Appendix N:

Stormwater Management Report

Stormwater Management Report
Project 16-4360

Class Environmental Assessment
Airport Road Improvements
From King Street to Huntsmill Drive

IBI Group Reference Number: 109535

Prepared for The Regional Municipality of Peel
by IBI Group
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1 Introduction

1.1 Background

The Region of Peel intends to complete a Schedule 'C' Municipal Class Environmental Assessment (EA) study for the proposed improvements to Airport Road (Regional Road 7) between King Street (Regional Road 9) and Huntsmill Drive in the Town of Caledon. IBI Group has been retained by the Region of Peel to provide consulting services for the preparation of the Technical Studies to support the Class EA for the proposed improvements to Airport Road between King Street and Huntsmill Drive. IBI Group is responsible for technical analyses and the preparation of technical reports to achieve the objectives of the Class EA, including recommendations for mitigation for the preferred design. This Stormwater Management (SWM) Report is a supporting document to the Class EA for the proposed improvements to Airport Road between King Street and Huntsmill Drive.

Airport Road is a two-lane, undivided, north-south major rural roadway under the jurisdiction of the Region of Peel. Within the study limits, Airport Road is situated in the Town of Caledon and supports a considerable volume of commuter and truck traffic. The study corridor extends for a distance of approximately 7.5 km from 100 m north of King Street to 300 m north of Huntsmill Drive, and includes 300 m along all legs of each intersection within the study limits. The study corridor also includes a 180 m segment of Old Church Road extending from Airport Road to John Street. South of the study area, from 1.0 km north of Mayfield Road to 0.6 km north of King Street, a Class EA study was already conducted by the Region of Peel to address the proposed widening of Airport Road from a two-lane road to a five-lane roadway with a center turning lane. The project limits for this study are delineated in **Figure 1** presented in **APPENDIX A.**

The objectives of the EA study for the proposed improvements to Airport Road between King Street and Huntsmill Drive are to:

- Identify and evaluate a variety of reconstruction and intersection improvement alternatives that will satisfy future travel demands.
- Analyze the potential replacement of nine culvert crossings, including one major watercourse crossing at Centreville Creek.

The purpose of this SWM Report is to support the Class EA, summarize the existing drainage and stormwater management conditions within the study limits, and develop a SWM Plan to convey external and internal runoff across the widened Airport Road in order to mitigate the potential impacts of the proposed roadway improvements on receiving drainage systems.

1.2 Existing Drainage Infrastructure

As part of the Airport Road EA, the following drainage components were identified:

- There are seven (7) transverse corrugated steel pipe (CSP) culverts and two (2) transverse concrete box culverts that convey external flows across Airport Road. All CSP culverts range in size from 450 mm to 900 mm in diameter.

- The existing road side ditches along Airport Road provide water quality/quantity control for runoff prior to discharge into receiving systems.
- Storm runoff along Airport Road from just south of Walker Road to approximately 200 m south of Hilltop Drive, and along Old Church Road from John Street to Airport Road is collected by storm sewers and conveyed to Centreville Creek.
- Most of the watercourses convey flow through rural or agricultural areas. Some pockets of estate/residential land use are also located adjacent to Airport Road.
- There are seven (7) low points located along Airport Road which convey overland flow from major system events towards receiving watercourses.
- There are no stormwater management facilities within or adjacent to the project corridor. However, as part of the proposed 15717 Airport Road Residential Subdivision development, a SWM Pond is proposed adjacent to the project corridor.

1.3 Proposed Roadway Improvements

As part of the Airport Road EA study, the following preferred roadway improvements were investigated:

Preferred Roadway Improvements

- Intersection improvements at the Boston Mills Road/Castlederg Sideroad/Airport Road intersection by incorporating a roundabout with vegetation in the center island and within the four entry/exit pedestrian islands.
- Widening of Airport Road from just south of Castlederg Sideroad to approximately 300 m north of the intersection to accommodate the proposed roundabout, northbound and southbound centre left turn lanes north of the intersection, and a southbound right turn lane along Airport Road.
- Intersection improvements at the Airport Road/Olde Base Line Road intersection by incorporating a southbound right turn lane along Airport Road, and center left turn lanes northbound on Airport Road and eastbound along Olde Base Line Road. Widening of Airport Road and Olde Base Line Road to facilitate the intersection improvements.
- Extension of Cranston Drive to the east of Airport Road featuring a roundabout with vegetation and/or gateway feature in the center island at the Cranston Drive/Airport Road intersection.
- Road currently proposed by development on the east side of Airport Road across from the Caledon East Public School driveway.
- Widening of Airport Road just south of the Foodland plaza driveway to accommodate a northbound right turn lane into the plaza.
- Extension of Old Church Road to the west of Airport Road with a proposed connection to Ivan Avenue. Intersection improvements at the Airport Road/Old Church Road intersection by incorporating a northbound right turn lane on Airport Road and a westbound centre left turn lane along Old Church Road.
- Intersection improvements at the Airport Road/Walker Road intersection by incorporating centre left turn lanes in all four directions and a southbound right turn lane along Airport Road. Widening of Airport Road and Walker Road to facilitate the intersection improvements.
- Proposed 7.0 m wide Median U-Turn (MUT) lane between Walker Road and Leamster Trail.

- Paved shoulder proposed on both sides of Airport Road between Huntsmill Drive and Leamster Trail, and on the east side of Airport Road between Leamster Trail and Walker Road.
- Multi-Use Path (MUP) and raised bike lane proposed on the west side of Airport Road between Leamster Trail and Walker Road.
- MUP on the west side or raised bike lanes on both sides of Airport Road between Walker Road and Mountcrest Road.
- Sidewalk proposed on both sides of Airport Road between Walker Road and Olde Base Line Road.
- Raised bike lanes proposed on both sides of Airport Road between Cranston Drive and Olde Base Line Road.
- Localized changes to the roadway profile, including a westerly shift between Parsons Avenue and Old Church Road in Caledon East. Currently no changes to the vertical profile are proposed.

Typical rural and urban cross sections for the proposed roadway are presented on **Figures 4-7** in **APPENDIX E**.

2 Site Description

2.1 Study Area

Airport Road from 100 m north of King Street to 300 m north of Huntsmill Drive generally features a two lane paved road with wide gravel shoulders and grassy ditches on both sides of the right-of-way (ROW). At the intersection with Cranston Drive, Hilltop Drive, Mountcrest Road and Old Church Road, the ROW has been widened and improved to include turning lanes, curbs, and paved shoulders. Airport Road is a straight roadway throughout the study corridor and follows a relatively flat topography. The topography within the project limits rises slightly toward the north and gently undulates at the location of creek crossings.

The landscape on either side of Airport Road is generally characterized by active agricultural fields and meadows that are part of large farm complexes. The study corridor also features pockets of homes that occupy small residential lots that were severed from the larger agricultural properties. There are multiple residential properties on both sides of Airport Road between Cranston Drive and Leamster Trail.

One provincially significant wetland (PSW), Widgett-Innis Wetland Complex, overlaps with the study area. This wetland complex is situated on the east side of Airport Road, and only a small portion of it that extends along Centreville Creek overlaps with the study area. This wetland is mainly dominated by reed canary grass (MAS2-1b). There are two locally significant wetlands, Caledon East Wetland Complex and Mono Road Wetland Complex, which also overlap with the study area. The Caledon East Wetland Complex is located north of Walker Road West and is mainly dominated by swamp communities, although smaller pockets of marsh are also present. The swamp communities are dominated by white cedar (Thuja occidentalis) and various hardwood species such as black ash (Fraxinus nigra) on mineral soil and in some cases organic soils (White Cedar – Hardwood Organic Mixed Swamp Type SWM4-1). The Mono Road Wetland Complex is

just inside of the 100 m buffer on the west and east sides of Airport Road and is located approximately 410 m north of Castlederg Sideroad. On the west side, the wetland is a swamp community dominated by various willow species (Willow Mineral Thicket Swamp Type - SWT2-2) and on the east it is identified as a marsh community dominated by narrow-leaved cattail (Narrow-Leaved Cattail Mineral Shallow Marsh MAS2-1b). Furthermore, there are two small unevaluated wetlands located north of Larry Street on the west side of Airport Road.

The majority of the study area falls within the Humber River watershed under the jurisdiction of the Toronto and Region Conservation Authority (TRCA) (TRCA 2012, The Humber River Watershed), with the exception of a stretch of Airport Road extending from approximately Olde Base Line Road to Boston Mills Road/Castlederg Sideroad which falls within the East Credit River watershed under the jurisdiction of the Credit River Conservation Authority (CVC). Headwaters of the Humber River watershed originate on the Niagara Escarpment and Oak Ridges Moraine and then flow towards Lake Ontario. Overall, this watershed includes 1800 km of waterways and over 600 bodies of water (TRCA 2012, The Humber River Watershed). Centreville Creek, a tributary of the Main Humber River, crosses Airport Road just south of the Caledon Trailway Path. Within the Humber River watershed, segments of Airport Road from Huntsmill Drive to Leamster Trail, and between Old Church Road and Larry Street fall within the TRCA's Regulation limit. Within the East Credit River watershed, a small stretch of Airport Road just south of Olde Base Line Road falls within the CVC's Regulation limit. As such, any proposed development, interference or alteration along these segments of Airport Road will require permits from the TRCA and/or the CVC. Refer to **APPENDIX C** for TRCA and CVC floodplain maps and Regulation Limits.

2.2 Existing Drainage Conditions

The majority of the study area is located within the Main Humber River and West Humber River subwatersheds, which are part of the Humber River watershed governed by the TRCA. Centreville Creek, a tributary of the Main Humber River, crosses Airport Road just south of Caledon Trailway Path. An unnamed tributary of the East Credit River crosses Airport Road approximately 230 m south of Olde Base Line Road within the East Credit River watershed governed by the CVC. Most of the watercourses within the project limits convey flow through rural or agricultural areas, with some through pockets of estate / residential land use adjacent to Airport Road.

Based upon a review of TRCA and CVC subwatershed mapping and the existing survey data, a total of nine drainage features cross the Airport Road ROW within the study area. These drainage features were characterized as either watercourses or Headwater Drainage Features (HDF). The location of the crossings is shown on **Figure 1** in **APPENDIX A**, with Crossings 1, 2, 3, and 5 situated along watercourses and Crossings 4, 6, 7, 8, and 9 situated along HDFs. According to TRCA and CVC floodplain maps, Crossings 1, 2, and 3 fall within TRCA Regulation limits and Crossing 5 and 6 fall within CVC Regulation limits. These five (5) locations are therefore considered Regulated watercourse crossings. Refer to **APPENDIX C** for floodplain mapping and the location of the four Regulated watercourse crossings.

Crossing 3 (Centreville Creek) has associated floodplains and conveys permanent flow which provides direct fish habitat. The portion of the study area north of Castlederg Sideroad (including Crossings 1, 2, 3, 4, and 6) is classified as Small Riverine Coldwater Habitat and is located within the Main Humber River subwatershed. The portion of the study area south of Castlederg Sideroad (including Crossings 7, 8 and 9) is classified as Small Riverine Warmwater Habitat (OMNR and TRCA 2005) and is located within the West Humber River subwatershed. Although Crossing 5 is located north of Castlederg Sideroad, it is part of the East Credit River watershed governed by the

CVC and is classified as Small Riverine Warmwater Habitat in RiverStone's Natural Environment Impact Assessment Report (July 2019). All fish species present were native and no species at risk were encountered.

Within the project limits, Airport Road is a two-lane, rural roadway, with an approximate roadway width of 7.8 m and gravel shoulders on either side varying in width from 2.1 m to 3.0 m. The general slope of Airport Road is from north to south, with seven low points (sags) along the roadway which convey overland flow from major system events towards receiving watercourses. In general, Airport Road has rural cross-sections throughout the entire length of the corridor, except from just south of Walker Road to approximately 200 m south of Hilltop Drive which constitutes an urban section. Within the rural areas, stormwater resulting from both minor and major storm events is managed through roadside ditches/swales on both sides of Airport Road, rather than through storm sewers, and there are no curbs or pedestrian sidewalks with exception of intersections. The roadside ditches/swales range in width from 3.0 m to 7.0 m and range in depth from 0.5 m to 2.0 m. Longitudinal CSP culverts of varying diameter and length convey stormwater beneath driveways and street entrances on both sides of Airport Road and ultimately discharge into the Main Humber River and West Humber River. Within the urban section, Airport Road features curbs, gutters, and pedestrian sidewalks on both sides of the roadway, and stormwater resulting from minor storm events is conveyed by storm sewers and discharged to the receiving watercourse (Centreville Creek). Major system flows within the urban section of the corridor are conveyed to existing watercourse crossings as roadway overland flow.

The location of the nine crossings within the Airport Road corridor and their associated external drainage areas are illustrated on **Figure 2** and **Figure 3** in **APPENDIX B**. These crossings convey external flows across Airport Road. The transverse drainage culverts associated with each crossing are labelled C1 through C9 (numbered from north to south along Airport Road) on **Figure 2** and **Figure 3** in **APPENDIX B**. The following **Table 1** lists all nine (9) transverse drainage culverts and provides details on their respective hydrologic and physical conditions.

Table 1: Summary of Existing Transverse Drainage Culverts

ID	LOCATION	TYPE	EXISTING SIZE	EXISTING LENGTH	SURFACE DRAINAGE CHARACTERISTICS
C1	70 m north of Huntsmill Drive	CSP	900 mm	22.35 m	Boyce's Creek
C2	At north side of Parsons Avenue	CSP	850 mm	150 m	Allison Creek (Tributary of Centreville Creek)
C3	35 m north of Mountcrest Road	Concrete Box	4300 x 870 mm	18.18 m	Centreville Creek
C4	175 m south of Cranston Drive	CSP	450 mm	24.05 m	Roadside Ditch/Swale
C5	230 m south of Olde Base Line Road	East Side: CSPA West Side: Concrete Box	East Side: 1100 mm West Side: 2000 x 1100 mm	63.50 m	Tributary of East Credit River
C6	400 m north of Boston Mills Road	CSP	700 mm	21.22 m	Roadside Ditch/Swale
C7	600 m south of Boston Mills Road	CSP	450 mm	23.19 m	Roadside Ditch/Swale
C8	725 m north of King Street	CSP	600 mm	21.24 m	Roadside Ditch/Swale
C9	100 m north of King Street	CSP	600 mm	23.66 m	Roadside Ditch/Swale

*Note: Refer to **Figure 2** and **Figure 3** in **APPENDIX B** for culvert location.*

2.3 Existing Drainage Areas

A review of available topographic maps, floodplain maps, and Ontario Base Maps was undertaken to establish drainage boundaries and associated external drainage areas within the project limits. Based on this assessment and drainage boundary information provided by the Region of Peel, nine external drainage areas were delineated and are illustrated on **Figure 2** and **Figure 3** in **APPENDIX B**. Roadside ditching has been used at most locations along Airport Road to direct runoff to the nearest receiving watercourse.

2.4 Existing Drainage Elements

2.4.1 Transverse Culverts

Currently, there are nine (9) transverse drainage culverts within the study area. Based on the field investigation that was conducted, the hydrologic and physical conditions of the culverts were assessed and summarized in the preceding **Table 1**. Site photographs at each culvert are presented in **APPENDIX P**.

CSP Culverts

Seven transverse CSP culverts (C1, C2, C4, C6, C7, C8, and C9) currently exist under Airport Road within the project limits. All CSP culverts range in size from 450 mm to 900 mm in diameter.

Allison Creek Culvert (C2)

The Allison Creek culvert consists of an 850 mm CSP at the upstream end (just north of Parsons Avenue). Survey data that was received from the Region of Peel indicates that this culvert connects to the storm sewer system along Airport Road just south of Parsons Avenue. Based upon site investigation and review of the Fluvial Geomorphological Assessment – Centreville Creek and East Credit River Tributary report prepared by GEO Morphix Ltd. in October 2018 , it was determined that the Allison Creek culvert (C2) crosses Airport Road just south of Parsons Avenue and ultimately discharges just north of the Caledon Trailway Path. At the downstream end, C2 is comprised of a concrete pipe. From the discharge point, Allison Creek flows in an easterly direction, parallel to and north of the Caledon Trailway Path along a defined ditch for approximately 32 m until it enters a CSP culvert which conveys flow across the Caledon Trailway Path. Allison Creek discharges just south of the Caledon Trailway Path and flows south for approximately 8 m before turning abruptly east and flowing into a small pond. From the pond, Allison Creek connects to Centreville Creek. **APPENDIX P** contains detailed photographs from site investigations which confirm the flow path of Allison Creek and the location/size/material of the upstream and downstream ends of C2.

Structural Culverts

Centreville Creek Culvert (C3)

The structural culvert has a West-East orientation and is located on Airport Road just south of the Caledon Trailway Path. C3 is a concrete box culvert measuring 4.3 m in width, 0.87 m in height, and 18.18 m in length, carrying two lanes of vehicular traffic across Centreville Creek. The overlying deck has a travelled width of 6.8 m and an overall width of 14.3 m.

Tributary of East Credit River Culvert (C5)

The structural culvert is located approximately 230 m south of Olde Base Line Road and has an East-West orientation. The culvert inlet is located approximately 40 m east of the edge of Airport Road and conveys flow from the east to the west side of the roadway. C5 is comprised of a concrete box section at the downstream end and a corrugated steel pipe arch (CSPA) section with a headwall at the upstream end.

2.4.2 Storm Sewers

Under existing conditions, runoff from Airport Road just south of Walker Road to approximately 200 m south of Hilltop Drive, and along Old Church Road from John Street to Airport Road is primarily collected by catchbasins, conveyed by storm sewers, and discharged into Centreville Creek. The storm sewer system along Airport Road is located between Station 15+340 and 16+300, with sewers ranging in size from 375 mm to 1200 mm in diameter and outletting to Centreville Creek just south of the Caledon Trailway Path. The storm sewer system along Old Church Road is located between Station 1+100 and 1+250 (ultimately connecting to the Airport Road storm sewer system), with sewers ranging in size from 300 mm to 450 mm in diameter. There is also a small network of storm sewers located at the intersection of Airport Road and Olde Base Line Road which is within the Project scope. A CCTV inspection was conducted to identify the structural condition of the existing storm sewers along Airport Road and Old Church Road within the corridor. **APPENDIX D** summarizes the results of the inspection, identifying legs of storm sewer as either Good, Fair, Poor, Bad, or Failure. Based on the results of the CCTV inspection, nine (9) sewer legs have been recommended for replacement due to structural deficiencies. Existing storm sewers and outlet points are illustrated on **Figure 8** in **APPENDIX F**. The sewer

legs that have been recommended for replacement due to structural deficiencies are identified on **Figure 9** in **APPENDIX G**.

2.4.3 Drainage Ditches

V-shaped roadside ditches currently exist within the study area and ultimately drain into receiving watercourses at crossing locations.

2.5 Existing Landuse, Soils and Physiography

The majority of lands adjacent to the study area are rural in character and include a mix of agricultural fields, historic farmsteads, and some residential and commercial developments. The sections of land beyond the road ROW are low and wet and/or steeply sloping. The majority of lands beyond the study appeared relatively undisturbed.

The soils within the study limits include Chingacousey clay loam, Peel clay, and Bottom Lands (Hoffman and Richards 1953). Soils throughout the Humber River watershed tend to be poorly drained clays and clay tills with relatively low infiltration capacity. As a result of low infiltration within the watershed, and because there are few sources of groundwater discharge from regional aquifers, base flow in Centreville Creek and associated tributaries tends to be low, with even large tributaries often dry in summer months. The upper half of the Humber River watershed within the Town of Caledon remains primarily agricultural, while the majority of the lower half of the watershed within the City of Brampton has been or will soon be developed.

The study area is located within the South Slope physiographic region. This physiographic region occupies approximately 2,400 km^2 and extends from the Niagara Escarpment in the west to the Trent River in the east (Chapman and Putnam 1984). The South Slope predominately consists of shallow shale and till plains which slope gently in a southeasterly direction towards Lake Ontario. The topography is mostly subdued and includes low-relief drumlins and moraines.

3 Drainage and Stormwater Management Issues

Airport Road has a rural cross-section throughout the majority of the corridor, meaning that stormwater runoff resulting from both minor and major storm events is largely managed through roadside ditches. The Region of Peel is proposing localized roadway improvements within the study area. Typical rural and urban cross sections for the proposed roadway are presented on **Figures 4-7** in **APPENDIX E**.

Under proposed conditions at urban sections along Airport Road, runoff resulting from major storm events will continue to be conveyed to existing watercourse crossings as roadway overland flow, while runoff from minor storm events will be conveyed by the proposed condition storm sewer system (comprising a combination of existing sewers, replacement sewers, and new sewers). At rural sections, both minor and major system flows will continue to be conveyed by roadside ditches towards receiving watercourses.

The proposed improvements to Airport Road will result in an increase in pavement area and green area within the Project limits. A pavement area analysis was conducted for the study corridor to determine the impervious surface area in the existing and proposed condition within the eleven

(11) internal roadway drainage areas defined for the site. Peak flow rates were also determined and compared for various design storms using the Rational Method for flow calculation, the Region of Peel 2019 IDF curves for determination of rainfall intensity, and Runoff Coefficient Adjustment Factors for higher intensity storm events to account for increases in runoff due to saturation of catchment surfaces as stipulated in the Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019). The results of the analysis are presented in the following **Table 2**. The existing and proposed internal roadway drainage areas and outlet locations defined for the corridor are delineated in **Figure 8** and **Figure 9** presented in **APPENDIX F** and **APPENDIX G**, respectively.

Table 2: Pavement Area Analysis

AREA ID	TOTAL AREA (ha)	PAVEMENT AREA (ha)	PERCENT IMPERV. (%)	RUNOFF COEFF.	FLOW (m^3/s)			
					2-YEAR	5-YEAR	10-YEAR	(1) 100-YEAR
EXISTING CONDITION								
C1	0.88	0.43	48.86	0.67	0.140	0.179	0.218	0.400
C2	1.02	0.24	23.55	0.45	0.109	0.140	0.171	0.313
C3A	3.63	2.00	55.05	0.63	0.543	0.695	0.850	1.557
C3B	0.92	0.77	84.08	0.79	0.172	0.221	0.270	0.494
C4A	2.03	0.63	30.94	0.50	0.239	0.306	0.374	0.686
C4B	0.33	0.11	31.56	0.52	0.041	0.053	0.064	0.118
C4C	1.64	0.73	44.46	0.57	0.224	0.287	0.351	0.643
C4D	2.72	0.94	34.68	0.54	0.347	0.444	0.543	0.994
C5A	1.48	0.48	32.50	0.48	0.168	0.216	0.264	0.483
C5B	7.68	2.01	26.14	0.48	0.878	1.124	1.374	2.517
C6	1.97	0.55	28.16	0.49	0.229	0.293	0.359	0.657
TOTAL	**24.30**	**8.89**	**36.58**	**0.53**	**3.092**	**3.956**	**4.839**	**8.861**
PROPOSED CONDITION								
C1	0.88	0.43	48.86	0.54	0.114	0.145	0.178	0.326
C2	1.02	0.29	28.63	0.40	0.097	0.124	0.152	0.279
C3A	3.63	2.33	64.24	0.65	0.562	0.719	0.879	1.610
C3B	0.92	0.76	83.05	0.78	0.171	0.219	0.267	0.490
C4A	2.03	1.26	61.96	0.63	0.306	0.392	0.479	0.878
C4B	0.33	0.19	57.12	0.60	0.048	0.061	0.075	0.136
C4C	1.64	1.02	61.84	0.63	0.248	0.317	0.388	0.710
C4D	2.72	1.10	40.60	0.48	0.314	0.401	0.491	0.899
C5A	1.48	0.64	43.58	0.51	0.178	0.228	0.278	0.510
C5B	7.68	1.66	21.61	0.35	0.642	0.822	1.005	1.841
C6	1.97	0.55	28.06	0.40	0.186	0.238	0.291	0.532
TOTAL	**24.30**	**10.24**	**42.15**	**0.50**	**2.864**	**3.665**	**4.483**	**8.209**

Note: (1) 100-year flow rates calculated using Runoff Coefficient Adjustment Factor of 1.25 to account for increase in runoff due to saturation of catchment surface as stipulated in Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019).

The results of the pavement area analysis revealed that the proposed improvements to Airport Road will slightly increase the existing minor and major flows within five (5) of the catchment areas (catchments C3A, C4A, C4B, C4C, and C5A). Minor and major flows within the remainder of the project corridor are decreased in the proposed condition. As a result of the increased flow rates in catchments C3A, C4A, C4B, C4C, and C5A, specific techniques to reduce the quantity and rate of runoff are required. Underground infiltration chambers are proposed within C3A upstream of OUTLET 1, within C4A upstream of OUTLET 2 (to provide combined storage for C4A and C4B), within C4C upstream of OUTLET 3, and within C5A upstream of OUTLET 6. The four (4) proposed infiltration chambers will provide 126 m^3, 142 m^3, 70 m^3, and 42.24 m^3 of storage volume, respectively, to address quantity control requirements within the corridor. Orifice plates will be proposed downstream of the infiltration chambers within control manholes to control post-development peak flows to pre-development levels. Refer to **APPENDIX M** for the full pavement area analysis and determination of peak flow rates and required storage volumes for the existing and proposed internal roadway drainage areas.

