Appendix F

Drainage and Stormwater Management Report

MMM Group Limited

Mavis Road Class Environmental Assessment

From Courtneypark Drive West to Ray Lawson Boulevard

Drainage and Stormwater Management Report

June 2017 | 3215102-000

COMMUNITIES

TRANSPORTATION

BUILDINGS

INFRASTRUCTURE

STANDARD LIMITATIONS

This report was prepared by WSP | MMM Group (MMM) for the City of Mississauga (the Client) in accordance with the agreement between the Client and MMM. This report is based on information provided to MMM which has not been independently verified.

The disclosure of any information contained in this report is the sole responsibility of the Client. The material in this report, accompanying spreadsheets and all information relating to this activity reflect MMM's judgment in light of the information available to us at the time of preparation of this report. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. MMM accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions based on this report.

MMM warrants that it performed services hereunder with that degree of care, skill, and diligence normally provided in the performance of such services in respect of projects of similar nature at the time and place those services were rendered. MMM disclaims all other warranties, representations, or conditions, either express or implied, including, without limitation, warranties, representations, or conditions of merchantability or profitability, or fitness for a particular purpose.

This Standard Limitations statement is considered part of this report.

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1.0 INTRODUCTION

MMM Group Limited (MMM) was retained by the City of Mississauga to carry out the Class Environmental Assessment (Class EA) Study for Mavis Road between Courtneypark Drive West and Ray Lawson Boulevard. The Class EA Study will be undertaken in accordance with Schedule 'C' of the Municipal Class Environmental Assessment process.

Mavis Road between Courtneypark Drive West and Ray Lawson Boulevard is a four-lane urban cross-section and is classified as an urban arterial road. Land use along Mavis Road is characterized by low and medium density residential areas between Courtneypark Drive West and Ray Lawson Boulevard. Natural areas are limited to Fletcher's Creek valley and the tributary of the Credit River. Areas surrounding the Highway 407 Interchange are open field / grassland. There is a convenience commercial area at the intersection of Twain Avenue and Mavis Road as well as a Fire Station (Station 121) located between north of Courtneypark Drive West and the Fletcher's Creek Bridge.

1.1 Study Purpose

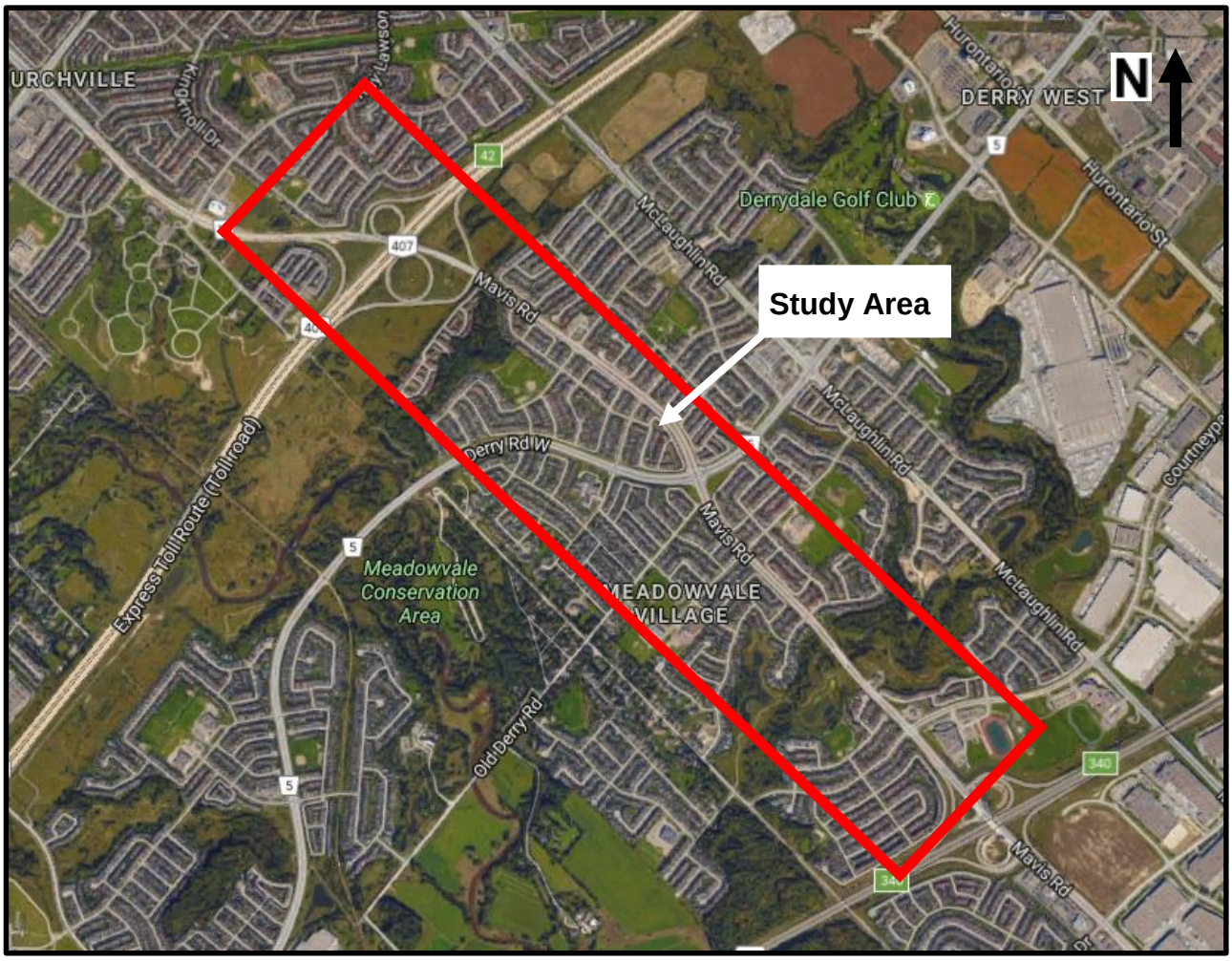
The purpose of the Drainage and Stormwater Management (SWM) Report is to provide a traceable decision-making process regarding the review of existing and proposed hydrological, hydraulic conditions and the function of the stormwater system. 'Approval in principle' from the relevant regulatory agencies is required for various aspects of the design. Relevant regulatory agencies include Credit Valley Conservation (CVC) and the Ontario Ministry of Natural Resources and Forestry (MNRF).

This Drainage and SWM Report documents the existing drainage characteristics, hydrologic analysis, hydraulic analysis, drainage and SWM issues and design, acceptable opening sizes of major crossing structures, and a feasible SWM strategy for the proposed roadway.

1.2 Study Area

The study area is Mavis Road between Courtneypark Drive West and Ray Lawson Boulevard.The study area and the extent of the study limits are shown in Exhibit 1.

Exhibit 1: Study Area



1.3 Scope of Work

The scope of work entails the following:

- Estimate existing and proposed conditions storm runoff;
- Design “Enhanced Level” water quality treatment facilities for roadway runoff;
- Design quantity control measures to control the post-development flows to existing conditions flows; and
- Assess the impacts of proposed road improvement.

1.4 Potential Drainage Impacts

Road expansion projects may potentially affect drainage patterns and watercourses in the following ways:

- Increased impervious surface area, if any;
- Increased overall volume and peak flow rate, if any,
- Increased erosivity potential for the receiving watercourse;
- Increased pollutant and sediment loading;
- Required physical changes to watercourses (e.g. bridge replacement);
- Required physical changes to drainage boundaries (e.g. new outlet locations and overland flow patterns);
- Required physical changes to hydrologically significant features (e.g. ponding areas, dams, zones of infiltration, etc.).

Any combinations of these effects have the potential to impact watercourse morphology, base flows, flooding levels, and overall water quality.

1.5 Background Information and Reports

MMM obtained relevant, drainage-related information and mapping from the City of Mississauga (City), Regional Municipality of Peel (Peel Region) and Credit Valley Conservation (CVC).

The following background information and reports were reviewed in the assessments of this study:

- Stormwater Management Study for Mavis Road Widening, from Steeles Avenue to Highway 407(ETR), prepared for City of Brampton and Regional Municipality of Peel by Schaeffers Consulting Engineers, dated August 2009.
- Design Report Fletcher’s Creek Stormwater Management Facility No. 5, prepared for Meadowvale Village Secondary Plan Area, by Rand Engineering Corporation, dated December 1996
- Stormwater Management Implementation Report, Arrowsmith Subdivision Phases 4 and 5 (21T-95007) Fletcher’s Creek SWM Facility No. 4, prepared for Meadowvale Village Secondary Plan Area, by Rand Engineering Corporation, dated June 2000

- Existing contract drawings of Highway 401 Bridge, Courtneypark Drive West, Mavis Road and the Highway 407 interchange within the study limit, received from the City of Mississauga.
- Storm Sewer Network book, by City of Mississauga, dated 2015
- Storm Drainage Design Chart, Mavis Road from the Highway 407 interchange to Derry Road, Sheet 1 of 1, by City of Mississauga, dated April 1997
- Storm Drainage Plans, Mavis Road from the Highway 407 interchange to Derry Road, by City of Mississauga, dated April 1997
- Storm Drainage Design Chart, Heritage Estates, All 10 sheets, by Urban Engineering Consultants, no date information available
- Storm Drainage Design Chart, Arrowsmith Village, All 3 sheets, by RAND Engineering Corporation, dated April 1997
- Storm Drainage Design Chart, Gooderham Estate, Sheet 5 of 7, by Urban Engineering, dated July 1996
- Fletchers Creek Restoration Study Characterization Report, Credit Valley Conservation, Feb 2012
- Fletchers Creek Subwatershed Plan, Study Report, City of Brampton, prepared by Paragon Engineering Limited et al., dated August 1995

1.6 Site Investigation

Field investigation of the existing drainage features were conducted on August12-14, 2016.The purpose of the field investigation is to review the existing drainage conditions of the area, confirm the drainage patterns and observe the conditions of existing culverts.

A photographic inventory of the study area is provided in Appendix A.

2.0 GUIDELINES AND DESIGN CRITERIA

2.1 SWM Design Criteria

The proposed improvements on Mavis Road include the widening of the roadway and implementation of sidewalk and multi-use trail. As a result, the drainage conditions in some areas have changed. It requires quantity and quality controls including stormwater management facilities (wet/dry/linear facilities) and roadside ditch/swale, etc.

The majority of the drainage area in the study limit lies within the Fletcher's Creek Subwatershed, which is a tributary to the Credit River and falls within the jurisdiction of Credit Valley Conservation (CVC). The City of Mississauga Transportation and Works Department, Development Requirements Manual has stipulated following SWM criteria:

- **SWM Quality Control Criteria:** Water quality controls are to be implemented on applications in accordance with the applicable Master Drainage Plan or Subwatershed Plan and the City stormwater quality study prepared by R.E. Winter dated January, 1996 Stormwater Management Practices Planning and Design Manual, MOEE.

- **SWM Quantity Control Criteria:** Stormwater management requirement vary depending upon the watershed, and in some case the storm sewer shed, that the site located in. The study area falls within the watershed of Fletcher's Creek. The type of control for Fletcher's Creek is downstream storage and required by Master Drainage or Subwatershed Plan. A stormwater management report will be required.

- **Extended Detention/Erosion Control Criteria:** SWM facilities shall include an additional storage volume for extended detention to reduce/mitigate the potential erosion impact on the receiving watercourse. Where appropriate, extended detention shall be included in the SWM facilities.

The following design objectives were established to minimize the potential impacts of the proposed road widening on the surrounding environment, based on the prevailing policy framework:

- Provide an effective/efficient drainage system;
- Minimize risk to public safety;
- Maintain flow paths for upstream lands;
- Maintain or enhance the quality of storm runoff;
- Maintain or reduce flood risk for lands within and surrounding the transportation corridor;
- Minimize future maintenance requirements; and
- Situate SWM measures on lands available in the transportation corridor.

3.0 HYDROLOGIC ANALYSES

3.1 Existing Land Use and Drainage

As noted above, the study area lies predominantly within the Fletcher's Creek watershed. Existing land use along Mavis Road is predominantly residential and includes a small portion of commercial area. Natural areas and other unpaved areas are associated with Fletcher's Creek valley, the Credit River tributary, the Highway 407 Interchange and small patches of grass / turf and roadside landscaping.

The Fletcher's Creek Subwatershed boundary with study area are included in Appendix B.

The soil types within the study area are mainly Chinguacousy clay loam and a small portion of Oneida clay loam. In general, the surface drainage pattern is from north to south for areas located north of Fletcher's Creek and from south to north for areas located south of Fletcher's Creek.

3.2 Mavis Road – South of Highway 407 Interchange to Courtneypark Drive West

The existing condition drainage mosaics are shown in Exhibits 2, 3 4 and 5.The minor system runoff from Catchment A1 to A13 drains to the Mavis Road storm sewer system between South of the Highway 407 Interchange and Old Derry Road. The total drainage area conveyed to this section of Mavis Road storm sewer system is 10.46 ha. This section of Mavis Road storm sewer system combines with Old Derry Road storm sewer system. From Catchment A13, the storm sewer runs westerly to collect runoff from Catchment E1, E2A and E2B, which ultimately discharges to the Fletcher's Creek Stormwater Management Facility No. 5. The major system runoff from these catchments flows overland to SWM Facility No. 5 which ultimately drains to Fletcher's Creek.

Runoff from Catchment A24 to A26 drains to the Mavis Road storm sewer system between Old Derry Road and Crawford Mill Ave. The total drainage area conveyed to this section of Mavis Road storm sewer system is 1.21 ha. This section of Mavis Road storm sewer system, combined with the runoff from Catchments E4A and E4B (combined drainage area of 7.01 ha), drains to the Crawford Mill Avenue storm sewer system. This storm sewer than joins with the storm sewer from Old Derry Road at Node 2 and runs southerly to Node 7 collecting runoff from Catchment E5 before discharging to the Fletcher's Creek Stormwater Management Facility No. 5. The major system runoff from these catchments flows overland to SWM Facility No. 5.

Runoff from Catchment A30 to A31 and A34 to A36 drains to the Mavis Road storm sewer system between Crawford Mill Ave and Fletcher's Creek Bridge at Mavis Road. The total drainage area conveyed to this section of Mavis Road storm sewer system is 1.96 ha. This section of Mavis Road storm sewer system, combined with the runoff from Catchment E6A and E6B (combined drainage area of 35.98 ha), drains to the Golden Farmer Way storm sewer system. This storm sewer combines with another storm sewer at Node 7

and discharge to the Fletcher's Creek Stormwater Management Facility No. 5 from a single outlet point. The major system runoff from these catchments flows overland to SWM Facility No. 5.

Runoff from Catchment C1 drains to the Mavis Road storm sewer system between Fletcher's Creek Bridge and Kazoo Court. The total drainage area conveyed to this section of Mavis Road storm sewer system is 0.57 ha. This section of Mavis Road storm sewer system combines with the runoff from Catchment E7 (drainage area of 2.19 ha) and drains to the Kazoo Court storm sewer system. Runoff from Catchments C6 to C2 (total drainage area of 2.05 ha) combines with the runoff from Catchment E8 (drainage area of 37.52 ha) and drains to the Mavis Road storm sewer system between Kazoo Court and Highway 401 Bridge. The total drainage area conveyed to this section of Mavis Road storm sewer system is 20.6 ha. This section of Mavis Road storm sewer system also drains to the Kazoo Court storm sewer system, then the Kazoo Court storm sewer system combined with Catchment E9 and discharge to the Fletcher's Creek SWM Facility No. 4. The major system runoff from these catchments flows overland to Fletcher's Creek.

Mavis Road consists of an urban road cross-section on both east and west sides. Under existing conditions, the major storm runoff flows overland along Mavis Road towards the road low point, which is ultimately captured by catch basins and conveyed to SWM Facilities No. 4 and 5 via storm sewers.

3.2.1 Fletcher's Creek Stormwater Management Facility No. 4 and No. 5

The existing SWM Facility No. 4 is water quality control only. It services approximately 79 ha of drainage area, with a permanent pool elevation of 169.55 m. This includes sections of Mavis Road from Fletcher's Creek Bridge to Highway 401 Bridge. The pond is controlled by a 2100 mm diameter storm sewer leading to a flow splitter manhole. The 2100 mm diameter pipe is sized to convey the peak flow of approximately 7.3 m^3/s from the 10-year storm event. The flow splitter manhole diverts the first flush flow of approximately 3.2 m^3/s from the 25-mm storm event into Facility No. 4. The flow splitter manhole consists of a 3.8 m x 3.0 m rectangular manhole, a 1350 mm diameter first flush pipe and an 1800 mm diameter bypass pipe. The balance of the minor system flow (approximately 4.1 m^3/s) discharges through the 1800 mm diameter pipe into a channel leading to Fletcher's Creek.

The existing SWM Facility No. 5 services approximately 134.9 ha of drainage area with a permanent pool elevation of 168.8 m. This includes sections of Mavis Road from South of the Highway 407 interchange to Fletcher's Creek Bridge. It is controlled by a flow control structure which is equipped with an orifice and weir designed to regulate outflows from the facility for lower frequency storms. The minimum elevation of the pond embankment at the southwest side is 173 m which act as an overflow weir. The outflows from the pond discharge directly to Fletcher's Creek. The Regional Storm water level of Fletcher's Creek is 169.82 m at the downstream of the SWM Facility No 5.

3.2.2 Highway 407 Interchange area

For the Highway 407 Interchange area, the existing condition drainage mosaic is shown in Exhibits 2. Runoff from Catchment E10A is conveyed by roadside ditch and drains to the west side of Mavis Road via 1050 mm diameter concrete pipe culvert (CV6). Runoff from Catchment B1 (drainage area of 0.07 ha) combines with the runoff from Catchment E10A and E10B (drainage area of 2.28 ha) and drains to a Mavis Road roadside ditch which, then, drains to the Highway 407 Interchange N-W Ramp via a 900 mm CSP culvert (CV1). The total drainage area conveyed to this culvert is 2.35 ha. The major system runoff from this catchment flows overland to the north side of Highway 407 Interchange along the ditches on Mavis Road.

Runoff from Catchments B2 and B3 (drainage area of 0.18 ha) combined with the runoff from Catchments E11A, E11B and E11C (drainage area of 4.18 ha) and drains to the ditch on the north side of Highway 407 Interchange through different catch basins and, then drains to the Highway 407 Interchange N-W Ramp via a 1200 mm CSP culvert (CV2). The total drainage area conveyed to this culvert is 4.98 ha. The major system runoff from these catchment flows overland to the north side of Highway 407 Interchange along the ditches on Mavis Road. Runoff from Catchment E11C is directed to Catchment E11B via a 600 mm CSP Culvert with 15 mm PVC lining (CV5)

Runoff from Catchment B4 (drainage area of 0.15 ha) combined with the runoff from Catchments E12A and E12B (drainage area of 3.1 ha) and drains to the ditch on south side of Highway 407 Interchange through the catch basin located on west side of the road and, then drains to the Highway 407 Interchange N-E Ramp via a 1200 mm CSP culvert (CV3). The total drainage area conveyed to this culvert is 3.25 ha.

Runoff from Catchments B5 to B10 (drainage area of 0.61 ha) combined with the runoff from Catchment E13 (drainage area of 2.38 ha) and drains to the ditch along Mavis Road through different single catchbasins located on the west side of the road and, then drains to the Highway 407 Interchange W-N/S Ramp via a 600 mm CSP Culvert with 15 mm PVC lining (CV4). The total drainage area conveyed to this culvert is 2.99 ha.

The major system runoff from Catchment B4 to B10 flows overland to the west of Mavis Road toward Catchment E13 which ultimately drain to the tributary of the Credit River located north of Zinnia Place via culvert CV4.

Table 1 summarizes the existing culvert characteristics. CV1 to CV5 culvert characteristics were estimated from the Hwy 407 Interchange drawings and site investigation. This information need to be confirm during detail design stage. For CV6 and CV7, culvert characteristics were obtained from Stormwater Management Report for Mavis Road widening between Steeles and Highway 407 Interchange by Schaeffers (Aug 2009).

