Swale

4.8.1 Overview

Description

Enhanced grass swales are vegetated open channels designed to convey, treat and attenuate stormwater runoff (also referred to as enhanced vegetated swales). Check dams and vegetation in the swale slows the water to allow sedimentation, filtration through the root zone and soil matrix, evapotranspiration, and infiltration into the underlying native soil. Simple grass channels or ditches have long been used for stormwater conveyance, particularly for roadway drainage. Enhanced grass swales incorporate design features such as modified geometry and check dams that improve the contaminant removal and runoff reduction functions of simple grass channel and roadside ditch designs (Figure 4.8.1). A dry swale is a design variation that incorporates an engineered soil media bed and optional perforated pipe underdrain system (see Section 4.9 – Dry Swale). Enhanced grass swales are not capable of providing the same water balance and water quality benefits as dry swales, as they lack the engineered soil media and storage capacity of that best management practice.

Where development density, topography and depth to water table permit, enhanced grass swales are a preferred alternative to both curb and gutter and storm drains as a stormwater conveyance system. When incorporated into a site design, they can reduce impervious cover, accent the natural landscape, and provide aesthetic benefits.

Figure 4.8.1 Enhanced grass swales can be applied in road rights-of-way or along parking lots

Source: Seattle Public Utilities (left); Sue Donaldson (right)

2.01 STORM DRAINAGE

2.01.01 Storm Sewer Design

2.01.01.01 Run-off Calculations

Storm sewers shall be designed to drain all lands based on the Rational Method. The Rational Method calculations must be checked using a model approved by the Transportation and Works Department where the drainage area is greater than 10 hectares. The larger of the flows is to be used in the design of the sewer system.

$$Q = 0.0028\ C\ I\ A$$

where:
- Q = Flow in cubic metres per second
- A = Area in Hectares
- C = Run-off coefficient
- I = Intensity in mm/hr

Intensity of Rainfall: The intensity of rainfall is to be determined from the most recent City of Mississauga standard INTENSITY - DURATION - FREQUENCY RAINFALL CURVES. These curves were originally derived from rainfall data taken from the Pearson International Airport (City Standard Drawing No. 2111.010). The equations for these curves are as follows:

2 Year Storm $$I = \frac{610}{(T.C. + 4.6)^{0.78}}$$

5 Year Storm $$I = \frac{820}{(T.C. + 4.6)^{0.78}}$$

10 Year Storm $$I = \frac{1010}{(T.C. + 4.6)^{0.78}}$$

25 Year Storm $$I = \frac{1160}{(T.C. + 4.6)^{0.78}}$$

50 Year Storm $$I = \frac{1300}{(T.C. + 4.7)^{0.78}}$$

100 Year Storm $$I = \frac{1450}{(T.C. + 4.9)^{0.78}}$$

Time of Concentration: The minimum initial time of concentration is to be 15 minutes.

Pre-Development: To calculate the initial time of concentration (t_c) for upstream, undeveloped lands, the following formulae may be used: Bransby Williams, HYMO/OTTHYMO, SCS Upland Method, etc. The most appropriate method will be determined at the discretion of the Transportation and Works Department.

Post-Development: To calculate the initial external time of concentration (t_c) for external lands that are scheduled for future development, a straight line is to be drawn from the furthest point within the watershed to the proposed inlet. The top 50 metres shall have an initial t_c of 15 minutes and the remainder shall have a t_c as if the velocity in the sewer is $2ms^{-1}$. The summation of the two t_c's will give the future external time of concentration.
If the upstream area has adequate storm sewers, channels, or culverts, the velocity of the flow through these sewers, channels, or culverts shall supersede the $2ms^{-1}$ calculation.

Run-off Coefficient: Unless otherwise demonstrated, the runoff co-efficients noted below are to be used.