Under proposed conditions, water quality control for the rural corridor will continue to be provided within the existing roadside ditches through vegetation runoff velocity reduction and infiltration. For the urban corridor, water quality control will be addressed through a combination of Oil Grit Separator (OGS) units, underground infiltration chambers, and Jellyfish Filters. Refer to **Section 6.4** for location specific water quality treatment measures along the proposed urban corridor. When implemented in tandem, the OGS units, infiltration chambers, and/or Jellyfish Filters will form treatment trains and provide Enhanced Level water quality protection for runoff prior to discharge into receiving systems. Water balance control for the proposed site will be achieved through infiltration of vegetative areas. Refer to **Section 6.5** for a more detailed description of the water balance control measures proposed for the Airport Road corridor.

4 Design Criteria

In compliance with the Ministry of Transportation of Ontario (MTO) Highway Drainage Design Standards (HDDS, 2008) and the Region of Peel current policies and guidelines, the following design criteria have been adopted in the development of drainage and stormwater management strategies for the Airport Road improvements project between King Street and Huntsmill Drive.

Culverts

Design Storm Event

According to MTO HDDS WC-1, the design return period for rural structures with a span less than or equal to 6.0 m is 25-year. A structure with a span exceeding 6.0 m on a Rural Arterial road should be designed to convey the 50-year design storm at the required freeboard and soffit clearance. The following criteria were applied to evaluate the hydraulic performance of the existing and proposed culverts within the project limits.

Freeboard

Clause 1-10.8.2 of the Canadian Highway Bridge and Design Code (CHBDC) recommends a freeboard of 1.0 metre *"….from the edge of through traffic lanes to the design high-water level ….."* for the design storm. This freeboard is a recommended value although it is recognized that, due to site-specific considerations, it is not always feasible to provide this value.

Vertical Clearance to Soffit

The provision of vertical clearance is typically related to scour and debris. For low vulnerability bridges (rigid frame, internal abutment and slab) and for culverts with a span less than or equal to 6 m in general, the requirement is a minimum of 0.3 m vertical clearance from the design flood to the soffit. For structures exceeding 6 m in span, the vertical clearance shall not be less than 1 m.

Headwater / Depth (HW/D) Ratio

MTO HDDS WC-7 stipulates a design standard for flood depth at the upstream face of a culvert which is expressed as a ratio of flood depth at the upstream face of the culvert to the diameter or rise of the culvert (HW/D). The following criteria apply for the Airport Road culverts:

Culverts with diameter or rise < 3.0 meters	HW/D ≤ 1.5
Culverts with diameter or rise 3.0 to 4.5 meters	HW/D ≤ 4.5
Culverts with diameter or rise > 4.5 meters	HW/D ≤ 1.0

Changes in Upstream Water Levels

In accordance with good design practice, any increase in the upstream flood elevation resulting from the construction of a new structure should be kept to a minimum. The design target for upstream water level increases is zero. Minor increases may be accepted if:

i. They are contained within the lands owned by the proponent;
ii. The increase is in a valley system in which the flood line does not change appreciably in a horizontal direction;
iii. No structures are impacted by the flood level change;
iv. The increase is contained within municipally owned land or easement;
v. The increase is at the face of the existing structure and does not impact upstream/downstream lands;
vi. Written approval is obtained from the affected landowner.

Regulated Watercourse Crossings & Criteria

REGULATED WATERCOURSE / CROSSING	TRCA / CVC JURISDICTION	FISH / AQUATIC (Y/N)	TERRESTRIAL / WILDLIFE (Y/N)	FLOOD HAZARD (Y/N)	GEOMORPHIC HAZARD (Y/N)
C1	TRCA	Y	Y	Y	N
C2	TRCA	N	N	Y	N
C3	TRCA	Y	Y	Y	N
C5	CVC	N	N	Y	N
C6	CVC	N	Y	Y	N

Storm Sewer System

In accordance with the Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019), the minor drainage system has been sized to convey runoff from a 10-year storm event.

Major System Drainage

In accordance with the Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019), major system flows (i.e. storms in excess of a 10-year event up to and including the 100-year event or Regional Storm) will be conveyed overland to receiving drainage watercourses.

IDF Curves

In accordance with the Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019), the Region of Peel 2019 IDF curves have been used for all hydrological analyses.

Climate Change

In accordance with the Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019), climate change considerations have been incorporated into the hydrologic and hydraulic analyses for the Airport Road culverts and storm sewers. The hydraulic capacities of the culverts and storm sewers have been evaluated using future condition flow rates calculated using Region of Peel 2095 IDF curve parameters determined through regression analysis of rainfall data taken from the Ontario Climate Change Data Portal (2065-2095, 90% dataset).

Water Quantity Control

Control post-development peak flows to pre-development levels for all storms up to and including the 100-year storm event (i.e., 2, 5, 10, 25, 50 and 100-year storms).

Water Quality Control

SWM measures implemented along the study corridor will provide the 'Enhanced' Level of Water Quality Protection (i.e. long-term average removal of 80% of suspended solids) as outlined by the Ministry of the Environment, Conservation and Parks (MECP) and stipulated in the Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019).

Water Balance Control

In accordance with the Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019), the proposed design for the Airport Road corridor will provide, at a minimum, on-site retention of all run-off from the first 27 mm of each rainfall event through infiltration, evapotranspiration, and/or stormwater reuse.

Allowable Flow Spread

In accordance with the Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019), the proposed design for the Airport Road corridor (Rural Arterial roadway) will adhere to the following:

DESIGN CITERIA	CRITERIA TO FOLLOW
MINOR SYSTEM	
25 mm	No surface ponding
10-year	• No barrier curb overtopping. • Flow spread must leave at least one lane free of water in each direction.
MAJOR SYSTEM	
Greater than 10-year up to 100-year	• No barrier curb overtopping. • Flow spread must leave at least one lane free of water in each direction. • Preferred Criteria: no greater than 150 mm under 100-year storm event.

5 Hydrotechnical Assessments

5.1 General

Hydrologic analyses were undertaken to determine peak flow rates for the Airport Road and Old Church Road storm sewers under existing and proposed roadway conditions, as well as external flow rates at the nine watercourses which cross the Airport Road ROW. The watercourses within the study limit are part of Main Humber River and West Humber River subwatersheds, with Crossing 5 part of the East Credit River watershed under the jurisdiction of the CVC. Hydraulic analyses were conducted to evaluate the performance of existing culverts and to determine appropriate sizing for culvert replacements, where required, to convey external runoff across Airport Road according to current design standards. Hydraulic analyses were also conducted to evaluate the performance of the existing storm sewer systems under existing and proposed roadway design flows, to determine appropriate sizing for storm sewer replacements, where required, and to design new storm sewers along Airport Road in locations where the rural corridor has been converted to an urban roadway.

Climate change considerations were incorporated into the hydrologic and hydraulic analyses for the Airport Road culverts and storm sewers. The hydraulic capacities of the culverts and storm sewers have been evaluated using future condition flow rates calculated using Region of Peel 2095 IDF curve parameters determined through regression analysis of rainfall data taken from the Ontario Climate Change Data Portal (2065-2095, 90% dataset). Refer to **APPENDIX O** for details on the regression analysis used in determining the Region of Peel 2095 IDF curve parameters.

5.2 Hydrologic Assessment

5.2.1 Culverts

All surface watercourses contributing flows to Airport Road are located within the jurisdiction of the TRCA, with the exception of Crossing 5 and 6 which are within the East Credit River watershed and under the jurisdiction of the CVC. The hydrological analysis undertaken for peak flows was based on the Rational Method using the Region of Peel 2019 IDF curves for determination of rainfall intensity and the external drainage areas for each crossing identified on **Figure 2** and **Figure 3** in **APPENDIX B**. However, for Allison Creek (C2) and Centreville Creek (C3), peak flows for all return periods were obtained from the Centreville Creek HEC-RAS model provided by the TRCA (HEC-RAS Project File Name: WR14-0447-03Caledo). The Regional storm flow for C1 was obtained from the Upper Huntsmill HEC-RAS model provided by the TRCA (HEC-RAS Project File Name: CVC), with peak flows for all other return periods calculated using the Rational Method. The hydrologic input parameters including pervious and impervious drainage area, runoff coefficient, and catchment length were calculated based on the available topographic and drainage area mapping. The Regional storm flow for C9 was calculated as part of the previous Airport Road EA study from Mayfield Road to King Street. Regional storm flows for C4, C5, C6, C7, and C8 were calculated through transposition and interpolation of the adjacent C9 Regional discharge value using the MTO's Transposition of Flood Discharge method. The time of concentration for each external drainage catchment was determined for flow computations using the Airport Equation. Hydrologic input parameters are presented in **APPENDIX H**. The results of the 2019 IDF hydrologic assessment for the Airport Road culverts are presented in the following **Table 3**.

Table 3: Hydrologic Assessment of Airport Road Culverts (2019 IDF Curves)

Drainage Outlet	Station	Drainage Area	Catchment Length	Watershed US Elev.	Watershed DS Elev.	Slope	Time of Concentration		Composite Runoff Coefficient	Rainfall Intensity (mm/hr)						Flow (m^3/s)						
		A	L	m	m	S	T_C															
		ha	m			%	min	hr	C	I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}	Q_2	Q_5	Q_{10}	Q_{25} [6]	Q_{50} [6]	Q_{100} [6]	$Q_{REGIONAL}$
C1	17+151	68.59	1080	372	316	5.19	52.90	0.88	0.25	29.3	41.2	50.2	61.6	69.8	78.7	1.41	1.98	2.41	3.25	4.02	4.72	24.15 [1]
C2	15+900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.5 [2]	5.13 [2]	6.25 [2]	8.01 [2]	9.26 [2]	10.56 [2]	12.40 [2]
C3	15+750	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.49 [2]	8.01 [2]	9.78 [2]	12.54 [2]	14.48 [2]	16.49 [2]	39.98 [2]
C4	14+700	4.90	410	305	302	0.73	51.22	0.85	0.40	30.0	42.2	51.4	63.0	71.5	80.5	0.16	0.23	0.28	0.38	0.47	0.55	0.54 [3]
C5	13+950	36.85	660	299	296	0.45	89.08	1.48	0.28	19.5	27.8	33.6	41.3	46.8	52.7	0.56	0.80	0.97	1.31	1.62	1.90	2.44 [3]
C6	13+350	8.30	320	299	297	0.63	56.52	0.94	0.27	27.9	39.3	47.8	58.7	66.5	74.9	0.17	0.25	0.30	0.40	0.50	0.59	0.80 [3]
C7	12+350	21.71	680	299	294	0.74	79.98	1.33	0.25	21.2	30.2	36.6	45.0	51.0	57.4	0.32	0.46	0.56	0.75	0.93	1.09	1.64 [3]
C8	10+600	12.75	700	286	281	0.71	67.47	1.12	0.40	24.3	34.4	41.8	51.4	58.2	65.6	0.35	0.49	0.60	0.81	1.00	1.17	1.10 [3]
C9	9+950	3.76	460	280	275	1.09	48.30	0.80	0.39	31.4	44.0	53.7	65.7	74.6	84.0	0.13	0.18	0.22	0.30	0.37	0.43	0.44 [4]

Notes:

[1] Regional storm flow at C1 is obtained from TRCA's HEC-RAS model.

[2] All flows at C2 and C3 are obtained from TRCA's HEC-RAS model.

[3] Regional storm flows are calculated based on transposition and interpolation of adjacent C9 Regional flow value using MTO Method.

[4] Regional storm flow at C9 was calculated in previous Airport Road EA study from Mayfield Road to King Street.

[5] All other flow rates calculated using Rational Method and Region of Peel 2019 IDF curve parameters outlined in Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019).

[6] 25-year, 50-year, and 100-year flow rates calculated using Rational Method were multiplied by runoff coefficient adjustment factors to account for increase in runoff due to saturation of catchment surface as stipulated in Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019).

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

$$I = \frac{A}{(T_C + C)^B}$$

[5] Region of Peel 2019 IDF Curve Parameters			
Return Period	A	B	
2-Year	1070	0.8759	7.85
5-Year	1593	0.8789	11.00
10-Year	2221	0.9080	12.00
25-Year	3158	0.9335	15.00
50-Year	3886	0.9495	16.00
100-Year	4688	0.9624	17.00

[6] Runoff Coefficient Adjustment Factor	
Design Storm Frequency	Adjustment Factor
10-Year	1.0
25-Year	1.1
50-Year	1.2
100-Year	1.25

Use Airport Equation to calculate time of concentration (T_C) for C < 0.4, and Bransby-Williams Equation for C > 0.4

Airport Equation:

$$T_C = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_W{}^{0.33}}$$

Where:

T_C = time of concentration (min)

C = rational method runoff coefficient

L = length of overland flow (m)

S_W = surface slope (%)

Bransby-Williams Equation:

$$T_C = \frac{0.057 \times L}{S_W{}^{0.2} \times A^{0.1}}$$

Where:

T_C = time of concentration (min)

A = catchment area (ha)

L = length of overland flow (m)

S_W = surface slope (%)

MTO's Transposition of Flood Discharge Method:

$$Q_2 = Q_1 \times \left(\frac{A_2}{A_1}\right)^{0.75}$$

Where:

Q_1 = known peak discharge

Q_2 = unknown peak discharge

A_1 = known basin area

A_2 = unknown basin area

5.2.1.1 Climate Change

The Region of Peel 2095 IDF curves were used in conjunction with the external drainage areas to calculate future condition peak flow rates associated with the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storm events for all crossings except C2 and C3. For C2 and C3, flow data was taken from the TRCA's Centreville Creek HEC-RAS model and therefore could not be extrapolated using 2095 IDF curves since external drainage areas were not delineated within the scope of this study. Refer to **APPENDIX O** for the results of the 2095 IDF hydrologic assessment for the Airport Road culverts.

5.2.2 Storm Sewers

The Rational Method was used in conjunction with existing and proposed internal roadway drainage areas and Region of Peel 2019 IDF curve data to compute existing and proposed peak flows for the storm sewer networks along Airport Road and Old Church Road. Peak flow calculations for the storm sewer systems are provided in the storm sewer design sheets presented in **APPENDIX L**.

5.2.2.1 Climate Change

The Region of Peel 2095 IDF curves were used in conjunction with the proposed internal roadway drainage areas to calculate future condition peak flow rates for the Airport Road and Old Church Road storm sewer systems. Future condition peak flow calculations for the storm sewer systems are provided in the storm sewer design sheets presented in **APPENDIX L**.

5.3 Hydraulic Assessment

5.3.1 Culverts

Existing Condition

In order to assess the hydraulic capacity of the existing culverts, the 2019 IDF peak flows established in the hydrologic assessment were used in conjunction with hydraulic modelling software. The Centreville Creek HEC-RAS model provided by TRCA already modelled the existing C3 crossing and associated flow data. The Upper Huntsmill HEC-RAS model provided by TRCA did not feature C1. As such, the Upper Huntsmill model was modified to include the existing culvert and was programmed with the Region of Peel 2019 IDF peak flow data. The HEC-RAS models were run to obtain water surface elevations at the cross sections upstream of the culverts. C2, C4, C5, C6, C7, C8, and C9 were modelled in CulvertMaster using the Region of Peel 2019 IDF peak flows, and corresponding headwater elevations were extracted from the outputs. Using the computed headwater elevations and surveyed road data, freeboard was calculated at all existing crossings. For the culverts modelled in CulvertMaster, HW/D ratios were also extracted from the outputs.

Evaluation of the culverts was based on a 25-year design storm event in accordance with MTO HDDS WC-1 (adopted by the Region of Peel) since all culvert spans are less than 6.0 m. All existing culverts are CSP with the exception of C3 and C5 which are concrete. The results of the 2019 IDF hydraulic assessment for the existing Airport Road culverts are presented in the following **Table 4**. As evident from **Table 4**, C1, C2, C3, C4, C7, C8, and C9 do not meet the minimum 1.0 m freeboard requirement, with C2, C7, and C8 overtopping the roadway for the design flow. For the culverts modelled in CulvertMaster, C4, C7, and C8 exceed the maximum HW/D ratio of 1.5. As a result of hydraulic deficiency, C1, C3, C4, C7, C8, and C9 will be replaced and upsized in the proposed condition. C6 will also be replaced due to poor physical condition.

Although hydraulically deficient, C2 cannot be upsized at this time due to road profile restrictions. As such, C2 will be maintained in the proposed condition, however, upsizing of this culvert should be considered in future road profile changes and rehabilitation work. C5 currently meets all hydraulic criteria and will also be maintained in the proposed condition. CulvertMaster and HEC-RAS outputs for the existing Airport Road culverts are presented in **APPENDIX I** and **APPENDIX J**, respectively.

Table 4: Hydraulic Assessment of Existing Airport Road Culverts (2019 IDF Curves)

Crossing / Structure	Drainage Area	Size (mm)		Type	U/S Invert	D/S Invert	Length	Roadway Elevation	Design Return Period	2019 Region of Peel IDF Curves			
										Design Storm			
										Design Flow	Design Headwater Elevation	Design Freeboard	Design HW/D Ratio
	ha	Span	Rise		m	m	m	m		m^3/s	m	m	
C1 (1)	68.59	-	900	CSP	314.06	313.74	22.35	316.65	25 Year	3.25	316.56	0.09	-
C2 (2)	-	-	850	CSP	287.35	286.69	150.00	288.15	25 Year	8.01	288.32	-0.17	1.15
C3 (1)	-	4300	870	Concrete Box	286.75	286.79	18.18	288.20	25 Year	12.54	288.14	0.06	-
C4 (2)	4.90	-	450	CSP	301.10	300.62	24.05	303.81	25 Year	0.38	302.92	0.89	3.97
C5 (2)	36.85	2000	1100	Concrete Box	295.20	295.13	63.50	297.00	25 Year	1.31	295.83	1.17	0.57
C6 (2)	8.30	-	700	CSP	296.68	296.62	21.22	299.21	25 Year	0.40	297.40	1.81	1.03
C7 (2)	21.71	-	450	CSP	293.28	293.61	23.19	294.64	25 Year	0.75	294.74	-0.10	3.2
C8 (2)	12.75	-	600	CSP	279.71	279.62	21.24	281.84	25 Year	0.81	281.88	-0.04	3.55
C9 (2)	3.76	-	600	CSP	274.48	274.20	23.66	275.80	25 Year	0.30	275.09	0.71	1.00

Notes:

(1) Design headwater elevation obtained from TRCA's HEC-RAS model.

(2) Design headwater elevation obtained from CulvertMaster.

Centreville Creek Culvert (C3)

A preliminary hydraulic analysis of C3 was undertaken using the Centreville Creek HEC-RAS model provided by the TRCA since the Centreville Creek culvert was already programmed into the model. The results of hydraulic analysis are presented in the following **Table 5**, detailing the existing condition flood elevations for all storm events upstream of the culvert.

Table 5: Water Surface Elevations at Existing C3 Culvert (HEC-RAS Station: 7.663)

CROSSING	WATER SURFACE ELEVATION (m)						
	2-YEAR	5-YEAR	10-YEAR	25-YEAR	50-YEAR	100-YEAR	REGIONAL
C3	288.20	288.34	288.43	288.14	288.23	288.62	289.30

The existing top of road elevation along the centreline of Airport Road at the location of C3 is approximately 288.20 m. Under existing conditions, the 25-year flood elevation at the cross section upstream of the culvert is 288.14 m, which indicates that the flood line is 0.06 m below the top of the roadway. It should be noted that the 25-year and 50-year water surface elevations computed upstream of C3 are less than the water surface elevations resulting from more frequent storm events (2-year, 5-year, and 10-year storm events).

Proposed Condition

As a result of inadequate hydraulic capacity or poor physical condition, all culverts will be replaced and upsized with the exception of C2 and C5. A comparison of existing and proposed culvert sizes is presented in the following **Table 6**.

Table 6: Comparison of Existing and Proposed Culvert Sizes

CULVERT	EXISTING			PROPOSED		
	SIZE (mm)	TYPE	LENGTH (m)	SIZE (mm)	TYPE	LENGTH (m)
C1	900	CSP	22.35	3658 x 1067	Open Footing Concrete Box	24.10
C2	850	CSP	150.00	Culvert To Be Maintained		
C3	4350 x 870	Concrete Box	18.18	12192 x 1372	Open Footing Concrete Box	18.4
C4	450	CSP	24.05	825	Concrete Pipe	26.00
C5	2000 x 1100	Concrete Box	63.50	Culvert To Be Maintained		
C6	700	CSP	21.22	4267 X 1524	Open Footing Concrete Box	25.85
C7	450	CSP	23.19	1830 x 900	Concrete Box	23.70
C8	600	CSP	21.24	750	Concrete Pipe	21.30
C9	600	CSP	23.66	825	Concrete Pipe	49.40

In order to assess the capacity of the proposed culverts, the 2019 IDF peak flows established in the hydrologic assessment were used. The proposed culverts were then modelled in either HEC-

RAS or CulvertMaster, and headwater elevations were extracted from the outputs. Using the proposed headwater elevations and proposed road data, freeboard was calculated at all proposed crossings. For the culverts modelled in CulvertMaster, proposed HW/D ratios were also extracted from the outputs. Although maintained, C2 and C5 were modelled in the proposed condition using proposed roadway elevations to assess the impact of the proposed roadway design on the existing culverts.

Evaluation of the proposed and maintained culverts was based on a 25-year design storm event, with the exception of C3 which was based on a 50-year design storm in accordance with MTO HDDS WC-1 for culvert spans exceeding 6.0 meters. In the proposed condition, all culverts are concrete with the exception of C2 which is CSP. The results of the 2019 IDF hydraulic assessment for the proposed condition Airport Road culverts are presented in the following **Table 7**. As evident from **Table 7**, all proposed culverts meet the hydraulic criteria with the exception of C3 and C7 which do not meet the required freeboard and are constrained by the Airport Road roadway profile. As a result, these culverts cannot be upsized further to meet hydraulic criteria without significantly impacting the road profile. Although it is not possible at this time, upsizing of C3 and C7 should be considered in future road profile changes and rehabilitation work. Refer to **APPENDIX K** for details on the road profile restrictions at C3. Based on the results of **Table 7**, C2 fails to meet the freeboard criteria in the proposed condition and overtops the roadway for the design flow. Since C2 was hydraulically deficient in the existing condition and was unable to be upsized at this time due to road profile constraints, C2 continues to be deficient in the proposed condition. Upsizing of C2 should also be considered in future road profile changes and rehabilitation work. From **Table 7**, C5 also fails to meet the freeboard requirement in the proposed condition. Although C5 is to be maintained, there is a road profile decrease at the location of the culvert in the proposed condition. As a result of this decrease, the freeboard at C5 drops below 1.0 m in the proposed condition, however, it is still within an acceptable limit. CulvertMaster and HEC-RAS outputs for the proposed condition Airport Road culverts are presented in **APPENDIX I** and **APPENDIX J**, respectively. Refer to **Table 8** for a comparison of existing and proposed Regional water surface elevations (WSEs) at the culvert locations for the 2019 IDF flows. In the proposed condition, all proposed culverts will reduce the existing Regional storm water surface elevations.

Crossing C6 falls under the jurisdiction of CVC and have high potential for amphibian movement between the two lobes of the Mono Road wetland complex. CVC has recommended wildlife crossing improvements to be incorporated in the proposed sizing to facilitate both reptile and amphibian movement. Accordingly, a 4.267 m X 1.524 m open footing concrete culvert is proposed for this crossing with an openness ratio of 0.25 as per CVC's Fish and Wildlife Crossing Guidelines (CVC 2017).

Table 7: Hydraulic Assessment of Proposed Airport Road Culverts (2019 IDF Curves)

Crossing / Structure	Drainage Area	Size (mm)		Type	U/S Invert	D/S Invert	Length	Roadway Elevation	Design Return Period	2019 Region of Peel IDF Curves			
										Design Storm			
										Design Flow	Design Headwater Elevation	Design Freeboard	Design HW/D Ratio
	ha	Span	Rise		m	m	m	m		m^3/s	m	m	
C1 [1]	68.59	3658	1067	Open Footing Concrete Box	314.06	313.74	24.10	316.62	25 Year	3.25	314.71	1.91	-
C2 [2] [3]	-	-	850	CSP	287.35	286.69	150.00	287.88	25 Year	8.01	288.10	-0.22	0.89
C3 [1] [4]	-	12192	1372	Open Footing Concrete Box	286.71	286.71	18.40	288.54	50 Year	14.48	288.14	0.40	-
C4 [2]	4.90	-	825	Concrete Pipe	301.64	301.42	26.00	304.05	25 Year	0.38	302.17	1.88	0.63
C5 [2] [5]	36.85	2000	1100	Concrete Box	295.20	295.13	63.50	296.78	25 Year	1.31	295.83	0.95	0.57
C6 [2]	8.30	4627	1524	Open Footing Concrete Box	297.05	296.93	25.85	299.48	25 Year	0.40	297.32	2.16	0.18
C7 [2] [4]	21.71	1830	900	Concrete Box	293.63	293.28	23.70	294.68	25 Year	0.75	294.04	0.64	0.45
C8 [2]	12.75	-	750	Concrete Pipe	279.71	279.62	21.30	281.88	25 Year	0.81	280.59	1.29	1.15
C9 [2]	3.76	-	825	Concrete Pipe	274.64	274.05	49.40	276.22	25 Year	0.30	275.11	1.11	0.56

Notes:

[1] Design headwater elevation obtained from TRCA's HEC-RAS model.