Table 1: Existing Culvert Characteristics

Culvert ID	Location	Culvert Length (m)	Culvert Diameter (mm)	Estimated Slope (%)	Estimated Invert Elevation (m)		Culvert Type
					Upstream	Downstream	
CV1	Mavis Rd - Highway 407 Interchange N-W Ramp	23.0	900	0.50	189.6	198.4	CSP
CV2	Mavis Rd - Highway 407 Interchange N-W Ramp	25.7	1200	0.50	191.0	190.8	CSP
CV3	Mavis Rd - Highway 407 Interchange N-E Ramp	26.9	1200	0.50	196.3	196.1	CSP
CV4	Highway 407 Interchange - Mavis Rd W-N/S Ramp	30.0	600	1.00	196.2	195.9	CSP
CV5	Mavis Rd - Highway 407 Interchange S-W Ramp	25.8	600	0.50	204.9	204.7	CSP
CV6	Mavis Road, North of Highway 407 Interchange	51.5	1050	4.00	201.7	199.65	Concrete Pipe
CV7	Mavis Road, North of Highway 407 Interchange	46.7	900	5.10	194.676	192.30	CSP

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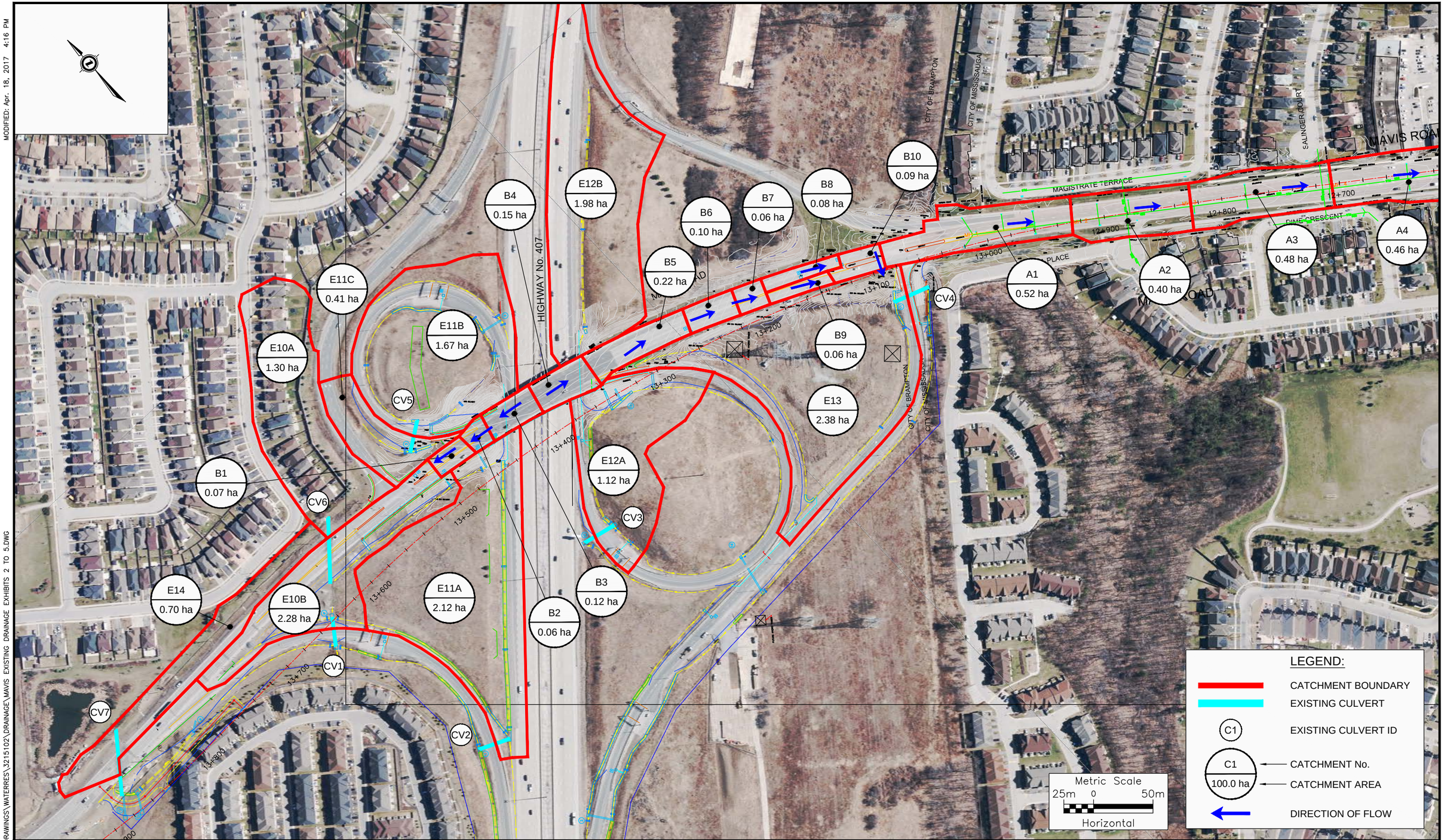

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EXISTING CONDITION DRAINAGE MOSAIC - SHEET 1

MAVIS ROAD CLASS EA AND PRELIMINARY DESIGN

EXHIBIT

2

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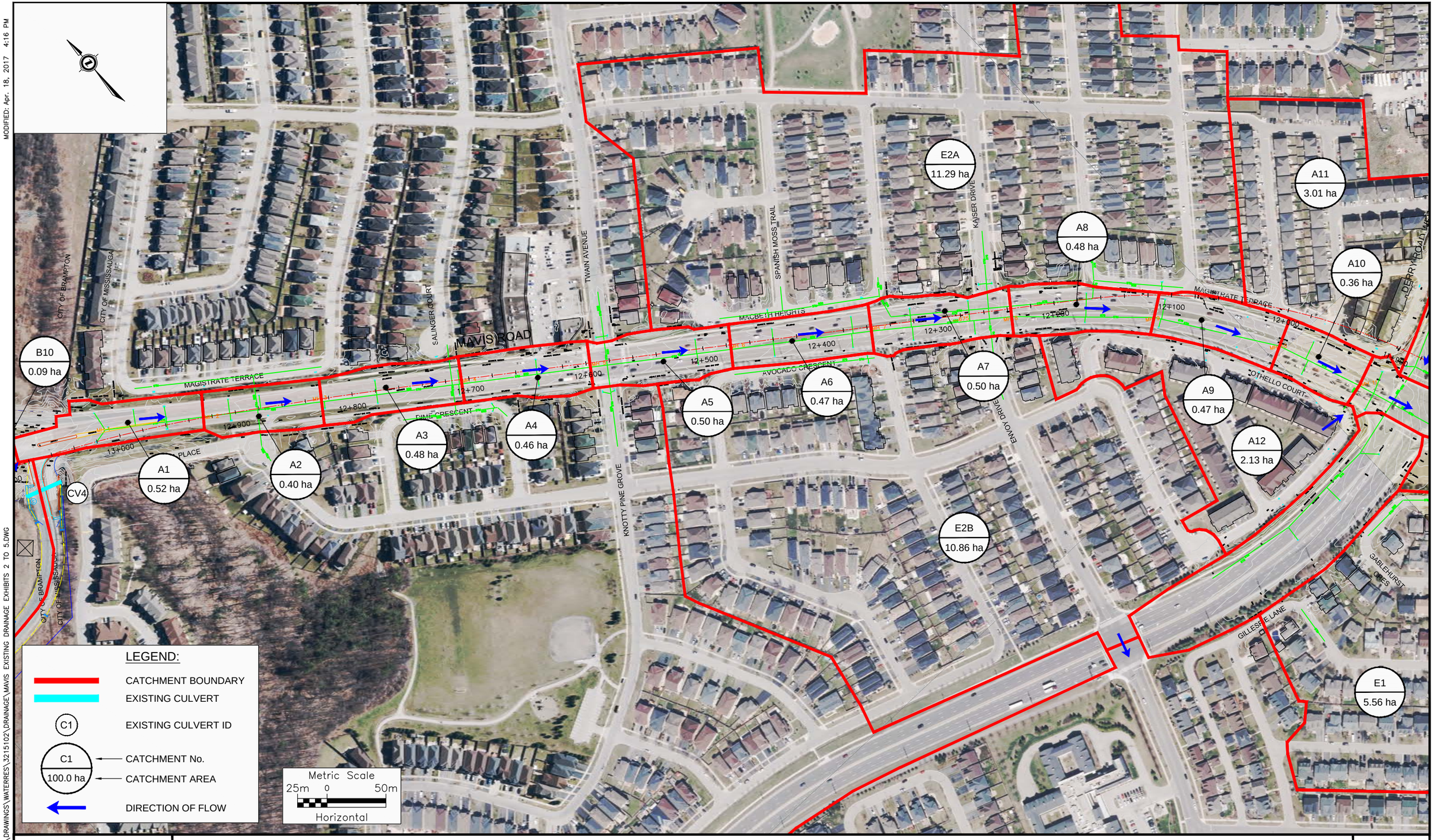

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EXISTING CONDITION DRAINAGE MOSAIC - SHEET 2

MAVIS ROAD CLASS EA AND PRELIMINARY DESIGN

EXHIBIT 3

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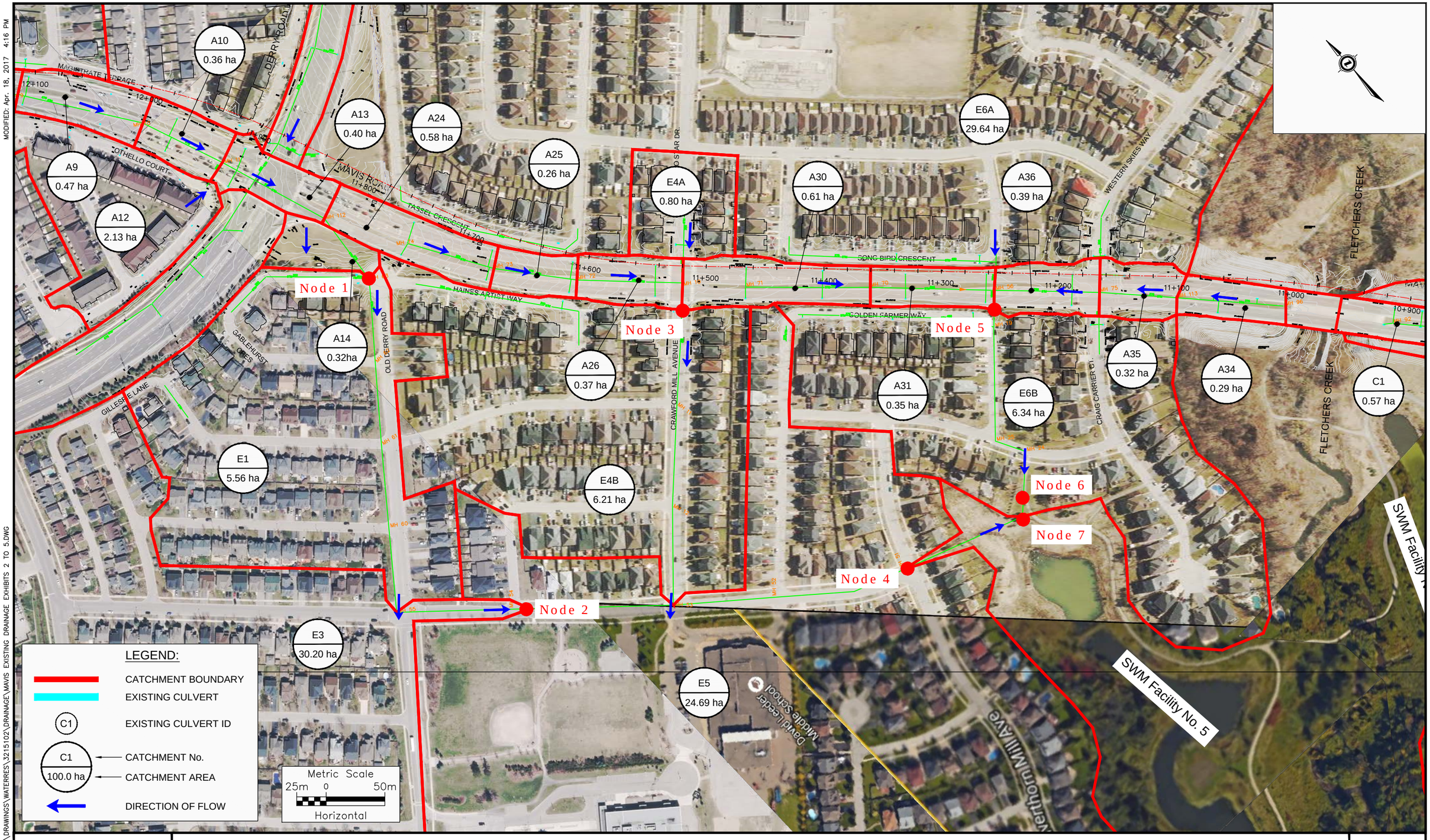

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EXISTING CONDITION DRAINAGE MOSAIC - SHEET 3

MAVIS ROAD CLASS EA AND PRELIMINARY DESIGN

EXHIBIT

4

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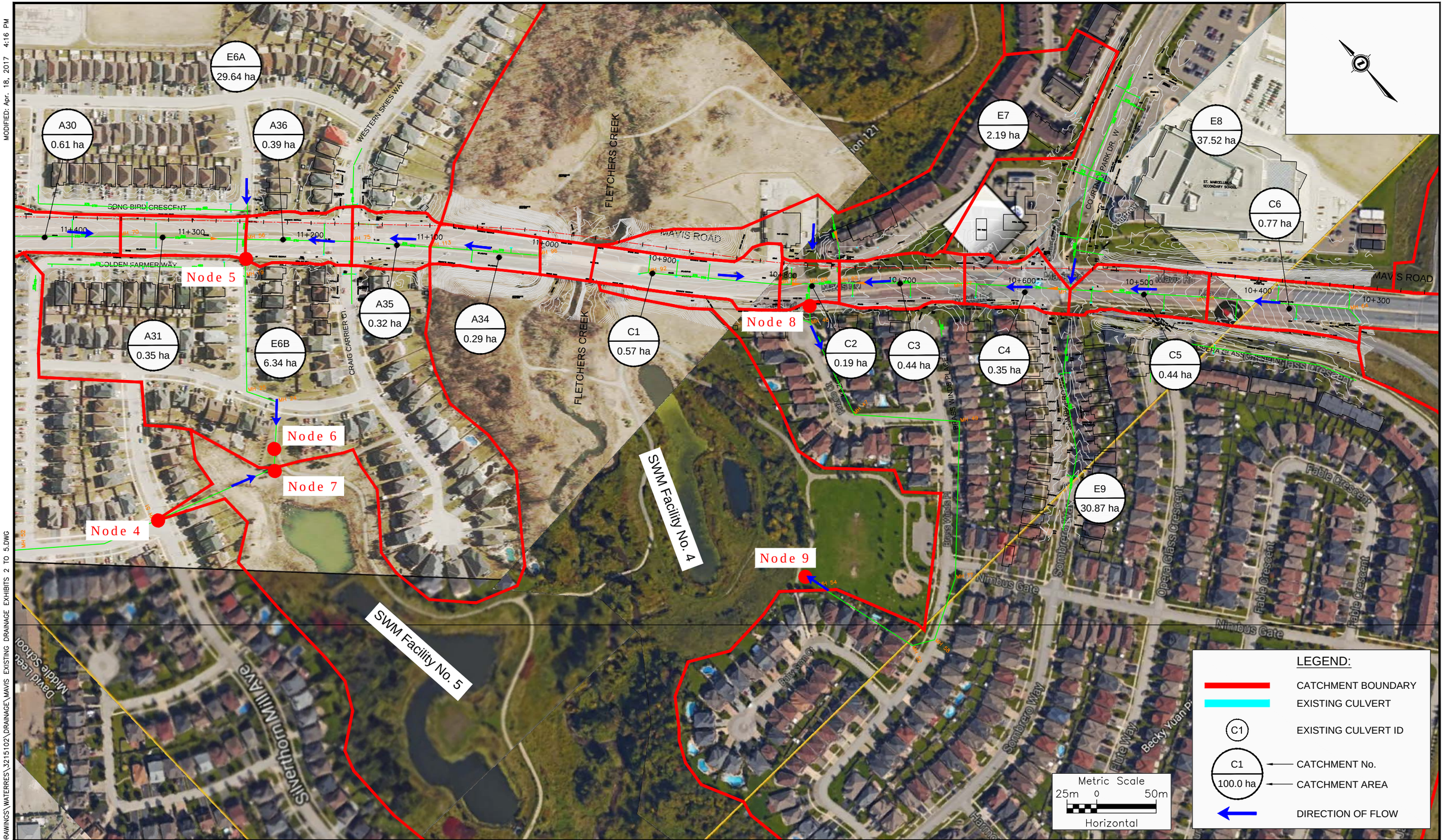

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EXISTING CONDITION DRAINAGE MOSAIC - SHEET 4

MAVIS ROAD CLASS EA AND PRELIMINARY DESIGN

EXHIBIT

5

3.3 Existing Conditions Hydrologic Modelling

The purpose of the hydrologic analysis is to determine the hydrologic response of the areas draining to various points of interest in the study area for the 10-year return period rainfall event. The Rational Method was used to determine the capacities of the existing storm sewer systems for the 10-year storm event. An initial time of concentration of 15 minutes was used per the City of Mississauga standards.

The Rational Method design sheet for each drainage area are included in Appendix B.

3.3.1 Existing Flows for the Study Area

The existing flows for the study area were generated for the 10, 50 and 100-year storm events using the Rational Method and the City of Mississauga IDF data, as provided in Table2.

Table 2: Rainfall IDF Data

Storm Data			
Event	***A***	***B***	***c***
10-year	1010	4.6	0.78
50-year	1300	4.7	0.78
100-year	1450	4.9	0.78

Table 3 provides the summary of the pre-development flows for the study area at different flow nodes.

Table 3: Existing Flows at Flow Node Locations

Flow Node	Drainage Area (ha)	Total Flow (m^3/s)	Outlets To
		10-year	
1	10.50	1.2	To Stormwater Management Facility No. 5
2	68.40	7.39	
3	1.21	0.17	
4	101.31	10.66	
5	1.96	0.28	
6	37.94	4.72	
7	139.25	14.26	
8	42.48	4.52	To Stormwater Management Facility No. 4
9	73.35	7.39	

Culverts in the Highway 407 Interchange area classified as “Freeway Ramp Culvert”. Mavis Road is an urban arterial road. The design flow for the culverts under Mavis Road and Highway 407 Interchange ramps is the 50-year flow. The 100-year flow will be used to check the overtopping condition. The proposed extension of multiuse path on the west side of Mavis Road will have no impact to the capacity of existing culverts CV6 and CV7. Table 4 provides the summary of the pre-development flows for the culverts.

Table 4: Existing Flows for Culverts

Flow at Culvert Location	Drainage Area (ha)	Flow (m^3/s)	Design Flow (m^3/s)	Check Flow (m^3/s)	Outlets To
		10-year	50-year	100-year	
CV1	2.40	0.27	0.35	0.39	To Highway 407 Interchange via road side ditches
CV2	4.38	0.49	0.63	0.70	
CV3	3.25	0.31	0.40	0.45	
CV4	2.99	0.36	0.46	0.51	
CV5	0.41	0.056	0.072	0.080	
CV6	1.30	0.097	0.125	0.138	
CV7	0.70	0.078	0.101	0.111	

3.4 Proposed Drainage Conditions

The proposed road improvements include an additional 3.5 m wide two lane roadway with one center left turn lane (4 lanes to 6 lanes), a 1.5 m wide pedestrian pathway on the east side and a 3.5 m to 4.0 m wide multi-use path on the west side.

The proposed conditions drainage mosaics are shown in Exhibits 6, 7, 8 and 9.

Under proposed conditions, the impervious area for all catchment areas increases due to the widening. The proposed impervious area for each catchment was estimated based on the average width of the proposed pavement times the length of the roadway in the catchment.

The proposed catchment areas for Highway 407 Bridge (Catchments B1 to B10) were increased due to the widening of the bridge.

There is no change in the drainage patterns from the existing conditions to proposed conditions.

Quantity and quality treatment of road runoff from Catchments A1 to A36 will be provided through the existing SWM Facility No. 5, which will provide an Enhanced level of water quality treatment and quantity control.

Quality treatment of road runoff from Catchments C1 to C6 will be provided through the existing SWM Facility No. 4, which will provide an Enhanced level of water quality treatment.

Quantity and quality treatment of runoff from roadway Catchments B1 to B10 will be provided through the existing grassed swales in Highway 407 Interchange area.

As in existing conditions, the major storm runoff flows overland along Mavis Road towards the road low point, which is ultimately captured by catch basins and conveyed to SWM Facilities No. 4 and 5 via storm sewers.