	Run-Off Coeff.
- Residential – single family, semi-detached	0.55
- Compact or dense housing (e.g. townhouses)	0.65
- High-rise residential	0.90
- Industrial and Commercial	0.90
- Neighbourhood Park	0.30
- Permeable Pavements	0.50
- Sodded Area	0.25
- All Other Surfaces	0.90

A minimum run-off coefficient of 0.55 is to be used for undeveloped upstream area external to the subdivision where future residential development is expected and 0.90, where future industrial or commercial development is expected.

In order to account for the increase in runoff due to saturation of the catchment surface that would occur for larger, less frequent storms, the adjustment factor below shall be used:

	Adjustment Factor.
- 10-year	1.0
- 25-year	1.1
- 50-year	1.2
- 100-year	1.25

Drainage Area: Drainage systems must be designed to accommodate all upstream drainage areas for interim and ultimate conditions, as determined by contour mapping and drainage plans.
Climate Change: Where storm sewers are being planned inclusive of a direct outlet to a receiving stream or watercourse, the City may consider an adjustment to the design flows (e.g. a +20% adjustment for IDF curves) to account for future climate change scenarios.

Hydraulic Grade Line: In infill scenarios the City may require a hydraulic grade line analysis (e.g. spreadsheet analysis based on sewer design). The purpose would be to demonstrate that existing properties and the subject development would not be impacted by any proposed changes.

2.01.01.02 Storm Sewer Requirements

Storm Sewer System

A storm sewer system shall be defined as the upper part of a drainage system draining areas less than 100 ha of land. Storm sewer systems shall be designed to accommodate a 10 year storm.

Trunk Sewer System

A trunk sewer system shall be defined as part of a drainage system that drains an area of 100 ha of land or greater. Trunk storm sewer systems shall be designed to accommodate a 25 year storm.

Pipe Capacities

Manning's formula shall be used in determining the capacity of all storm sewers. The capacity of the sewer shall be determined on the basis of the pipe flowing full.

The value of the roughness coefficient 'n' used in the Manning's formula shall be as follows:

-	Concrete Pipe	0.013
-	Concrete box culverts	0.013
-	Corrugated Metal 68 x 13mm corrugations	0.024
-	Corrugated Metal 25% paved invert	0.021
-	PVC Pipe	0.013

Design flow calculations must be completed on City of Mississauga forms shown on City Standard Drawing No.'s 2112.020 and 2112.030, for this purpose.

Flow Velocities (Flowing full)

For circular concrete pipes the:
Minimum acceptable velocity is 0.75 ms^{-1} and the
Maximum acceptable velocity is 4.0 ms^{-1}

Minimum Sizes

The minimum size for an on street storm sewer shall be 300mm.