[2] Design headwater elevation obtained from CulvertMaster.

[3] Due to road profile restrictions and criteria for minimum cover, C2 cannot be upsized to meet hydraulic criteria.

[4] Due to road profile restrictions and criteria for minimum cover, C3 and C7 cannot be upsized further to meet hydraulic criteria.

[5] Due to road profile decrease at C5, freeboard is below 1.0 m, however, it is still within acceptable limit.

Table 8: Comparison of Existing and Proposed Regional WSEs

CULVERT ID	EXISTING CONDITION	PROPOSED CONDITION	DIFFERENCE (m)	FLOODING HAZARD INCREASE (Y/N)
	REGIONAL STORM WSE (m)	REGIONAL STORM WSE (m)		
C1	316.88	316.82	-0.06	N
C2	288.37	288.16	-0.21	N
C3	289.30	289.05	-0.25	N
C4	303.87	302.29	-1.58	N
C5	296.09	296.09	0.00	N
C6	298.21	297.34	-0.87	N
C7	294.80	294.33	-0.47	N
C8	281.90	280.87	-1.03	N
C9	275.29	275.22	-0.07	N

Note: Negative value indicates reduction in flood elevation.

The following **Table 9** summarizes the deficient culverts in the proposed condition and the constraints and justification for the hydraulic deficiency.

Table 9: Summary of Hydraulically Deficient Culverts in Proposed Condition

CULVERT ID	TYPE OF DEFICIENCY IN PROPOSED CONDITION	CONSTRAINT/JUSTIFICATION
C2	Freeboard	Road profile cannot be raised at this time due to significant impact on the intersection and access roads. Upsizing of this culvert should be considered in future road profile changes and rehabilitation work.
C3	Freeboard	Road profile cannot be increased at this time. Culvert cannot be upsized further to meet hydraulic criteria without significantly impacting the road profile. Upsizing of this culvert should be considered in future road profile changes and rehabilitation work.
C7	Freeboard	Road profile cannot be increased at this time. Culvert cannot be upsized further to meet hydraulic criteria without significantly impacting the road profile. Upsizing of this culvert should be considered in future road profile changes and rehabilitation work.

Centreville Creek Culvert (C3)

A preliminary hydraulic analysis of the proposed Centreville Creek culvert was undertaken by modifying the Centreville Creek HEC-RAS model provided by the TRCA. Proposed culvert dimensions were programmed into the model, and the proposed condition flood elevations upstream of the culvert were recorded for all storm events using the flow data already programmed into the model. The results of the hydraulic analysis are presented in the following **Table 10**.

Table 10: Water Surface Elevations at Proposed C3 Culvert (HEC-RAS Station: 7.663)

CROSSING	WATER SURFACE ELEVATION (m)						
	2-YEAR	5-YEAR	10-YEAR	25-YEAR	50-YEAR	100-YEAR	REGIONAL
C3	287.31	287.48	287.56	288.00	288.14	288.30	289.05

The top of road elevation along the centreline of Airport Road was increased to 288.54 m at the location of C3 in the proposed condition. Under proposed conditions, the 50-year flood elevation at the cross section upstream of the culvert is 288.14 m, which indicates that the flood line is 0.40 m below the top of the roadway. It should be noted that the water surface elevations for all storm events decrease as a result of upsizing C3 in the proposed condition, with the Regional storm water surface elevation reducing by 0.25 m.

5.3.1.1 Climate Change

Existing and proposed culverts were evaluated using the 2095 IDF peak flows established in the hydrologic assessment to assess the impact of climate change on the culverts. Future condition flow rates were programed into HEC-RAS and CulvertMaster for associated culverts, and the resulting headwater elevations and HW/D ratios were recorded and used in the 2095 IDF hydraulic assessment. C2 and C3 were not included in the 2095 IDF hydraulic assessment because flow data for these culverts was originally obtained from the TRCA's Centreville Creek HEC-RAS model. The results of the 2095 IDF hydraulic assessment for the existing and proposed Airport Road culverts are presented in **APPENDIX O**. CulvertMaster and HEC-RAS outputs are presented in **APPENDIX I** and **APPENDIX J**, respectively.

The existing culverts which were hydraulically deficient for the 2019 IDF flows are also deficient when modeled with the 2095 IDF flow rates, with increased headwater elevations, decreased freeboard, and increased HW/D ratios (for those modeled in CulvertMaster). However, existing C5 and C6 continue to meet hydraulic criteria for future flows under existing roadway conditions.

Similarly, proposed C7, which was hydraulically deficient for the 2019 IDF flows, continues to be deficient when modelled with the 2095 IDF flow rate, with an increased headwater elevation, decreased freeboard, and increased HW/D ratio. As previously stated, road profile restrictions prevent C7 from being upsized further at this time, however, upsizing of this culvert should be considered in future road profile changes and rehabilitation work. In the proposed condition, C5 is maintained, however, the road design results in a decrease in roadway elevation at the location of the culvert. As such, the freeboard at C5 drops below 1.0 m in the proposed condition under 2019 IDF flows. When modelled with the 2095 IDF flow rate, the freeboard at C5 decreases further, however, it is still within an acceptable limit. All culverts which met hydraulic criteria in the proposed condition for the 2019 IDF flows continue to meet hydraulic criteria for future flows. The results of the 2095 IDF hydraulic assessment indicate that, where road profile allows, proposed culverts have been designed to sufficiently convey external flows under climate change considerations.

5.3.2 Storm Sewers

A storm sewer assessment was conducted to determine the hydraulic performance of the existing Airport Road and Old Church Road sewers under existing and proposed design flows. Storm sewer capacity was calculated using Manning's Equation as detailed in the storm sewer design sheets presented in **APPENDIX L**. The results of the 2019 IDF hydraulic assessment for the existing storm sewers along Airport Road and Old Church Road indicate that based on a 10-year

design return period, seven (7) sewer legs are deficient in capacity and require replacement and upsizing. Based on the results of the CCTV inspection, nine (9) sewer legs have been recommended for replacement due to structural deficiencies. Refer to **Table 11** for a summary of the deficient storm sewer legs, identified from manhole (MH) to MH along the study corridor.

Table 11: Summary of Deficient Storm Sewers

EXISTING STORM SEWER LEGS TO BE REPLACED				TYPE OF DEFICIENCY
FROM MH	TO MH	FROM STATION	TO STATION	
MH8576191490	MH8576591454	15+345.4	15+396.0	Poor CCTV
MH8576591454	MH8576991416	15+396	15+451.0	Poor CCTV
MH8577191388	MH8577591348	15+490.0	15+546.0	Poor CCTV
MH8577991307	MH8578191286	15+604.0	15+634.4	Failure CCTV
MH8578191286	MH8578691245	15+634.4	15+692.1	Poor CCTV
MH8578691245	MH8578791229	15+692.1	15+715.0	Survey Abandoned CCTV
MH8582890822	MH8582490863	16+288.7	16+231.2	Undersized
MH8582490863	MH8582190890(MH1A-7)	16+231.2	16+192.5	Poor CCTV/Under sized
MH8582190890(MH1A-7)	MH851890923(MH1A-8)	16+192.5	16+146.2	Poor CCTV/Under sized
MH858190923(MH1A-8)	MH8581490957(MH1A-9)	16+146.2	16+100.0	Undersized
MH8581490957(MH1A-10)	MH8581190987(MH1A-11)	16+100.0	16+057.0	Undersized
MH8581190987(MH1A-11)	MH8581190987A	16+057.0	16+012.5	Undersized
MH8581190987A	MH8580691035	16+012.5	15+987.8	Poor CCTV/Under sized

In addition to storm sewer replacements, new storm sewers have been proposed along Airport Road in locations where the rural corridor has been converted to an urban roadway. As such, the storm sewer system in the proposed condition is comprised of a combination of existing sewers, replacement sewers, and new sewers. A storm sewer assessment was conducted to determine the hydraulic performance of the Airport Road and Old Church Road storm sewer systems in the proposed condition under proposed design flows. Details are provided in the storm sewer design sheets presented in **APPENDIX L**. The results of the 2019 IDF hydraulic assessment for the proposed condition Airport Road and Old Church Road storm sewers indicate that based on a 10-year design return period, all legs of the storm sewer systems have been designed to sufficiently convey minor flows. The proposed condition storm sewer systems are illustrated on **Figure 9** in **APPENDIX G**.

5.3.2.1 Climate Change

The proposed condition Airport Road and Old Church Road storm sewers were evaluated using the 2095 IDF future condition peak flows established in the hydrologic assessment to assess the impact of climate change on the storm sewer systems. The results of the assessment indicate that

all storm sewers in the proposed condition have been designed to sufficiently convey minor flows under climate change considerations. The results of the 2095 IDF hydraulic assessment for the proposed condition Airport Road and Old Church Road storm sewers are provided in the storm sewer design sheets presented in **APPENDIX L**.

6 Design Features of Proposed SWM System

6.1 Minor and Major System Drainage

Under proposed conditions at urban sections along Airport Road, runoff resulting from major storm events will continue to be conveyed to existing watercourse crossings as roadway overland flow, while runoff from minor storm events will be conveyed by the proposed condition storm sewer system (comprising a combination of existing sewers, replacement sewers, and new sewers). At rural sections, both minor and major system flows will continue to be conveyed by roadside ditches towards receiving watercourses.

6.2 Low Impact Development (LID) Measures

Four (4) underground infiltration chambers are proposed along the Airport Road corridor as LID measures to provide storage volume, reduce the quantity and rate of runoff leaving the proposed site, and provide water quality treatment through infiltration. As another LID measure, vegetation is proposed within the center island and four entry/exit pedestrian islands at the Boston Mills Road/Castlederg Sideroad/Airport Road roundabout, as well as within the center island at the Cranston Drive/Airport Road roundabout. The vegetation within the roundabouts is proposed to reduce hard surfaces and promote water balance and peak flow reduction through infiltration. Refer to **Figure 9** in **APPENDIX G** for details on the proposed LID measures to be implemented along the Airport Road corridor.

6.3 Water Quantity Control

As outlined in **Section 3**, the results of the pavement area analysis revealed that the proposed improvements to Airport Road will slightly increase the existing minor and major flows within five (5) of the catchment areas (catchments C3A, C4A, C4B, C4C, and C5A). Minor and major flows within the remainder of the project corridor are decreased in the proposed condition. As a result of the increased flow rates in catchments C3A, C4A, C4B, C4C, and C5A, specific techniques to reduce the quantity and rate of runoff are required. Underground infiltration chambers are proposed within C3A upstream of OUTLET 1, within C4A upstream of OUTLET 2 (to provide combined storage for C4A and C4B), within C4C upstream of OUTLET 3, and within C5A upstream of OUTLET 6. The four (4) proposed infiltration chambers will provide 126 m^3, 142 m^3, 70 m^3, and 42.24 m^3 of storage volume, respectively, to address quantity control requirements within the corridor. Orifice plates will be proposed downstream of the infiltration chambers within control manholes to control the 100-year post-development peak flows to 100-year pre-development levels. Refer to **APPENDIX M** for the full pavement area analysis and determination of peak flow rates and required storage volumes for the existing and proposed internal roadway drainage areas.

6.4 Water Quality Control

Under proposed conditions, the existing roadside ditches will continue to provide water quality treatment for the rural corridor through vegetation runoff velocity reduction and infiltration as outlined by the MECP and stipulated in the Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019). For the urban corridor, water quality control will be addressed

through a combination of OGS units, underground infiltration chambers, and Jellyfish Filters. Refer to **Table 12** for location specific water quality treatment measures along the proposed urban corridor. When implemented in tandem, the OGS units, infiltration chambers, and/or Jellyfish Filters will form treatment trains and provide Enhanced Level water quality protection for runoff prior to discharge into receiving systems. In total, five (5) OGS units, two (2) Jellyfish Filters, and four (4) underground infiltration chambers have been proposed within the Project limits. The OGS sizing calculations are provided in **APPENDIX N.**

Table 12: Summary of Water Quality Control Measures

CATCHMENT AREA	WATER QUALITY CONTROL MEASURE(S)
C3A	OGS + Infiltration Chamber + Jellyfish Filter
C3B	OGS + Jellyfish Filter
C4A & C4B	OGS + Infiltration Chamber
C4C	OGS + Infiltration Chamber
C5A	OGS + Infiltration Chamber

6.5 Water Balance Control

Based on the water balance control criteria outlined in the Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019), the proposed design for the Airport Road corridor must provide, at a minimum, on-site retention of all run-off from the first 27 mm of each rainfall event through infiltration, evapotranspiration, and/or stormwater reuse. For the proposed corridor, water balance control is achieved through infiltration of vegetative areas. Water balance calculations yielded a required infiltration volume of 6560.76 m^3 for the proposed site. Based on the total vegetative area within the Project limits, the infiltration rate of the underlying soil, and a 24-hour detention time, the proposed Airport Road corridor will be capable of infiltrating 16,282.19 m^3 of runoff which is equivalent to a rainfall depth of 116 mm, substantially exceeding the Region of Peel requirements. Calculations for water balance control are provided in **APPENDIX M**.

6.6 Flow Spread

A flow spread analysis was conducted at three low points located within urban sections along Airport Road to confirm that the proposed roadway design meets the Region of Peel criteria for allowable flow spread onto travel lanes under both minor and major system flows at low points/sags along the roadway, in accordance with the Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019). The results of the analysis indicate that the ponding depth at all three low points is less than 150 mm for the major system event, thereby meeting Region of Peel requirements. Encroachment for all three low points ranges from 0.74 m to 3.25 m for the major system. Since the depth of flooding for the major storm (100-year) is in the range of 41 mm to 65 mm, the proposed roadway can still be used at a reduced posted speed. There is no risk of flooding during the 25 mm and 10-year storms and proposed storm sewers have enough capacity to convey the minor flows. The results of the flow spread analysis are presented in **APPENDIX N**. A summary of the results is provided in **Table 13**.

Table 13: Summary of Low Point Spread Analysis

LOW POINT STATION	PONDING DEPTH (m)	FLOW SPREAD (m)	ENCROACHMENT ONTO 1ST TRAVEL LANE (m)	CLEAR WIDTH OF 1ST TRAVEL LANE (m)
MAJOR SYSTEM				
14+182.253	0.041	2.057	2.057	1.443
14+854.431	0.065	3.251	3.251	0.749
15+817.424	0.063	3.137	0.737	1.863

7 Mitigation Measures

Mitigation measures will be required due to culvert replacements at crossing locations within the study area. The following mitigation measures are recommended to offset negative impacts of the project on the terrestrial and aquatic features in the vicinity of the crossings.

- Detailed staging drawings, to minimize temporary effects to the watercourse during construction, will be provided in the detailed design stage;
- Water management plans will be developed to facilitate completion of works “in the dry” through the use of by-pass pumping, dam and flume, partial coffer dams or timing of the works during dry conditions in the ephemeral channels;
- An in-water construction timing restriction must be implemented based on the recommendations provided by the TRCA and CVC. For coldwater systems (Crossings 1, 2, 3, 4, and 6), no in-water works are to be undertaken between October 1 and May 31. For warmwater systems (Crossings 5, 7, 8, and 9), no in-water works are to be undertaken between May 1 and July 15;
- A detailed restoration plan will be prepared for channel and bank areas associated with the culvert replacements. The restoration plans will include erosion and sediment control, vegetation strategies, and permanent stabilization measures;
- All culvert replacements will maintain or improve the current hydraulics of the crossings and will be designed to maintain the current watercourse gradient with appropriate embedding to promote fish passage;
- Incorporate habitat diversity into the final structure design (i.e., bank diversity and substrate placement associated with any scour protection requirements);
- All materials and equipment used shall be operated and stored in such a manner that prevents any deleterious substance from entering watercourses, wetlands or other sensitive area;
- Work areas should be delineated with construction fencing to minimize the area of disturbance;
- Where cofferdams are to be employed, dewatering effluent should be treated prior to discharge to receiving watercourse. Dewatering must be discharged in a vegetated area 30 metres from the creek;
- Cofferdams should be constructed using pea gravel bags to isolate the work area and maintain flow;

- Fish isolated by construction activities should be captured and safely released to the watercourse. Fish capture and release to be conducted by fisheries professionals;
- Apply standard sediment and erosion control measures (e.g., silt fence, flow checks, silt curtain, sedimentation basins) consistent with Ontario Provincial Standards and Specifications (OPSS) to ensure no effects to the surface waters. The control measures shall be implemented prior to construction of the work and be maintained during construction and until disturbed areas have been effectively stabilized with permanent vegetation cover;
- All disturbed areas of the work site shall be stabilized and re-vegetated promptly, and/or treated with appropriate erosion protection materials. In riparian and aquatic habitats, all temporarily disturbed areas will be reinstated to original condition upon completion of works;
- Any stockpiled materials shall be stored and stabilized away from the water; and
- Crossings which are within the TRCA and CVC Regulated areas will require TRCA and CVC permits, respectively. Within the TRCA's jurisdiction, C1, C2, and C3 are Regulated watercourse crossings and within the CVC's jurisdiction, C5 is a Regulated watercourse crossing.

8 Erosion and Sediment Control

If uncontrolled, the construction activities associated with Airport Road improvements could result in increased rates of erosion and sedimentation within and adjacent to the study area and Humber River subwatersheds. Erosion, for the purposes of this discussion, is described as the process whereby soil particles are detached from an exposed surface and transported by water, wind or some other agent. Sedimentation is defined as the deposition of (eroded) particles at a "downstream" point, typically a watercourse. The potential environmental impacts from increased erosion and sedimentation include: degradation of water quality; destruction of fisheries habitat; and, increased flooding potential.

Erosion and sedimentation processes are typically accelerated due to construction activities. Literature indicates that construction activities can increase erosion and sedimentation rates by 2 to 3 orders of magnitude over that expected from a natural forested area. Erosion and sedimentation control are therefore an integral and important component in the design and construction of any project.

8.1 Erosion and Sediment Control Measures

To minimize the potential environmental impacts, the following erosion and sedimentation control practices will serve to guide the design and implementation phase of the Erosion and Sedimentation Control Plan:

- limit size of disturbed area,
- limit duration of soil exposure,
- retain existing vegetation where feasible,
- limit slope length and gradient of disturbed areas,
- preserve overland sheet flow and micro-drainage (avoid concentrated channel flows),
- break and redirect flows to lower gradients,
- design and implement staged stripping,

- prevent disturbance of previously stripped and stabilized parcels, and
- stabilize stripped parcels with temporary vegetative controls.

Appropriate permanent/temporary erosion control measures to be considered in the design and implementation of the Erosion and Sedimentation Control Plan are:

- **Hydroseeding** - One step application of seed and hydraulic slurry with adhesive binder (provides permanent stabilization for moderate to steep slopes).
- **Seed and Straw Mulch** - Alternative two step application that will be applied to provide permanent/temporary vegetative stabilization of disturbed areas.
- **Mulch (straw, wood etc.)** - Used to provide temporary erosion protection of exposed slopes during over-wintering and for disturbed areas inactive for greater than 45 days.
- **Sod** - Utilized to provide quick permanent stabilization of disturbed areas. Applications include lateral ditches with gradients < 5% and slopes with steep to moderate grades (i.e. 3% to 5%).
- **Erosion Control Blanket** - Applied as temporary/permanent erosion protection for slopes greater than 2:1 or as a ditch liner. For permanent applications, seed will be applied prior to installation.
- **Aggregate Stone** - Appropriate material, such as rip rap will be used to provide immediate permanent erosion protection of lateral ditches > 5% gradient; and along chute/spillways. Geotextile fabric will be applied prior to placement of any aggregate material.

8.2 Sediment Control

The following elements should be included in the sediment control plan:

- provision of a series of temporary interceptor/conveyor ditches to direct runoff to the siltation/watercourses;
- provision of rock or straw bale within drainage swales/ditches; and
- placement of a series of silt control fencing for the interception of sheet flow drainage.

All sediment control measures should not be removed until final stabilization of the site. In addition, any accumulated sediment shall be removed, as part of a maintenance program, from all control measures when accumulation reaches 50% of the height or volume of the control structure.

Environmental Inspection Process - As a component of erosion and sedimentation control, environmental inspections of the construction site will be conducted. Environmental inspections will be conducted to assess the performance of erosion and sedimentation control measures and identify any required maintenance. The frequent inspections will also permit the identification of localized erosion and sedimentation control issues that require site specific attention.

Implementation and Recommendation - A 200 m standby supply of prefabricated silt fence barrier, in addition to silt fence requirements, shall be maintained at the construction site prior to commencement of grading operations and throughout the duration of the contract.

- Where interceptor ditches and/or subsurface drains are specified, they shall be constructed prior to commencement of any related cut or fill activities.
- Cut and fill earth slopes and ditches, shall be treated with the specified cover material (seed and mulch, seed and erosion control blanket, seed and sod, rip rap, etc.) within 45 days from the commencement of the cut, fill or ditching operation. Commencement of a cut, fill or ditching operation shall be considered to have occurred when the original stabilizing cover has been removed, including grubbing, or has been covered with fill material.
- Run-off from the site and stockpiles shall be controlled to the extent possible to minimize sediment entry to the adjacent watercourses.
- Where dewatering is required, and where culverts are cleaned by hydraulic means, the effluent shall be discharged in a manner that prevents the entry of sediments to watercourses, or scouring and erosion at the outlet.
- All erosion and sediment control measures will be clearly stated in the contract drawings and documents.
- Erosion and sediment control plan for the project must adhere to Erosion and Sediment Control (ESC) Guidelines for Urban Construction, December 2006, Greater Golden Horseshoe Area Conservation Authorities.