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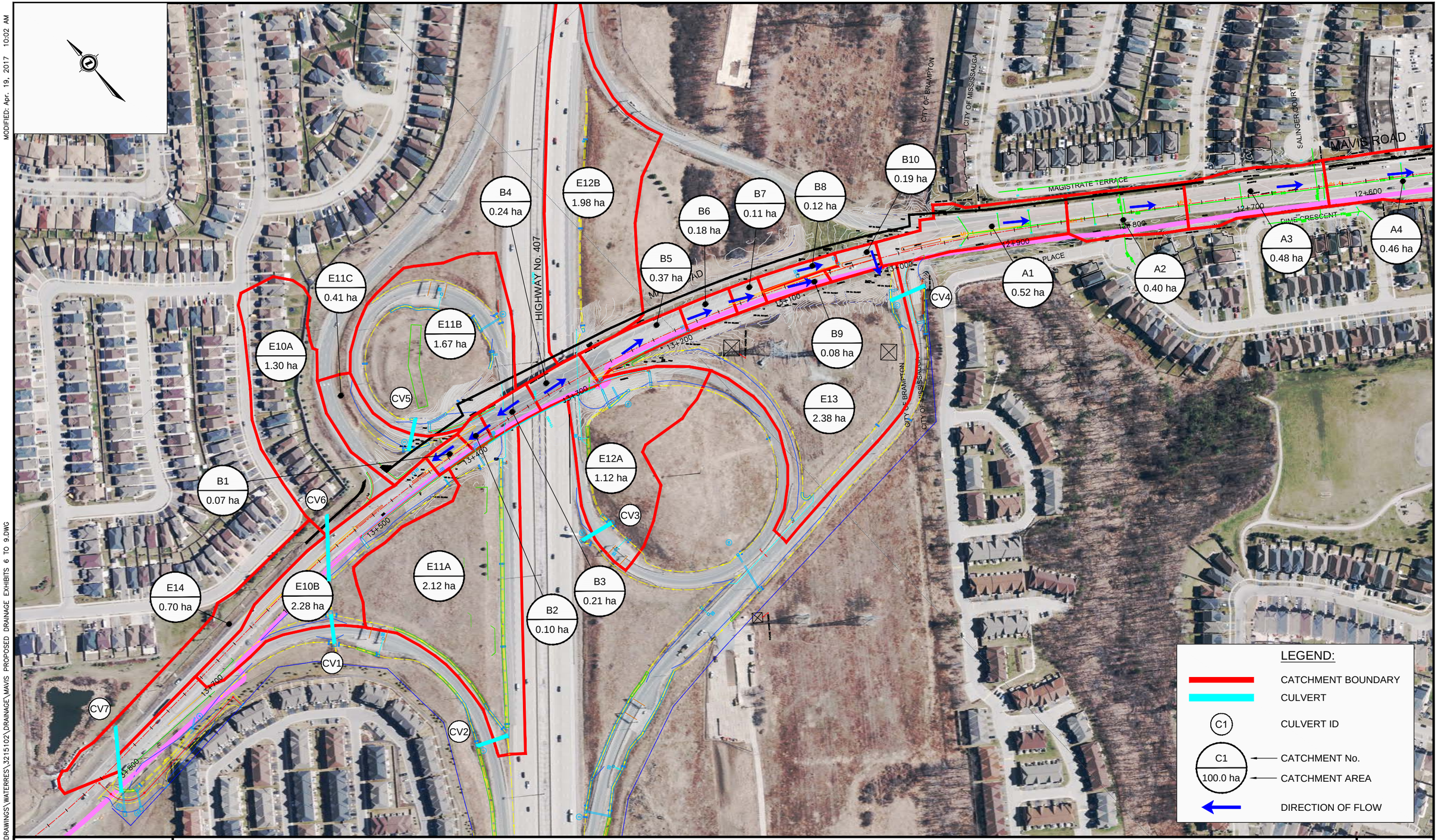

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PROPOSED CONDITION DRAINAGE MOSAIC - SHEET 1

MAVIS ROAD CLASS EA AND PRELIMINARY DESIGN

EXHIBIT

6

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B10
0.19 ha

A1
0.52 ha

A2
0.40 ha

A3
0.48 ha

A4
0.46 ha

A5
0.50 ha

A6
0.47 ha

A7
0.50 ha

A8
0.48 ha

A9
0.47 ha

A10
0.36 ha

A11
3.01 ha

A12
2.13 ha

E1
5.56 ha

E2A
11.29 ha

E2B
10.86 ha

CV4

MAVIS ROAD

MAGISTRATE TERRACE

MACBETH HEIGHTS

AVOCADO CRESCENT

DIME CRESCENT

OTHELLO COURT

ENVOY DRIVE

KAISER DRIVE

SPANISH MOSS TRAIL

TWAIN AVENUE

SALINGER COURT

KNOTTY PINE GROVE

GABLEHURST CRES

GILLESPIE LANE

DERRY ROAD W

CITY OF BRAMPTON

CITY OF MISSISSAUGA

12+000 12+100 12+200 12+300 12+400 12+500 12+600 12+700 12+800 12+900 11+900 11+800

LEGEND:

CATCHMENT BOUNDARY

CULVERT

C1 — CULVERT ID

C1 / 100.0 ha — CATCHMENT No. / CATCHMENT AREA

DIRECTION OF FLOW

Metric Scale
25m 0 50m
Horizontal

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PROPOSED CONDITION DRAINAGE MOSAIC - SHEET 2

MAVIS ROAD CLASS EA AND PRELIMINARY DESIGN

EXHIBIT
7

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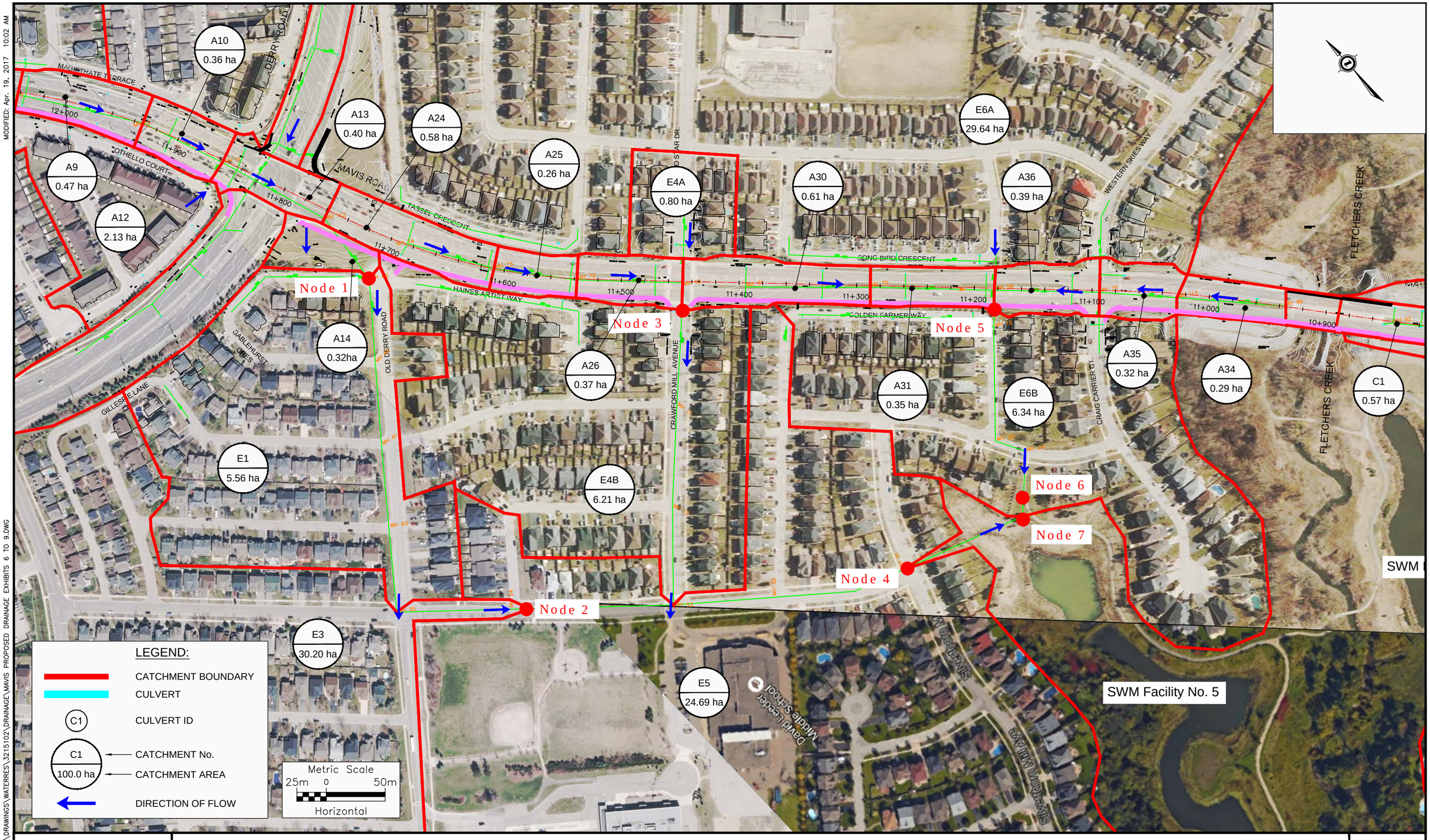

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PROPOSED CONDITION DRAINAGE MOSAIC - SHEET 3

MAVIS ROAD CLASS EA AND PRELIMINARY DESIGN

EXHIBIT

8

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E6A
29.64 ha

A30
0.61 ha

A36
0.39 ha

A31
0.35 ha

E6B
6.34 ha

A35
0.32 ha

A34
0.29 ha

C1
0.57 ha

E7
2.19 ha

E8
37.52 ha

C6
0.77 ha

C2
0.19 ha

C3
0.44 ha

C4
0.35 ha

C5
0.44 ha

E9
30.87 ha

Node 4

Node 5

Node 6

Node 7

Node 8

Node 9

SWM Facility No. 4

SWM Facility No. 5

WESTERN SKIES WAY

SONG BIRD CRESCENT

GOLDEN FARMER WAY

CRAIG CARRIER CI.

FLETCHERS CREEK

MAVIS ROAD

COURTNEY PARK DR W

ST. MARCELLINUS SECONDARY SCHOOL

OPERA GLASS CRESCENT

BRASS WINDS PLACE

SOMBRERO WAY

Nimbus Gate

Sombrero Way

11+300
11+200
11+100
11+000
10+900
10+800
10+700
10+600
10+500
10+400
10+300
10+200

Metric Scale
25m 0 50m
Horizontal

LEGEND:

- CATCHMENT BOUNDARY
- CULVERT
- C1 — CULVERT ID
- C1 / 100.0 ha — CATCHMENT No. / CATCHMENT AREA
- DIRECTION OF FLOW

WSP | MMM GROUP

PROPOSED CONDITION DRAINAGE MOSAIC - SHEET 4

MAVIS ROAD CLASS EA AND PRELIMINARY DESIGN

EXHIBIT
9

3.5 Proposed Conditions Hydrologic Modelling

The proposed improvements to Mavis Road will result in very minor increases in imperviousness, post-development flows from every roadway catchments remain the same as in existing conditions and runoff from the roadway catchments will be directed to the existing SWM facilities to provide both quality and quantity control. These changes are deemed not significant. As discussed in Section 3.1, the Regional Storm event was not analyzed.

SWM facilities, as discussed in Section 3.3 and Section 6.2, have been provided at different locations to provide quantity and quality control. Table 5 and 6 provides a summary of the post-development flows for the study area.

Table 5: Post-development Flows at Flow Node Locations

Flow Node	Drainage Area (ha)	Total Flow (m^3/s)	Outlets To
		10-year	
1	10.50	1.35	To Stormwater Management Facility No. 5
2	68.40	7.53	
3	1.21	0.27	
4	101.31	10.87	
5	1.96	0.38	
6	37.94	4.82	
7	139.25	14.54	
8	42.48	4.53	To Stormwater Management Facility No. 4
9	73.35	7.40	

Table 6: Post-development Flows at Culverts

Flow at Culvert Location	Drainage Area (ha)	Flow (m^3/s)	Design Flow (m^3/s)	Check Flow (m^3/s)	Outlets To
		10-year	50-year	100-year	
CV1	2.47	0.28	0.36	0.40	To Highway 407 Interchange via road side ditches
CV2	4.52	0.53	0.68	0.76	
CV3	3.33	0.32	0.41	0.46	
CV4	3.42	0.39	0.50	0.55	
CV5	0.41	0.066	0.085	0.094	
CV6	1.30	0.107	0.138	0.152	
CV7	0.70	0.084	0.107	0.119	

3.5.1 Comparison of Flows

Table 7 provides a comparison of the pre-development and post-development flows for SWM facilities.

Table 7: Comparison of Pre- and Post-development Flows for SWM facilities

Outlet Location	Drainage Area (ha)	10-Year Flow (m^3/s)		
		Existing	Proposed	Change
Flow to Stormwater Management Facility No. 5	139.25	14.26	14.54	+0.28
Flow to Stormwater Management Facility No. 4	73.35	7.39	7.40	+0.01

Pre and post-development flows for stormwater management facilities were examined and results are provided in **Table 7.** The results indicate that the post-development flows will not significantly increase compared to the pre-development flows at the stormwater facility outlets

The flows draining to the Stormwater Facility No. 5 will increase by 0.28 m^3/s only which is considered negligible.

The flows draining to the Stormwater Facility No. 4 will increase by 0.01m^3/s only which is considered negligible.

Based on the Rational Method storm sewer design sheets (Appendix B) it can be concluded that the existing storm sewer system has been designed for the future widening of Mavis Road. The existing storm sewers have adequate capacity to accommodate the small increases in runoff.

The total roadway drainage area draining to Highway 407 Interchange from Highway 407 Bridge has increased from 12.97 ha under existing conditions to 13.69 ha under proposed conditions, resulting from the widening of the Highway 407 Bridge. Table 8 provides a comparison of the pre-development and post-development flows for Culverts.

Table 8: Comparison of Pre- and Post-development Flows for Culverts

Culvert Location	Drainage Area (ha)	Event (year)	Flow (m^3/s)		
			Existing	Proposed	Change
CV1	2.40 (Existing) 2.47 (Proposed)	10	0.27	0.28	+0.00
		50	0.35	0.36	+0.01
		100	0.39	0.40	+0.01
CV2	4.38 (Existing) 4.52 (Proposed)	10	0.49	0.53	+0.04
		50	0.63	0.68	+0.05
		100	0.70	0.76	+0.06
CV3	3.25 (Existing) 3.33 (Proposed)	10	0.31	0.32	+0.01
		50	0.40	0.41	+0.01
		100	0.45	0.46	+0.01
CV4	2.99 (Existing) 3.42 (Proposed)	10	0.36	0.39	+0.03
		50	0.46	0.50	+0.04
		100	0.51	0.55	+0.04
CV5	0.41 (Existing and Proposed)	10	0.056	0.066	+0.01
		50	0.072	0.085	+0.01
		100	0.080	0.094	+0.01
CV6	1.3 (Existing and Proposed)	10	0.097	0.107	+0.01
		50	0.125	0.138	+0.01
		100	0.138	0.152	+0.01
CV7	0.70 (Existing and Proposed)	10	0.078	0.084	+0.01
		50	0.101	0.107	+0.01
		100	0.111	0.119	+0.01

As shown in Table 8, the flow draining to Culvert CV1, CV3, CV5, CV6 and CV7 will increase by 0.01 m^3/s, which is considered negligible. The flow draining to Culvert CV4 will increase by 0.04 m^3/s and flow draining to Culvert CV2 will increase by0.06 m^3/s.

The Rational Method design sheet for each culvert drainage areas are included in Appendix B.

4.0 HYDRAULIC ASSESSMENT

The hydraulic assessment of the Fletcher's Creek Bridge is not undertaken since the existing bridge can accommodate the roadway widening. There are five culverts within Highway 407 Interchange area and two culverts across Mavis Road north of Highway 407 Interchange. Invert elevations of existing Highway 407 Interchange ramp culverts were estimated from the existing contract drawings, which needs to be confirmed during the detail design phase.

4.1 Hydraulic Capacity Analysis of Culverts

The design standard for the hydraulic analyses of culverts are based on the MTO Highway Drainage Design Standards (HDDS; February 2008). The CulvertMaster hydraulic modelling software was used to estimate the headwater elevation and to assess the hydraulic capacity of each of the existing culverts within the study area. The CulvertMaster modelling software was selected for the following reasons:

- Evaluates inlet and outlet controlled headwater depths;
- Simulates the hydraulic performance of culverts based on user-specific flows;
- Considers variable tailwater depths bases on either outlet channel geometry or user specified depth discharge rating curves; and
- Incorporates an extensive database of standard culvert sizes, shapes and materials, and allows for the addition of custom culvert types and sizes.

The existing conditions hydraulic analysis was carried out for seven existing culverts (CV1 to CV7). Due to the extension of multiuse path on the west side of Mavis Road, Culvert CV7 may require some extension. It may be possible to avoid a culvert extension by providing a wing or headwall at the downstream end. This will be confirmed during the detailed design phase.

Culverts in the Highway 407 Interchange area are classified as freeway ramp culverts. Mavis Road is classified as an urban arterial road. Therefore, design flow for the culverts located in Highway 407 Interchange ramps and Mavis Road is the 50-year flow. The 100-year flow will be used to check for no overtopping requirement.

Peak flows obtained using Rational Method which were discussed in section 3.2.1 and 3.4. Inputs to CulvertMaster included the design storm peak flow, the 100-year peak flow and the physical culvert characteristics (e.g. inverts, sizes, length, slope, etc.).

Table 9 and Table 10 provide the hydraulic assessment for culverts under existing and proposed conditions, respectively.

Table 9: Hydraulic Assessment Culverts – Existing Conditions

Culvert ID	Size (mm) / Type	Length (m)	U/s Invert (m)	D/s Invert (m)	EOP Elev. at Low Point / Spill Elev. (m)	Events	Flow (m^3/s)	Computed HWL (m)	Exit Velocity (m/s)	Upstream Velocity Head (m)	EGL (m)	Freeboard (m)	HW/D	Meets requirements?
CV1	900mm Ø CSP Circular	23.0	198.60	184.40	199.75	50-year	0.316	199.15	5.94	0.12	199.27	0.48	0.61	Freeboard > 1m → No HW/D ≤ 1.5 → Yes
						100-year	0.350	199.18	6.12	0.13	199.31	0.44	0.64	No Overtopping → Yes
CV2	1200mm Ø CSP Circular	25.7	191.00	190.80	194.00	50-year	0.588	191.67	1.71	0.11	191.78	2.22	0.56	Freeboard > 1m → Yes HW/D ≤ 1.5 → Yes
						100-year	0.650	191.70	1.76	0.11	191.81	2.19	0.58	No Overtopping → Yes
CV3	1200mm Ø CSP Circular	26.9	196.30	196.10	197.50	50-year	0.403	196.84	1.54	0.09	196.93	0.57	0.45	Freeboard > 1m → No HW/D ≤ 1.5 → Yes
						100-year	0.446	196.87	1.58	0.09	196.96	0.54	0.47	No Overtopping → Yes
CV4	600mm Ø CSP Circular	30.0	196.20	195.90	200.00	50-year	0.457	196.99	2.26	0.21	197.20	2.80	1.13	Freeboard > 1m → Yes HW/D ≤ 1.5 → Yes
						100-year	0.506	197.04	2.30	0.23	197.27	2.73	1.20	No Overtopping → Yes
CV5	600mm Ø CSP Circular	25.8	204.90	204.70	207.50	50-year	0.072	205.14	1.40	0.06	205.20	2.30	0.34	Freeboard > 1m → Yes HW/D ≤ 1.5 → Yes
						100-year	0.080	205.16	1.45	0.06	205.22	2.28	0.37	No Overtopping → Yes
CV6	1050mm Ø Concrete Circular	51.5	201.70	199.65	203.50	50-year	0.125	201.97	2.59	0.07	202.04	1.46	0.39	Freeboard > 1m → Yes HW/D ≤ 1.5 → Yes
						100-year	0.138	201.99	2.67	0.07	202.06	1.44	0.41	No Overtopping → Yes
CV7	900mm Ø CSP Circular	46.7	194.60	192.30	196.00	50-year	0.101	194.90	1.74	0.06	194.96	1.04	0.43	Freeboard > 1m → Yes HW/D ≤ 1.5 → Yes
						100-year	0.111	194.91	1.79	0.07	194.98	1.02	0.44	No Overtopping → Yes

Note: * Desirable freeboard obtained from subtracting EOP elevation at low point and EGL elevation.