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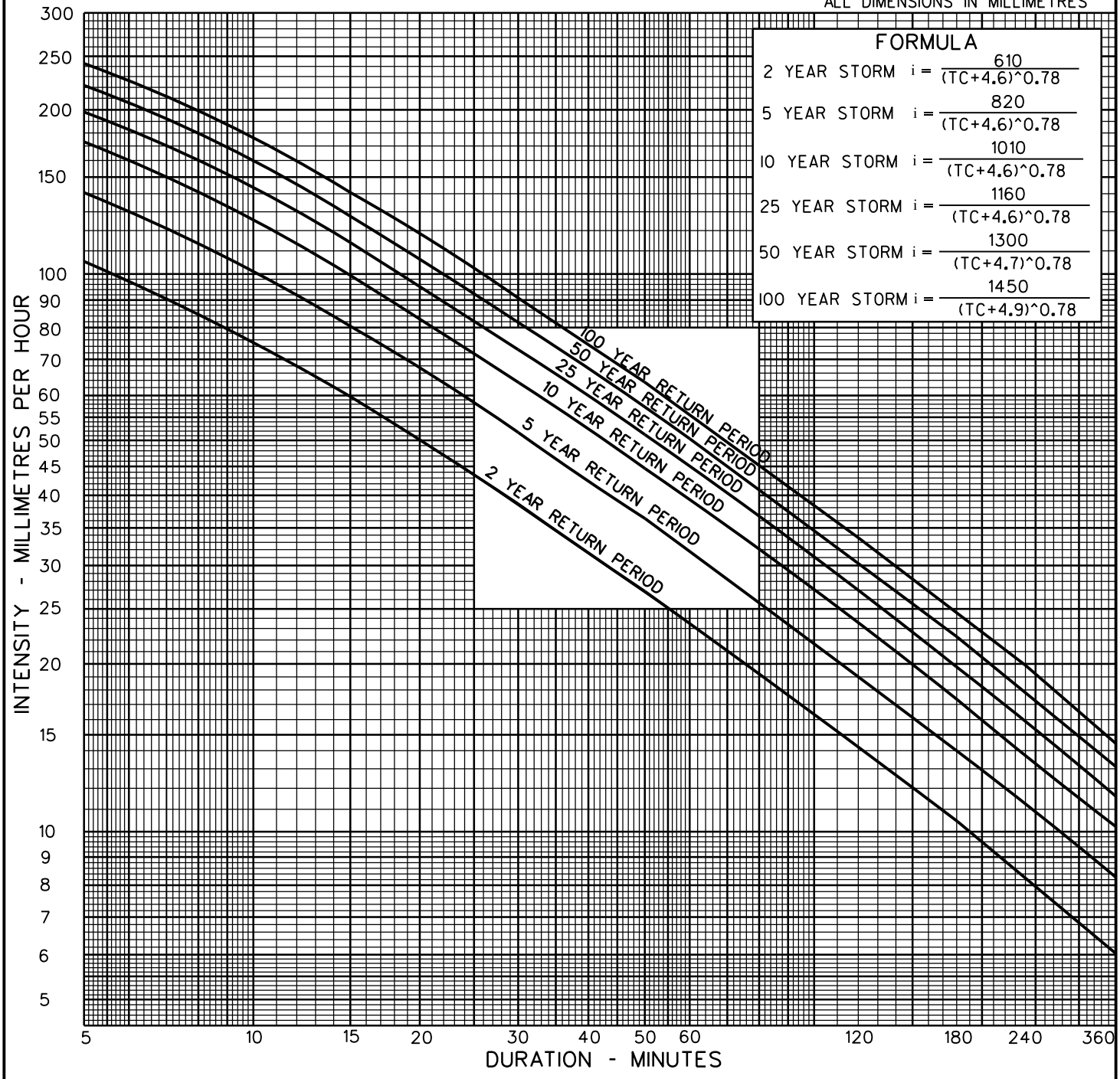
METRIC

ALL DIMENSIONS IN MILLIMETRES



FORMULA

2 YEAR STORM $i = \frac{610}{(TC+4.6)^{0.78}}$

5 YEAR STORM $i = \frac{820}{(TC+4.6)^{0.78}}$

10 YEAR STORM $i = \frac{1010}{(TC+4.6)^{0.78}}$

25 YEAR STORM $i = \frac{1160}{(TC+4.6)^{0.78}}$

50 YEAR STORM $i = \frac{1300}{(TC+4.7)^{0.78}}$

100 YEAR STORM $i = \frac{1450}{(TC+4.9)^{0.78}}$

NOTES

1. ALL CALCULATIONS TO BE DONE ASSUMING FULL DEVELOPMENT AS SHOWN ON CITY OF MISSISSAUGA ZONING MAPS.
2. TO BE USED WITH RATIONAL FORMULA:
   $Q = \frac{CIA}{360}$
   Q=QUANTITY OF RUNOFF (M^3/S)
   C=RUNOFF COEFFICIENT
   A=AREA (ha)
   I=RAINFALL INTENSITY (mm/hr)

MISSISSAUGA

STANDARD INTENSITY-DURATION-FREQUENCY RAINFALL CURVES

EFF. DATE	2002-01-01	SCALE	N.T.S
REV.	2016-07-22	STANDARD No.	2111.010

E

Appendix E
OGS Sizing Calculations

Hydroworks Sizing Summary

01-10-2020

Recommended Size: HS 10

A HydroStorm HS 10 is recommended to provide 80 % annual TSS removal based on a drainage area of 1.21 (ha) with an imperviousness of 68 % and Toronto Bloor St., Ontario rainfall for the ETV Canada particle size distribution.