9 Conclusion

This report documents the SWM aspects associated with the improvements to Airport Road between King Street and Huntsmill Drive. It describes the existing and proposed drainage conditions within the study limits and outlines the proposed SWM Plan for conveying external and internal runoff across the widened Airport Road in order to mitigate the potential impacts of the proposed roadway improvements on receiving drainage systems. The findings of this SWM study completed in support of the Airport Road EA from King Street to Huntsmill Drive are summarized as follows:

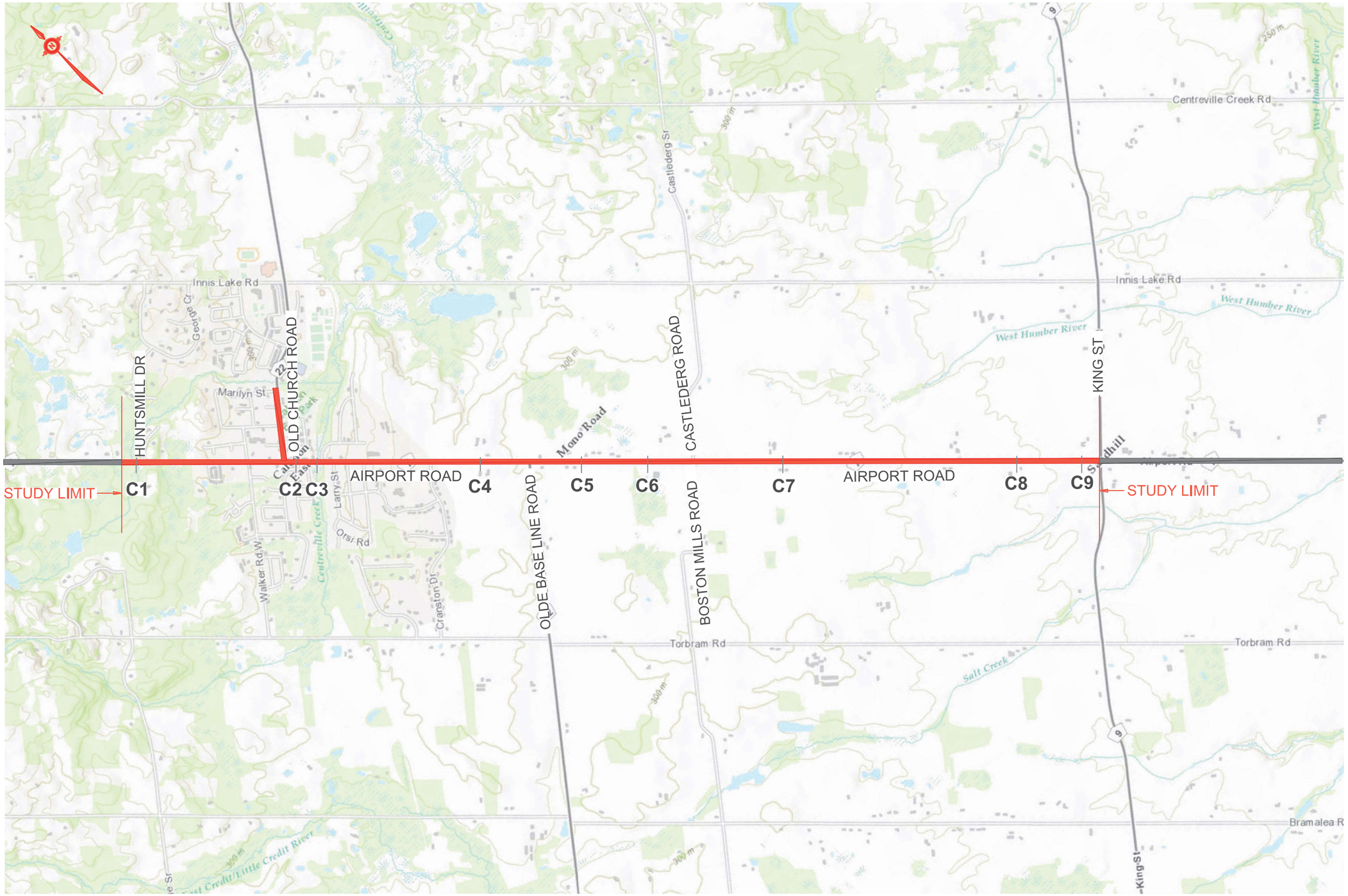
- There are seven (7) CSP culverts and two (2) concrete box culverts that convey external flows across Airport Road in the existing condition. All CSP culverts range in size from 450 mm to 900 mm in diameter.
- All existing culverts will be replaced due to inadequate hydraulic capacity or poor structural condition, with the exception of C2 and C5. In the proposed condition, all culverts are concrete, with the exception of C2 which is CSP.
- All proposed culverts meet the MTO HDDS hydraulic criteria, with the exception of C3 and C7 which do not meet the required freeboard and are constrained by the Airport Road roadway profile. As a result, these culverts cannot be upsized further to meet hydraulic criteria without significantly impacting the road profile. Although it is not possible at this time, upsizing of C3 and C7 should be considered in future road profile changes and rehabilitation work.
- C2 fails to meet the freeboard criteria in the proposed condition and overtops the roadway for the design flow. Since C2 was hydraulically deficient in the existing condition and was unable to be upsized due to road profile constraints, C2 continues to be deficient in the proposed condition. Although it is not possible at this time, upsizing of C2 should be considered in future road profile changes and rehabilitation work.
- Although C5 is to be maintained, there is a road profile decrease at the location of the culvert in the proposed condition, however, the freeboard is still within an acceptable limit.

- Crossing C6 falls under the jurisdiction of CVC and have high potential for amphibian movement between the two lobes of the Mono Road wetland complex. A 4.267 m X 1.524 m open footing concrete culvert is proposed for this crossing with an openness ratio of 0.25 as per CVC's Fish and Wildlife Crossing Guidelines (CVC 2017).
- The proposed culverts will significantly reduce the existing Regional storm water surface elevations.
- Within the urban sections of the Airport Road corridor and along Old Church Road from Airport Road to John Street, runoff is collected and conveyed by storm sewers. The existing Airport Road storm sewer system is located between Station 15+340 and 16+300, with sewers ranging in size from 375 mm to 1200 mm in diameter and outletting to Centreville Creek. The existing Old Church Road storm sewer system is located between Station 1+100 and 1+250 (ultimately connecting to the Airport Road storm sewer system), with sewers ranging in size from 300 mm to 450 mm in diameter. There is also a small network of storm sewers located at the intersection of Airport Road and Olde Base Line Road.
- Based on the results of the CCTV inspection, nine (9) existing sewer legs have been recommended for replacement due to structural deficiencies. Based on the results of the storm sewer assessment, seven (7) existing sewer legs are deficient in capacity and require replacement and upsizing.
- In addition to storm sewer replacements, new storm sewers have been proposed along Airport Road in locations where the rural corridor has been converted to an urban roadway. As such, the storm sewer system in the proposed condition is comprised of a combination of existing sewers, replacement sewers, and new sewers.
- In the proposed condition, all proposed storm sewer legs have been designed to convey minor flow
- Underground infiltration chambers are proposed within the corridor to provide storage volume, reduce the quantity and rate of runoff leaving the proposed site, and provide water quality treatment through infiltration. As another LID measure, vegetation is proposed within roundabouts along the Airport Road corridor to reduce hard surfaces and promote water balance and peak flow reduction through infiltration.
- The existing roadside ditches will continue to provide water quality treatment for the rural Airport Road corridor in the proposed condition. Proposed OGS units, infiltration chambers, and Jellyfish Filters will form treatment trains and provide Enhanced Level water quality protection for urban runoff prior to discharge into receiving systems.
- The results of the pavement area analysis revealed that the proposed improvements to Airport Road will slightly increase the existing minor and major flows within five of the roadway catchment areas. Minor and major flows within the remainder of the project corridor are decreased in the proposed condition. Underground infiltration chambers are proposed to provide storage and address quantity control requirements within the corridor. Orifice plates will be proposed downstream of the infiltration chambers within control manholes to control post-development peak flows to pre-development levels.
- Water balance control for the proposed Airport Road corridor will be achieved through infiltration of vegetative areas within the study limit.
- There are seven low points along the Airport Road corridor within the study limits. Of the seven low points, three occur within urban sections. Ponding depth at all three urban low points is less than 150 mm for the major system event, thereby meeting Region of Peel requirements. Since the depth of flooding for the major storm (100-year) is in the range of 41 mm to 65 mm, the proposed roadway can still be used at a reduced posted speed. There is

no risk of flooding during the 25 mm and 10-year storms and proposed storm sewers have enough capacity to convey the minor flows.

- In accordance with the Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019), climate change considerations have been incorporated into the hydrologic and hydraulic analyses for the Airport Road culverts and storm sewers. The hydraulic capacities of the culverts and storm sewers have been evaluated using future condition flow rates calculated using Region of Peel 2095 IDF curve parameters determined through regression analysis of rainfall data taken from the Ontario Climate Change Data Portal (2065-2095, 90% dataset).
- The results of the 2095 IDF culvert hydraulic assessment indicate that, where road profile allows, proposed culverts have been designed to sufficiently convey external flows across Airport Road under climate change considerations.
- The results of the 2095 IDF storm sewer hydraulic assessment indicate that all storm sewers in the proposed condition have been designed to sufficiently convey minor flows under climate change considerations.

APPENDIX A: KEY PLAN



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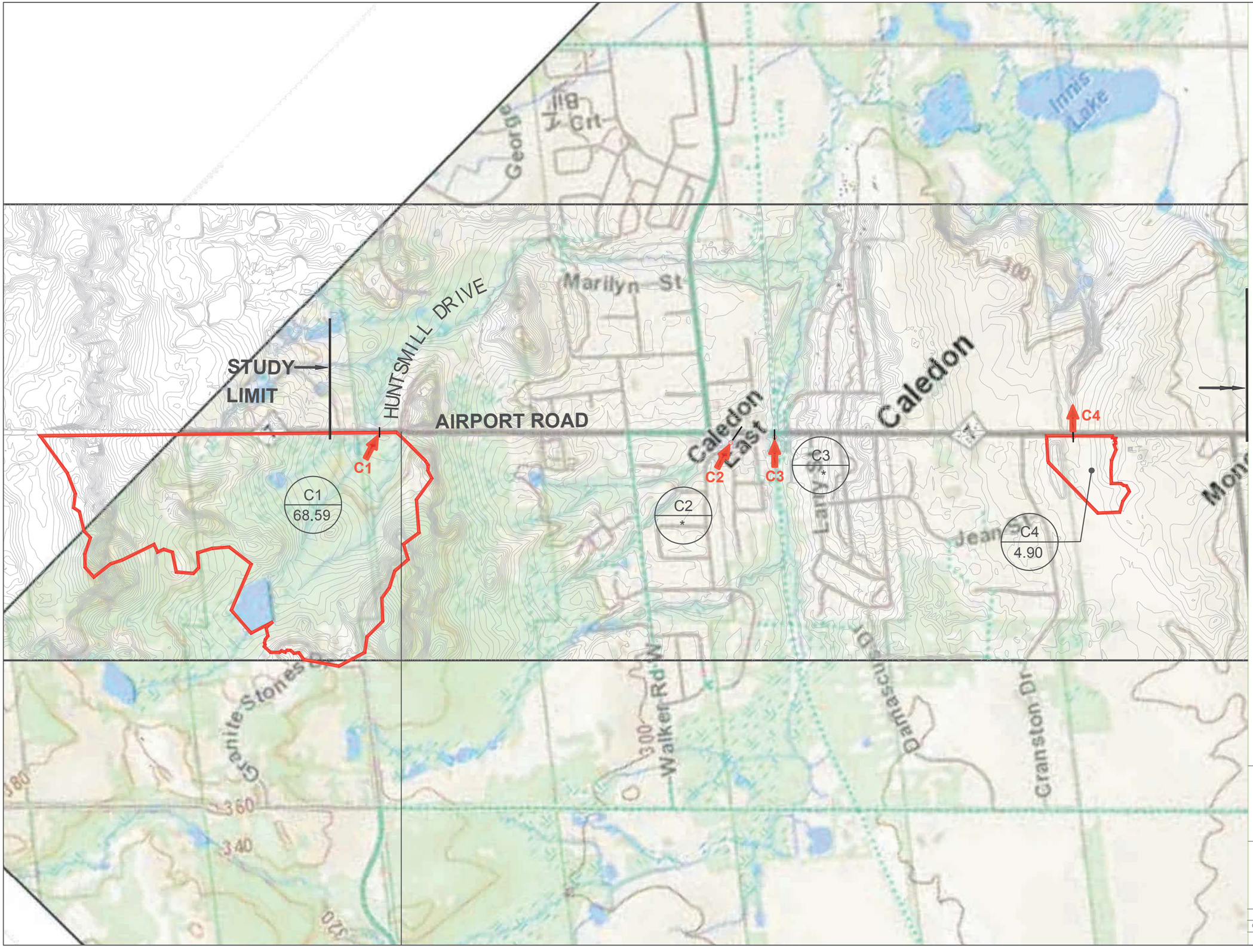
Client	THE REGION OF PEEL
Project	AIRPORT ROAD EA STUDY FROM KING STREET TO HUNTSMILL DRIVE
Drawing Title	KEYPLAN
Project No.	109535
Drawing No.	FIGURE-1

LEGEND

STUDY AREA

C1 WATERCOURSE CROSSING

APPENDIX B: CROSSING LOCATIONS & EXTERNAL DRAINAGE AREAS



LEGEND

EXTERNAL DRAINAGE CATCHMENT BOUNDARY

C1 / 3.88 — WATERCOURSE CROSSING IDENTIFICATION NO. / EXTERNAL AREA TO CROSSING IN HECTARES

NOTES ;

* DRAINAGE AREA N/A FLOW OBTAINED FROM TRCA's HEC–RAS MODEL

SCALE

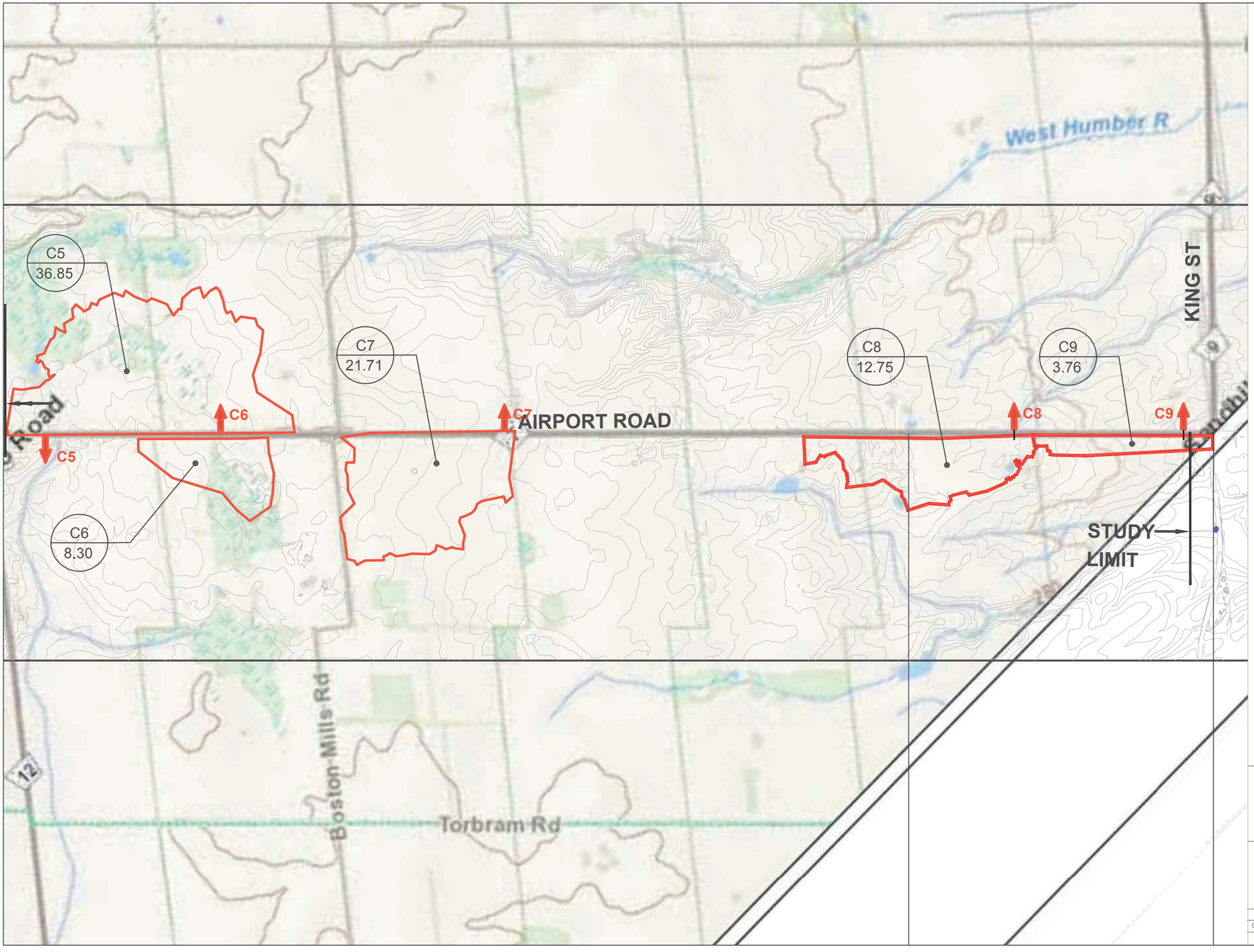
125m 0 125 250 375m SCALE

Region of Peel
Public Works

AIRPORT ROAD EA STUDY

(BETWEEN KING STREET AND HUNTMILL DRIVE)

	AREA	PROJECT NO. 109535
CHECKED BY: RP	DRAWN BY: NC	
Jan. 2018	FIGURE 2	PLAN NO.



LEGEND

EXTERNAL DRAINAGE CATCHMENT BOUNDARY

C1 / 3.88 — WATERCOURSE CROSSING IDENTIFICATION NO. / EXTERNAL AREA TO CROSSING IN HECTARES

NOTES ;

* DRAINAGE AREA N/A FLOW OBTAINED FROM TRCA's HEC–RAS MODEL

SCALE

125m 0 125 250 375m SCALE

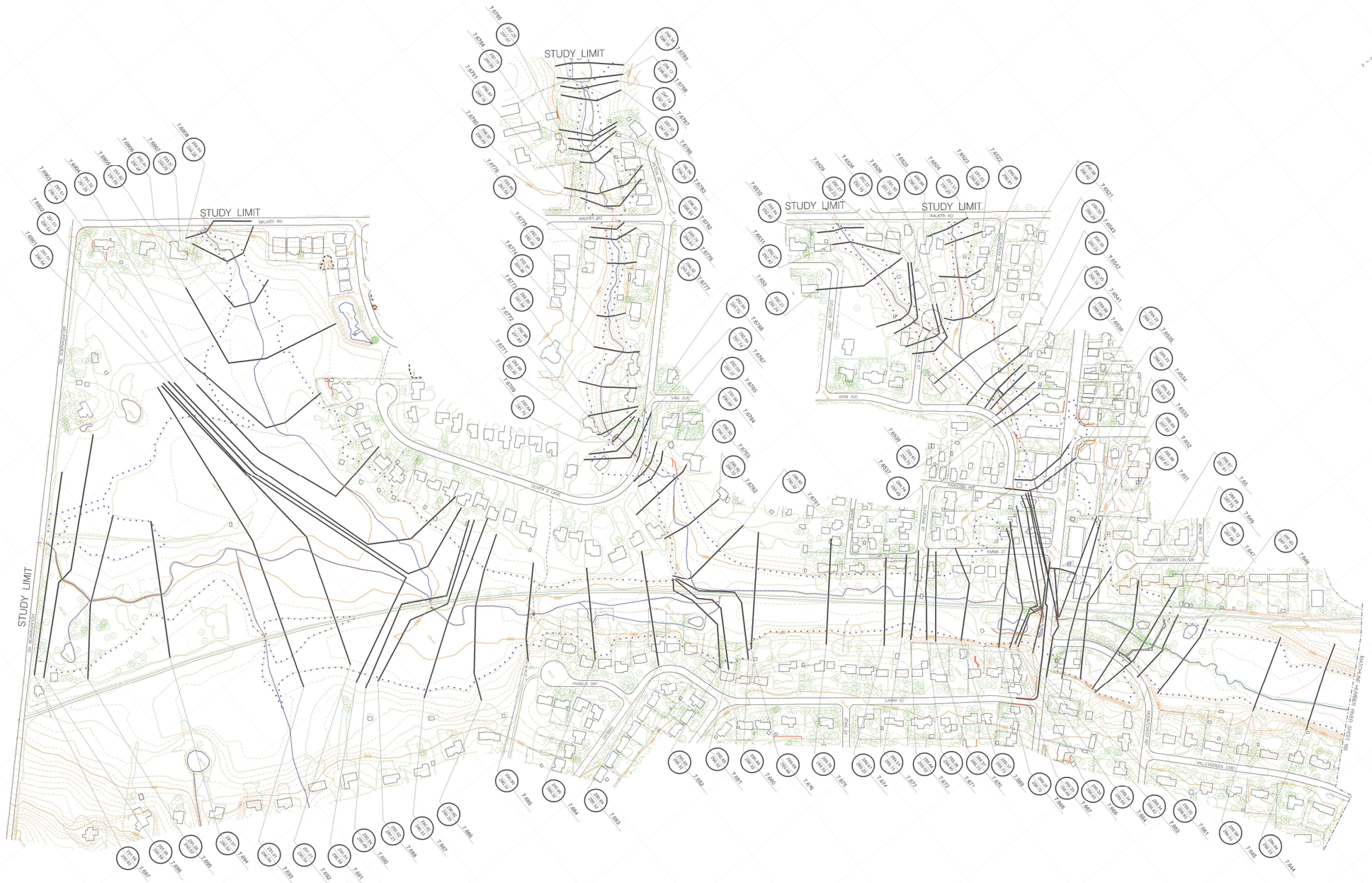
Region of Peel
Public Works

AIRPORT ROAD EA STUDY

(BETWEEN KING STREET AND HUNTMILL DRIVE)

	AREA	PROJECT NO. 109535
CHECKED BY: RP	DRAWN BY: NC	
Jan. 2018	FIGURE 3	PLAN NO.

APPENDIX C: TRCA & CVC FLOODPLAIN MAPPING



REVISIONS

NO.	DESCRIPTION	BY	DATE

LEGEND

Cross-Section Label
Cross-Section Leader Line
Regional Flood Elevation (m)
Cross-Section Number — 14.060 — 172.00 / 172.00
100 Year Existing Flood Elevation (m)
Cross-Section Length
REGULATORY FLOOD ELEVATION IS THE HIGHER OF THE TWO ELEVATIONS DISPLAYED

LEGEND

Contour Index		Trail	
Contour Intermediate		Bridge	
Contour Auxiliary		Wooded Area	
Contour Depression		Tree	
Contour Text	100.20 MAJOR	Hedge	
Spot Height		Fence	
Road		Water Feature	
Parking Lot		Culvert Symbol	
Race Track		Culvert to Scale	
Wall		Dam	
Retaining Wall		Pool	
Rail Line		Building	
Runway		Pit	
Silo, Smoke, Tank		Pile	
Marsh Symbol		Regulatory Flood Line	
Marsh Boundary			
Township Fabric			
Hydro Tower			

This map was compiled photogrammetrically from aerial photography with 15cm ground sample distance flown in December 2009.

The vertical datum is mean sea level as established by the Geographic Survey of Canada, CVGS: 1928:1978.

North American Datum 1983, U.T.M. 6° projection Zone 17, Central Meridian 81° W.

Grid Interval 100 metres.

PLEASE NOTE:
FLOODLINE ELEVATIONS ARE SUBJECT TO CHANGE DUE TO REVISED INFORMATION.