U/s - Upstream
D/s - Downstream
EOP - Edge of pavement
HWL - Headwater Elevation
EGL - Energy Grade Line
HW/D - Headwater over Depth Ratio

Table 10: Hydraulic Assessment Culverts – Proposed Conditions

Culvert ID	Size (mm) / Type	Length (m)	U/s Invert (m)	D/s Invert (m)	EOP Elev. at Low Point / Spill Elev. (m)	Events	Flow (m^3/s)	Computed HWL (m)	Exit Velocity (m/s)	Upstream Velocity Head (m)	EGL (m)	Freeboard (m)	HW/D	Meets requirements?
CV1	900mm Ø CSP Circular	23.0	198.60	184.40	199.75	50-year	0.322	199.15	5.97	0.12	199.27	0.48	0.61	Freeboard > 1m → No HW/D ≤ 1.5 → Yes
						100-year	0.357	199.19	6.16	0.13	199.32	0.43	0.66	No Overtopping → Yes
CV2	1200mm Ø CSP Circular	25.7	191.00	190.80	194.00	50-year	0.599	191.67	1.72	0.11	191.78	2.22	0.56	Freeboard > 1m → Yes HW/D ≤ 1.5 → Yes
						100-year	0.663	191.71	1.77	0.12	191.83	2.17	0.59	No Overtopping → Yes
CV3	1200mm Ø CSP Circular	26.9	196.30	196.10	197.50	50-year	0.411	196.85	1.55	0.09	196.94	0.56	0.46	Freeboard > 1m → No HW/D ≤ 1.5 → Yes
						100-year	0.455	196.88	1.59	0.09	196.97	0.53	0.48	No Overtopping → Yes
CV4	600mm Ø CSP Circular	30.0	196.20	195.90	200.00	50-year	0.495	197.03	2.29	0.22	197.25	2.75	1.19	Freeboard > 1m → Yes HW/D ≤ 1.5 → Yes
						100-year	0.548	197.09	2.32	0.25	197.34	2.66	1.27	No Overtopping → Yes
CV5	600mm Ø CSP Circular	25.8	204.90	204.70	207.50	50-year	0.085	205.16	1.47	0.07	205.23	2.27	0.37	Freeboard > 1m → Yes HW/D ≤ 1.5 → Yes
						100-year	0.094	205.18	1.52	0.07	205.25	2.25	0.40	No Overtopping → Yes
CV6	1050mm Ø Concrete Circular	51.5	201.70	199.65	203.50	50-year	0.138	201.99	2.67	0.07	202.06	1.44	0.41	Freeboard > 1m → Yes HW/D ≤ 1.5 → Yes
						100-year	0.152	202.00	2.75	0.07	202.07	1.43	0.43	No Overtopping → Yes
CV7	900mm Ø CSP Circular	46.7	194.60	192.30	196.00	50-year	0.107	194.91	1.77	0.06	194.97	1.03	0.44	Freeboard > 1m → Yes HW/D ≤ 1.5 → Yes
						100-year	0.119	194.93	1.83	0.07	195.00	1.00	0.47	No Overtopping → Yes

Note: * Desirable freeboard obtained from subtracting EOP elevation at low point and EGL elevation.

U/s - Upstream
D/s - Downstream
EOP - Edge of pavement
HWL - Headwater Elevation
EGL - Energy Grade Line
HW/D - Headwater over Depth Ratio

From the comparison of Table 9 and Table 10, it can be concluded that:

- Culvert CV1 does not meet the required freeboard of 1.0 m for 50-year design storm for existing and proposed conditions. However, the 100-year storm does not overtop the road. There is no increase in the headwater elevation for the 50-year design flow under proposed conditions; however, the headwater elevation for the 100-year flow increased by 0.01 m under the proposed conditions. This increase is considered negligible.
- Culvert CV2 meets all hydraulic requirements. The 100-year flow does not overtop the road. There is no increase in the headwater elevation for the 50-year design flow. The headwater elevation for the 100-year flow increased by 0.02 m under the proposed conditions. This increase is considered negligible.
- Culvert CV3 does not meet the required freeboard of 1.0 m for 50-year design storm for existing and proposed conditions. However, the 100-year storm does not overtop the road. The headwater elevation of the 50-year design flow and the 100-year flow increased by 0.01 m under the proposed conditions. These increases are considered negligible.
- Culvert CV4 meets all hydraulic requirements. The 100-year flow does not overtop the road. The headwater elevation for the 50-year design flow increased by 0.05 m and the 100-year flow increased by 0.07 m under the proposed conditions. The increases in headwater elevations are within the ramp loop and the available freeboard is more than 2.0 m, therefore, the increase in headwater elevations will not impact the ramp.
- Culvert CV5 meets all hydraulic requirements. The 100-year flow does not overtop the road. The headwater elevation for the 50-year design flow and the 100-year design flow increased by 0.03 m under the proposed conditions. These increases are considered negligible.
- Culvert CV6 meets all hydraulic requirements. The 100-year flow does not overtop the road. The headwater elevation for the 50-year design flow increased by 0.02 m and the 100-year flow increased by 0.01 m under the proposed conditions. These increases are considered negligible.
- Culvert CV7 meet all hydraulic requirements. The 100-year flow does not overtop the road. The headwater elevation for the 50-year design flow increased by 0.01 m and the 100-year flow increased by 0.02 m under the proposed conditions. These increases are considered negligible.

The CulvertMaster output files for the Culvert CV1 to CV7 are included in Appendix C.

5.0 STORMWATER MANAGEMENT

5.1 Approach

As noted above, improvements of Mavis Road will not result in significant increases in impervious areas compared to the existing conditions. Under current conditions, there are two existing SWM facilities in place namely Facility No. 4 and Facility No. 5 for quality control and quantity control and extended detention of the roadway runoff for the residential areas on both sides of Mavis Road from Highway 401 Bridge to Highway 407 Interchange. Under proposed conditions, quality and quantity control are maintained by directing the widened roadway areas to the two existing SWM facilities.

The MOECC has identified a broad range of storm water management practices. Some of the practices, which were implemented in existing Mavis Road, will still be valid for the proposed Mavis Road improvements. The practices that are being used as part of this project are:

- SWM pond; and
- Vegetated grassed swale providing some measure of quality treatment and quantity control;

5.2 Impact to Existing Stormwater Management Facilities

5.2.1 Fletcher's Creek Stormwater Management Facility No. 5

Under proposed conditions, 134.9 ha of catchment area drains to existing SWM Facility No. 5 with a directly connected impervious level of 43%. According to the MOECC design guidelines, approximately 16,200 m^3 of permanent pool volume is required for the Enhanced level of quality treatment. The existing SWM facility has a permanent pool volume of 20,000 m^3. Therefore, the existing SWM Facility No. 5 meets the requirement under proposed conditions.

5.2.2 Fletcher's Creek Stormwater Management Facility No. 4

Under proposed conditions, 73.4 ha of catchment area drains to existing SWM Facility No. 4 with an average impervious level of 46%. According to the MOECC design guidelines, approximately 10,130 m^3 of permanent pool volume is required for the Enhanced level of quality treatment. The existing SWM facility has a permanent pool volume of 10,280 m^3. Therefore, the existing SWM Facility No. 4 meets the requirement under proposed conditions.

5.3 Impact of the Proposed Improvement and Recommended Strategy

The proposed improvements on Mavis Road between Courtneypark Drive and Ray Lawson Boulevard includes an additional 3.5 m wide two lane roadway with one center left turn lane (from 4 lanes to 6 lanes), a 1.5 m wide pedestrian pathway on the east side and a 4.0 m wide multi-use path on the west side. In addition, a 1.0 m wide vegetative strip between pathways and roadside curbs are also included throughout

the roadway section. The vegetative strip helps to reduce the imperviousness as well as promotes infiltration of runoff into the ground.

As discussed in Section 3.3, the increase in flows to the existing SWM Facility No. 5 is not significant, as such, no peak flow control on quality treatment is recommended for the Mavis Road roadway runoff.

Similarly, there are negligible increases in flows to the existing SWM Facility No. 4, therefore, no peak flow control on quality treatment is recommended for the Mavis Road roadway runoff.

SWM Facilities No. 4 and 5 both have an orifice to control the flow and the minor increase in drainage area and flow to these SWM facilities will not affect the discharge to Fletcher's Creek. The drawings (C39484 and C42551) related to the control system of SWM Facilities No. 4 and 5 are included in Appendix D.

Runoff of the Highway 407 bridge area is collected by catch basins and ditch inlets and drains towards grassed swales and culverts which further drain to receiving ditches. The receiving ditches convey runoff along long vegetative path before discharging into the regulated features, including the Credit River. As discussed in Section 3.4, peak flow controls are not required. Quality treatment will be maintained by existing grassed swale within the Hwy 407 Interchange area and the vegetative ditches on both sides of Highway 407.

The existing drainage system at the Highway 407 interchange is under the ownership / operation of MTO and 407ETR. While changes to the existing drainage system within the interchange are not proposed as part of the Mavis Road Class EA, the Region of Peel will work with MTO and 407ETR during detailed design phase to ensure that water quality is appropriately managed that the final design meets MTO and MOECC requirements.

5.4 Water Balance Requirements and Low Impact Development Practices

The Recommended Stormwater Management Strategy for Mavis Road largely utilizes the existing boulevard and median areas to accommodate the road widening and the completion of the multi-use path, and therefore minimizes property impacts to the extent possible. The existing storm sewer systems and stormwater management facilities have capacity to accommodate the nominal increases in runoff from the additional impervious areas. However, there are some Low Impact Development (LID) measures that may be considered during detailed design in an effort to offset the minor increase in runoff and provide for stormwater management in terms of water balance requirement within the City's right-of-way.

The water balance requirement is the retention of a minimum of 5 mm of runoff from the site to mitigate the impacts of increased runoff volume. Infiltration would be one of the ideal management techniques for handling the increased runoff volume, but filtration is also beneficial where soils or other constraints limit infiltration. The feasibility of water infiltration depends on the soil materials and the area available to construct the infiltration galleries. Sandy soils will allow faster infiltration than clayey soils. Sandy soils will not require

a large gallery to retain the runoff. For a contributing area of 1.0 ha, the 5 mm retention requires 50 m^3 of available volume in the infiltration gallery which consists of clear stones with 0.4 void ratio. The dimensions (length, width and depth) of the infiltration gallery will be designed such that water can be infiltrated within a 24-hour or 48-hour period.

Table 11 provides the details of water balance requirement based on the increased impervious area at different storm sewer outlet nodes.

Table 11: Water Balance Requirements with respect to Increased Impervious Area

Node ID	Total Drainage Area	Existing Conditions Imperviousness		Proposed Conditions Imperviousness		Increase in Imperviousness		5 mm Runoff Volume of Increased Impervious area for water balance	Required Volume for Infiltration Gallery with 40% Void Ratio
		Area	%	Area	%	Area	%		
	(ha)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(m^3)	(m^3)
Node 1 (Catchments A1 to A10 and A13	5.04	2.84	56%	3.96	79%	1.12	22%	56	140
Node 3 (Catchments A24 to A26)	1.22	0.53	43%	1.06	87%	0.53	44%	27	67
Node 5 (Catchments A30, A31 and A34 to A36)	1.96	0.94	48%	1.55	79%	0.61	31%	31	77
Node 8 (Catchments C1 to C6)	2.76	2.23	81%	2.51	91%	0.29	10%	14	36

Possible LID measures include the following:

1. The multi-use trail would possibly be constructed with permeable pavement to achieve infiltration and the required storage volume.
2. Infiltration galleries could be introduced beneath the permeable pavement of the multi-use trail to enhance infiltration and to achieve required storage volume for water balance.
3. Where catchbasins are to be relocated, localized water quality treatment (e.g. CB Shield) and lateral pipes could be included to direct some road runoff to the adjacent infiltration gallery.
4. Grassed swales / bioswales and infiltration galleries may be considered in some intersections and roadside areas contingent upon the presence of buried utilities and the ability to direct road runoff to

these areas. Possible areas include the northwest quadrant of Mavis Road / Derry Road intersection, and within the road right-of-way of Mavis Road adjacent to Magistrate Terrace.

The feasibility of these measures, or other viable alternatives to achieve the runoff volume reduction targets, will be further explored during detailed design phase.

6.0 CONCLUSIONS AND RECOMMENDATIONS

1. **Hydrologic Analysis:**

   - The Rational Method was used to estimate runoff generated from the roadway pavements and from the external areas under existing and proposed conditions in order to ensure that there will be no impact to the overall watershed hydrology.
   - The pre-development flows for the study area were generated for the 10-year storm events and used as the basis for the assessment of proposed conditions flows. The City of Mississauga's rainfall IDF data was used to determine the flows for the study area.
   - The pre-development flows for the culverts in the Highway 407 Interchange area were generated for the 10-year, 50-year and 100-year storm events and used as the basis for the assessment of proposed conditions flows. The City of Mississauga's rainfall IDF data was used to determine the flows for the study area.
   - Any localized increase in flows resulting from the roadway improvements will be controlled to pre-development levels by the existing SWM Facility No. 4 and No. 5 before discharging to the watercourses. Increases in flows are negligible.
   - Increase in flows in Hwy 407 Interchange area are nominal and not considered significant,
   - Existing storm sewers have adequate capacities.

2. **Hydraulic Analysis:**

   - The hydraulic assessment of the Fletcher's Creek Bridge was not undertaken since the existing bridge can accommodate the roadway widening.
   - The CulvertMaster hydraulic modelling software was used to estimate the headwater depth under both existing and proposed conditions.
   - Increase in headwater depth are considered negligible.
   - The culvert CV7 outlet will need to be modified to accommodate the extension of the multi-use path. A culvert extension can likely be avoided by the use of wing wall or head wall. This needs to be confirmed during the detail design phase.

3. **Stormwater Management:**

   - Under proposed conditions, a 134.9 ha of drainage will be directed to existing SWM Facility No. 5 with a directly connected impervious level of 43%. Approximately 16200 m^3 of permanent pool volume is required. The available permanent pool storage volume is approximately 20,000 m^3. The SWM facility can accommodate the proposed Mavis Road improvements.
   - Under proposed conditions, a 73.4 ha of drainage will be directed to existing SWM Facility No. 4 with an average impervious level of 46%. Approximately 10,130 m^3 of permanent pool volume is required. The available permanent pool storage volume is 10,280 m^3. The SWM facility can accommodate the proposed Mavis Road improvements.

- Use of permeable pavement material in the construction of the multi-use trail and infiltration galleries below the permeable pavement could be considered as LID measures to achieve the water balance requirement. The feasibility of these measures or other viable alternatives to achieve the runoff volume reduction targets be further explored during the detailed design phase.

Based on the conclusions above, the following recommendations are made:

- Existing peak flow control and water quality treatment infrastructure will accommodate the proposed Mavis Road improvements.
- Existing peak flow control and water quality treatment will accommodate the proposed Highway 407 Bridge improvements.
- The existing grassed swales in the Highway 407 Interchange will continue to provide quality treatment.
- Culvert characteristics estimated from Highway 407 Interchange drawings need to be confirmed during detail design stage.
- Increase in flows resulting from the increased impervious area are nominal.
- The existing storm sewer system has adequate capacity.
- Increase headwater depth at all culverts is considered negligible.
- The outlet of Culvert CV7 (west side of Mavis Road) will need to be modified to accommodate the extension of multiuse path. A culvert extension can likely be avoided by the use of wing wall or head wall. This needs to be confirmed during the detail design phase.
- Existing stormwater management facilities have adequate permanent pool, storage volume to accommodate minor increases in road runoff.
- Use of permeable pavement material in the construction of the multi-use trail and infiltration galleries below the permeable pavement be considered as LID measures to achieve the water balance requirement. The feasibility of these measures or other viable alternatives to achieve the runoff volume reduction targets be further explored during the detailed design phase.

All of which is respectfully submitted,

WSP | MMM Group Limited

Jenny Chui
June 1, 2017

Jenny Chui, M.A.Sc.
Water Resource Modeller

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Project Manager / Senior Engineer

APPENDIX A –PHOTOGRAPHIC INVENTORY

Photo 1: U/S side of culvert CV6 that crosses Mavis Road

Photo 2: D/S side of culvert CV6 that crosses Mavis Road

Photo 3: From Mavis Road overpass Hwy 407 bridge looking Hwy 407 N-W Ramp

Photo 4: D/S of culvert CV6 that crosses Mavis Road and U/S of Culvert CV1 that crosses Hwy 407 N-W ramp.

Photo 5: U/S side of culvert CV5 that crosses Hwy 407 S-W Ramp

Photo 6: Ditches along Hwy 407 N-E Ramp

Photo 7: Swale on the west side of Mavis Road that drain to culvert CV4

Photo 8: U/S face of culvert CV4 that crosses Hwy 407 W-N/S Ramp

Photo 9: D/S face of culvert CV4 that crosses Hwy 407 W-N/S Ramp and Storm inlet located downstream of Culvert CV4

Photo 10: Looking north, Ditch Inlet located between Mavis Road and Hwy 407 S-E Ramp

Photo 11: U/S face of culvert that crosses Hwy 407 S-E Ramp

Photo 12: D/S face of culvert that crosses Hwy 407 S-E Ramp

Photo 13: Storm Inlet located at the east side of Mavis Road where the Hwy 407 S-E Ramp start.

Photo 14: Catch basin along the south Bound of Mavis Road where Mavis Road Storm Sewer System start

Photo 15: Looking south along Mavis Road on the east side

Photo 16: Catch basin along the north bound of Mavis Road between Tawin Ave and Envoy Dr

Photo 17: Looking north at Mavis Road and Envoy Dr intersection

Photo 18: Catch basin along the north bound of Mavis Road between Envoy Dr and Derry Road

Photo 19: Ditch inlet at east side of Mavis Road, south of Derry Road

Photo 20: Looking eastward at ditch inlet

Photo 21: Catch basin along the north bound of Mavis Road between Derry Road and Crawford Mill Ave

Photo 22: Looking north along Mavis Road at Mavis Road and Crawford Mill Ave intersection, median at north side

Photo 23: Catch basin along the north bound of Mavis Road between Crawford Mill Ave and Craig Carrier Court

Photo 24: Looking north along Mavis Road between Crawford Mill Ave and Craig Carrier Court

Photo 25: SWM facility no. 5 – Inlet structure and sediment forebay

Photo 26: SWM facility no. 5 – View of deep pool toward north direction

Photo 27: SWM facility no. 5 – Outlet structure

Photo 28: SWM facility no. 5 – Outlet structure, headwall in the downstream face.

Photo 29: Second walkway bridge crossing Fletcher's Creek (Upstream of Mavis Road Bridge)

Photo 30: View of upstream of second walkway bridge

Photo 31: View of downstream of second walkway bridge

Photo 32: First walkway bridge crossing Fletcher's Creek (Upstream of Mavis Road Bridge)

Photo 33: View of upstream of first walkway bridge

Photo 34: View of downstream of first walkway bridge

Photo 35: U/S face of Mavis Road bridge crossing Fletcher's Creek

Photo 36: Looking north at pathway under the Mavis Road bridge

Photo 37: View of the pathway and sheet pile under the Mavis Road bridge

Photo 38: View of downstream of the Mavis Road bridge

Photo 39: D/S face of Mavis Road bridge crossing Fletcher's Creek

Photo 40: SWM facility no. 4 – Overview from the inlet location

Photo 41: SWM facility no. 4 – Overview from the outlet location

Photo 42: SWM facility no. 4 – Storm outlet control manhole

Photo 43: SWM facility no. 4 – Concrete headwall with gate from storm outlet control manhole

Photo 44: SWM facility no. 4 – Outlet open channel

Photo 45: SWM facility no. 4 – Bypass outlet

Photo 46: SWM facility no. 4 - Downstream of bypass outlet drain to outlet open channel

Photo 47: SWM facility no. 4 – Overview from south west side of Mavis Road bridge

Photo 48: Looking north along Mavis Road bridge at the median

Photo 49: Looking southeast along Mavis Road bridge at median

Photo 50: Looking southwest along Mavis Road bridge at median

Photo 51: Inlet along Mavis Road bridge that drain into Fletcher's Creek directly

Photo 52: Ditch along Mavis Road to Fletcher's Creek – Looking North on along Mavis Road south bound.

Photo 53: Ditch along Mavis Road between Courtney Park Dr and Hwy 401. Looking south along Mavis Road north bound

Photo 54: Ditch along Mavis Road between Courtney Park Dr and Hwy 401. Looking South along Mavis Road south bound.