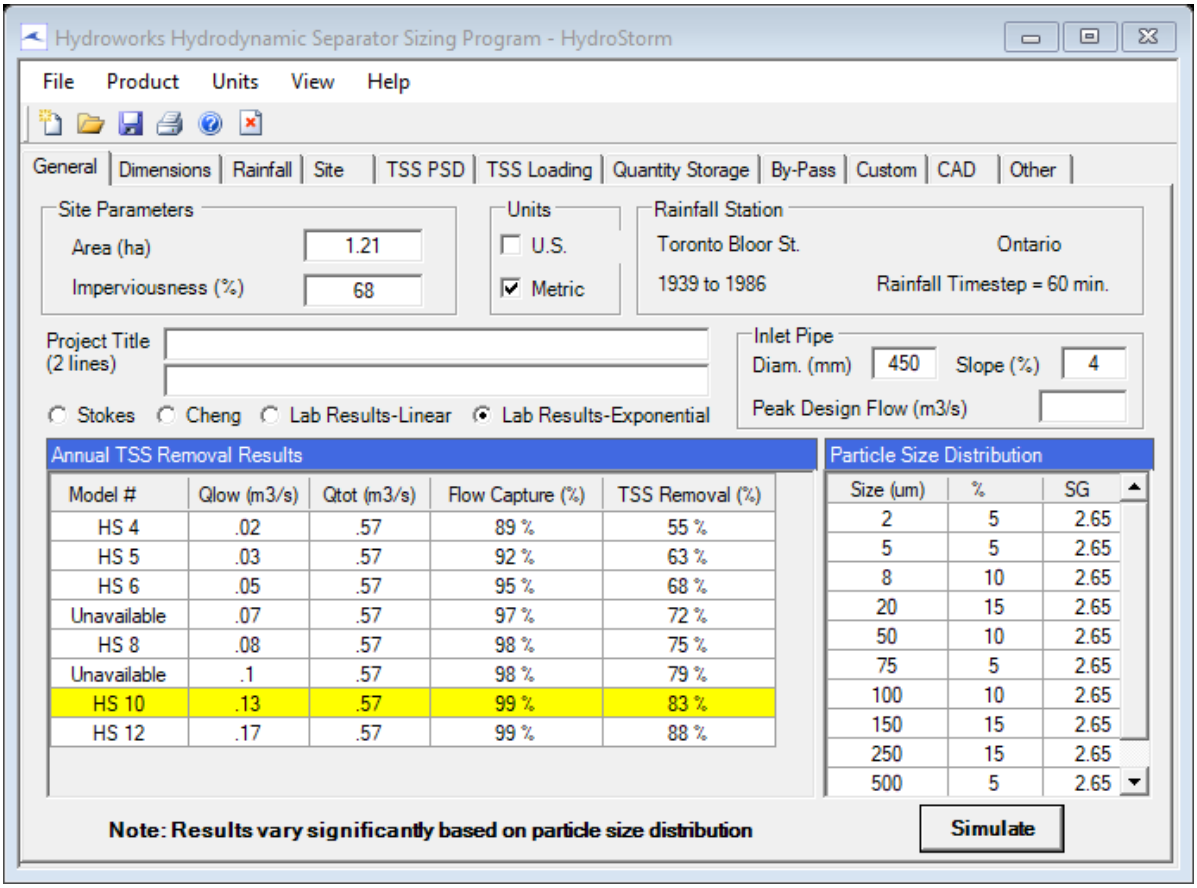
The recommended HydroStorm HS 10 treats 99 % of the annual runoff and provides 83 % annual TSS removal for the Toronto Bloor St. rainfall records and ETV Canada particle size distribution.

The HydroStorm has a headloss coefficient (K) of 1.04. Since a peak flow was not specified, headloss was calculated using the full pipe flow of .6 (m3/s) for the given 450 (mm) pipe diameter at 4% slope. The headloss was calculated to be 682 (mm) based on a flow depth of 450 (mm) (full pipe flow).