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FAX: (416) 441-1042
Web: www.northway-photomap.com

DATE ISSUED
May 11 2010

PLEASE NOTE:
THE CONTROL LAND SURVEYOR STAMP WRITTEN ONLY THE TOPOGRAPHIC AND PLANIMETRIC DATA AND THE CONTROL DATA UNLESS OTHERWISE NOTED

COLE ENGINEERING
75 VALLEYWOOD DRIVE, MARKHAM, ON L3R 4T5
T 905.307.0161 | 905.940.0161 F 905.940.2664

PLEASE NOTE:
THE PROFESSIONAL ENGINEER'S STAMP WRITTEN THE FLOOD PLAIN MAPPING CONTROL DATA AND THE BENCHMARKS UNLESS OTHERWISE NOTED

C. L. CHOLKAN

FLOOD PLAIN MAPPING PROGRAM

FLOODLINE APPROVED DATE: 2015-09-03

Toronto and Region Conservation for The Living City
5 Shoreham Drive Downsview Ontario M3N 1S4 (416) 661-6600

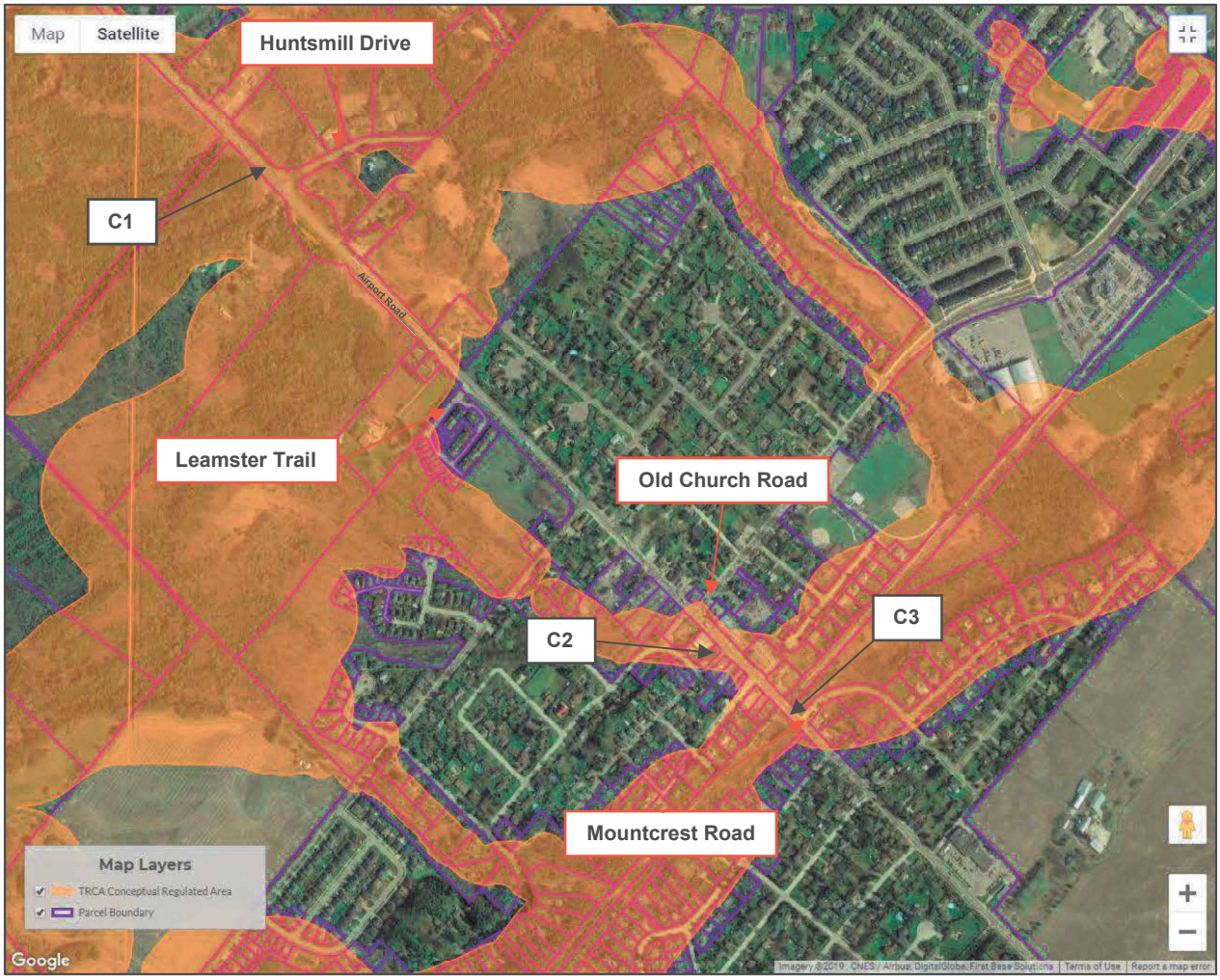
Scale 1:2000

CONTOUR INTERVAL 1.0 METRE

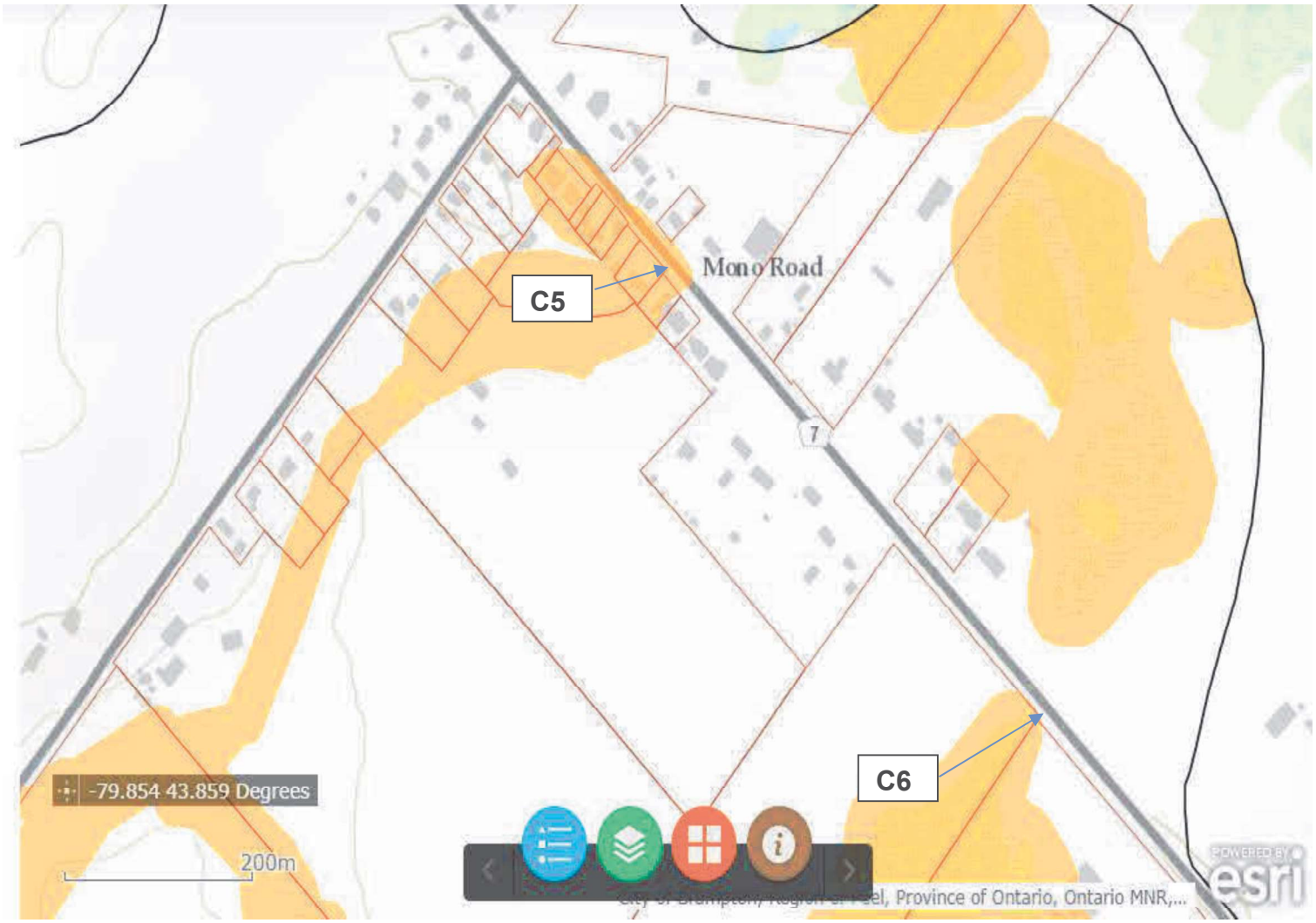
HUMBER RIVER

SHEET No. 161

TRCA Regulation Limits Mapping



CVC Regulation Limits Mapping



APPENDIX D: CCTV INSPECTION RESULTS

17-12 Airport Rd

17-12 Airport Rd

17-12 Airport Rd

17-12 Airport Rd

17-12 Airport Rd

17-12 Airport Rd

17-12 Airport Rd

17-12 Airport Rd

17-12 Old Church Rd

17-12 Old Church Rd

17-12 Old Church Rd

17-12 Airport Rd

AssetID *	AssetType	Street	City	Upstream MH ID	USMH Cover Elevation	US Invert Elevation	Downstream MH ID	DSMH Cover Elevation
SL5827590817	SEWER	Airport Rd	CALEDON	MH8582690813	291.703	289.913	MH8582890822	291.638
SL5826090842	SEWER	Airport Rd	CALEDON	MH8582890822	291.638	289.638	MH8582490863	291.269
SL5822790876	SEWER	Airport Rd	CALEDON	MH8582490863	291.269	289.539	MH8582190890	291.098
SL5819790907	SEWER	Airport Rd	CALEDON	MH8582190890	291.098	289.358	MH8581890923	290.814
SL5816490940	SEWER	Airport Rd	CALEDON	MH8581890923	290.814	289.114	MH8581490957	290.486
SL5813290972	SEWER	Airport Rd	CALEDON	MH8581490957	290.486	288.736	MH8581190987	290.142
SL5809391011	SEWER	Airport Rd	CALEDON	MH8581190987	290.142	288.192	MH8581190987A	<Null>
SL5805891045	SEWER	Airport Rd	CALEDON	MH8580691035	289.645	287.855	MH8580491056	289.291
SL5802791078	SEWER	Airport Rd	CALEDON	MH8580491056	289.291	287.501	MH8580091100	288.377
SL5798391122	SEWER	Airport Rd	CALEDON	MH8580091100	288.377	286.977	MH8579691144	288.203
SL5790991196	SEWER	Airport Rd	CALEDON	MH8579191191	288.175	286.875	MH8579091201	288.509
SL5790491204	SEWER	Airport Rd	CALEDON	MH8579091201	288.509	286.819	CB5790591208	287.666
SL5793891168	SEWER	Airport Rd	CALEDON	MH8579691144	288.203	286.933	MH8579191191	288.175
SL5788491219	SEWER	Airport Rd	CALEDON	MH8578791229	289.056	286.956	MH8578991210	288.633
SL5789791212	SEWER	Airport Rd	CALEDON	MH8578991210	288.633	286.933	CB5790191215	288.752
SL5786891237	SEWER	Airport Rd	CALEDON	MH8578691245	289.747	288.047	MH8578791229	289.056
SL5789091206	SEWER	Airport Rd	CALEDON	MH8578891203	288.713	287.253	MH8578991210	288.633
SL5784091265	SEWER	Airport Rd	CALEDON	MH8578191286	292.401	290.131	MH8578691245	289.747
SL5773791368	SEWER	Airport Rd	CALEDON	MH8577191388	302.793	300.613	MH8577591348	298.37
SL5770491402	SEWER	Airport Rd	CALEDON	MH8576991416	305.19	303.15	MH8577191388	302.793
SL5776191334	SEWER	Airport Rd	CALEDON	MH8577491354	299.439	294.959	MH8577791314A	<Null>
SL5779891297	SEWER	Airport Rd	CALEDON	MH8577791314	295.5	293.66	MH8577791314A	<Null>
SL5784491253	SEWER	Airport Rd	CALEDON	MH8578191281	292.368	287.768	MH8578791226	289.056
SL5787391227	SEWER	Airport Rd	CALEDON	MH8578791226	289.056	287.146	MH8578791229	289.056
SL5826990836	SEWER	Airport Rd	CALEDON	MH8582790837	291.594	290.234	CB5826890835	<Null>
SL5799091068	SEWER	Airport Rd	CALEDON	CB5798891062	288.823	287.823	MH8579991075	288.839
SL5799491080	SEWER	Airport Rd	CALEDON	MH8579991075	288.839	287.439	MH8579991085	288.56

AssetID *	DS Invert Elevation	SewerUse	Direction	FlowControl	Height	Width	PipeShape	Material	TotalLength	Release2017
SL5827590817	289.768	STM	DOWN	<Null>	450	<Null>	CIRCULAR	CP	14.41	64
SL5826090842	289.539	STM	DOWN	<Null>	525	<Null>	CIRCULAR	CP	57.49	64
SL5822790876	289.358	STM	DOWN	<Null>	600	<Null>	CIRCULAR	CP	38.74	64
SL5819790907	289.114	STM	DOWN	<Null>	600	<Null>	CIRCULAR	CP	46.33	64
SL5816490940	288.736	STM	DOWN	<Null>	600	<Null>	CIRCULAR	CP	47.26	64
SL5813290972	288.192	STM	DOWN	<Null>	600	<Null>	CIRCULAR	CP	42.17	64
SL5809391011	<Null>	STM	DOWN	<Null>	600	<Null>	CIRCULAR	CP	44.23	64
SL5805891045	287.501	STM	DOWN	<Null>	900	<Null>	CIRCULAR	CP	28.93	64
SL5802791078	286.977	STM	DOWN	<Null>	900	<Null>	CIRCULAR	CP	61.17	64
SL5798391122	286.933	STM	DOWN	<Null>	1050	1720	OVAL	CP	63.49	64
SL5790991196	286.819	STM	DOWN	<Null>	1050	1720	OVAL	CP	14.66	64
SL5790491204	285.976	STM	DOWN	<Null>	1050	1720	OVAL	CP	7.87	64
SL5793891168	286.875	STM	DOWN	<Null>	1050	1720	OVAL	CP	65.58	64
SL5788491219	286.933	STM	DOWN	<Null>	825	<Null>	CIRCULAR	CP	25.14	64
SL5789791212	286.752	STM	DOWN	<Null>	825	<Null>	CIRCULAR	CP	9.46	64
SL5786891237	286.956	STM	DOWN	<Null>	450	<Null>	CIRCULAR	CP	22.66	64
SL5789091206	286.933	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	8.44	64
SL5784091265	288.047	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	57.75	64
SL5773791368	296	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	55.98	64
SL5770491402	300.613	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	38.91	64
SL5776191334	<Null>	STM	DOWN	<Null>	525	<Null>	CIRCULAR	CP	71.16	64
SL5779891297	<Null>	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	18.28	64
SL5784491253	287.146	STM	DOWN	<Null>	750	<Null>	CIRCULAR	CP	76.99	64
SL5787391227	286.956	STM	DOWN	<Null>	750	<Null>	CIRCULAR	CP	6.57	64
SL5826990836	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	CP	3.99	64
SL5799091068	287.439	STM	DOWN	<Null>	525	<Null>	CIRCULAR	CMP	13.54	64
SL5799491080	287.22	STM	DOWN	<Null>	600	965	OVAL	CP	11.30	64

AssetID *	CleanupRelease2017	Condition Score	A.E Comment
SL5827590817	23	2	Longitudinal cracks in wall. Minor settled debris (5-10%).
SL5826090842	23	3	Pipe is slightly broken at 11.8m from USMH.Moderate settled debris (15-20%).
SL5822790876	23	3	Longitudinal cracks in wall. Moderate settled debris (15-20%).
SL5819790907	23	2	Longitudinal cracks in wall. Minor settled debris (5-10%).
SL5816490940	23	2	Intruding sealing ring material. Minor settled debris (5-10%).
SL5813290972	23	2	Intruding sealing ring material near connection. Minor settled debris (5-10%).
SL5809391011	23	2	Minor settled debris (5-10%).
SL5805891045	23	2	Longitudinal cracks in wall. Minor settled debris (5-10%).
SL5802791078	23	4	Multiple cracks in pipe. Heavy settled debris (25-30%).Highwater level near DSMH.
SL5798391122	23	11	SA-High Water Level in Sewer due to Direct Connection to Pond/Outfalls
SL5790991196	23	11	SA-High Water Level in Sewer due to Direct Connection to Pond/Outfalls
SL5790491204	23	11	SA-High Water Level in Sewer due to Direct Connection to Pond/Outfalls
SL5793891168	23	11	SA-High Water Level in Sewer due to Direct Connection to Pond/Outfalls
SL5788491219	23	8	SA-Obstructions
SL5789791212	23	8	SA-Obstructions
SL5786891237	23	4	Heavy settled debris, wood logs near DSMH.
SL5789091206	23	8	SA-Obstructions. Heavy debris
SL5784091265	23	3	Large joint offsetat 16.1m from DSMH.
SL5773791368	23	3	Multiple fractures and cracks in pipe.
SL5770491402	23	2	Longitudinal cracks in wall.
SL5776191334	23	1	Pipe is in good condition. Release 82
SL5779891297	23	3	Defromation in PVC portion of the pipe.
SL5784491253	23	2	Longitudinal cracks in wall.
SL5787391227	23	2	Minor settled debris (5-10%).
SL5826990836	23	2	Minor settled debris (5-10%).
SL5799091068	23	3	Surface corrosion throughout CMP. Moderate settled debris (15-20%).
SL5799491080	23	2	Minor settled debris (5-10%).

AssetID *	AssetType	Street	City	Upstream MH ID	USMH Cover Elevation	US Invert Elevation	Downstream MH ID	DSMH Cover Elevation
SL5800191092	SEWER	Airport Rd	CALEDON	MH8579991085	288.56	287.22	MH8580091100	288.377
SL5777791328	SEWER	Airport Rd	CALEDON	MH8577591348	298.37	296	MH8577991307	294.318
SL5780891296	SEWER	Airport Rd	CALEDON	MH8577991307	294.318	291.948	MH8578191286	292.401
SL5767391429	SEWER	Airport Rd	CALEDON	MH8576591443	307.353	303.623	MH8577091391	305.275
SL5767191435	SEWER	Airport Rd	CALEDON	MH8576591454	307.75	305.55	MH8576991416	305.19
SL5763491472	SEWER	Airport Rd	CALEDON	MH8576191490	309.107	306.857	MH8576591454	307.75
SL5771291390	SEWER	Airport Rd	CALEDON	MH8577091391	305.275	303.275	MH8576991416	305.19
SL5676892314	SEWER	Airport Rd	CALEDON	MH5676292312	298.476	<Null>	MH5677592316	298.664
SL5678192322	SEWER	Airport Rd	CALEDON	MH5677592316	298.664	<Null>	CB5678692327	297.625
SL5677992313	SEWER	Airport Rd	CALEDON	CB5678392309	297.509	297.209	MH5677592316	298.664
SL5809391011-1	SEWER	Airport Rd	CALEDON	MH8581190987A	<Null>	<Null>	MH8580691035	289.645
SL5779891297-1	SEWER	Airport Rd	CALEDON	MH8577791314A	<Null>	<Null>	MH8578191281	292.368
CL5817890916	LEAD	Airport Rd	CALEDON	CB5817690910	290.839	289.809	MH8581890923	290.814
CL5814390952	LEAD	Airport Rd	CALEDON	CB5813990947	290.617	289.377	MH8581490957	290.486
CL5811390982	LEAD	Airport Rd	CALEDON	CB5810990978	290.162	289.232	MH8581190987	290.142
CL5804591051	LEAD	Airport Rd	CALEDON	CB5804191046	289.192	288.022	MH8580491056	289.291
CL5808191014	LEAD	Airport Rd	CALEDON	CB5807791009	289.666	288.426	MH8581190987A	<Null>
CL5808891016	LEAD	Airport Rd	CALEDON	CB5808991017	289.838	288.618	CN5808891016	<Null>
CL5828290823	LEAD	Airport Rd	CALEDON	CB5828390825	290.902	289.702	MH8582890822	291.638
CL5827990833	LEAD	Airport Rd	CALEDON	CB5828390831	291.529	290.409	CB5827590836	291.506
CL5827390836	LEAD	Airport Rd	CALEDON	CB5827590836	291.506	290.236	MH8582790837	291.594
CL5826090826	LEAD	Airport Rd	CALEDON	CB5825190819	291.561	290.361	CN5826990833	<Null>
CL5823790858	LEAD	Airport Rd	CALEDON	CB5823390853	291.2	290.13	MH8582490863	291.269
CL5820990886	LEAD	Airport Rd	CALEDON	CB5820490882	290.951	289.951	MH8582190890	291.098
CL5805391052	LEAD	Airport Rd	CALEDON	CB5805391052	289.295	288.195	CN5805291052	<Null>
CL5801291084	LEAD	Airport Rd	CALEDON	CB5800891079	288.538	287.468	CN5801791088	<Null>

AssetID *	DS Invert Elevation	SewerUse	Direction	FlowControl	Height	Width	PipeShape	Material	TotalLength	Release2017
SL5800191092	286.977	STM	DOWN	<Null>	600	965	OVAL	CP	16.95	64
SL5777791328	291.948	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	57.90	64
SL5780891296	290.131	STM	DOWN	<Null>	450	<Null>	CIRCULAR	CP	30.46	64
SL5767391429	303.31	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	43.21	64
SL5767191435	303.15	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	55.03	64
SL5763491472	305.55	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	50.66	64
SL5771291390	303.15	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	6.23	64
SL5676892314	<Null>	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	14.65	64
SL5678192322	297.325	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CMP	15.07	64
SL5677992313	<Null>	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CMP	10.93	64
SL5809391011-1	287.855	STM	DOWN	<Null>	600	<Null>	CIRCULAR	CP	24.81	64
SL5779891297-1	287.768	STM	DOWN	<Null>	525	<Null>	CIRCULAR	CP	32.48	64
CL5817890916	289.114	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	14.14	64
CL5814390952	288.736	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	12.62	64
CL5811390982	288.192	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	12.48	64
CL5804591051	287.501	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	12.59	64
CL5808191014	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	11.76	64
CL5808891016	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	1.44	64
CL5828290823	289.738	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	4.56	64
CL5827990833	290.236	STM	DOWN	<Null>	200	<Null>	CIRCULAR	CMP	9.06	64
CL5827390836	290.234	STM	DOWN	<Null>	200	<Null>	CIRCULAR	CP	4.45	64
CL5826090826	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	23.43	64
CL5823790858	289.539	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	12.35	64
CL5820990886	289.358	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	12.29	64
CL5805391052	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	1.26	64
CL5801291084	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	12.50	64

AssetID *	CleanupRelease2017	Condition Score	A.E Comment
SL5800191092	23	4	Heavy settled debris (25-30%).Highwater level near DSMH.
SL5777791328	23	3	Fractures in pipe.
SL5780891296	23	4	Possible crossbore at 12.7m with hole in invert.
SL5767391429	23	1	<Null>
SL5767191435	23	3	Fractures in pipe.
SL5763491472	23	3	Fractures in pipe.
SL5771291390	23	1	Pipe is in good condition.
SL5676892314	<Null>	7	SA-High Water Level in MH
SL5678192322	<Null>	7	SA-High Water Level in USMH. DS Outfall Not found
SL5677992313	<Null>	7	SA-High Water Level in MH.
SL5809391011-1	23	3	Multiple offset joints near DSMH. Minor settled debris (5-10%).
SL5779891297-1	23	9	SA-MH Inaccessible. USMH Not Found, paved over. DSMH is a drop pipe unable for crawler to get in.
CL5817890916	<Null>	1	Pipe is in good condition.
CL5814390952	<Null>	1	Pipe is in good condition.
CL5811390982	<Null>	1	Pipe is in good condition.
CL5804591051	<Null>	3	Moderate settled debris (15-20%).
CL5808191014	<Null>	1	Pipe is in good condition.
CL5808891016	<Null>	1	Pipe is in good condition.
CL5828290823	<Null>	2	Minor settled debris (5-10%).
CL5827990833	<Null>	3	Moderate settled debris (15-20%).
CL5827390836	<Null>	4	Surface corrosion in pipe. Moderate settled debris (15-20%).
CL5826090826	<Null>	2	Minor settled debris (5-10%).
CL5823790858	<Null>	2	Minor settled debris (5-10%).
CL5820990886	<Null>	1	Pipe is in good condition.
CL5805391052	<Null>	1	Pipe is in good condition.
CL5801291084	<Null>	7	SA-Debris

AssetID *	AssetType	Street	City	Upstream MH ID	USMH Cover Elevation	US Invert Elevation	Downstream MH ID	DSMH Cover Elevation
CL5796991128	LEAD	Airport Rd	CALEDON	CB5796591123	288.19	287.29	CN5797391132	<Null>
CL5797591131	LEAD	Airport Rd	CALEDON	CB5797591131	288.089	287.219	CN5797591131	<Null>
CL5796991140	LEAD	Airport Rd	CALEDON	CB5797091141	288.216	287.326	CN5796791138	<Null>
CL5795791136	LEAD	Airport Rd	CALEDON	CB5795091130	288.27	287.16	CN5796391142	<Null>
CL5794791133	LEAD	Airport Rd	CALEDON	CB5794391136	288.215	287.115	CB5795091130	288.27
CL5795091159	LEAD	Airport Rd	CALEDON	CB5795191160	288.089	287.319	CB5794991157	288.04
CL5794991157	LEAD	Airport Rd	CALEDON	CB5794991157	288.04	286.99	CN5794991157	<Null>
CL5794091157	LEAD	Airport Rd	CALEDON	CB5793691152	288.156	287.056	CN5794491161	<Null>
CL5792591181	LEAD	Airport Rd	CALEDON	CB5792691181	288.04	287.09	CN5792591180	<Null>
CL5792191176	LEAD	Airport Rd	CALEDON	CB5791691171	288.005	286.965	CN5792591180	<Null>
CL5788791203	LEAD	Airport Rd	CALEDON	CB5788791204	288.707	287.697	MH8578891203	288.713
CL5786591242	LEAD	Airport Rd	CALEDON	CB5786691243	289.649	288.549	CN5786491241	<Null>
CL5786191246	LEAD	Airport Rd	CALEDON	CB5786291247	289.743	288.223	MH8578691245	289.747
CL5784891246	LEAD	Airport Rd	CALEDON	CB5784791245	290.131	289.031	CN5785091247	<Null>
CL5782091285	LEAD	Airport Rd	CALEDON	CB5782091284	292.335	291.475	MH8578191286	292.401
CL5775891347	LEAD	Airport Rd	CALEDON	CB5775991346	298.191	297.361	MH8577591348	298.37
CL5777891314	LEAD	Airport Rd	CALEDON	CB5777791315	295.659	294.569	MH8577791314	295.5
CL5769091415	LEAD	Airport Rd	CALEDON	CB5769091415	305.135	304.275	MH8576991416	305.19
CL5768491414	LEAD	Airport Rd	CALEDON	CB5768191410	305.275	303.645	MH8577091391	305.275
CL5770791392	LEAD	Airport Rd	CALEDON	CB5770491389	303.345	302.265	CN5768491414	<Null>
CL5773791362	LEAD	Airport Rd	CALEDON	CB5773491359	299.954	298.854	CN5774191365	<Null>
CL5799891098	LEAD	Airport Rd	CALEDON	CB5799491093	288.44	287.41	CN5800291103	<Null>
CL5824390861	LEAD	Airport Rd	CALEDON	CB5824390862	291.218	290.018	CN5824290861	<Null>
CL5821590888	LEAD	Airport Rd	CALEDON	CB5821690889	291.045	289.905	CN5821590888	<Null>
CL5817990925	LEAD	Airport Rd	CALEDON	CB5817990925	290.722	289.632	CN5817990925	<Null>

AssetID *	DS Invert Elevation	SewerUse	Direction	FlowControl	Height	Width	PipeShape	Material	TotalLength	Release2017
CL5796991128	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	12.64	64
CL5797591131	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	0.80	64
CL5796991140	<Null>	STM	DOWN	<Null>	100	<Null>	CIRCULAR	PVC	4.29	64
CL5795791136	<Null>	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	17.97	64
CL5794791133	287.16	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	9.45	64
CL5795091159	286.99	STM	DOWN	<Null>	200	<Null>	CIRCULAR	CP	3.35	64
CL5794991157	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	0.84	64
CL5794091157	<Null>	STM	DOWN	<Null>	100	<Null>	CIRCULAR	PVC	12.59	64
CL5792591181	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	1.04	64
CL5792191176	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	12.47	64
CL5788791203	287.253	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	2.39	64
CL5786591242	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	2.77	64
CL5786191246	288.047	STM	DOWN	<Null>	200	<Null>	CIRCULAR	CP	3.03	64
CL5784891246	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	3.76	64
CL5782091285	290.131	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	1.89	64
CL5775891347	296	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	2.53	64
CL5777891314	293.66	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	1.42	64
CL5769091415	303.15	STM	DOWN	<Null>	200	<Null>	CIRCULAR	CP	1.09	64
CL5768491414	303.275	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	4.70	64
CL5770791392	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	9.22	64
CL5773791362	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	8.52	64
CL5799891098	<Null>	STM	DOWN	<Null>	100	<Null>	CIRCULAR	PVC	12.65	64
CL5824390861	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	1.04	64
CL5821590888	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	0.84	64
CL5817990925	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	0.79	64

AssetID *	CleanupRelease2017	Condition Score	A.E Comment
CL5796991128	<Null>	3	Moderate settled debris (15-20%).
CL5797591131	<Null>	1	Pipe is in good condition.
CL5796991140	<Null>	7	SA-Debris
CL5795791136	<Null>	7	SA-Debris
CL5794791133	<Null>	3	Moderate settled debris (15-20%).
CL5795091159	<Null>	8	SA-High Water Level in MH due to highwater level in downstream pipe
CL5794991157	<Null>	1	Pipe is in good condition.
CL5794091157	<Null>	7	SA-High Water Level in MH
CL5792591181	<Null>	1	Pipe is in good condition.
CL5792191176	<Null>	7	SA-High Water Level in MH
CL5788791203	<Null>	2	Longitudinal cracks in wall.
CL5786591242	<Null>	7	SA-Debris
CL5786191246	<Null>	1	Pipe is in good condition.
CL5784891246	<Null>	4	Medium joint offset, multiple longitudinal cracks in wall throughout the pipe. Obstrction (wood) in sewer 1.98 m from upstream MH. Moderate settled debris (15-20%).
CL5782091285	<Null>	5	Significant settled debris (>30%).
CL5775891347	<Null>	3	Moderate settled debris (15-20%).
CL5777891314	<Null>	5	Significant settled debris (>30%).
CL5769091415	<Null>	1	Pipe is in good condition.
CL5768491414	<Null>	3	Moderate settled debris (15-20%).
CL5770791392	<Null>	1	Pipe is in good condition.
CL5773791362	<Null>	1	Pipe is in good condition.
CL5799891098	<Null>	3	Moderate settled debris (15-20%).
CL5824390861	<Null>	1	Pipe is in good condition.
CL5821590888	<Null>	1	Pipe is in good condition.
CL5817990925	<Null>	1	Pipe is in good condition.