APPENDIX B – HYDROLOGIC MODELLING SUMMARY

3215102 Mavis Road Class Environmental Assessment, South of Highway 407 Interchange to Flectcher's Creek Bridge (Drainage Area to SWM Facility No. 5) - Existing Conditions

STORM SEWER DESIGN SHEET

Location: **Mavis Roads**
Design Storm: **10-year**
Initial Time of Concentration: **15 min**

Rainfall Intensity: $I = A/(T+B)^C$
T= Time of Concentration in hour

City of Mississaiga IDF Data	Storm	A	B	C
	10-year	1010	4.60	0.7800

Calculated By: JC
Checked By:

DRAINAGE AREA							RUNOFF DATA											PIPE DATA										
From			TO						Pavement/ Impervious		Grass																		
MH/ CB	Station	Invert Elevation	MH / CB	Station	Invert Elevation	Catchment ID	Time of Conc.	AREA					Weighted Runoff Coeff.	AC	Accum. AC	Intensity	Runoff	Pipe Length	Pipe Size	Pipe Type	FALL		SLOPE	VELOCITY	CAPACITY	FLOW TIME	PIPE USAGE	COMMENTS
							T	A	A1	C1	A2	C2	C			I	Q_{ac}= $2.78ACI$					n		V_{full}	Q_{full}		Q_{ac} / Q_{full}	
No.		m	No.		m		min.	(ha)								mm/hr	l/sec.	m	mm		m		%	m/sec.	l/sec.	min.	%	
1		198.43	2		198.17	A1	15.00	0.52	0.304	0.900	0.212	0.250	0.63	0.327	0.327	99	90	50.0	375	Conc	0.25	0.013	0.51	1.13	124.7	0.74	72%	
2		198.10	3		197.60	A2	15.74	0.40	0.247	0.900	0.151	0.250	0.65	0.260	0.586	96	157	100.0	450	Conc	0.50	0.013	0.50	1.27	201.7	1.31	78%	
3		197.53	4		196.93	A3	17.05	0.48	0.292	0.900	0.184	0.250	0.65	0.309	0.896	92	228	120.0	525	Conc	0.60	0.013	0.50	1.41	304.2	1.42	75%	
4		196.85	5		195.75	A4	18.47	0.46	0.268	0.900	0.191	0.250	0.63	0.289	1.185	87	288	110.0	600	Conc	1.10	0.013	1.00	2.17	614.1	0.84	47%	
5		195.75	6		194.55	A5	19.31	0.50	0.293	0.900	0.212	0.250	0.63	0.317	1.501	85	354	120.0	600	Conc	1.20	0.013	1.00	2.17	614.1	0.92	58%	
6		194.55	7		193.35	A6	20.23	0.47	0.245	0.900	0.228	0.250	0.59	0.277	1.779	82	408	120.0	600	Conc	1.20	0.013	1.00	2.17	614.1	0.92	66%	
7		193.28	8		192.08	A7	21.15	0.50	0.244	0.900	0.258	0.250	0.57	0.284	2.062	80	460	120.0	675	Conc	1.20	0.013	1.00	2.35	840.6	0.85	55%	
8		192.08	9		190.88	A8	22.00	0.48	0.249	0.900	0.235	0.250	0.58	0.283	2.345	78	510	120.0	675	Conc	1.20	0.013	1.00	2.35	840.6	0.85	61%	
9		190.88	10		189.68	A9	22.85	0.47	0.226	0.900	0.243	0.250	0.56	0.264	2.609	76	553	120.0	675	Conc	1.20	0.013	1.00	2.35	840.6	0.85	66%	
10		188.82	11		187.70	A10	23.70	0.36	0.155	0.900	0.205	0.250	0.53	0.191	2.800	74	580	74.2	675	Conc	1.11	0.013	1.50	2.88	1,029.5	0.43	56%	
External area						A11	15.00	3.01	1.203	0.900	1.804	0.300	0.54	1.624	1.624	99	448	23.6	675	Conc		0.013	0.50	1.66	594.4	0.24	75%	
External area						A12	15.00	2.13	0.852	0.900	1.278	0.300	0.54	1.151	1.151	99	317	18.5	600	Conc		0.013	0.50	1.54	434.3	0.20	73%	
11		186.50	112		185.50	A13	24.13	0.40	0.321	0.900	0.079	0.250	0.77	0.309	5.884	74	1,204	100.0	900	Conc	1.00	0.013	1.00	2.85	1,810.6	0.59	66%	
112		186.50	63		185.50	A14	24.72	0.32	0.032	0.900	0.284	0.250	0.32	0.099	5.983	72	1,205	100.0	900	Conc	1.00	0.013	1.00	2.85	1,810.6	0.59	67%	Node 1
External area						E1	15.00	5.56	2.223	0.900	3.334	0.300	0.54	3.001	8.984	99	2,477	72.0	1050	Conc		0.013	1.00	3.15	2,731.1	0.38	91%	
External area						E2A + E2B	15.00	22.15	8.859	0.900	13.288	0.300	0.54	11.960	11.960	99	3,297	105.0	1950	Conc		0.013	0.30	2.61	7,794.7	0.67	42%	
External area						E3	25.31	30.20	12.080	0.900	18.120	0.300	0.54	16.308	37.251	71	7,385	138.0	1950	Conc		0.013	0.30	2.61	7,794.7	0.88	95%	Node 2
74		187.31	73		185.00	A24	15.00	0.58	0.260	0.900	0.323	0.250	0.54	0.315	0.315	99	87	77.0	300	Conc	2.31	0.013	3.00	2.37	167.5	0.54	52%	
73		184.88	72		182.75	A25	15.54	0.26	0.118	0.900	0.144	0.250	0.54	0.142	0.456	97	123	71.0	375	Conc	2.13	0.013	3.00	2.75	303.7	0.43	41%	
72		182.65	10		180.85	A26	15.67	0.37	0.148	0.900	0.222	0.250	0.51	0.189	0.645	97	173	90.0	450	Conc	1.80	0.013	2.00	2.54	403.2	0.59	43%	Node 3
52		169.82	51		169.47	E4A +E4B	16.26	7.01	2.804	0.900	4.206	0.300	0.54	3.786	4.431	94	1,164	117.0	2100	Conc	0.35	0.013	0.30	2.74	9,483.4	0.71	12%	
51		169.50	57		169.13	E5	26.19	24.69	9.874	0.900	14.811	0.300	0.54	13.330	55.013	70	10,663	93.0	2100	Conc	0.37	0.013	0.40	3.16	10,938.1	0.49	97%	Node 4
71		180.78	70		180.25	A30	15.00	0.61	0.287	0.900	0.319	0.250	0.56	0.338	0.338	99	93	105.0	450	Conc	0.53	0.013	0.50	1.27	202.6	1.37	46%	
70		180.13	56		179.60	A31	16.37	0.35	0.190	0.900	0.164	0.250	0.60	0.212	0.550	94	144	106.0	525	Conc	0.53	0.013	0.50	1.41	304.2	1.26	47%	
96		179.17	113		178.51	A34	15.00	0.29	0.186	0.900	0.107	0.250	0.66	0.194	0.194	99	54	90.0	375	Conc	0.66	0.013	0.73	1.36	150.1	1.10	36%	
113		178.53	75		178.20	A35	16.10	0.32	0.119	0.900	0.205	0.250	0.49	0.158	0.352	95	93	66.0	375	Conc	0.33	0.013	0.50	1.12	124.0	0.98	75%	
75		176.81	76		176.37	A36	17.63	0.39	0.161	0.900	0.226	0.250	0.52	0.201	1.104	90	276	90.0	750	Conc	0.44	0.013	0.49	1.76	778.4	0.85	35%	Node 5
External area						E6A + E6B	18.48	35.98	14.392	0.900	21.588	0.250	0.51	18.350	19.453	87	4,721	57.0	1650	Conc		0.013	0.50	3.01	6,444.7	0.32	73%	Node 6
57		169.13	Pond		168.83		26.68	139.25		0.900					74.466	69	14,257	58.0	2400	Conc	0.30	0.013	0.52	3.94	17,806.0	0.25	80%	Node 7

3215102 Mavis Road Class Environmental Assessment, South of Highway 407 Interchange to Flectcher's Creek Bridge (Drainage Area to SWM Facility No. 5) - Proposed Conditions

STORM SEWER DESIGN SHEET

Location: **Mavis Roads**
Design Storm: **10-year**
Initial Time of Concentration: **15 min**

Rainfall Intensity: $I = A/(T+B)^C$
T= Time of Concentration in hour

City of Mississaiga IDF Data	Storm	A	B	C
	10-year	1010	4.60	0.7800

Calculated By: JC
Checked By:

DRAINAGE AREA							RUNOFF DATA											PIPE DATA										
From			TO						Pavement/ Impervious		Grass																		
MH/ CB	Station	Invert Elevation	MH / CB	Station	Invert Elevation	Catchment ID	Time of Conc. T	AREA A	A1	C1	A2	C2	Weighted Runoff Coeff. C	AC	Accum. AC	Intensity I	Runoff Q_{ac}= 2.78ACI	Pipe Length	Pipe Size	Pipe Type	FALL	n	SLOPE	VELOCITY V_{full}	CAPACITY Q_{full}	FLOW TIME	PIPE USAGE Q_{ac} / Q_{full}	COMMENTS
No.		m	No.		m		min.	(ha)								mm/hr	l/sec.	m	mm		m		%	m/sec.	l/sec.	min.	%	
1		198.43	2		198.17	A1	15.00	0.52	0.374	0.900	0.142	0.250	0.72	0.372	0.372	99	103	50.0	375	Conc	0.25	0.013	0.51	1.13	124.7	0.74	82%	
2		198.10	3		197.60	A2	15.74	0.40	0.303	0.900	0.094	0.250	0.75	0.297	0.669	96	179	100.0	450	Conc	0.50	0.013	0.50	1.27	201.7	1.31	89%	
3		197.53	4		196.93	A3	17.05	0.48	0.359	0.900	0.117	0.250	0.74	0.353	1.021	92	261	120.0	525	Conc	0.60	0.013	0.50	1.41	304.2	1.42	86%	
4		196.85	5		195.75	A4	18.47	0.46	0.330	0.900	0.129	0.250	0.72	0.329	1.350	87	328	110.0	600	Conc	1.10	0.013	1.00	2.17	614.1	0.84	53%	
5		195.75	6		194.55	A5	19.31	0.50	0.361	0.900	0.144	0.250	0.71	0.361	1.711	85	404	120.0	600	Conc	1.20	0.013	1.00	2.17	614.1	0.92	66%	
6		194.55	7		193.35	A6	20.23	0.47	0.404	0.900	0.069	0.250	0.81	0.380	2.091	82	479	120.0	600	Conc	1.20	0.013	1.00	2.17	614.1	0.92	78%	
7		193.28	8		192.08	A7	21.15	0.50	0.402	0.900	0.100	0.250	0.77	0.387	2.478	80	552	120.0	675	Conc	1.20	0.013	1.00	2.35	840.6	0.85	66%	
8		192.08	9		190.88	A8	22.00	0.48	0.411	0.900	0.073	0.250	0.80	0.388	2.866	78	623	120.0	675	Conc	1.20	0.013	1.00	2.35	840.6	0.85	74%	
9		190.88	10		189.68	A9	22.85	0.47	0.384	0.900	0.085	0.250	0.78	0.367	3.233	76	685	120.0	675	Conc	1.20	0.013	1.00	2.35	840.6	0.85	82%	
10		188.82	11		187.70	A10	23.70	0.36	0.264	0.900	0.097	0.250	0.73	0.262	3.495	74	723	74.2	675	Conc	1.11	0.013	1.50	2.88	1,029.5	0.43	70%	
External area						A11	15.00	3.01	1.203	0.900	1.804	0.300	0.54	1.624	1.624	99	448	23.6	675	Conc		0.013	0.50	1.66	594.4	0.24	75%	
External area						A12	15.00	2.13	0.852	0.900	1.278	0.300	0.54	1.151	1.151	99	317	18.5	600	Conc		0.013	0.50	1.54	434.3	0.20	73%	
11		186.50	112		185.50	A13	24.13	0.40	0.375	0.900	0.025	0.250	0.86	0.344	6.614	74	1,353	100.0	900	Conc	1.00	0.013	1.00	2.85	1,810.6	0.59	75%	
112		186.50	63		185.50	A14	24.72	0.32	0.032	0.900	0.284	0.250	0.32	0.099	6.713	72	1,352	100.0	900	Conc	1.00	0.013	1.00	2.85	1,810.6	0.59	75%	Node 1
External area						E1	15.00	5.56	2.223	0.900	3.334	0.300	0.54	3.001	9.714	99	2,678	72.0	1050	Conc		0.013	1.00	3.15	2,731.1	0.38	98%	
External area						E2A + E2B	15.00	22.15	8.859	0.900	13.288	0.300	0.54	11.960	11.960	99	3,297	105.0	1950	Conc		0.013	0.30	2.61	7,794.7	0.67	42%	
External area						E3	25.31	30.20	12.080	0.900	18.120	0.300	0.54	16.308	37.981	71	7,530	138.0	1950	Conc		0.013	0.30	2.61	7,794.7	0.88	97%	Node 2
74		187.31	73		185.00	A24	15.00	0.58	0.524	0.900	0.059	0.250	0.83	0.486	0.486	99	134	77.0	300	Conc	2.31	0.013	3.00	2.37	167.5	0.54	80%	
73		184.88	72		182.75	A25	15.54	0.26	0.237	0.900	0.024	0.250	0.84	0.219	0.706	97	190	71.0	375	Conc	2.13	0.013	3.00	2.75	303.7	0.43	63%	
72		182.65	10		180.85	A26	15.67	0.37	0.299	0.900	0.071	0.250	0.77	0.287	0.992	97	267	90.0	450	Conc	1.80	0.013	2.00	2.54	403.2	0.59	66%	Node 3
52		169.82	51		169.47	E4A +E4B	16.26	7.01	2.804	0.900	4.206	0.300	0.54	3.786	4.778	94	1,255	117.0	2100	Conc	0.35	0.013	0.30	2.74	9,483.4	0.71	13%	
51		169.50	57		169.13	E5	26.19	24.69	9.874	0.900	14.811	0.300	0.54	13.330	56.089	70	10,871	93.0	2100	Conc	0.37	0.013	0.40	3.16	10,938.1	0.49	99%	Node 4
71		180.78	70		180.25	A30	15.00	0.61	0.479	0.900	0.127	0.250	0.76	0.463	0.463	99	128	105.0	450	Conc	0.53	0.013	0.50	1.27	202.6	1.37	63%	
70		180.13	56		179.60	A31	16.37	0.35	0.316	0.900	0.037	0.250	0.83	0.294	0.757	94	198	106.0	525	Conc	0.53	0.013	0.50	1.41	304.2	1.26	65%	
96		179.17	113		178.51	A34	15.00	0.29	0.293	0.900		0.250	0.90	0.264	0.264	99	73	90.0	375	Conc	0.66	0.013	0.73	1.36	150.1	1.10	48%	
113		178.53	75		178.20	A35	16.10	0.32	0.198	0.900	0.125	0.250	0.65	0.209	0.473	95	125	66.0	375	Conc	0.33	0.013	0.50	1.12	124.0	0.98	101%	
75		176.81	76		176.37	A36	17.63	0.39	0.268	0.900	0.119	0.250	0.70	0.271	1.501	90	375	90.0	750	Conc	0.44	0.013	0.49	1.76	778.4	0.85	48%	Node 5
External area						E6A + E6B	18.48	35.98	14.392	0.900	21.588	0.250	0.51	18.350	19.851	87	4,818	57.0	1650	Conc		0.013	0.50	3.01	6,444.7	0.32	75%	Node 6
57		169.13	Pond		168.83		26.68	139.25		0.900					75.941	69	14,539	58.0	2400	Conc	0.30	0.013	0.52	3.94	17,806.0	0.25	82%	Node 7

3215102 Mavis Road Class Environmental Assessment, Flectcher's Creek Bridge to Courtneypark Drive West (Drainage Area to SWM Facility No. 4) - Existing Condition

STORM SEWER DESIGN SHEET

Location: **Mavis Roads**
Design Storm: **10-year**
Initial Time of Concentration: **15 min**

Rainfall Intensity: $I = A/(T+B)^C$
T= Time of Concentration in hour

City of Mississaiga IDF Data	Storm	A	B	C
	10-year	1010	4.60	0.7800

Calculated By: JC
Checked By:

DRAINAGE AREA							RUNOFF DATA											PIPE DATA										
From			TO						Pavement/ Impervious		Grass																	
MH/ CB	Station	Invert Elevation	MH / CB	Station	Invert Elevation	Catchment ID	Time of Conc. T	AREA A	A1	C1	A2	C2	Weighted Runoff Coeff. C	AC	Accum. AC	Intensity I	Runoff Q_{ac}= 2.78ACI	Pipe Length	Pipe Size	Pipe Type	FALL	n	SLOPE	VELOCITY V_{full}	CAPACITY Q_{full}	FLOW TIME	PIPE USAGE Q_{ac} / Q_{full}	COMMENTS
No.		m	No.		m		min.	(ha)								mm/hr	l/sec.	m	mm		m		%	m/sec.	l/sec.	min.	%	
92		178.70	85		177.34	C1	15.00	0.57	0.510	0.900	0.060	0.250	0.83	0.474	0.474	99	131	136.0	375	Conc	1.36	0.013	1.00	1.59	175.3	1.43	75%	
64		186.68	69		183.68	C6	15.00	0.77	0.636	0.900	0.130	0.250	0.79	0.605	0.605	99	167	120.0	375	Conc	3.00	0.013	2.50	2.51	277.2	0.80	60%	
69		183.60	75		182.00	C5	15.80	0.44	0.371	0.900	0.069	0.250	0.80	0.351	0.957	96	256	118.0	450	Conc	1.60	0.013	1.36	2.09	331.9	0.94	77%	
External area						E8	22.00	37.52	13.508	0.900	24.015	0.300	0.52	19.362	19.362	78	4,206	87.0	1650	Conc	0.59	0.013	0.68	3.53	7,537.3	0.41	56%	
75		174.24	77		173.81	C4	22.41	0.35	0.286	0.900	0.065	0.250	0.78	0.274	19.636	77	4,215	87.0	1650	Conc	0.44	0.013	0.50	3.01	6,444.7	0.48	65%	
77		173.75	82		173.23	C3	22.89	0.44	0.340	0.900	0.103	0.250	0.75	0.332	19.967	76	4,228	105.0	1650	Conc	0.53	0.013	0.50	3.01	6,444.7	0.58	66%	
External area						E7	15.00	2.19	0.790	0.900	1.404	0.300	0.52	1.132	1.132	99	312	28.0	675	Conc	0.14	0.013	0.50	1.66	594.4	0.28	53%	
85		172.76	46		172.62	C2	23.47	0.19	0.083	0.900	0.106	0.250	0.53	0.101	21.674	75	4,515	27.0	1650	Conc	0.13	0.013	0.50	3.01	6,444.7	0.15	70%	Node 8
58		171.46	52		171.38	E9	23.62	30.87	10.806	0.900	20.068	0.250	0.48	14.742	14.742	75	3,058	17.5	1800	Conc	0.08	0.013	0.47	3.09	7,868.2	0.09	39%	
52		170.12	53		169.85		23.71	73.35		0.900					36.417	74	7,536	107.0	2100	Conc	0.27	0.013	0.25	2.50	8,662.5	0.71	87%	
53		169.85	Flow Spilter @ Pond		169.76		24.42	73.35		0.900					36.417	73	7,392	58.0	2400	Conc	0.09	0.013	0.15	2.12	9,586.1	0.46	77%	Node 9

3215102 Mavis Road Class Environmental Assessment, Flectcher's Creek Bridge to Courtneypark Drive West (Drainage Area to SWM Facility No. 4) - Proposed Condition

STORM SEWER DESIGN SHEET

Location: **Mavis Roads**
Design Storm: **10-year**
Initial Time of Concentration: **15 min**

Rainfall Intensity: $I = A/(T+B)^C$
T= Time of Concentration in hour

City of Mississaiga IDF Data	Storm	A	B	C
	10-year	1010	4.60	0.7800

Calculated By: JC
Checked By:

DRAINAGE AREA							RUNOFF DATA											PIPE DATA										
From			TO						Pavement/ Impervious		Grass																	
MH/ CB	Station	Invert Elevation	MH / CB	Station	Invert Elevation	Catchment ID	Time of Conc. T	AREA A	A1	C1	A2	C2	Weighted Runoff Coeff. C	AC	Accum. AC	Intensity I	Runoff $Q_{ac}=2.78ACI$	Pipe Length	Pipe Size	Pipe Type	FALL	n	SLOPE	VELOCITY V_{full}	CAPACITY Q_{full}	FLOW TIME	PIPE USAGE Q_{ac} / Q_{full}	COMMENTS
No.		m	No.		m		min.	(ha)								mm/hr	l/sec.	m	mm		m		%	m/sec.	l/sec.	min.	%	
92		178.70	85		177.34	C1	15.00	0.57	0.482	0.900	0.088	0.250	0.80	0.456	0.456	99	126	136.0	375	Conc	1.36	0.013	1.00	1.59	175.3	1.43	72%	
64		186.68	69		183.68	C6	15.00	0.77	0.758	0.900	0.009	0.250	0.89	0.684	0.684	99	189	120.0	375	Conc	3.00	0.013	2.50	2.51	277.2	0.80	68%	
69		183.60	75		182.00	C5	15.80	0.44	0.440	0.900	0.001	0.250	0.90	0.396	1.080	96	289	118.0	450	Conc	1.60	0.013	1.36	2.09	331.9	0.94	87%	
External area						E8	22.00	37.52	13.508	0.900	24.015	0.300	0.52	19.362	19.362	78	4,206	87.0	1650	Conc	0.59	0.013	0.68	3.53	7,537.3	0.41	56%	
75		174.24	77		173.81	C4	22.41	0.35	0.340	0.900	0.010	0.250	0.88	0.309	19.671	77	4,223	87.0	1650	Conc	0.44	0.013	0.50	3.01	6,444.7	0.48	66%	
77		173.75	82		173.23	C3	22.89	0.44	0.405	0.900	0.038	0.250	0.84	0.374	20.045	76	4,244	105.0	1650	Conc	0.53	0.013	0.50	3.01	6,444.7	0.58	66%	
External area						E7	15.00	2.19	0.790	0.900	1.404	0.300	0.52	1.132	1.132	99	312	28.0	675	Conc	0.14	0.013	0.50	1.66	594.4	0.28	53%	
85		172.76	46		172.62	C2	23.47	0.19	0.088	0.900	0.100	0.250	0.55	0.104	21.738	75	4,528	27.0	1650	Conc	0.13	0.013	0.50	3.01	6,444.7	0.15	70%	Node 8
58		171.46	52		171.38	E9	23.62	30.87	10.806	0.900	20.068	0.250	0.48	14.742	14.742	75	3,058	17.5	1800	Conc	0.08	0.013	0.47	3.09	7,868.2	0.09	39%	
52		170.12	53		169.85		23.71	73.35		0.900					36.480	74	7,549	107.0	2100	Conc	0.27	0.013	0.25	2.50	8,662.5	0.71	87%	
53		169.85	Flow Spilter @ Pond		169.76		24.42	73.35		0.900					36.480	73	7,405	58.0	2400	Conc	0.09	0.013	0.15	2.12	9,586.1	0.46	77%	Node 9

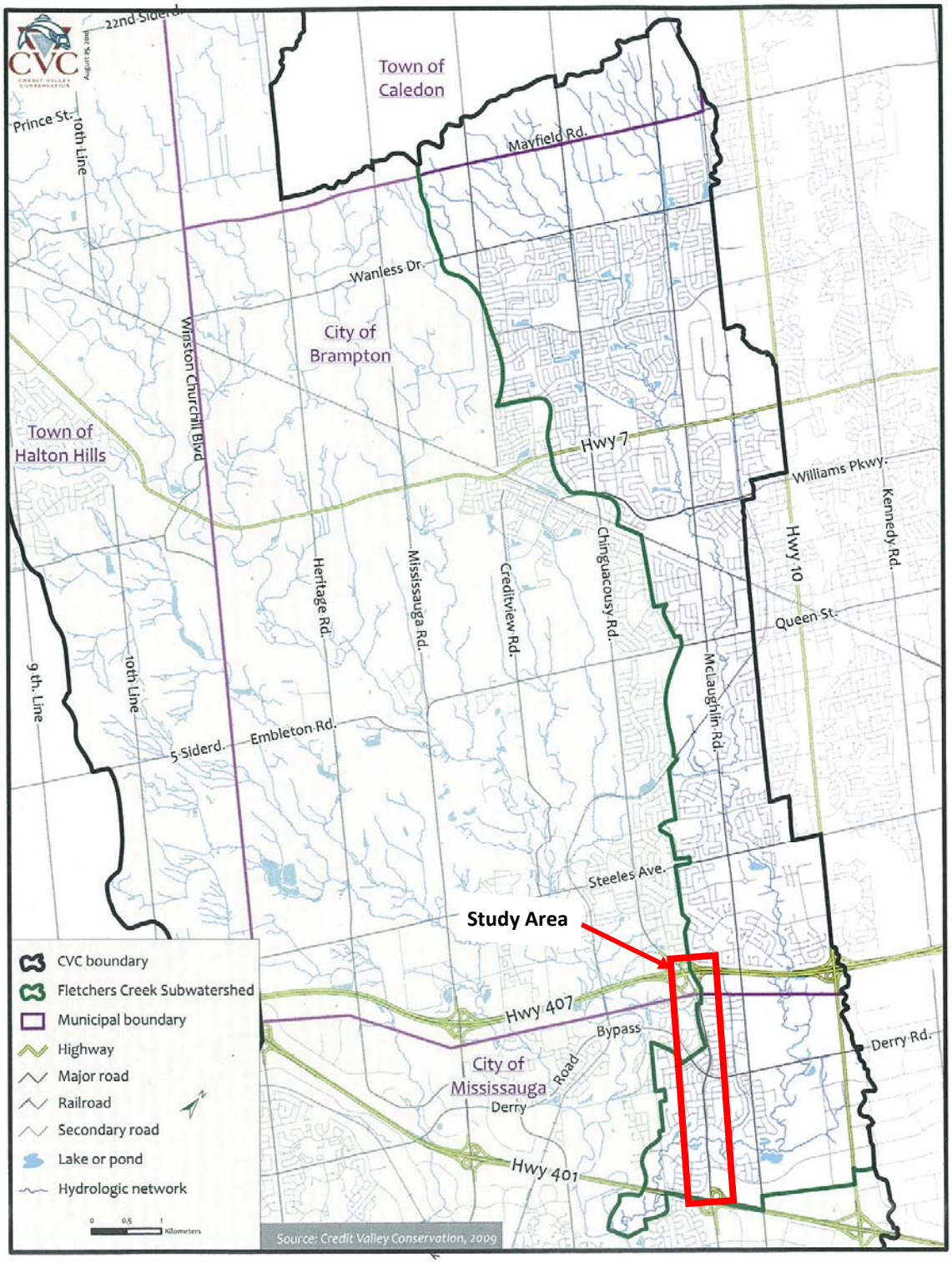
3215102 Mavis Road Class Environmental Assessment, Hwy 407 Interchange area - Existing Condition

Location:	Mavis Roads at Hwy 407 Interchange area												Storm	A	B	C
Design Storm:	10, 50 and 100	Rainfall Intensity: $I = A/(T+B)^C$										**City of Mississaga IDF Data**	10-year	1010	4.60	0.7800
Initial Time of Concentration:	15 min												50-year	1300	4.70	0.7800
		T= Time of Concentration in hour											100-year	1450	4.90	0.7800

DRAINAGE AREA		**RUNOFF DATA**														
Culvert No.	**Catchment ID**	**Time of Conc.**	**AREA**	**Pavement/ Impervious**		**Grass**		**Weighted Runoff Coeff.**		**Accum.**	**Intensity (10yr)**	**Intensity (50yr)**	**Intensity (100yr)**	**Runoff (10 yr)**	**Runoff (50 yr)**	**Runoff (100 yr)**
		T	**A**	**A1**	**C1**	**A2**	**C2**	**C**	**AC**	**AC**	I	I	I	Q_{10}= 2.78ACI	Q_{50}= 2.78ACI	Q_{100}= 2.78ACI
		min.	**(ha)**								**mm/hr**	**mm/hr**	**mm/hr**	**l/sec.**	**l/sec.**	**l/sec.**
CV1	E10A+B1+E10B	15	1.10	0.558	0.900	0.543	0.250	0.58	0.638	0.992	99	127	141	273	350	388
CV2	E11C+B2+B3+E11B+E11A	15	3.97	0.911	0.900	3.058	0.250	0.40	1.584	1.788	99	127	141	493	632	699
CV3	B4+E12B+E12A	15	3.25	0.505	0.900	2.743	0.250	0.35	1.140	1.140	99	127	141	314	403	446
CV4	B5 to B10, E13	15	2.99	0.842	0.900	2.145	0.250	0.43	1.294	1.294	99	127	141	357	457	506
CV5	E11C	15	0.41	0.154	0.900	0.260	0.250	0.49	0.204	0.204	99	127	141	56	72	80
CV6	E10A	15	1.30	0.043	0.900	1.260	0.250	0.27	0.354	0.354	99	127	141	97	125	138
CV7	E14	15	0.70	0.170	0.900	0.526	0.250	0.41	0.285	0.285	99	127	141	78	101	111

3215102 Mavis Road Class Environmental Assessment, Hwy 407 Interchange area - Proposed Condition

Location:	Mavis Roads at Hwy 407 Interchange area												City of Mississaiga IDF Data	Storm	A	B	C
Design Storm:	10, 50 and 100			Rainfall Intensity: $I = A/(T+B)^C$										10-year	1010	4.60	0.7800
Initial Time of Concentration:	15 min													50-year	1300	4.70	0.7800
				T= Time of Concentration in hour										100-year	1450	4.90	0.7800
DRAINAGE AREA		**RUNOFF DATA**															
Culvert No.	**Catchment ID**	**Time of Conc.**	**AREA**	**Pavement/ Impervious**		**Grass**		**Weighted Runoff Coeff.**		**Accum.**	**Intensity (10yr)**	**Intensity (50yr)**	**Intensity (100yr)**	**Runoff (10 yr)**	**Runoff (50 yr)**	**Runoff (100 yr)**	
		T	**A**	**A1**	**C1**	**A2**	**C2**	**C**	**AC**	**AC**	***I***	***I***	***I***	**Q_{10}= 2.78ACI**	**Q_{50}= 2.78ACI**	**Q_{100}= 2.78ACI**	
		min.	**(ha)**								**mm/hr**	**mm/hr**	**mm/hr**	**l/sec.**	**l/sec.**	**l/sec.**	
CV1	B1 + E10B	15	1.17	0.529	0.900	0.642	0.250	0.54	0.636	1.025	99	127	141	283	362	401	
CV2	E11C+B2+B3+E11B+E11A	15	4.10	1.026	0.900	3.075	0.250	0.41	1.692	1.933	99	127	141	533	683	756	
CV3	B4+E12B+E12A	15	3.33	0.505	0.900	2.829	0.250	0.35	1.162	1.162	99	127	141	320	411	455	
CV4	B5 to B10, E13	15	3.42	0.842	0.900	2.573	0.250	0.41	1.401	1.401	99	127	141	386	495	548	
CV5	E11C	15	0.41	0.211	0.900	0.204	0.250	0.58	0.241	0.241	99	127	141	66	85	94	
CV6	E10A	15	1.30	0.097	0.900	1.206	0.250	0.30	0.389	0.389	99	127	141	107	138	152	
CV7	E14	15	0.70	0.200	0.900	0.496	0.250	0.44	0.304	0.304	99	127	141	84	107	119	



(Source: Fletchers Creek Restoration Study Characterization Report, Credit Valley Conservation, Feb 2012)

Figure 1: Fletcher's Creek Subwatershed and Study Area

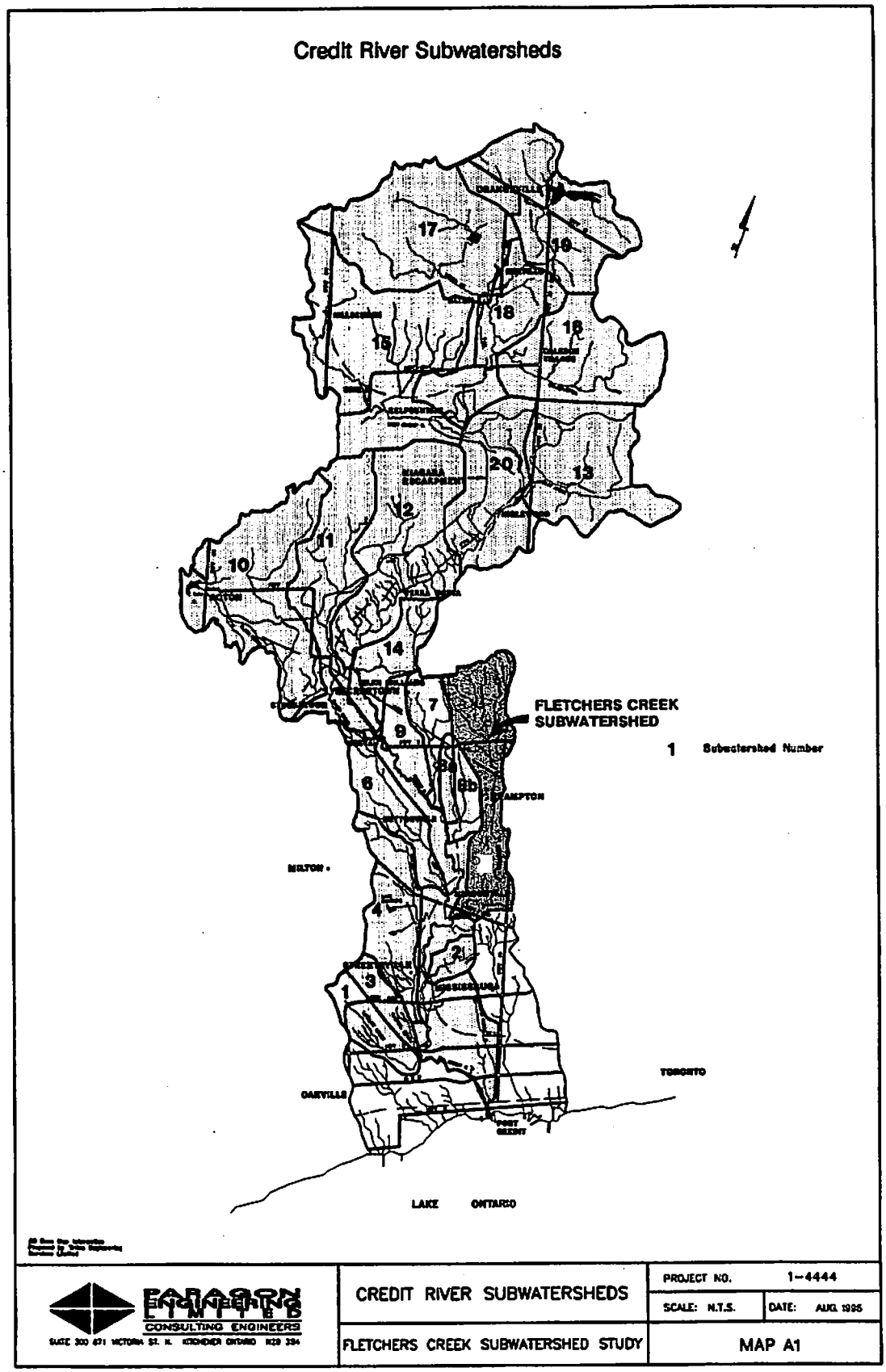


Figure 2: Fletchers Creek Subwatershed with Credit River watershed

APPENDIX C – HYDRAULIC ASSESSMENTS

Culvert Designer/Analyzer Report
C1 Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.3500	m³/s	Check Discharge	0.3880	m³/s

Grades Model: Inverts					
Invert Upstream	198.60	m	Invert Downstream	184.40	m
Length	23.00	m	Slope	0.617391	m/m
Drop	14.20	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-900 mm Circular	0.3500 m³/s	199.18 m	6.12 m/s
	Trial-2	1-900 mm Circular	0.3880 m³/s	199.21 m	6.31 m/s

Culvert Designer/Analyzer Report
C1 Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	199.18	m	Discharge	0.3500	m³/s
Headwater Depth/Height	0.63		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	198.82	m	Control Type	Entrance Control	
Outlet Control HW Elev.	199.18	m			

Grades					
Upstream Invert	198.60	m	Downstream Invert	184.40	m
Length	23.00	m	Constructed Slope	0.617391	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.13	m
Slope Type	Steep		Normal Depth	0.13	m
Flow Regime	Supercritical		Critical Depth	0.34	m
Velocity Downstream	6.12	m/s	Critical Slope	0.013444	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	199.18	m	Upstream Velocity Head	0.13	m
Ke	0.90		Entrance Loss	0.11	m

Inlet Control Properties					
Inlet Control HW Elev.	198.82	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C1 Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	199.21	m	Discharge	0.3880	m³/s
Headwater Depth/Height	0.67		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	198.85	m	Control Type	Entrance Control	
Outlet Control HW Elev.	199.21	m			

Grades					
Upstream Invert	198.60	m	Downstream Invert	184.40	m
Length	23.00	m	Constructed Slope	0.617391	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.14	m
Slope Type	Steep		Normal Depth	0.14	m
Flow Regime	Supercritical		Critical Depth	0.36	m
Velocity Downstream	6.31	m/s	Critical Slope	0.013550	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	199.21	m	Upstream Velocity Head	0.13	m
Ke	0.90		Entrance Loss	0.12	m

Inlet Control Properties					
Inlet Control HW Elev.	198.85	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C1 Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.3620	m³/s	Check Discharge	0.4010	m³/s

Grades Model: Inverts					
Invert Upstream	198.60	m	Invert Downstream	184.40	m
Length	23.00	m	Slope	0.617391	m/m
Drop	14.20	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-900 mm Circular	0.3620 m³/s	199.19 m	6.18 m/s
	Trial-2	1-900 mm Circular	0.4010 m³/s	199.23 m	6.37 m/s

Culvert Designer/Analyzer Report
C1 Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	199.19	m	Discharge	0.3620	m³/s
Headwater Depth/Height	0.65		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	198.83	m	Control Type	Entrance Control	
Outlet Control HW Elev.	199.19	m			

Grades					
Upstream Invert	198.60	m	Downstream Invert	184.40	m
Length	23.00	m	Constructed Slope	0.617391	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.13	m
Slope Type	Steep		Normal Depth	0.13	m
Flow Regime	Supercritical		Critical Depth	0.35	m
Velocity Downstream	6.18	m/s	Critical Slope	0.013475	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	199.19	m	Upstream Velocity Head	0.13	m
Ke	0.90		Entrance Loss	0.12	m

Inlet Control Properties					
Inlet Control HW Elev.	198.83	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C1 Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	199.23	m	Discharge	0.4010	m³/s
Headwater Depth/Height	0.68		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	198.86	m	Control Type	Entrance Control	
Outlet Control HW Elev.	199.23	m			

Grades					
Upstream Invert	198.60	m	Downstream Invert	184.40	m
Length	23.00	m	Constructed Slope	0.617391	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.14	m
Slope Type	Steep		Normal Depth	0.14	m
Flow Regime	Supercritical		Critical Depth	0.37	m
Velocity Downstream	6.37	m/s	Critical Slope	0.013591	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	199.23	m	Upstream Velocity Head	0.14	m
Ke	0.90		Entrance Loss	0.12	m

Inlet Control Properties					
Inlet Control HW Elev.	198.86	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C2 Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.6320	m³/s	Check Discharge	0.6990	m³/s

Grades Model: Inverts					
Invert Upstream	191.00	m	Invert Downstream	190.80	m
Length	25.70	m	Slope	0.007782	m/m
Drop	0.20	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1200 mm Circular	0.6320 m³/s	191.69 m	1.75 m/s
	Trial-2	1-1200 mm Circular	0.6990 m³/s	191.73 m	1.80 m/s

Culvert Designer/Analyzer Report
C2 Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	191.69	m	Discharge	0.6320	m³/s
Headwater Depth/Height	0.57		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	191.61	m	Control Type	Outlet Control	
Outlet Control HW Elev.	191.69	m			

Grades					
Upstream Invert	191.00	m	Downstream Invert	190.80	m
Length	25.70	m	Constructed Slope	0.007782	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.42	m
Slope Type	Mild		Normal Depth	0.48	m
Flow Regime	Subcritical		Critical Depth	0.42	m
Velocity Downstream	1.75	m/s	Critical Slope	0.012129	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.22	m
Section Size	1200 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	191.69	m	Upstream Velocity Head	0.11	m
Ke	0.90		Entrance Loss	0.10	m