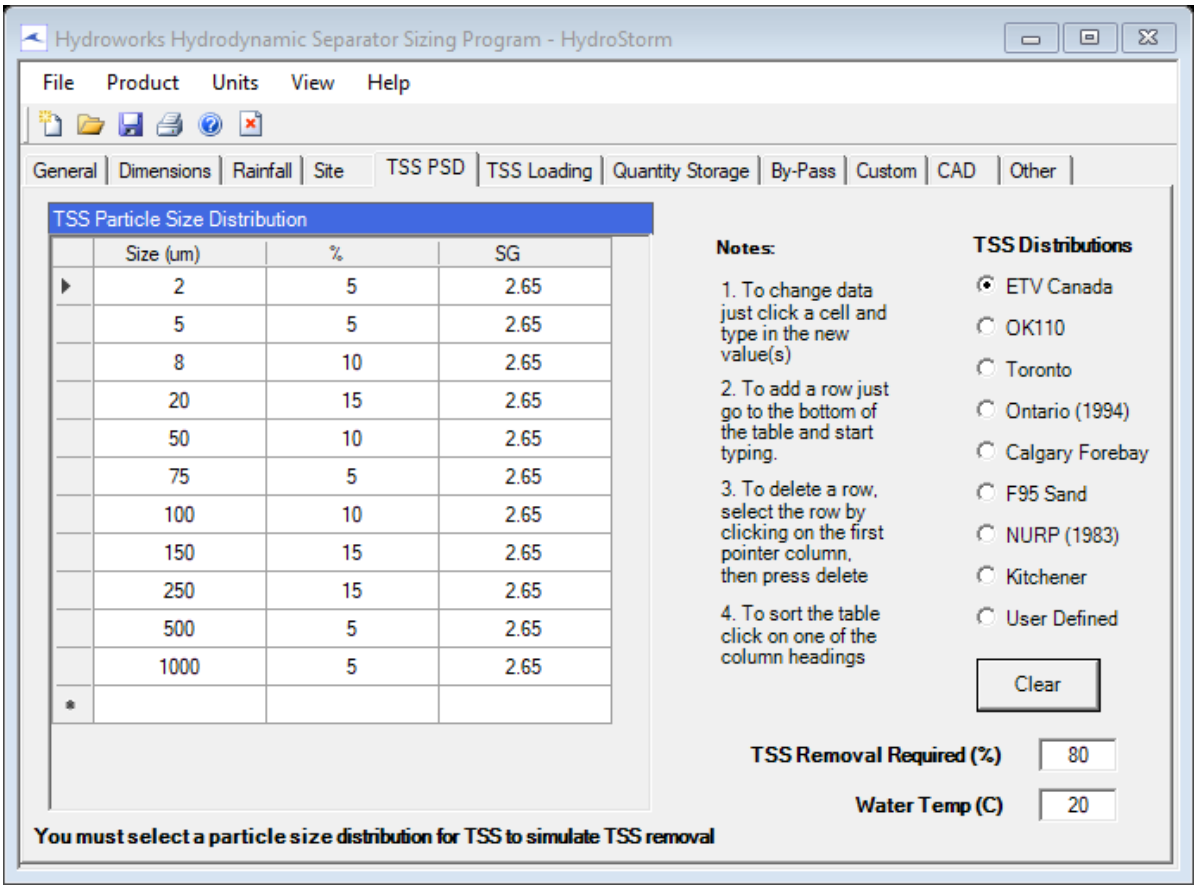
This summary report provides the main parameters that were used for sizing. These parameters are shown on the summary tables and graphs provided in this report.

If you have any questions regarding this sizing summary please do not hesitate to contact Hydroworks at 888-290-7900 or email us at support@hydroworks.com.