AssetID *	AssetType	Street	City	Upstream MH ID	USMH Cover Elevation	US Invert Elevation	Downstream MH ID	DSMH Cover Elevation
CL5814490960	LEAD	Airport Rd	CALEDON	CB5814490961	290.378	289.168	CN5814490960	<Null>
CL5811490990	LEAD	Airport Rd	CALEDON	CB5811590990	290.109	288.999	CN5811490990	<Null>
CL5801191095	LEAD	Airport Rd	CALEDON	CB5801191095	288.402	287.772	CN5801091095	<Null>
CL5780691288	LEAD	Airport Rd	CALEDON	CB5780591287	292.867	291.747	CN5780791289	<Null>
CL5771791388	LEAD	Airport Rd	CALEDON	CB5771791387	302.579	301.799	MH8577191388	302.793
CL5761291486	LEAD	Airport Rd	CALEDON	CB5760891482	305.275	303.985	MH8576191490	309.107
CL5676392340	LEAD	Olde Base Line Rd	CALEDON	CB5675792335	298.485	297.715	CN5676992345	<Null>
CL5675392312	LEAD	Olde Base Line Rd	CALEDON	CB5674592313	298.749	297.449	MH5676292312	298.476
CL5676092315	LEAD	Olde Base Line Rd	CALEDON	CB5675892318	298.429	<Null>	MH5676292312	298.476
CL5813991085	LEAD	Old Church Rd	CALEDON	CB5814291081	291.858	290.688	MH5813591088	291.916
CL5813491090	LEAD	Old Church Rd	CALEDON	CB5813491091	291.812	291.362	MH5813591088	291.916
CL5808691043	LEAD	Old Church Rd	CALEDON	CB5808991039	289.643	288.693	MH8580891046	289.832
CL5808391049	LEAD	Old Church Rd	CALEDON	CB5808291050	289.644	289.094	CN5808491048	<Null>
CL5817091110	LEAD	Old Church Rd	CALEDON	CB5817391107	292.983	291.803	CN5816791114	<Null>
CL5818391122	LEAD	Old Church Rd	CALEDON	CB5818591119	293.199	292.029	CN5818091125	<Null>
CL5821191144	LEAD	Old Church Rd	CALEDON	CB5821391141	293.488	292.248	CB5820891147	293.448
CL5829491216	LEAD	Old Church Rd	CALEDON	CB5829591215	293.979	293.079	CN5829491217	<Null>
CL5835791268	LEAD	Old Church Rd	CALEDON	CB5835691269	294.645	293.245	CN5835891267	<Null>
CL5840991286	LEAD	Old Church Rd	CALEDON	CB5840591280	294.751	293.531	MH5841391291	294.655
CL5840791297	LEAD	Old Church Rd	CALEDON	MH5841391291	294.655	292.905	MH5840291302	294.846
CL5841291304	LEAD	Old Church Rd	CALEDON	CB5841491301	294.845	293.595	CN5840991308	<Null>
CL5848091359	LEAD	Old Church Rd	CALEDON	CB5848391355	293.395	292.135	CN5847891362	<Null>
CL5846091347	LEAD	Old Church Rd	CALEDON	CB5846091347	293.997	292.697	CN5845991348	<Null>
CL5837291273	LEAD	Old Church Rd	CALEDON	CB5837591269	294.593	293.193	CN5836991276	<Null>
CL5829891214	LEAD	Old Church Rd	CALEDON	CB5830191210	294.014	292.814	CN5829591217	<Null>
SL5807591040	SEWER	Old Church Rd	CALEDON	MH8580891046	289.832	288.212	MH8580691035	289.645

AssetID *	DS Invert Elevation	SewerUse	Direction	FlowControl	Height	Width	PipeShape	Material	TotalLength	Release2017
CL5814490960	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	0.75	64
CL5811490990	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	0.83	64
CL5801191095	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	CP	0.93	64
CL5780691288	<Null>	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	3.28	64
CL5771791388	300.613	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	0.94	64
CL5761291486	306.857	STM	DOWN	<Null>	200	<Null>	CIRCULAR	PVC	11.48	64
CL5676392340	<Null>	STM	DOWN	<Null>	375	<Null>	CIRCULAR	CP	16.19	64
CL5675392312	<Null>	STM	DOWN	<Null>	250	<Null>	CIRCULAR	CP	16.31	64
CL5676092315	<Null>	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	7.74	64
CL5813991085	289.616	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	9.1	64
CL5813491090	289.616	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	3.5	64
CL5808691043		STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	10.5	64
CL5808391049	<Null>	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	2.8	64
CL5817091110	<Null>	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	9.5	64
CL5818391122	<Null>	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	7.6	64
CL5821191144	292.148	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	7.4	64
CL5829491216	<Null>	STM	DOWN	<Null>	250	<Null>	CIRCULAR	CP	1.6	64
CL5835791268	<Null>	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	2.3	64
CL5840991286	292.905	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	13.4	64
CL5840791297	291.446	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	15.4	64
CL5841291304	<Null>	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	8.9	64
CL5848091359	<Null>	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	8.9	64
CL5846091347	<Null>	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	1.5	64
CL5837291273	<Null>	STM	DOWN	<Null>	250	<Null>	CIRCULAR	PVC	9.1	<Null>
CL5829891214	<Null>	STM	DOWN	<Null>	250	<Null>	CIRCULAR	PVC	9.2	<Null>
SL5807591040	287.855	STM	DOWN	<Null>	450	<Null>	CIRCULAR	CP	17.7	64

AssetID *	CleanupRelease2017	Condition Score	A.E Comment
CL5814490960	<Null>	1	Pipe is in good condition.
CL5811490990	<Null>	1	Pipe is in good condition.
CL5801191095	<Null>	1	Pipe is in good condition.
CL5780691288	<Null>	1	Pipe is in good condition.
CL5771791388	<Null>	2	Longitudinal cracks in wall.
CL5761291486	<Null>	3	Medium joint offset, multiple longitudinal cracks in wall throughout the pipe.
CL5676392340	<Null>	5	Crossbore in pipe at 2.5m from USMH.
CL5675392312	<Null>	7	SA-High Water Level in MH
CL5676092315	<Null>	7	SA-High Water Level in MH
CL5813991085	<Null>	1	Pipe is in good condition.
CL5813491090	<Null>	1	Pipe is in good condition.
CL5808691043	<Null>	1	Pipe is in good condition.
CL5808391049	<Null>	1	Pipe is in good condition.
CL5817091110	<Null>	1	Pipe is in good condition.
CL5818391122	<Null>	1	Pipe is in good condition.
CL5821191144	<Null>	4	Large Joint Offset at 3.44 m from downstream MH. High water level in pipe.
CL5829491216	<Null>	1	Pipe is in good condition.
CL5835791268	<Null>	1	Pipe is in good condition.
CL5840991286	<Null>	3	Multiple longitudinal cracks in wall throughout the pipe.
CL5840791297	<Null>	4	Pipe is broken 3.58 m from upstream MH, multiple longitudinal cracks in wall. Minor settled debris (5-10%).
CL5841291304	<Null>	1	Pipe is in good condition.
CL5848091359	<Null>	1	Pipe is in good condition.
CL5846091347	<Null>	1	Pipe is in good condition.
CL5837291273	<Null>	<Null>	Not surveyed due to previous construction in the area
CL5829891214	<Null>	<Null>	Not surveyed due to previous construction in the area
SL5807591040	23	1	Pipe is in good condition.

AssetID *	AssetType	Street	City	Upstream MH ID	USMH Cover Elevation	US Invert Elevation	Downstream MH ID	DSMH Cover Elevation
SL5810991067	SEWER	Old Church Rd	CALEDON	MH5813591088	291.916	289.616	MH8580891046	289.832
SL5815391102	SEWER	Old Church Rd	CALEDON	MH5817191117	293.037	290.137	MH5813591088	291.916
SL5818491127	SEWER	Old Church Rd	CALEDON	MH5819791138	293.543	290.743	MH5817191117	293.037
SL5820291142	SEWER	Old Church Rd	CALEDON	CB5820891147	293.448	292.148	MH5819791138	293.543
SL5831691235	SEWER	Old Church Rd	CALEDON	MH5828991213	294.061	292.111	MH5834491256	294.56
SL5837391279	SEWER	Old Church Rd	CALEDON	MH5834491256	294.56	291.86	MH5840291302	294.846
SL5843991332	SEWER	Old Church Rd	CALEDON	MH5840291302	294.846	291.446	MH5847691361	293.515
SL5848391366	SEWER	Old Church Rd	CALEDON	MH5847691361	293.515	290.715	MH5849091371	293.182

AssetID *	DS Invert Elevation	SewerUse	Direction	FlowControl	Height	Width	PipeShape	Material	TotalLength	Release2017
SL5810991067	288.212	STM	DOWN	<Null>	375	<Null>	CIRCULAR	CP	68.2	64
SL5815391102	289.616	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	45.5	64
SL5818491127	290.137	STM	DOWN	<Null>	300	<Null>	CIRCULAR	CP	33.3	64
SL5820291142	290.743	STM	DOWN	<Null>	300	<Null>	CIRCULAR	PVC	14.7	64
SL5831691235	291.86	STM	DOWN	<Null>	600	<Null>	CIRCULAR	CP	69.9	64
SL5837391279	291.446	STM	DOWN	<Null>	675	<Null>	CIRCULAR	CP	74.1	64
SL5843991332	290.715	STM	DOWN	<Null>	675	<Null>	CIRCULAR	CP	94.7	64
SL5848391366	290.182	STM	DOWN	<Null>	675	<Null>	CIRCULAR	CP	16.7	64

AssetID *	CleanupRelease2017	Condition Score	A.E Comment
SL5810991067	23	3	Longitudinal cracks in wall. Moderate settled debris (15-20%).
SL5815391102	23	2	Longitudinal cracks in wall. Minor settled debris (5-10%).
SL5818491127	23	2	Longitudinal cracks in wall.
SL5820291142	23	1	Pipe is in good condition.
SL5831691235	23	3	Moderate settled debris (15-20%).
SL5837391279	23	3	Longitudinal cracks in wall.Moderate settled debris (15-20%).
SL5843991332	23	2	Longitudinal cracks in wall.Minor settled debris (5-10%).
SL5848391366	23	2	Longitudinal cracks in wall.

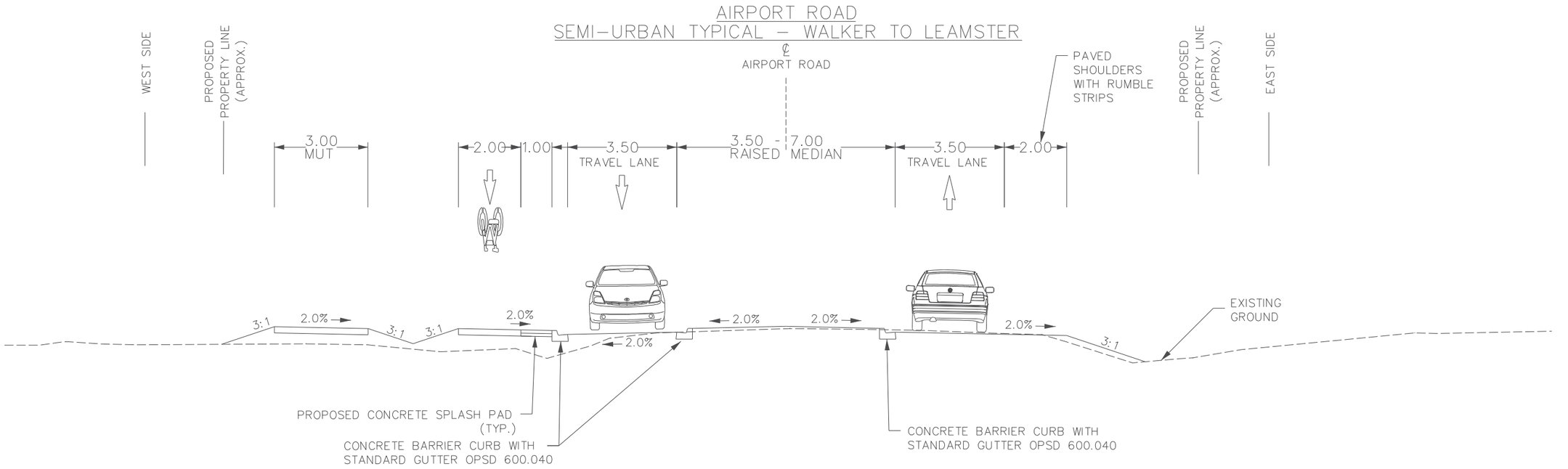
						Outgoing Pipe's Information				
Manhole ID	AssetType	Cover Elevation	InvertElev	RimInvert	GISComment	Material	Diameter1	ClockPosition	Direction	PipeShape
CB5798891062	DI	288.823	287.823	1	<Null>	CMP	525	6	OUT	CIRCULAR
CB5825190819	CB	291.561	290.361	1.2	<Null>	PVC	200	6	OUT	CIRCULAR
CB5771791387	CB	302.579	301.799	0.78	<Null>	CP	300	6	OUT	CIRCULAR
CB5777791315	CB	295.659	294.569	1.09	<Null>	PVC	200	6	OUT	CIRCULAR
CB5801191095	CB	288.402	287.772	0.63	<Null>	CP	200	6	OUT	CIRCULAR
CB5792691181	DCB	288.04	287.09	0.95	<Null>	PVC	200	6	OUT	CIRCULAR
CB5786291247	DCB	289.743	288.223	1.52	<Null>	CP	200	6	OUT	CIRCULAR
CB5795191160	CB	288.089	287.319	0.77	<Null>	CP	200	6	OUT	CIRCULAR
CB5775991346	CB	298.191	297.361	0.83	<Null>	PVC	200	6	OUT	CIRCULAR
CB5782091284	CB	292.335	291.475	0.86	<Null>	PVC	200	6	OUT	CIRCULAR
CB5786691243	DCB	289.649	288.549	1.1	<Null>	PVC	200	6	OUT	CIRCULAR
CB5794991157	DCB	288.04	286.99	1.05	<Null>	PVC	200	6	OUT	CIRCULAR
CB5797091141	CB	288.216	287.576	0.64	<Null>	PVC	100	6	OUT	CIRCULAR
CB5797591131	DCB	288.089	287.219	0.87	<Null>	PVC	200	6	OUT	CIRCULAR
CB5799491093	CB	288.44	287.41	1.03	<Null>	PVC	100	6	OUT	CIRCULAR
CB5796591123	DCB	288.19	287.29	0.9	<Null>	PVC	200	6	OUT	CIRCULAR
CB5795091130	CB	288.27	287.16	1.11	<Null>	CP	300	6	OUT	CIRCULAR
CB5770491389	CB	303.345	302.265	1.08	<Null>	PVC	200	6	OUT	CIRCULAR
CB5768191410	CB	305.275	303.645	1.63	<Null>	PVC	200	6	OUT	CIRCULAR
CB5769091415	CB	305.135	304.275	0.86	<Null>	CP	200	6	OUT	CIRCULAR
CB5794391136	CB	288.215	287.115	1.1	<Null>	PVC	200	6	OUT	CIRCULAR
CB5793691152	CB	288.156	287.056	1.1	<Null>	PVC	100	6	OUT	CIRCULAR
CB5791691171	DCB	288.005	286.965	1.04	<Null>	PVC	200	6	OUT	CIRCULAR
CB5773491359	CB	299.954	298.854	1.1	<Null>	PVC	200	6	OUT	CIRCULAR
CB5823390853	CB	291.2	290.13	1.07	<Null>	PVC	200	6	OUT	CIRCULAR
CB5820490882	CB	290.951	289.951	1	<Null>	PVC	200	6	OUT	CIRCULAR
CB5817690910	CB	290.839	289.809	1.03	<Null>	PVC	200	6	OUT	CIRCULAR
CB5813990947	CB	290.617	289.377	1.24	<Null>	PVC	200	6	OUT	CIRCULAR
CB5810990978	CB	290.162	289.232	0.93	<Null>	PVC	200	6	OUT	CIRCULAR
CB5807791009	CB	289.666	288.426	1.24	<Null>	PVC	200	6	OUT	CIRCULAR
CB5804191046	CB	289.192	288.022	1.17	<Null>	PVC	200	6	OUT	CIRCULAR
CB5800891079	CB	288.538	287.468	1.07	<Null>	PVC	200	6	OUT	CIRCULAR
CB5805391052	CB	289.295	288.195	1.1	<Null>	PVC	200	6	OUT	CIRCULAR
CB5808991017	CB	289.838	288.618	1.22	<Null>	PVC	200	6	OUT	CIRCULAR
CB5811590990	CB	290.109	288.999	1.11	<Null>	PVC	200	6	OUT	CIRCULAR
CB5814490961	CB	290.378	289.168	1.21	<Null>	PVC	200	6	OUT	CIRCULAR
CB5817990925	CB	290.722	289.632	1.09	<Null>	PVC	200	6	OUT	CIRCULAR
CB5821690889	CB	291.045	289.905	1.14	<Null>	PVC	200	6	OUT	CIRCULAR
CB5824390862	CB	291.218	290.018	1.2	<Null>	PVC	200	6	OUT	CIRCULAR
CB5827590836	CB	291.506	290.236	1.27	<Null>	CP	200	6	OUT	CIRCULAR
CB5828390831	CB	291.529	290.409	1.12	<Null>	CMP	200	6	OUT	CIRCULAR
CB5828390825	DI	290.902	289.702	1.2	<Null>	CP	300	6	OUT	CIRCULAR
CB5788791204	CB	288.707	287.697	1.01	<Null>	PVC	200	6	OUT	CIRCULAR

						Outgoing Pipe's Information				
Manhole ID	AssetType	Cover Elevation	InvertElev	RimInvert	GISComment	Material	Diameter1	ClockPosition	Direction	PipeShape
CB5784791245	CB	290.131	289.031	1.1	<Null>	PVC	200	6	OUT	CIRCULAR
CB5780591287	CB	292.867	291.747	1.12	<Null>	PVC	200	6	OUT	CIRCULAR
CB5760891482	CB	305.275	303.985	1.29	<Null>	PVC	200	6	OUT	CIRCULAR
CB5675892318	DCB	298.429	<Null>	<Null>	Surcharged	CP	300	6	OUT	CIRCULAR
CB5674592313	CB	298.749	297.449	1.3	<Null>	CP	250	6	OUT	CIRCULAR
CB5675792335	CB	298.485	297.715	0.77	<Null>	CP	375	6	OUT	CIRCULAR
CB5678392309	DI	297.509	297.209	0.3	Intake	CMP	300	6	OUT	CIRCULAR
MH8582690813	MH	291.703	289.913	1.79	<Null>	CP	450	6	OUT	CIRCULAR
MH8580491056	MH	289.291	287.501	1.79	<Null>	CP	600	6	OUT	CIRCULAR
MH8581190987	MH	290.142	288.192	1.95	<Null>	CP	600	6	OUT	CIRCULAR
MH8581490957	MH	290.486	288.736	1.75	<Null>	CP	600	6	OUT	CIRCULAR
MH8581890923	MH	290.814	289.114	1.7	<Null>	CP	600	6	OUT	CIRCULAR
MH8582190890	MH	291.098	289.358	1.74	<Null>	CP	600	6	OUT	CIRCULAR
MH8578791226	MH	289.056	287.146	1.91	<Null>	CP	450	6	OUT	CIRCULAR
MH8577991307	CBMH	294.318	291.948	2.37	<Null>	CP	450	6	OUT	CIRCULAR
MH8577191388	MH	302.793	300.613	2.18	<Null>	CP	300	6	OUT	CIRCULAR
MH8577791314	MH	295.5	293.66	1.84	<Null>	CP	300	6	OUT	CIRCULAR
MH8580091100	MH	288.377	286.977	1.4	<Null>	CP	1050	6	OUT	CIRCULAR
MH8579991085	MH	288.56	287.22	1.34	<Null>	CP	1050	6	OUT	CIRCULAR
MH8582490863	MH	291.269	289.539	1.73	<Null>	CP	600	6	OUT	CIRCULAR
MH8582790837	MH	291.594	290.234	1.36	<Null>	CP	200	6	OUT	OTHER
MH8582890822	CBMH	291.638	289.638	1.9	<Null>	CP	525	6	OUT	CIRCULAR
MH8578891203	MH	288.713	287.253	1.46	<Null>	PVC	200	6	OUT	CIRCULAR
MH8578991210	MH	288.633	286.933	1.7	<Null>	CP	450	6	OUT	CIRCULAR
MH8578791229	MH	289.056	286.956	2.1	<Null>	CP	450	6	OUT	CIRCULAR
MH8578691245	MH	289.747	288.047	1.7	<Null>	CP	450	6	OUT	CIRCULAR
MH8578191281	MH	292.368	287.768	4.6	<Null>	CP	300	6	OUT	CIRCULAR
MH8577491354	MH	299.439	294.959	4.48	<Null>	CP	300	6	OUT	CIRCULAR
MH8576591443	MH	307.353	303.623	3.73	<Null>	PVC	300	6	OUT	CIRCULAR
MH8577591348	MH	298.37	296	2.37	<Null>	CP	300	6	OUT	CIRCULAR
MH8578191286	MH	292.401	290.131	2.27	<Null>	CP	300	6	OUT	CIRCULAR
MH8579991075	MH	288.839	287.439	1.4	<Null>	CP	1050	6	OUT	CIRCULAR
MH8579191191	MH	288.175	286.875	1.3	<Null>	CP	1050	6	OUT	CIRCULAR
MH8576991416	MH	305.19	303.15	2.04	<Null>	CP	300	6	OUT	CIRCULAR
MH8579091201	CBMH	288.509	286.819	1.69	<Null>	CP	1050	6	OUT	OVAL