Inlet Control Properties					
Inlet Control HW Elev.	191.61	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	1.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C2 Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	191.73	m	Discharge	0.6990	m³/s
Headwater Depth/Height	0.60		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	191.65	m	Control Type	Outlet Control	
Outlet Control HW Elev.	191.73	m			

Grades					
Upstream Invert	191.00	m	Downstream Invert	190.80	m
Length	25.70	m	Constructed Slope	0.007782	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.45	m
Slope Type	Mild		Normal Depth	0.51	m
Flow Regime	Subcritical		Critical Depth	0.45	m
Velocity Downstream	1.80	m/s	Critical Slope	0.012193	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.22	m
Section Size	1200 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	191.73	m	Upstream Velocity Head	0.12	m
Ke	0.90		Entrance Loss	0.11	m

Inlet Control Properties					
Inlet Control HW Elev.	191.65	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	1.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C2 Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.6830	m³/s	Check Discharge	0.7560	m³/s

Grades Model: Inverts					
Invert Upstream	191.00	m	Invert Downstream	190.80	m
Length	25.70	m	Slope	0.007782	m/m
Drop	0.20	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1200 mm Circular	0.6830 m³/s	191.72 m	1.79 m/s
	Trial-2	1-1200 mm Circular	0.7560 m³/s	191.76 m	1.84 m/s

Culvert Designer/Analyzer Report
C2 Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	191.72	m	Discharge	0.6830	m³/s
Headwater Depth/Height	0.59		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	191.64	m	Control Type	Outlet Control	
Outlet Control HW Elev.	191.72	m			

Grades					
Upstream Invert	191.00	m	Downstream Invert	190.80	m
Length	25.70	m	Constructed Slope	0.007782	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.44	m
Slope Type	Mild		Normal Depth	0.50	m
Flow Regime	Subcritical		Critical Depth	0.44	m
Velocity Downstream	1.79	m/s	Critical Slope	0.012176	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.22	m
Section Size	1200 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	191.72	m	Upstream Velocity Head	0.12	m
Ke	0.90		Entrance Loss	0.11	m

Inlet Control Properties					
Inlet Control HW Elev.	191.64	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	1.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C2 Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	191.76	m	Discharge	0.7560	m³/s
Headwater Depth/Height	0.63		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	191.68	m	Control Type	Outlet Control	
Outlet Control HW Elev.	191.76	m			

Grades					
Upstream Invert	191.00	m	Downstream Invert	190.80	m
Length	25.70	m	Constructed Slope	0.007782	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.47	m
Slope Type	Mild		Normal Depth	0.53	m
Flow Regime	Subcritical		Critical Depth	0.47	m
Velocity Downstream	1.84	m/s	Critical Slope	0.012259	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.22	m
Section Size	1200 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	191.76	m	Upstream Velocity Head	0.12	m
Ke	0.90		Entrance Loss	0.11	m

Inlet Control Properties					
Inlet Control HW Elev.	191.68	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	1.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C3 Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.4030	m³/s	Check Discharge	0.4460	m³/s

Grades Model: Inverts					
Invert Upstream	196.30	m	Invert Downstream	196.10	m
Length	26.90	m	Slope	0.007435	m/m
Drop	0.20	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1200 mm Circular	0.4030 m³/s	196.84 m	1.54 m/s
	Trial-2	1-1200 mm Circular	0.4460 m³/s	196.87 m	1.58 m/s

Culvert Designer/Analyzer Report
C3 Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	196.84	m	Discharge	0.4030	m³/s
Headwater Depth/Height	0.45		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	196.77	m	Control Type	Outlet Control	
Outlet Control HW Elev.	196.84	m			

Grades					
Upstream Invert	196.30	m	Downstream Invert	196.10	m
Length	26.90	m	Constructed Slope	0.007435	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.34	m
Slope Type	Mild		Normal Depth	0.38	m
Flow Regime	Subcritical		Critical Depth	0.34	m
Velocity Downstream	1.54	m/s	Critical Slope	0.012072	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.22	m
Section Size	1200 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	196.84	m	Upstream Velocity Head	0.09	m
Ke	0.90		Entrance Loss	0.08	m

Inlet Control Properties					
Inlet Control HW Elev.	196.77	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	1.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C3 Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	196.87	m	Discharge	0.4460	m³/s
Headwater Depth/Height	0.47		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	196.80	m	Control Type	Outlet Control	
Outlet Control HW Elev.	196.87	m			

Grades					
Upstream Invert	196.30	m	Downstream Invert	196.10	m
Length	26.90	m	Constructed Slope	0.007435	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.35	m
Slope Type	Mild		Normal Depth	0.40	m
Flow Regime	Subcritical		Critical Depth	0.35	m
Velocity Downstream	1.58	m/s	Critical Slope	0.012057	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.22	m
Section Size	1200 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	196.87	m	Upstream Velocity Head	0.09	m
Ke	0.90		Entrance Loss	0.08	m

Inlet Control Properties					
Inlet Control HW Elev.	196.80	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	1.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C3 Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.4110	m³/s	Check Discharge	0.4550	m³/s

Grades Model: Inverts					
Invert Upstream	196.30	m	Invert Downstream	196.10	m
Length	26.90	m	Slope	0.007435	m/m
Drop	0.20	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1200 mm Circular	0.4110 m³/s	196.85 m	1.55 m/s
	Trial-2	1-1200 mm Circular	0.4550 m³/s	196.88 m	1.59 m/s

Culvert Designer/Analyzer Report
C3 Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	196.85	m	Discharge	0.4110	m³/s
Headwater Depth/Height	0.45		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	196.78	m	Control Type	Outlet Control	
Outlet Control HW Elev.	196.85	m			

Grades					
Upstream Invert	196.30	m	Downstream Invert	196.10	m
Length	26.90	m	Constructed Slope	0.007435	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.34	m
Slope Type	Mild		Normal Depth	0.39	m
Flow Regime	Subcritical		Critical Depth	0.34	m
Velocity Downstream	1.55	m/s	Critical Slope	0.012068	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.22	m
Section Size	1200 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	196.85	m	Upstream Velocity Head	0.09	m
Ke	0.90		Entrance Loss	0.08	m

Inlet Control Properties					
Inlet Control HW Elev.	196.78	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	1.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C3 Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	196.88	m	Discharge	0.4550	m³/s
Headwater Depth/Height	0.48		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	196.80	m	Control Type	Outlet Control	
Outlet Control HW Elev.	196.88	m			

Grades					
Upstream Invert	196.30	m	Downstream Invert	196.10	m
Length	26.90	m	Constructed Slope	0.007435	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.36	m
Slope Type	Mild		Normal Depth	0.41	m
Flow Regime	Subcritical		Critical Depth	0.36	m
Velocity Downstream	1.59	m/s	Critical Slope	0.012056	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.22	m
Section Size	1200 mm		Rise	1.22	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	196.88	m	Upstream Velocity Head	0.09	m
Ke	0.90		Entrance Loss	0.08	m

Inlet Control Properties					
Inlet Control HW Elev.	196.80	m	Flow Control	N/A	
Inlet Type	Projecting		Area Full	1.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C4 Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.4570	m³/s	Check Discharge	0.5060	m³/s

Grades Model: Inverts					
Invert Upstream	196.30	m	Invert Downstream	196.10	m
Length	26.90	m	Slope	0.007435	m/m
Drop	0.20	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	0.4570 m³/s	196.99 m	2.26 m/s
	Trial-2	1-600 mm Circular	0.5060 m³/s	197.04 m	2.30 m/s

Culvert Designer/Analyzer Report
C4 Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	196.99	m	Discharge	0.4570	m³/s
Headwater Depth/Height	1.13		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	196.98	m	Control Type	Entrance Control	
Outlet Control HW Elev.	196.99	m			

Grades					
Upstream Invert	196.30	m	Downstream Invert	196.10	m
Length	26.90	m	Constructed Slope	0.007435	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.40	m
Slope Type	Steep		Normal Depth	0.40	m
Flow Regime	Supercritical		Critical Depth	0.44	m
Velocity Downstream	2.26	m/s	Critical Slope	0.005672	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior)		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	196.99	m	Upstream Velocity Head	0.21	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties					
Inlet Control HW Elev.	196.98	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.3	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
C4 Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	197.04	m	Discharge	0.5060	m³/s
Headwater Depth/Height	1.21		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	197.03	m	Control Type	Entrance Control	
Outlet Control HW Elev.	197.04	m			

Grades					
Upstream Invert	196.30	m	Downstream Invert	196.10	m
Length	26.90	m	Constructed Slope	0.007435	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.43	m
Slope Type	Steep		Normal Depth	0.43	m
Flow Regime	Supercritical		Critical Depth	0.46	m
Velocity Downstream	2.30	m/s	Critical Slope	0.006174	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior)		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	197.04	m	Upstream Velocity Head	0.23	m
Ke	0.20		Entrance Loss	0.05	m

Inlet Control Properties					
Inlet Control HW Elev.	197.03	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.3	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
C4 Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.4950	m³/s	Check Discharge	0.5480	m³/s

Grades Model: Inverts					
Invert Upstream	196.30	m	Invert Downstream	196.10	m
Length	26.90	m	Slope	0.007435	m/m
Drop	0.20	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	0.4950 m³/s	197.03 m	2.29 m/s
	Trial-2	1-600 mm Circular	0.5480 m³/s	197.09 m	2.32 m/s

Culvert Designer/Analyzer Report
C4 Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	197.03	m	Discharge	0.4950	m³/s
Headwater Depth/Height	1.20		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	197.02	m	Control Type	Entrance Control	
Outlet Control HW Elev.	197.03	m			

Grades					
Upstream Invert	196.30	m	Downstream Invert	196.10	m
Length	26.90	m	Constructed Slope	0.007435	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.42	m
Slope Type	Steep		Normal Depth	0.42	m
Flow Regime	Supercritical		Critical Depth	0.46	m
Velocity Downstream	2.29	m/s	Critical Slope	0.006054	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior)		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	197.03	m	Upstream Velocity Head	0.22	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties					
Inlet Control HW Elev.	197.02	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.3	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
C4 Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	197.09	m	Discharge	0.5480	m³/s
Headwater Depth/Height	1.29		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	197.09	m	Control Type	Inlet Control	
Outlet Control HW Elev.	197.08	m			

Grades					
Upstream Invert	196.30	m	Downstream Invert	196.10	m
Length	26.90	m	Constructed Slope	0.007435	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.46	m
Slope Type	Steep		Normal Depth	0.46	m
Flow Regime	Supercritical		Critical Depth	0.48	m
Velocity Downstream	2.32	m/s	Critical Slope	0.006676	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior)		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	197.08	m	Upstream Velocity Head	0.25	m
Ke	0.20		Entrance Loss	0.05	m

Inlet Control Properties					
Inlet Control HW Elev.	197.09	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.3	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
C5 Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.0720	m³/s	Check Discharge	0.0800	m³/s

Grades Model: Inverts					
Invert Upstream	204.90	m	Invert Downstream	204.70	m
Length	25.80	m	Slope	0.007752	m/m
Drop	0.20	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	0.0720 m³/s	205.14 m	1.40 m/s
	Trial-2	1-600 mm Circular	0.0800 m³/s	205.16 m	1.45 m/s

Culvert Designer/Analyzer Report
C5 Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	205.14	m	Discharge	0.0720	m³/s
Headwater Depth/Height	0.40		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	205.13	m	Control Type	Entrance Control	
Outlet Control HW Elev.	205.14	m			

Grades					
Upstream Invert	204.90	m	Downstream Invert	204.70	m
Length	25.80	m	Constructed Slope	0.007752	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.14	m
Slope Type	Steep		Normal Depth	0.14	m
Flow Regime	Supercritical		Critical Depth	0.17	m
Velocity Downstream	1.40	m/s	Critical Slope	0.003802	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior)		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	205.14	m	Upstream Velocity Head	0.06	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	205.13	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.3	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
C5 Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	205.16	m	Discharge	0.0800	m³/s
Headwater Depth/Height	0.42		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	205.14	m	Control Type	Entrance Control	
Outlet Control HW Elev.	205.16	m			

Grades					
Upstream Invert	204.90	m	Downstream Invert	204.70	m
Length	25.80	m	Constructed Slope	0.007752	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.15	m
Slope Type	Steep		Normal Depth	0.15	m
Flow Regime	Supercritical		Critical Depth	0.18	m
Velocity Downstream	1.45	m/s	Critical Slope	0.003797	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior)		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	205.16	m	Upstream Velocity Head	0.06	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	205.14	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.3	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
C5 Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.0850	m³/s	Check Discharge	0.0940	m³/s

Grades Model: Inverts					
Invert Upstream	204.90	m	Invert Downstream	204.70	m
Length	25.80	m	Slope	0.007752	m/m
Drop	0.20	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-600 mm Circular	0.0850 m³/s	205.16 m	1.47 m/s
	Trial-2	1-600 mm Circular	0.0940 m³/s	205.18 m	1.52 m/s

Culvert Designer/Analyzer Report
C5 Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	205.16	m	Discharge	0.0850	m³/s
Headwater Depth/Height	0.43		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	205.15	m	Control Type	Entrance Control	
Outlet Control HW Elev.	205.16	m			

Grades					
Upstream Invert	204.90	m	Downstream Invert	204.70	m
Length	25.80	m	Constructed Slope	0.007752	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.15	m
Slope Type	Steep		Normal Depth	0.15	m
Flow Regime	Supercritical		Critical Depth	0.18	m
Velocity Downstream	1.47	m/s	Critical Slope	0.003797	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior)		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	205.16	m	Upstream Velocity Head	0.07	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	205.15	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.3	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
C5 Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	205.18	m	Discharge	0.0940	m³/s
Headwater Depth/Height	0.46		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	205.16	m	Control Type	Entrance Control	
Outlet Control HW Elev.	205.18	m			

Grades					
Upstream Invert	204.90	m	Downstream Invert	204.70	m
Length	25.80	m	Constructed Slope	0.007752	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.16	m
Slope Type	Steep		Normal Depth	0.16	m
Flow Regime	Supercritical		Critical Depth	0.19	m
Velocity Downstream	1.52	m/s	Critical Slope	0.003801	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	HDPE (Smooth Interior)		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	205.18	m	Upstream Velocity Head	0.07	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	205.16	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.3	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
C6 Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.1250	m³/s	Check Discharge	0.1380	m³/s

Grades Model: Inverts					
Invert Upstream	201.70	m	Invert Downstream	199.65	m
Length	51.50	m	Slope	0.039806	m/m
Drop	2.05	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1050 mm Circular	0.1250 m³/s	201.97 m	2.59 m/s
	Trial-2	1-1050 mm Circular	0.1380 m³/s	201.99 m	2.67 m/s

Culvert Designer/Analyzer Report
C6 Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	201.97	m	Discharge	0.1250	m³/s
Headwater Depth/Height	0.25		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	201.94	m	Control Type	Entrance Control	
Outlet Control HW Elev.	201.97	m			

Grades					
Upstream Invert	201.70	m	Downstream Invert	199.65	m
Length	51.50	m	Constructed Slope	0.039806	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.11	m
Slope Type	Steep		Normal Depth	0.11	m
Flow Regime	Supercritical		Critical Depth	0.19	m
Velocity Downstream	2.59	m/s	Critical Slope	0.003860	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	201.97	m	Upstream Velocity Head	0.07	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	201.94	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.9	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
C6 Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	201.99	m	Discharge	0.1380	m³/s
Headwater Depth/Height	0.27		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	201.95	m	Control Type	Entrance Control	
Outlet Control HW Elev.	201.99	m			

Grades					
Upstream Invert	201.70	m	Downstream Invert	199.65	m
Length	51.50	m	Constructed Slope	0.039806	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.11	m
Slope Type	Steep		Normal Depth	0.11	m
Flow Regime	Supercritical		Critical Depth	0.20	m
Velocity Downstream	2.67	m/s	Critical Slope	0.003833	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	201.99	m	Upstream Velocity Head	0.07	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	201.95	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.9	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
C6 Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.1380	m³/s	Check Discharge	0.1520	m³/s

Grades Model: Inverts					
Invert Upstream	201.70	m	Invert Downstream	199.65	m
Length	51.50	m	Slope	0.039806	m/m
Drop	2.05	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-1050 mm Circular	0.1380 m³/s	201.99 m	2.67 m/s
	Trial-2	1-1050 mm Circular	0.1520 m³/s	202.00 m	2.75 m/s

Culvert Designer/Analyzer Report
C6 Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	201.99	m	Discharge	0.1380	m³/s
Headwater Depth/Height	0.27		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	201.95	m	Control Type	Entrance Control	
Outlet Control HW Elev.	201.99	m			

Grades					
Upstream Invert	201.70	m	Downstream Invert	199.65	m
Length	51.50	m	Constructed Slope	0.039806	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.11	m
Slope Type	Steep		Normal Depth	0.11	m
Flow Regime	Supercritical		Critical Depth	0.20	m
Velocity Downstream	2.67	m/s	Critical Slope	0.003833	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	201.99	m	Upstream Velocity Head	0.07	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	201.95	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.9	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
C6 Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	202.00	m	Discharge	0.1520	m³/s
Headwater Depth/Height	0.28		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	201.97	m	Control Type	Entrance Control	
Outlet Control HW Elev.	202.00	m			

Grades					
Upstream Invert	201.70	m	Downstream Invert	199.65	m
Length	51.50	m	Constructed Slope	0.039806	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.12	m
Slope Type	Steep		Normal Depth	0.12	m
Flow Regime	Supercritical		Critical Depth	0.21	m
Velocity Downstream	2.75	m/s	Critical Slope	0.003808	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.07	m
Section Size	1050 mm		Rise	1.07	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	202.00	m	Upstream Velocity Head	0.07	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	201.97	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.9	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Designer/Analyzer Report
C7 Existing

Peak Discharge Method: User-Specified					
Design Discharge	0.1010	m³/s	Check Discharge	0.1110	m³/s

Grades Model: Inverts					
Invert Upstream	194.60	m	Invert Downstream	192.30	m
Length	46.70	m	Slope	0.049251	m/m
Drop	2.30	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-900 mm Circular	0.1010 m³/s	194.90 m	1.74 m/s
	Trial-2	1-900 mm Circular	0.1110 m³/s	194.91 m	1.79 m/s

Culvert Designer/Analyzer Report
C7 Existing

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	194.90	m	Discharge	0.1010	m³/s
Headwater Depth/Height	0.33		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	194.82	m	Control Type	Entrance Control	
Outlet Control HW Elev.	194.90	m			

Grades					
Upstream Invert	194.60	m	Downstream Invert	192.30	m
Length	46.70	m	Constructed Slope	0.049251	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.13	m
Slope Type	Steep		Normal Depth	0.13	m
Flow Regime	Supercritical		Critical Depth	0.18	m
Velocity Downstream	1.74	m/s	Critical Slope	0.013686	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	194.90	m	Upstream Velocity Head	0.06	m
Ke	0.90		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	194.82	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C7 Existing

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	194.91	m	Discharge	0.1110	m³/s
Headwater Depth/Height	0.34		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	194.84	m	Control Type	Entrance Control	
Outlet Control HW Elev.	194.91	m			

Grades					
Upstream Invert	194.60	m	Downstream Invert	192.30	m
Length	46.70	m	Constructed Slope	0.049251	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.14	m
Slope Type	Steep		Normal Depth	0.14	m
Flow Regime	Supercritical		Critical Depth	0.19	m
Velocity Downstream	1.79	m/s	Critical Slope	0.013608	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	194.91	m	Upstream Velocity Head	0.07	m
Ke	0.90		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	194.84	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C7 Proposed

Peak Discharge Method: User-Specified					
Design Discharge	0.1070	m³/s	Check Discharge	0.1190	m³/s

Grades Model: Inverts					
Invert Upstream	194.60	m	Invert Downstream	192.30	m
Length	46.70	m	Slope	0.049251	m/m
Drop	2.30	m			

Headwater Model: Unspecified

Tailwater Conditions: Constant Tailwater		
Tailwater Elevation	N/A	m

	Name	Description	Discharge	HW Elev.	Velocity
x	Trial-1	1-900 mm Circular	0.1070 m³/s	194.91 m	1.77 m/s
	Trial-2	1-900 mm Circular	0.1190 m³/s	194.93 m	1.83 m/s

Culvert Designer/Analyzer Report
C7 Proposed

Design:Trial-1

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Design	
Computed Headwater Elev	194.91	m	Discharge	0.1070	m³/s
Headwater Depth/Height	0.34		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	194.83	m	Control Type	Entrance Control	
Outlet Control HW Elev.	194.91	m			