TSS Removal Sizing Summary



TSS Particle Size Distribution



Dimensions And Capacities

Hydroworks Hydrodynamic Separator Sizing Program - HydroStorm

File Product Units View Help

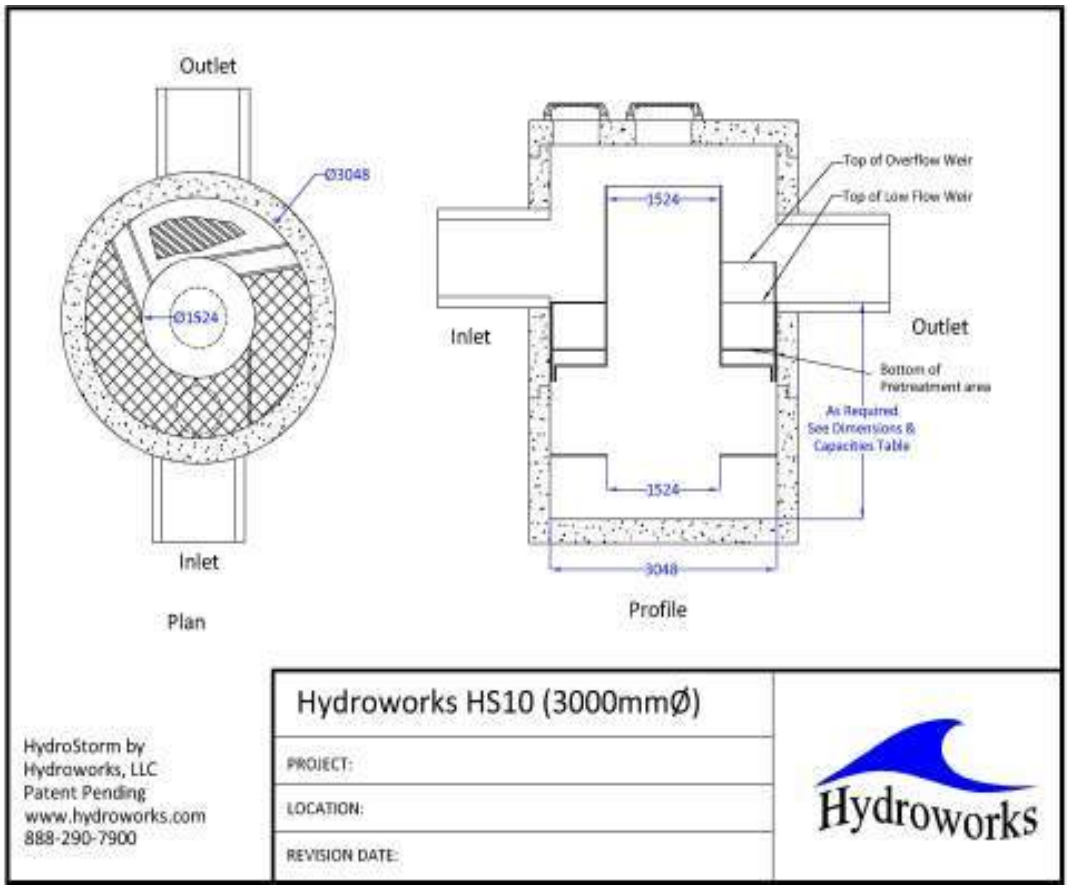
General | Dimensions | Rainfall | Site | TSS PSD | TSS Loading | Quantity Storage | By-Pass | Custom | CAD | Other

Dimensions and Capacities

Model	Diam. (m)	Depth (m)	Float. Vol. (L)	Sediment Vol. (m3)	Total Vol. (m3)
HS 4	1.22	1.22	360	0.9	1.4
HS 5	1.52	1.52	625	1.8	2.8
HS 6	1.83	1.83	1022	3.2	4.8
HS 7	2.13	1.98	1552	4.6	7.1
HS 8	2.44	2.13	2328	6.3	10
HS 9	2.74	2.44	3217	9.3	14.4
HS 10	3.05	2.74	4277	13.2	20
HS 12	3.66	3.35	7097	23.8	35.2

Depth = Depth from outlet invert to inside bottom of tank

Generic HS 10 CAD Drawing



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