						Outgoing Pipe's Information				
Manhole ID	AssetType	Cover Elevation	InvertElev	RimInvert	GISComment	Material	Diameter1	ClockPosition	Direction	PipeShape
MH8577091391	CBMH	305.275	303.275	2	<Null>	PVC	300	6	OUT	CIRCULAR
MH5676292312	CBMH	298.476	<Null>	<Null>	Surcharged	CP	300	6	OUT	CIRCULAR
MH5677592316	MH	298.664	<Null>	<Null>	Surcharged	CMP	300	6	OUT	CIRCULAR
MH8579691144	MH	288.203	286.933	1.27	<Null>	CP	1050	6	OUT	CIRCULAR
MH8576191490	CBMH	309.107	306.857	2.25	<Null>	CP	300	6	OUT	CIRCULAR
MH8576591454	CBMH	307.75	305.55	2.2	<Null>	CP	300	6	OUT	CIRCULAR
MH8581190987A	MH	<Null>	<Null>	<Null>	Found during CCTV inspection. Need to collection GPS	CP	600	6	OUT	CIRCULAR
MH8577791314A	CBMH	<Null>	<Null>	<Null>	Found during CCTV inspection. Not found in field. Paved over.	CP	525	6	OUT	CIRCULAR
CB5790591208	OF	287.666	285.976	1.69	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>
CB5790191215	OF	288.752	287.052	1.7	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>
CB5678692327	OF	297.625	297.325	0.3	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>
CB5808291050	CB	289.644	289.094	0.55	<Null>	PVC	300	6	OUT	CIRCULAR
CB5813491091	CB	291.812	291.362	0.45	<Null>	PVC	300	6	OUT	CIRCULAR
CB5820891147	CB	293.448	292.148	1.3	<Null>	PVC	300	6	OUT	CIRCULAR
CB5829591215	CB	293.979	293.079	0.9		CP	250	6	OUT	CIRCULAR
CB5830191210	CB	294.014	292.814	1.2	not opened due to construction	PVC	250	6	OUT	CIRCULAR
CB5835691269	CB	294.645	293.245	1.4	<Null>	PVC	300	6	OUT	CIRCULAR
CB5837591269	CB	294.593	293.193	1.4	not opened due to construction	PVC	250	6	OUT	CIRCULAR
CB5846091347	CB	293.997	292.697	1.3	<Null>	PVC	300	6	OUT	CIRCULAR
CB5848391355	CB	293.395	292.135	1.26	<Null>	PVC	300	6	OUT	CIRCULAR
CB5841491301	CB	294.845	293.595	1.25	<Null>	PVC	300	6	OUT	CIRCULAR
CB5821391141	CB	293.488	292.248	1.24	<Null>	PVC	300	6	OUT	CIRCULAR
CB5818591119	CB	293.199	292.029	1.17	<Null>	PVC	300	6	OUT	CIRCULAR
CB5817391107	CB	292.983	291.803	1.18	<Null>	PVC	300	6	OUT	CIRCULAR
CB5814291081	CB	291.858	290.688	1.17	<Null>	PVC	300	6	OUT	CIRCULAR
CB5808991039	CB	289.643	288.693	0.95	<Null>	PVC	300	6	OUT	CIRCULAR
MH5841391291	CBMH	294.655	292.905	1.75		PVC	300	6	OUT	CIRCULAR
CB5840591280	DI	294.751	293.531	1.22	<Null>	PVC	300	6	OUT	CIRCULAR
MH8580891046	MH	289.832	288.212	1.62	<Null>	CP	450	6	OUT	CIRCULAR
MH5813591088	MH	291.916	289.616	2.3	<Null>	CP	375	6	OUT	CIRCULAR
MH5817191117	CBMH	293.037	290.137	2.9	<Null>	CP	300	6	OUT	CIRCULAR
MH5819791138	MH	293.543	290.743	2.8	<Null>	CP	300	6	OUT	CIRCULAR
MH5828991213	MH	294.061	292.111	1.95	Upstream incoming pipe from Marilyn St	CP	600	6	OUT	CIRCULAR
MH5834491256	MH	294.56	291.86	2.7	<Null>	CP	675	6	OUT	CIRCULAR
MH5840291302	MH	294.846	291.446	3.4	<Null>	CP	675	6	OUT	CIRCULAR
MH5847691361	MH	293.515	290.715	2.8	<Null>	CP	675	6	OUT	CIRCULAR
MH5849091371	MH	293.182	290.182	3	Pipe continues and discharge underneath bridge structure	CP	950	6	OUT	RECTANGULAR

APPENDIX E: TYPICAL PROPOSED ROAD CROSS SECTIONS

AIRPORT ROAD
SEMI-URBAN TYPICAL – WALKER TO LEAMSTER



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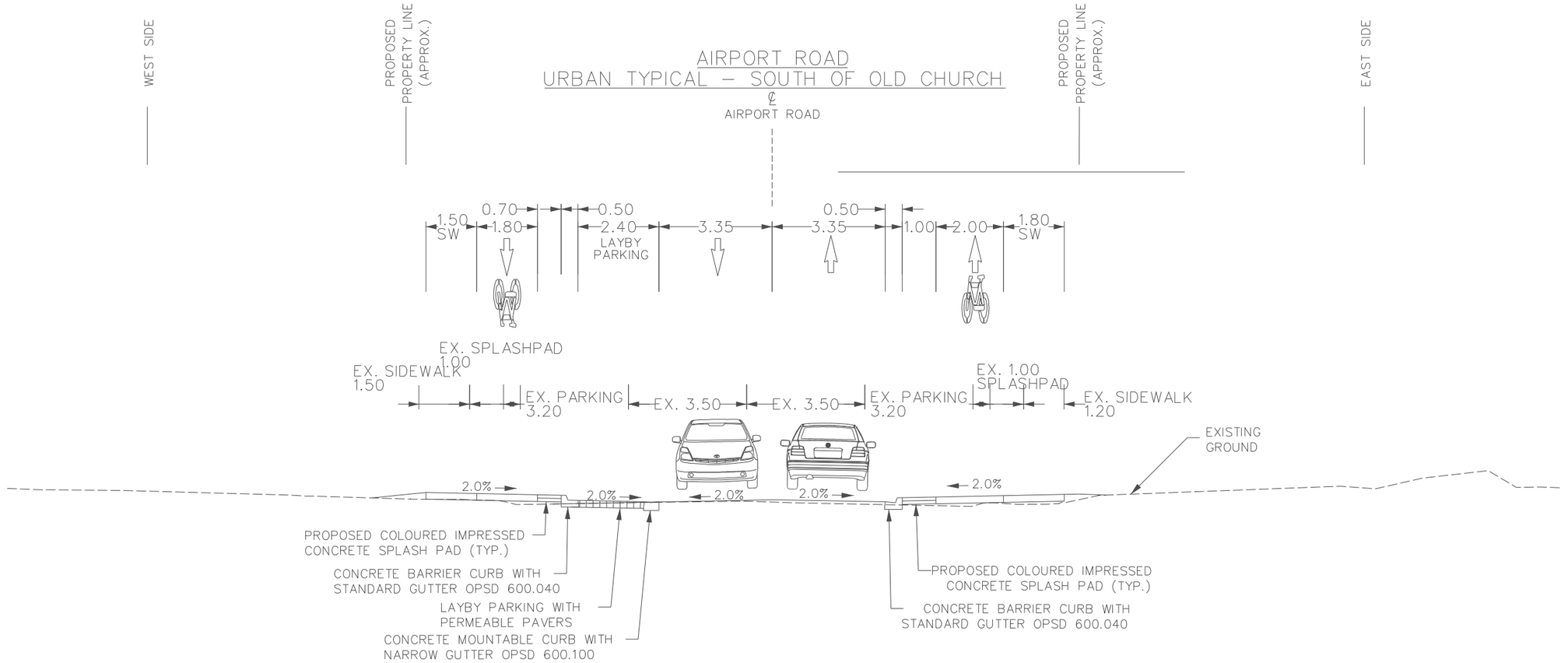
Region of Peel
Working for you

AIRPORT ROAD

(FROM KING STREET TO HUNSTVILLE DRIVE)

TYPICAL SECTION

Checked by R.P.	Drawn by Z.L	Project No. 109535
Date SEP, 2019	Sheet 1 of 1	Drawing No. FIGURE 4



TYPICAL 2 LANE URBAN CROSS-SECTION CYCLETRACK WITH LAYBY PARKING

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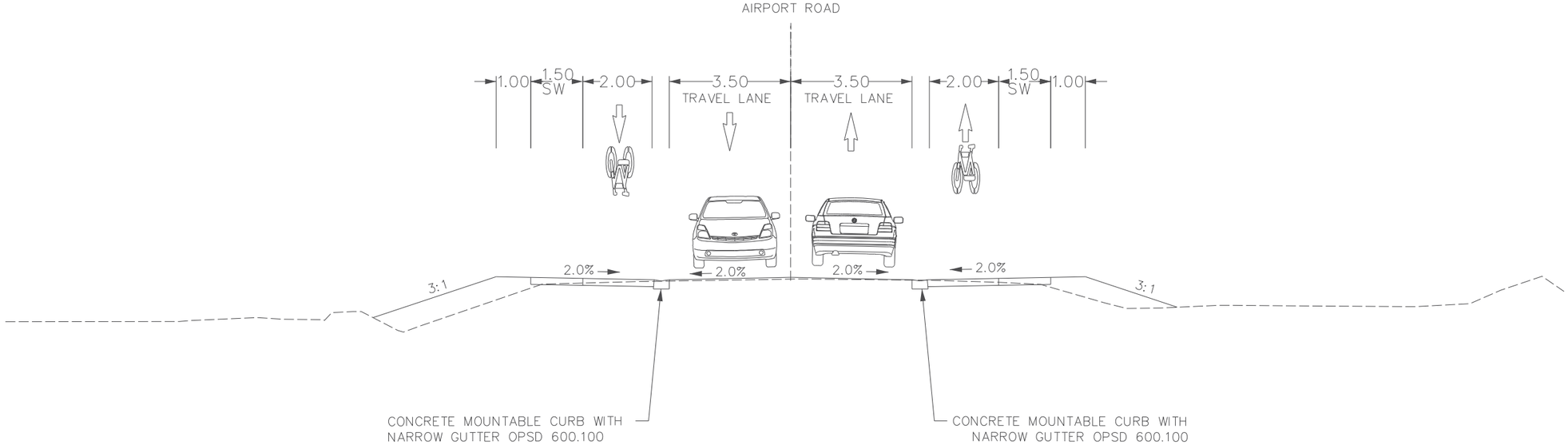
AIRPORT ROAD

(FROM KING STREET TO HUNSTVILLE DRIVE)

TYPICAL SECTION

Checked by R.P.	Drawn by Z.L	Project No. 109535
Date SEP, 2019	Sheet 1 of 1	Drawing No. FIGURE 5

AIRPORT ROAD
URBAN TYPICAL – CRANSTON TO OLDE BASELINE ROAD



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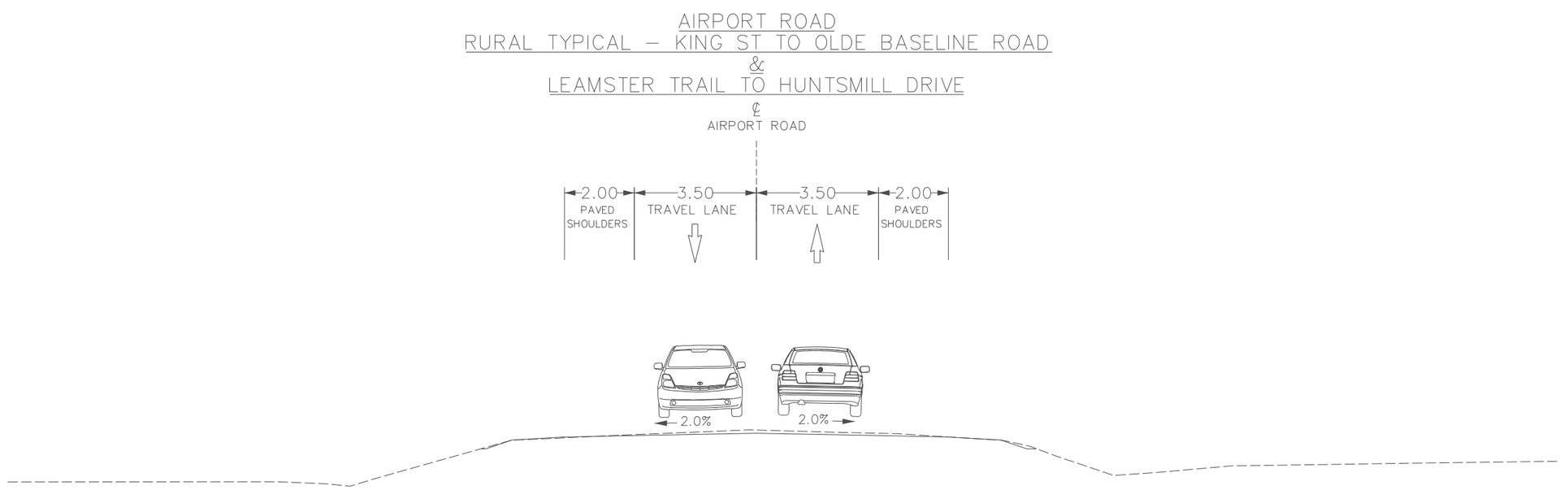
AIRPORT ROAD

(FROM KING STREET TO HUNSTVILLE DRIVE)

TYPICAL SECTION

Checked by R.P.	Drawn by Z.L	Project No. 109535
Date SEP, 2019	Sheet 1 of 1	Drawing No. FIGURE 6

AIRPORT ROAD
RURAL TYPICAL – KING ST TO OLDE BASELINE ROAD
&
LEAMSTER TRAIL TO HUNTSMILL DRIVE



TYPICAL 2 LANE RURAL CROSS-SECTION WITH PAVED SHOULDERS

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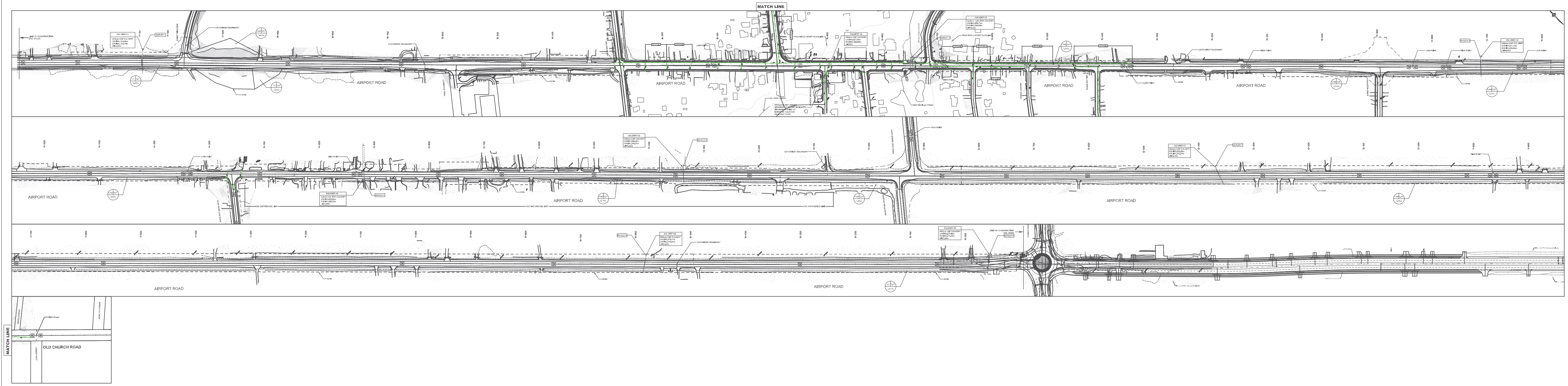
AIRPORT ROAD

(FROM KING STREET TO HUNSTVILLE DRIVE)

TYPICAL SECTION

Checked by R.P.	Drawn by Z.L	Project No. 109535
Date SEP. 2019	Sheet 1 of 1	Drawing No. FIGURE 7

APPENDIX F: EXISTING CONDITION ROLL PLAN



LEGEND

- ROADWAY RUNOFF
- CATCHMENT BOUNDARY / ROW
- CATCHMENT ID / RUNOFF COEFFICIENT / CATCHMENT AREA
- EXISTING CULVERT
- CULVERT FLOW DIRECTION
- CATCHBASIN
- DOUBLE CATCHBASIN
- MANHOLE
- CATCHBASIN MANHOLE
- STORM SEWER
- GRASSED SWALE
- DITCH
- REGULATORY FLOOD LINE

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AIRPORT ROAD

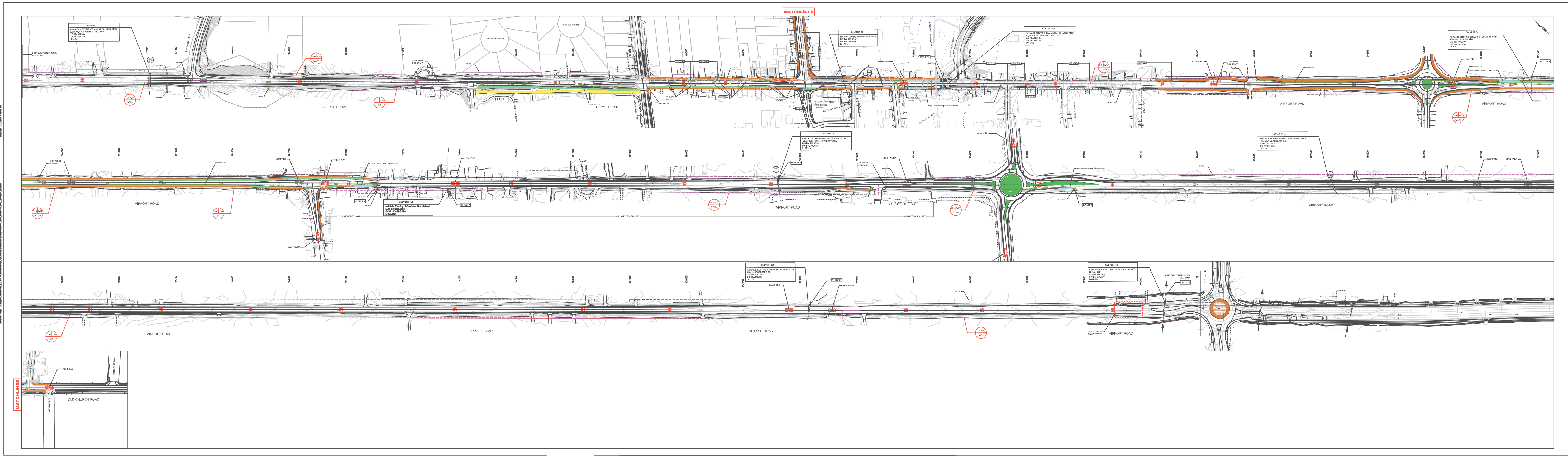
(FROM KING STREET TO HUNSTVILLE DRIVE)

EXISTING DRAINAGE CONDITION

STA. 5 + 850 TO STA. 13+275

Checked by R.P.	Drawn by Z.L	Project No. 109535
Date OCT 2019	Sheet 1 of 1	Plan No. FIGURE 8

APPENDIX G: PROPOSED CONDITION ROLL PLAN



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Region of Peel
Working for you

AIRPORT ROAD

(FROM KING STREET TO HUNSTVILLE DRIVE)

PROPOSED DRAINAGE CONDITION

STA. 5 + 850 TO STA. 13+275

CAD Area	Area	Project No. 109535
Checked by R.P	Drawn by N.M	
Date OCT 2019	Sheet 1 of 1	Plan No. FIGURE 9

APPENDIX H: HYDROLOGIC INPUT PARAMETERS

Project Name: Airport Road
Municipality: Region of Peel
Project No.: 109535
Date: 11-Jan-17

Time of Concentration Estimate

Location **Culvert C1**

INPUT DATA

Catchment Length (m):	1080
Catchment Slope (m/m):	0.0518
Watershed Area (ha):	68.59
Rational Method Runoff Coefficient:	0.25

RESULTS

Kirpich Formula

$$t_c = 0.0078 \times L^{0.77} \times S^{-0.385}$$

Tc=	**13.18**	min

where:

L = length of channel/ditch from headwater to outlet, ft
S = average watershed slope, ft/ft

Federal Aviation Administration - Airport Method

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

Tc=	**52.92**	min

where:

C = rational method runoff coefficient
L = length of overland flow, m
S = surface slope, %
C < 0.40

Bransby Williams Formula

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

Tc=	**29.03**	min

where:

L = gross length of main channel head of basin, m
S = net slope of main channel, %
A = watershed area, ha
C > 0.40

Tc (Average)=	**32**	min

Project Name: Airport Road
Municipality: Region of Peel
Project No.: 109535
Date: 11-Jan-17

Time of Concentration Estimate

Location **CULVERT C4**

INPUT DATA

Catchment Length (m):	410
Catchment Slope (m/m):	0.0073
Watershed Area (ha):	4.9
Rational Method Runoff Coefficient:	0.40

RESULTS

Kirpich Formula

$$t_c = 0.0078 \times L^{0.77} \times S^{-0.385}$$

Tc= **13.30** min

where:

L = length of channel/ditch from headwater to outlet, ft
S = average watershed slope, ft/ft

Federal Aviation Administration - Airport Method

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

Tc= **51.26** min

where:

C = rational method runoff coefficient
L = length of overland flow, m
S = surface slope, %
C < 0.40

Bransby Williams Formula

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

Tc= **21.23** min

where:

L = gross length of main channel head of basin, m
S = net slope of main channel, %
A = watershed area, ha
C > 0.40

Tc (Average)= **29** min

Project Name: Airport Road
Municipality: Region of Peel
Project No.: 109535
Date: 11-Jan-17

Time of Concentration Estimate

Location **CULVERT C5**

INPUT DATA

Catchment Length (m):	700
Catchment Slope (m/m):	0.0071
Watershed Area (ha):	12.75
Rational Method Runoff Coefficient:	0.40

RESULTS

Kirpich Formula

$$t_c = 0.0078 \times L^{0.77} \times S^{-0.385}$$

Tc=	**20.29**	min

where:

L = length of channel/ditch from headwater to outlet, ft
S = average watershed slope, ft/ft

Federal Aviation Administration - Airport Method

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

Tc=	**67.60**	min

where:

C = rational method runoff coefficient
L = length of overland flow, m
S = surface slope, %
C < 0.40

Bransby Williams Formula

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

Tc=	**33.13**	min

where:

L = gross length of main channel head of basin, m
S = net slope of main channel, %
A = watershed area, ha
C > 0.40

Tc (Average)=	**40**	min

Project Name: Airport Road
Municipality: Region of Peel
Project No.: 109535
Date: 11-Jan-17

Time of Concentration Estimate

Location **CULVERT 6**

INPUT DATA

Catchment Length (m):	460
Catchment Slope (m/m):	0.0108
Watershed Area (ha):	3.76
Rational Method Runoff Coefficient:	0.39

RESULTS

Kirpich Formula

$$t_c = 0.0078 \times L^{0.77} \times S^{-0.385}$$

Tc=	**12.50**	min

where:

L = length of channel/ditch from headwater to outlet, ft
S = average watershed slope, ft/ft

Federal Aviation Administration - Airport Method

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

Tc=	**48.40**	min

where:

C = rational method runoff coefficient
L = length of overland flow, m
S = surface slope, %
C < 0.40

Bransby Williams Formula

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

Tc=	**22.62**	min

where:

L = gross length of main channel head of basin, m
S = net slope of main channel, %
A = watershed area, ha
C > 0.40

Tc (Average)=	**28**	min

APPENDIX I: CULVERTMASTER OUTPUTS

EXISTING CONDITION

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	288.10	m	Discharge	0.5049	m³/s
Inlet Control HW Elev.	288.00	m	Tailwater Elevation	287.12	m
Outlet Control HW Elev.	288.10	m	Control Type	Outlet Control	
Headwater Depth/Height	0.89				

Grades					
Upstream Invert	287.35	m	Downstream Invert	286.69	m
Length	150.00	m	Constructed Slope	0.004400	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.43	m
Slope Type	Mild		Normal Depth	0.63	m
Flow Regime	Subcritical		Critical Depth	0.42	m
Velocity Downstream	1.75	m/s	Critical Slope	0.014815	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.85	m
Section Size	850 mm		Rise	0.85	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	288.10	m	Upstream Velocity Head	0.06	m
Ke	0.90		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	288.00	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	7.5027	m³/s	Allowable HW Elevation	288.10	m
Roadway Width	9.10	m	Overtopping Coefficient	1.66	SI
Low Point	287.88	m	Headwater Elevation	288.10	m
Discharge Coefficient (Cr)	3.00		Submergence Factor (Kt)	1.00	
Tailwater Elevation	287.12	m			

Sta (m)	Elev. (m)
0.00	288.34
20.00	288.08
40.00	287.92
57.00	287.88
60.00	287.88
80.00	287.95
100.00	288.13