Grades					
Upstream Invert	194.60	m	Downstream Invert	192.30	m
Length	46.70	m	Constructed Slope	0.049251	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.14	m
Slope Type	Steep		Normal Depth	0.14	m
Flow Regime	Supercritical		Critical Depth	0.19	m
Velocity Downstream	1.77	m/s	Critical Slope	0.013612	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	194.91	m	Upstream Velocity Head	0.06	m
Ke	0.90		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	194.83	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Designer/Analyzer Report
C7 Proposed

Design:Trial-2

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	N/A	m	Storm Event	Check	
Computed Headwater Elev	194.93	m	Discharge	0.1190	m³/s
Headwater Depth/Height	0.36		Tailwater Elevation	N/A	m
Inlet Control HW Elev.	194.85	m	Control Type	Entrance Control	
Outlet Control HW Elev.	194.93	m			

Grades					
Upstream Invert	194.60	m	Downstream Invert	192.30	m
Length	46.70	m	Constructed Slope	0.049251	m/m

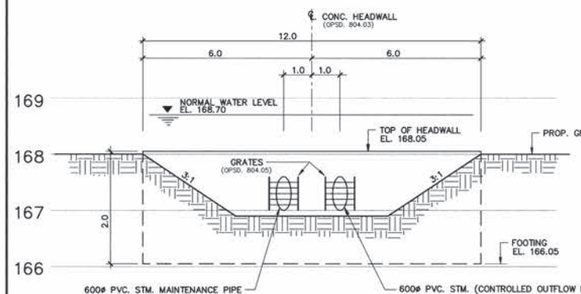
Hydraulic Profile					
Profile	S2		Depth, Downstream	0.14	m
Slope Type	Steep		Normal Depth	0.14	m
Flow Regime	Supercritical		Critical Depth	0.20	m
Velocity Downstream	1.83	m/s	Critical Slope	0.013540	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.91	m
Section Size	900 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	194.93	m	Upstream Velocity Head	0.07	m
Ke	0.90		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	194.85	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.7	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

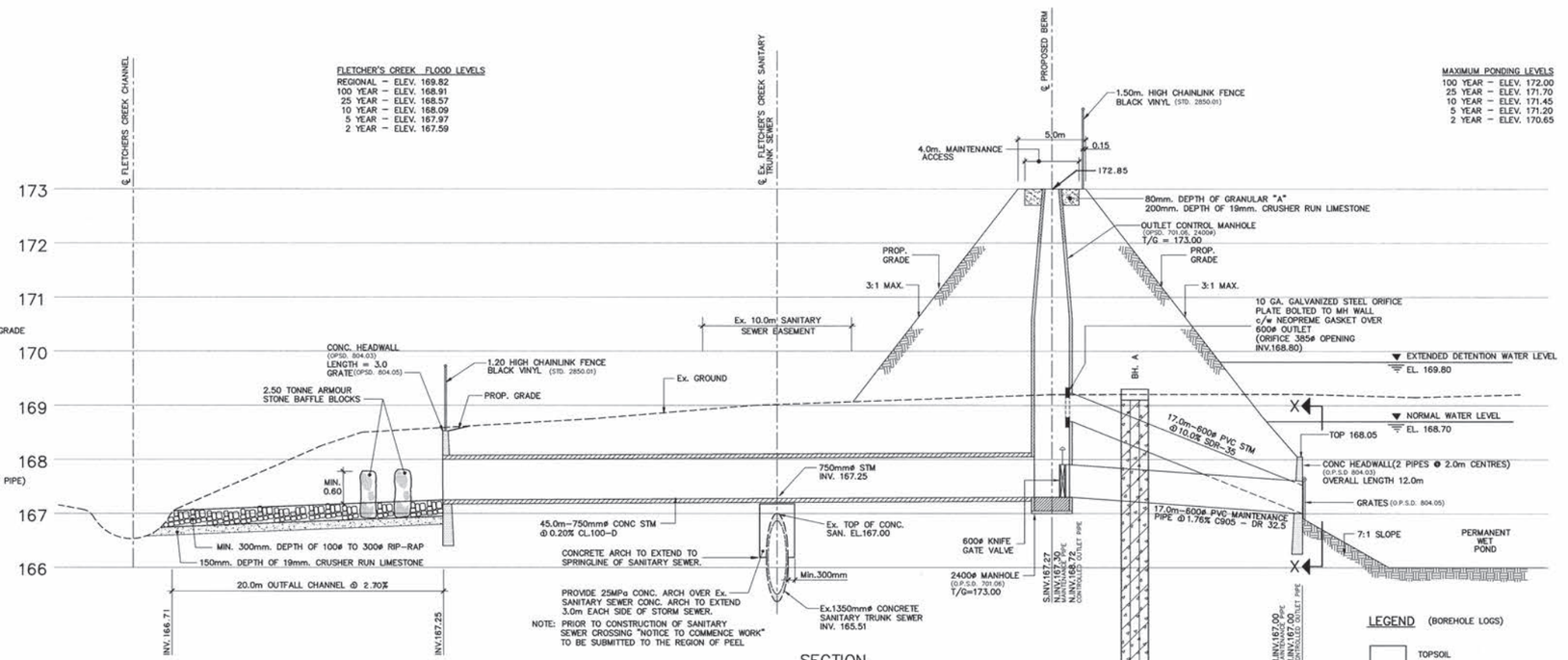
APPENDIX D – DRAWINGS OF SWM FACILITIES NO. 4 & 5



SECTION X–X

CONCRETE HEADWALL DETAIL

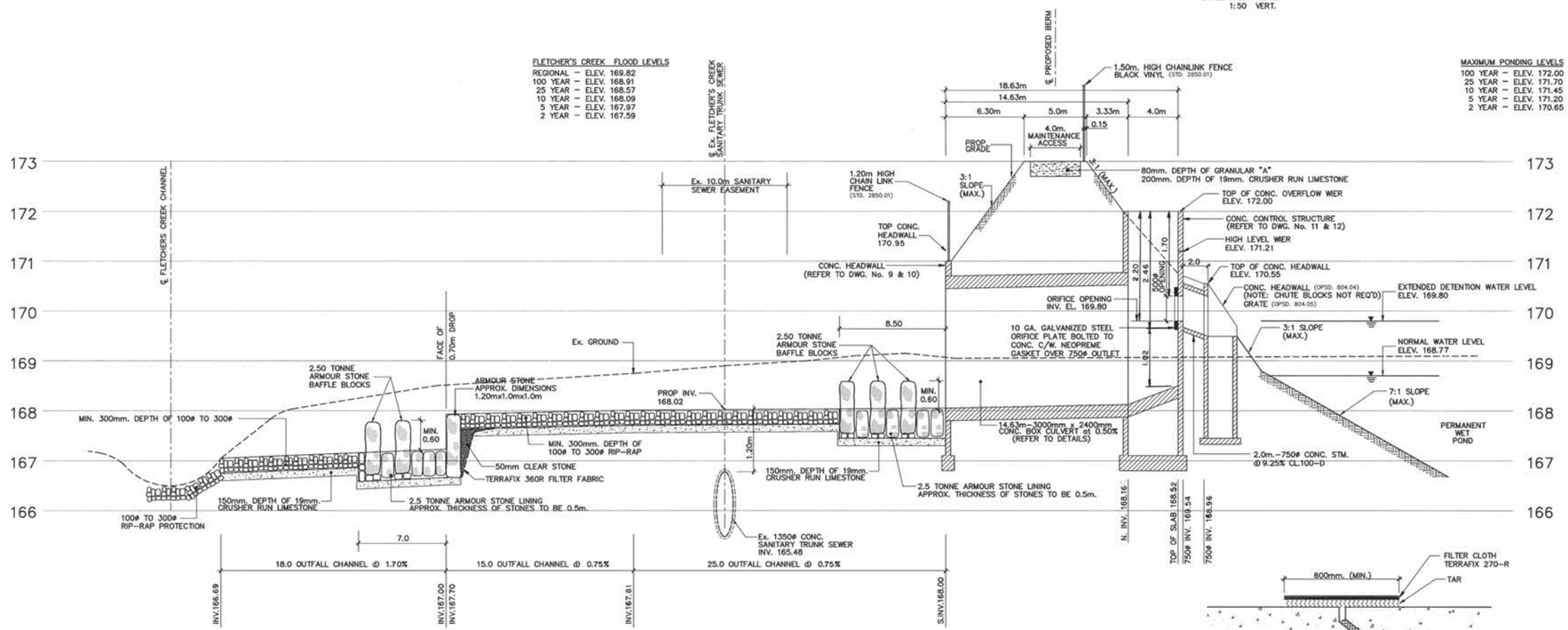
SCALE 1:100 HORIZ.
1:50 VERT.



SECTION

OUTLET STRUCTURE SECTION

SCALE 1:200 HORIZ.
1:50 VERT.



SECTION

BOX CULVERT OUTFALL CHANNEL

SCALE 1:200 HORIZ.
1:50 VERT.

CONC. BOX CULVERT JOINT DETAIL

N.T.S

SERVICE DATA					
SERVICE	DATE	INIT.	SERVICE	DATE	INIT.
SAN. SEWERS			GAS MAINS		
STORM SEWERS			BELL U/G CABLE		
WATERMAINS			HYDRO U/G CABLE		

REVISIONS		
DATE	DETAILS	INIT.
JULY/1999	AS CONSTRUCTED	

FOR GENERAL NOTES REFER TO DRAWING No. 1

BENCH MARK No. 241 ELEV. 174.317
ON THE N. FACE, 600mm. W. OF THE E. CORNER OF UNITED CHURCH AT THE S.W. CORNER OF DERRY ROAD W. AND SECOND LINE W.

FIRST	SECOND	INTERIM	PRE–SER	FINAL
DATE	DATE	DATE	DATE	DATE
JUNE 5, 1996	SEPT. 6, 1996	DEC. 19, 1996		APRIL 2, 1997

REGISTERED PROFESSIONAL ENGINEER
V. CAVALLO
23/04/97
PROVINCE OF ONTARIO

DESIGNED BY — CHKD.

APPROVED BY

RAND ENGINEERING CORPORATION
5285 SOLAR DRIVE
MISSISSAUGA, ONTARIO
L4W 5B8
TEL. (905) 625–9500

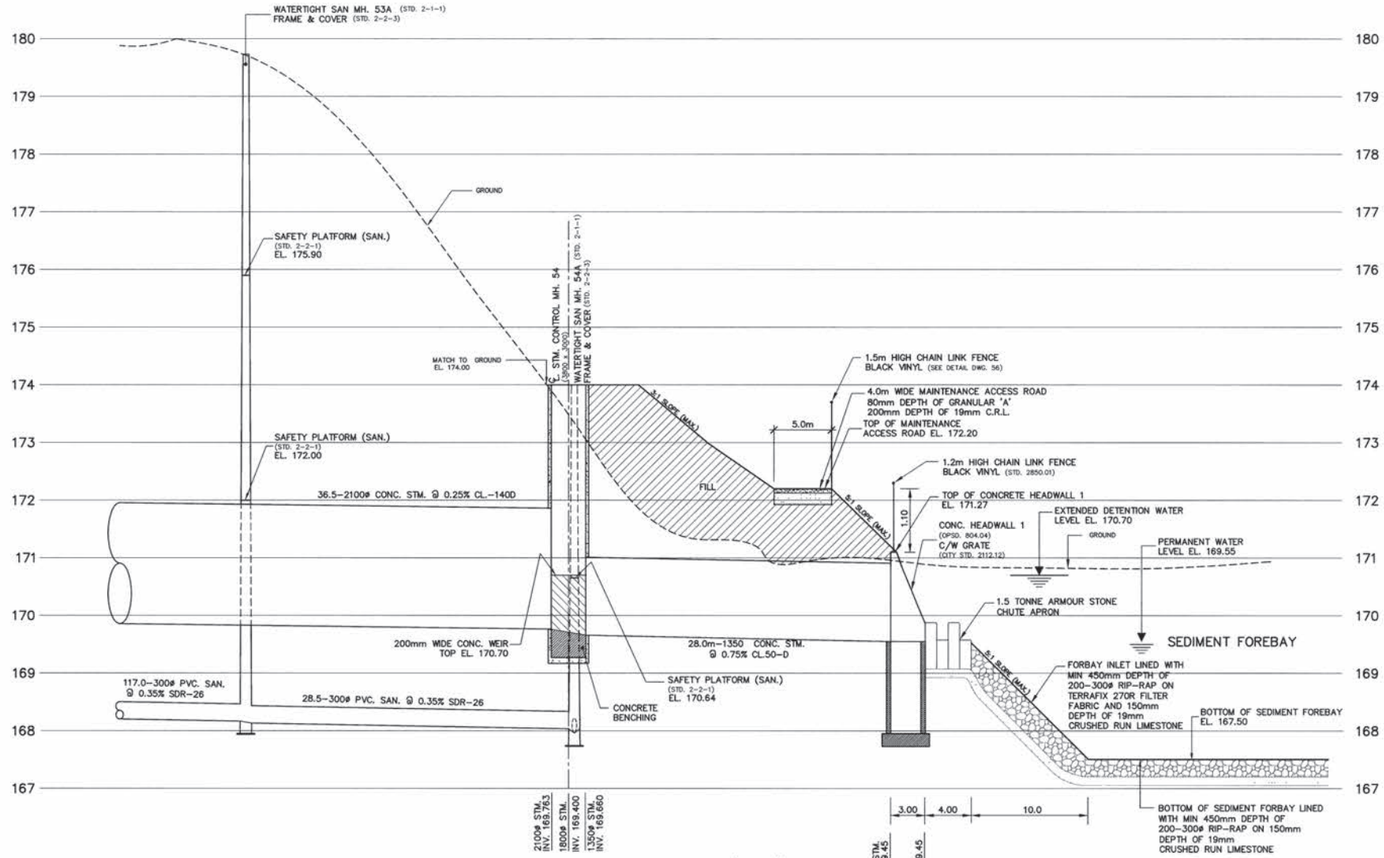
TARMAC CANADA INC.
FLETCHER'S CREEK
STORMWATER MANAGEMENT FACILTY No.5
CITY FILE 16 111 96200

MISSISSAUGA
Public Works Department

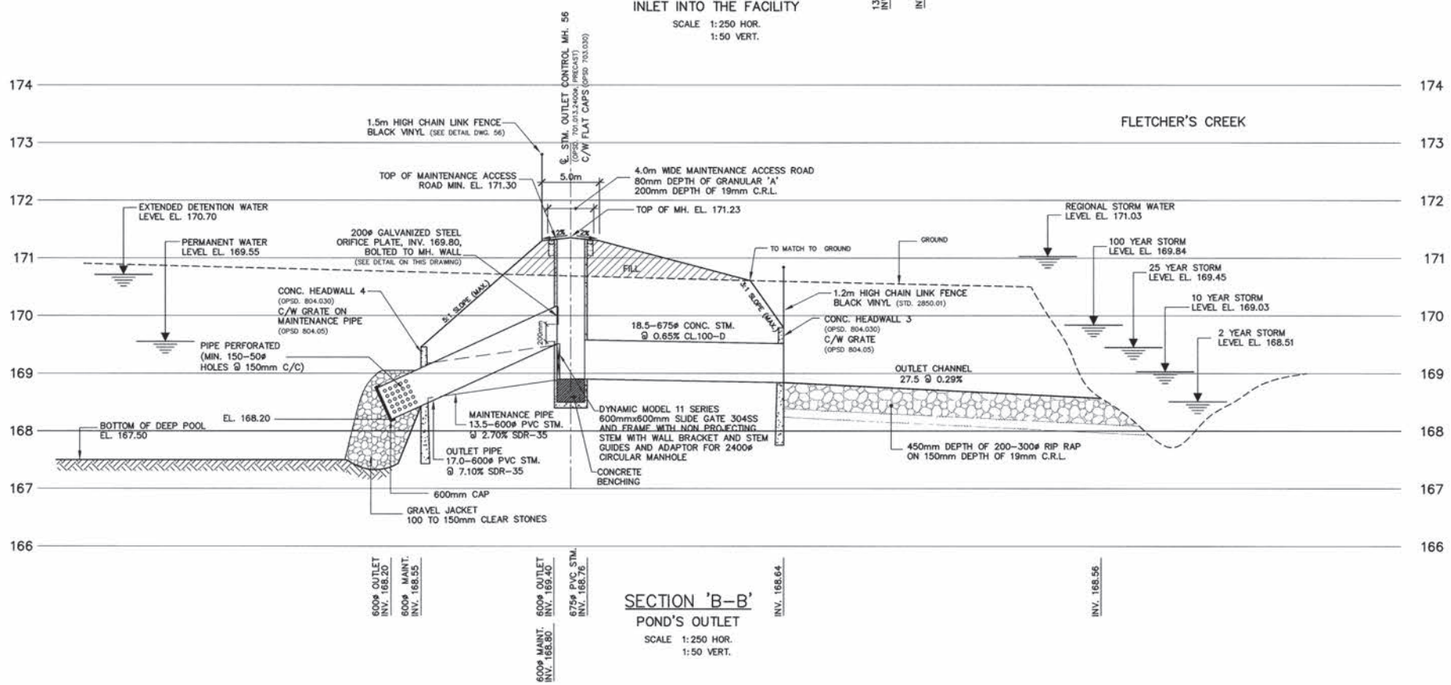
OUTLET DETAILS

SCALE H. 1:200 V. 1:50	AREA	PROJECT No. 96410
DRAWN BY ACAD	CHECKED BY	PLAN No. 8
DATE MAY 1996	SHEET OF	

C–39484



SECTION 'A-A'
INLET INTO THE FACILITY
SCALE 1:250 HOR.
1:50 VERT.



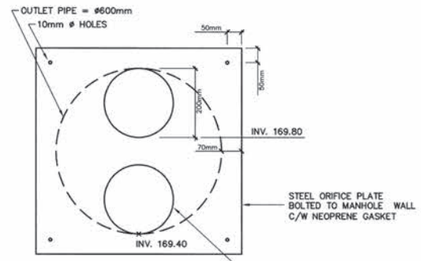
SECTION 'B-B'
POND'S OUTLET
SCALE 1:250 HOR.
1:50 VERT.

PLACEMENT OF FILL MATERIALS

1. SUBGRADE TO BE STRIPPED OF TOPSOIL AND ORGANIC MATERIALS IN ALL DESIGNATED FILL AREAS.
2. ALL EARTH FILL TO BE PLACED IN LIFTS NOT EXCEEDING 200mm AND COMPACTED TO 95% S.P.D.
3. ALL GRANULAR MATERIALS TO BE COMPACTED TO 100% S.P.D.
4. ALL CONSTRUCTION AND MATERIAL TO BE APPROVED BY A GEOTECHNICAL ENGINEER.

BERMS

1. SUBGRADE TO BE STRIPPED OF TOPSOIL AND ORGANIC MATERIALS TO A MINIMUM OF 2.0m BEYOND PROPOSED TOE OF SLOPE PRIOR TO PLACEMENT OF FILL MATERIAL FOR BERMS.
2. INORGANIC SOILS CONSISTING OF TILLS ARE TO BE USED FOR BERM CONSTUCTION.
3. FILL MATERIALS ARE TO BE UNIFORMLY COMPACTED TO MIN. 95ø STANDARD PROCTOR DENSITY USING 200mm LIFTS.
4. ALL FILL MATERIAL AND CONSTRUCTION TO BE APPROVED BY THE GEOTECHNICAL ENGINEER.



ORIFICE PLATE DETAIL
N.T.S

AS CONSTRUCTED
AUGUST 2004

FIRST	INTERIM	SECOND	PRE-SER	FINAL
DATE OCT. 8, 1999	DATE MAY 19, 2000	DATE JUNE 30, 2000	DATE SEPT. 8, 2000	DATE MAY 15, 2001

REGISTERED PROFESSIONAL ENGINEER P.M. SZPONAR 01/31/05 PROVINCE OF ONTARIO
DESIGNED BY

REGISTERED PROFESSIONAL ENGINEER E.W.C. GODDARD 01/31/05 PROVINCE OF ONTARIO
APPROVED BY

CHKD.

RAND ENGINEERING CORPORATION
5285 SOLAR DRIVE
MISSISSAUGA, ONTARIO
L4W 588
TEL. (905) 625-9500

ARROWSMITH VILLAGE - PHASE 4
968907 ONTARIO INC.
GASMUZ CONSTRUCTION INC.

MISSISSAUGA Transportation And Works Department

SWM SECTIONS

21T-95007E

SCALE: AS SHOWN	AREA:	PROJECT No. 97457
DRAWN BY: ACAD	CHECKED BY: P.S.	PLAN No. 47
DATE: OCTOBER 2000	SHEET OF	C-42551