Culvert Calculator Report
Culvert_C4_Existing_25_Year_ROP_2019_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	304.04	m	Headwater Depth/Height	3.97	
Computed Headwater Eleva	302.92	m	Discharge	0.3800	m³/s
Inlet Control HW Elev.	302.31	m	Tailwater Elevation	300.85	m
Outlet Control HW Elev.	302.92	m	Control Type	Outlet Control	

Grades					
Upstream Invert	301.10	m	Downstream Invert	300.62	m
Length	24.05	m	Constructed Slope	0.019958	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.42	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.42	m
Velocity Downstream	2.42	m/s	Critical Slope	0.048583	m/m

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

Outlet Control Properties					
Outlet Control HW Elev.	302.92	m	Upstream Velocity Head	0.27	m
Ke	0.90		Entrance Loss	0.25	m

Inlet Control Properties					
Inlet Control HW Elev.	302.31	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
Culvert_C4_Existing_25_Year_ROP_2095_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	304.04	m	Headwater Depth/Height	5.63	
Computed Headwater Eleva	303.67	m	Discharge	0.4500	m³/s
Inlet Control HW Elev.	302.71	m	Tailwater Elevation	300.85	m
Outlet Control HW Elev.	303.67	m	Control Type	Outlet Control	

Grades					
Upstream Invert	301.10	m	Downstream Invert	300.62	m
Length	24.05	m	Constructed Slope	0.019958	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.43	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.43	m
Velocity Downstream	2.80	m/s	Critical Slope	0.067535	m/m

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

Outlet Control Properties					
Outlet Control HW Elev.	303.67	m	Upstream Velocity Head	0.38	m
Ke	0.90		Entrance Loss	0.34	m

Inlet Control Properties					
Inlet Control HW Elev.	302.71	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
Culvert_C5_Existing_25_Year_ROP_2019_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	297.00	m	Headwater Depth/Height	0.57	
Computed Headwater Eleva	295.83	m	Discharge	1.3100	m³/s
Inlet Control HW Elev.	295.75	m	Tailwater Elevation	295.68	m
Outlet Control HW Elev.	295.83	m	Control Type	Outlet Control	

Grades					
Upstream Invert	295.20	m	Downstream Invert	295.13	m
Length	63.50	m	Constructed Slope	0.001102	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	0.52	m
Flow Regime	Subcritical		Critical Depth	0.35	m
Velocity Downstream	1.19	m/s	Critical Slope	0.003509	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	m
Section Size	2000 x 1100 mm		Rise	1.10	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	295.83	m	Upstream Velocity Head	0.08	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	295.75	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	2.2	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Calculator Report
Culvert_C5_Existing_25_Year_ROP_2095_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	297.00	m	Headwater Depth/Height	0.64	
Computed Headwater Eleva	295.91	m	Discharge	1.6600	m³/s
Inlet Control HW Elev.	295.85	m	Tailwater Elevation	295.68	m
Outlet Control HW Elev.	295.91	m	Control Type	Outlet Control	

Grades					
Upstream Invert	295.20	m	Downstream Invert	295.13	m
Length	63.50	m	Constructed Slope	0.001102	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	0.62	m
Flow Regime	Subcritical		Critical Depth	0.41	m
Velocity Downstream	1.51	m/s	Critical Slope	0.003528	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	m
Section Size	2000 x 1100 mm		Rise	1.10	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	295.91	m	Upstream Velocity Head	0.10	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	295.85	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	2.2	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Calculator Report
Culvert_C6_Existing_25_Year_ROP_2019_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	299.21	m	Headwater Depth/Height	1.03	
Computed Headwater Eleva	297.40	m	Discharge	0.4000	m³/s
Inlet Control HW Elev.	297.32	m	Tailwater Elevation	296.97	m
Outlet Control HW Elev.	297.40	m	Control Type	Outlet Control	

Grades					
Upstream Invert	296.68	m	Downstream Invert	296.62	m
Length	21.22	m	Constructed Slope	0.002828	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.40	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.40	m
Velocity Downstream	1.78	m/s	Critical Slope	0.016931	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.70	m
Section Size	700 mm		Rise	0.70	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	297.40	m	Upstream Velocity Head	0.07	m
Ke	0.90		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	297.32	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.4	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 Calculator Report
Culvert_C6_Existing_25_Year_ROP_2095_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	299.21	m	Headwater Depth/Height	1.19	
Computed Headwater Eleva	297.51	m	Discharge	0.4800	m³/s
Inlet Control HW Elev.	297.41	m	Tailwater Elevation	296.97	m
Outlet Control HW Elev.	297.51	m	Control Type	Outlet Control	

Grades					
Upstream Invert	296.68	m	Downstream Invert	296.62	m
Length	21.22	m	Constructed Slope	0.002828	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.44	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.44	m
Velocity Downstream	1.91	m/s	Critical Slope	0.018165	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.70	m
Section Size	700 mm		Rise	0.70	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	297.51	m	Upstream Velocity Head	0.08	m
Ke	0.90		Entrance Loss	0.07	m

Inlet Control Properties					
Inlet Control HW Elev.	297.41	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.4	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	294.54	m	Discharge	0.2097	m³/s
Inlet Control HW Elev.	294.18	m	Tailwater Elevation	293.84	m
Outlet Control HW Elev.	294.54	m	Control Type	Outlet Control	
Headwater Depth/Height	2.77				

Grades					
Upstream Invert	293.28	m	Downstream Invert	293.61	m
Length	23.19	m	Constructed Slope	-0.014230	m/m

Hydraulic Profile					
Profile	CompositeA2PressureProfile		Depth, Downstream	0.32	m
Slope Type	Adverse		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.32	m
Velocity Downstream	1.70	m/s	Critical Slope	0.023919	m/m

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

Outlet Control Properties					
Outlet Control HW Elev.	294.54	m	Upstream Velocity Head	0.08	m
Ke	0.90		Entrance Loss	0.07	m

Inlet Control Properties					
Inlet Control HW Elev.	294.18	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	0.5423	m³/s	Allowable HW Elevation	294.55	m
Roadway Width	7.00	m	Overtopping Coefficient	1.61	SI
Low Point	294.43	m	Headwater Elevation	294.54	m
Discharge Coefficient (Cr)	2.92		Submergence Factor (Kt)	1.00	
Tailwater Elevation	293.84	m			

Sta (m)	Elev. (m)
0.00	294.43
20.00	294.53
40.00	294.63
62.00	294.75
80.00	294.89
100.00	295.06
120.00	295.25

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	294.56	m	Discharge	0.2120	m³/s
Inlet Control HW Elev.	294.19	m	Tailwater Elevation	293.84	m
Outlet Control HW Elev.	294.56	m	Control Type	Outlet Control	
Headwater Depth/Height	2.80				

Grades					
Upstream Invert	293.28	m	Downstream Invert	293.61	m
Length	23.19	m	Constructed Slope	-0.014230	m/m

Hydraulic Profile					
Profile	CompositeA2PressureProfile		Depth, Downstream	0.32	m
Slope Type	Adverse		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.32	m
Velocity Downstream	1.71	m/s	Critical Slope	0.024098	m/m

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

Outlet Control Properties					
Outlet Control HW Elev.	294.56	m	Upstream Velocity Head	0.09	m
Ke	0.90		Entrance Loss	0.08	m

Inlet Control Properties					
Inlet Control HW Elev.	294.19	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	0.7280	m³/s	Allowable HW Elevation	294.56	m
Roadway Width	7.00	m	Overtopping Coefficient	1.61	SI
Low Point	294.43	m	Headwater Elevation	294.56	m
Discharge Coefficient (Cr)	2.92		Submergence Factor (Kt)	1.00	
Tailwater Elevation	293.84	m			

Sta (m)	Elev. (m)
0.00	294.43
20.00	294.53
40.00	294.63
62.00	294.75
80.00	294.89
100.00	295.06
120.00	295.25

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	281.85	m	Discharge	0.7521	m³/s
Inlet Control HW Elev.	281.24	m	Tailwater Elevation	279.92	m
Outlet Control HW Elev.	281.85	m	Control Type	Outlet Control	
Headwater Depth/Height	3.50				

Grades					
Upstream Invert	279.71	m	Downstream Invert	279.62	m
Length	21.24	m	Constructed Slope	0.004237	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.55	m
Velocity Downstream	2.72	m/s	Critical Slope	0.041389	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	281.85	m	Upstream Velocity Head	0.34	m
Ke	0.90		Entrance Loss	0.30	m

Inlet Control Properties					
Inlet Control HW Elev.	281.24	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	0.0584	m³/s	Allowable HW Elevation	281.85	m
Roadway Width	7.00	m	Overtopping Coefficient	1.61	SI
Low Point	281.82	m	Headwater Elevation	281.85	m
Discharge Coefficient (Cr)	2.91		Submergence Factor (Kt)	1.00	
Tailwater Elevation	279.92	m			

Sta (m)	Elev. (m)
0.00	282.07
20.00	282.05
40.00	281.96
44.00	281.93
60.00	281.86
80.00	281.82
100.00	281.86

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	281.86	m	Discharge	0.7561	m³/s
Inlet Control HW Elev.	281.26	m	Tailwater Elevation	279.92	m
Outlet Control HW Elev.	281.86	m	Control Type	Outlet Control	
Headwater Depth/Height	3.53				

Grades					
Upstream Invert	279.71	m	Downstream Invert	279.62	m
Length	21.24	m	Constructed Slope	0.004237	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.55	m
Velocity Downstream	2.73	m/s	Critical Slope	0.041770	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	281.86	m	Upstream Velocity Head	0.34	m
Ke	0.90		Entrance Loss	0.31	m

Inlet Control Properties					
Inlet Control HW Elev.	281.26	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	0.2260	m³/s	Allowable HW Elevation	281.86	m
Roadway Width	7.00	m	Overtopping Coefficient	1.61	SI
Low Point	281.82	m	Headwater Elevation	281.86	m
Discharge Coefficient (Cr)	2.91		Submergence Factor (Kt)	1.00	
Tailwater Elevation	279.92	m			

Sta (m)	Elev. (m)
0.00	282.07
20.00	282.05
40.00	281.96
44.00	281.93
60.00	281.86
80.00	281.82
100.00	281.86

Culvert Calculator Report
Culvert_C9_Existing_25_Year_ROP_2019_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	275.80	m	Headwater Depth/Height	1.00	
Computed Headwater Eleva	275.09	m	Discharge	0.3000	m³/s
Inlet Control HW Elev.	275.06	m	Tailwater Elevation	274.50	m
Outlet Control HW Elev.	275.09	m	Control Type	Outlet Control	

Grades					
Upstream Invert	274.48	m	Downstream Invert	274.20	m
Length	23.66	m	Constructed Slope	0.011834	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	1.70	m/s	Critical Slope	0.018095	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	275.09	m	Upstream Velocity Head	0.11	m
Ke	0.90		Entrance Loss	0.09	m

Inlet Control Properties					
Inlet Control HW Elev.	275.06	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.3	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 Calculator Report
Culvert_C9_Existing_25_Year_ROP_2095_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	275.80	m	Headwater Depth/Height	1.10	
Computed Headwater Eleva	275.15	m	Discharge	0.3500	m³/s
Inlet Control HW Elev.	275.12	m	Tailwater Elevation	274.50	m
Outlet Control HW Elev.	275.15	m	Control Type	Outlet Control	

Grades					
Upstream Invert	274.48	m	Downstream Invert	274.20	m
Length	23.66	m	Constructed Slope	0.011834	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.39	m
Slope Type	Mild		Normal Depth	0.46	m
Flow Regime	Subcritical		Critical Depth	0.39	m
Velocity Downstream	1.80	m/s	Critical Slope	0.019286	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	275.15	m	Upstream Velocity Head	0.11	m
Ke	0.90		Entrance Loss	0.10	m

Inlet Control Properties					
Inlet Control HW Elev.	275.12	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	288.35	m	Discharge	0.6552	m³/s
Inlet Control HW Elev.	288.13	m	Tailwater Elevation	287.12	m
Outlet Control HW Elev.	288.35	m	Control Type	Outlet Control	
Headwater Depth/Height	1.18				

Grades					
Upstream Invert	287.35	m	Downstream Invert	286.69	m
Length	150.00	m	Constructed Slope	0.004400	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.48	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.48	m
Velocity Downstream	1.97	m/s	Critical Slope	0.015913	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.85	m
Section Size	850 mm		Rise	0.85	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	288.35	m	Upstream Velocity Head	0.07	m
Ke	0.90		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	288.13	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	9.9194	m³/s	Allowable HW Elevation	288.35	m
Roadway Width	9.10	m	Overtopping Coefficient	1.66	SI
Low Point	288.15	m	Headwater Elevation	288.35	m
Discharge Coefficient (Cr)	3.01		Submergence Factor (Kt)	1.00	
Tailwater Elevation	287.12	m			

Sta (m)	Elev. (m)
0.00	288.30
20.00	288.16
40.00	288.15
57.00	288.21
60.00	288.22
80.00	288.22
100.00	288.20

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	303.87	m	Discharge	0.4665	m³/s
Inlet Control HW Elev.	302.81	m	Tailwater Elevation	300.85	m
Outlet Control HW Elev.	303.87	m	Control Type	Outlet Control	
Headwater Depth/Height	6.05				

Grades					
Upstream Invert	301.10	m	Downstream Invert	300.62	m
Length	24.05	m	Constructed Slope	0.019958	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.44	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.44	m
Velocity Downstream	2.89	m/s	Critical Slope	0.072790	m/m

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

Outlet Control Properties					
Outlet Control HW Elev.	303.87	m	Upstream Velocity Head	0.41	m
Ke	0.90		Entrance Loss	0.37	m

Inlet Control Properties					
Inlet Control HW Elev.	302.81	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	0.0840	m³/s	Allowable HW Elevation	303.87	m
Roadway Width	7.00	m	Overtopping Coefficient	1.61	SI
Low Point	303.81	m	Headwater Elevation	303.87	m
Discharge Coefficient (Cr)	2.91		Submergence Factor (Kt)	1.00	
Tailwater Elevation	300.85	m			

Sta (m)	Elev. (m)
0.00	304.83
20.00	304.53
40.00	304.27
51.00	304.16
60.00	304.06
80.00	303.92
100.00	303.81

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	295.96	m	Discharge	1.9000	m³/s
Inlet Control HW Elev.	295.91	m	Tailwater Elevation	295.68	m
Outlet Control HW Elev.	295.96	m	Control Type	Outlet Control	
Headwater Depth/Height	0.69				

Grades					
Upstream Invert	295.20	m	Downstream Invert	295.13	m
Length	63.50	m	Constructed Slope	0.001102	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	0.68	m
Flow Regime	Subcritical		Critical Depth	0.45	m
Velocity Downstream	1.73	m/s	Critical Slope	0.003550	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	m
Section Size	2000 x 1100 mm		Rise	1.10	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	295.96	m	Upstream Velocity Head	0.12	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	295.91	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	2.2	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	297.72	m	Discharge	0.5900	m³/s
Inlet Control HW Elev.	297.53	m	Tailwater Elevation	296.97	m
Outlet Control HW Elev.	297.72	m	Control Type	Outlet Control	
Headwater Depth/Height	1.48				

Grades					
Upstream Invert	296.68	m	Downstream Invert	296.62	m
Length	21.22	m	Constructed Slope	0.002828	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.48	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.48	m
Velocity Downstream	2.08	m/s	Critical Slope	0.020336	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.70	m
Section Size	700 mm		Rise	0.70	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	297.72	m	Upstream Velocity Head	0.12	m
Ke	0.90		Entrance Loss	0.11	m

Inlet Control Properties					
Inlet Control HW Elev.	297.53	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.4	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	294.77	m	Discharge	0.2452	m³/s
Inlet Control HW Elev.	294.27	m	Tailwater Elevation	293.84	m
Outlet Control HW Elev.	294.77	m	Control Type	Outlet Control	
Headwater Depth/Height	3.25				

Grades					
Upstream Invert	293.28	m	Downstream Invert	293.61	m
Length	23.19	m	Constructed Slope	-0.014230	m/m

Hydraulic Profile					
Profile	CompositeA2PressureProfile		Depth, Downstream	0.35	m
Slope Type	Adverse		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.35	m
Velocity Downstream	1.83	m/s	Critical Slope	0.027057	m/m

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

Outlet Control Properties					
Outlet Control HW Elev.	294.77	m	Upstream Velocity Head	0.11	m
Ke	0.90		Entrance Loss	0.10	m

Inlet Control Properties					
Inlet Control HW Elev.	294.27	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	0.8467	m³/s	Allowable HW Elevation	294.77	m
Roadway Width	7.00	m	Overtopping Coefficient	1.61	SI
Low Point	294.64	m	Headwater Elevation	294.77	m
Discharge Coefficient (Cr)	2.92		Submergence Factor (Kt)	1.00	
Tailwater Elevation	293.84	m			

Sta (m)	Elev. (m)
0.00	294.64
20.00	294.72
40.00	294.86
62.00	295.01
80.00	295.15
100.00	295.31
120.00	295.49

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	281.91	m	Discharge	0.7659	m³/s
Inlet Control HW Elev.	281.29	m	Tailwater Elevation	279.92	m
Outlet Control HW Elev.	281.91	m	Control Type	Outlet Control	
Headwater Depth/Height	3.61				

Grades					
Upstream Invert	279.71	m	Downstream Invert	279.62	m
Length	21.24	m	Constructed Slope	0.004237	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.55	m
Velocity Downstream	2.76	m/s	Critical Slope	0.042727	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	281.91	m	Upstream Velocity Head	0.35	m
Ke	0.90		Entrance Loss	0.32	m

Inlet Control Properties					
Inlet Control HW Elev.	281.29	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	0.4062	m³/s	Allowable HW Elevation	281.91	m
Roadway Width	7.00	m	Overtopping Coefficient	1.61	SI
Low Point	281.84	m	Headwater Elevation	281.91	m
Discharge Coefficient (Cr)	2.92		Submergence Factor (Kt)	1.00	
Tailwater Elevation	279.92	m			

Sta (m)	Elev. (m)
0.00	281.96
20.00	281.92
40.00	281.84
44.00	281.94
60.00	281.86
80.00	281.90
100.00	281.94

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	275.27	m	Discharge	0.4300	m³/s
Inlet Control HW Elev.	275.23	m	Tailwater Elevation	274.50	m
Outlet Control HW Elev.	275.27	m	Control Type	Outlet Control	
Headwater Depth/Height	1.30				

Grades					
Upstream Invert	274.48	m	Downstream Invert	274.20	m
Length	23.66	m	Constructed Slope	0.011834	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.43	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.43	m
Velocity Downstream	1.96	m/s	Critical Slope	0.021715	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	275.27	m	Upstream Velocity Head	0.12	m
Ke	0.90		Entrance Loss	0.11	m

Inlet Control Properties					
Inlet Control HW Elev.	275.23	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	288.37	m	Discharge	0.6603	m³/s
Inlet Control HW Elev.	288.13	m	Tailwater Elevation	287.12	m
Outlet Control HW Elev.	288.37	m	Control Type	Outlet Control	
Headwater Depth/Height	1.20				

Grades					
Upstream Invert	287.35	m	Downstream Invert	286.69	m
Length	150.00	m	Constructed Slope	0.004400	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.48	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.48	m
Velocity Downstream	1.97	m/s	Critical Slope	0.015955	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.85	m
Section Size	850 mm		Rise	0.85	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	288.37	m	Upstream Velocity Head	0.07	m
Ke	0.90		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	288.13	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	11.7555	m³/s	Allowable HW Elevation	288.37	m
Roadway Width	9.10	m	Overtopping Coefficient	1.66	SI
Low Point	288.15	m	Headwater Elevation	288.37	m
Discharge Coefficient (Cr)	3.01		Submergence Factor (Kt)	1.00	
Tailwater Elevation	287.12	m			

Sta (m)	Elev. (m)
0.00	288.30
20.00	288.16
40.00	288.15
57.00	288.21
60.00	288.22
80.00	288.22
100.00	288.20

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	303.87	m	Discharge	0.4663	m³/s
Inlet Control HW Elev.	302.81	m	Tailwater Elevation	300.85	m
Outlet Control HW Elev.	303.87	m	Control Type	Outlet Control	
Headwater Depth/Height	6.05				

Grades					
Upstream Invert	301.10	m	Downstream Invert	300.62	m
Length	24.05	m	Constructed Slope	0.019958	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.44	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.44	m
Velocity Downstream	2.89	m/s	Critical Slope	0.072714	m/m

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

Outlet Control Properties					
Outlet Control HW Elev.	303.87	m	Upstream Velocity Head	0.41	m
Ke	0.90		Entrance Loss	0.37	m

Inlet Control Properties					
Inlet Control HW Elev.	302.81	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	0.0742	m³/s	Allowable HW Elevation	303.87	m
Roadway Width	7.00	m	Overtopping Coefficient	1.61	SI
Low Point	303.81	m	Headwater Elevation	303.87	m
Discharge Coefficient (Cr)	2.91		Submergence Factor (Kt)	1.00	
Tailwater Elevation	300.85	m			

Sta (m)	Elev. (m)
0.00	304.83
20.00	304.53
40.00	304.27
51.00	304.16
60.00	304.06
80.00	303.92
100.00	303.81

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	296.09	m	Discharge	2.4400	m³/s
Inlet Control HW Elev.	296.04	m	Tailwater Elevation	295.68	m
Outlet Control HW Elev.	296.09	m	Control Type	Outlet Control	
Headwater Depth/Height	0.81				

Grades					
Upstream Invert	295.20	m	Downstream Invert	295.13	m
Length	63.50	m	Constructed Slope	0.001102	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	0.81	m
Flow Regime	Subcritical		Critical Depth	0.53	m
Velocity Downstream	2.22	m/s	Critical Slope	0.003614	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	m
Section Size	2000 x 1100 mm		Rise	1.10	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	296.09	m	Upstream Velocity Head	0.15	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	296.04	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	2.2	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	298.21	m	Discharge	0.8000	m³/s
Inlet Control HW Elev.	297.84	m	Tailwater Elevation	296.97	m
Outlet Control HW Elev.	298.21	m	Control Type	Outlet Control	
Headwater Depth/Height	2.19				

Grades					
Upstream Invert	296.68	m	Downstream Invert	296.62	m
Length	21.22	m	Constructed Slope	0.002828	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.56	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.56	m
Velocity Downstream	2.42	m/s	Critical Slope	0.026418	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.70	m
Section Size	700 mm		Rise	0.70	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	298.21	m	Upstream Velocity Head	0.22	m
Ke	0.90		Entrance Loss	0.20	m

Inlet Control Properties					
Inlet Control HW Elev.	297.84	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.4	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	294.80	m	Discharge	0.2497	m³/s
Inlet Control HW Elev.	294.28	m	Tailwater Elevation	293.84	m
Outlet Control HW Elev.	294.80	m	Control Type	Outlet Control	
Headwater Depth/Height	3.31				

Grades					
Upstream Invert	293.28	m	Downstream Invert	293.61	m
Length	23.19	m	Constructed Slope	-0.014230	m/m

Hydraulic Profile					
Profile	CompositeA2PressureProfile		Depth, Downstream	0.35	m
Slope Type	Adverse		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.35	m
Velocity Downstream	1.85	m/s	Critical Slope	0.027508	m/m

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

Outlet Control Properties					
Outlet Control HW Elev.	294.80	m	Upstream Velocity Head	0.12	m
Ke	0.90		Entrance Loss	0.11	m

Inlet Control Properties					
Inlet Control HW Elev.	294.28	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.2	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	1.3934	m³/s	Allowable HW Elevation	294.80	m
Roadway Width	7.00	m	Overtopping Coefficient	1.62	SI
Low Point	294.64	m	Headwater Elevation	294.80	m
Discharge Coefficient (Cr)	2.93		Submergence Factor (Kt)	1.00	
Tailwater Elevation	293.84	m			

Sta (m)	Elev. (m)
0.00	294.64
20.00	294.72
40.00	294.86
62.00	295.01
80.00	295.15
100.00	295.31
120.00	295.49

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	281.90	m	Discharge	0.7651	m³/s
Inlet Control HW Elev.	281.28	m	Tailwater Elevation	279.92	m
Outlet Control HW Elev.	281.90	m	Control Type	Outlet Control	
Headwater Depth/Height	3.60				

Grades					
Upstream Invert	279.71	m	Downstream Invert	279.62	m
Length	21.24	m	Constructed Slope	0.004237	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.55	m
Velocity Downstream	2.76	m/s	Critical Slope	0.042642	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	281.90	m	Upstream Velocity Head	0.35	m
Ke	0.90		Entrance Loss	0.32	m

Inlet Control Properties					
Inlet Control HW Elev.	281.28	m	Flow Control	Submerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	0.3361	m³/s	Allowable HW Elevation	281.90	m
Roadway Width	7.00	m	Overtopping Coefficient	1.61	SI
Low Point	281.84	m	Headwater Elevation	281.90	m
Discharge Coefficient (Cr)	2.92		Submergence Factor (Kt)	1.00	
Tailwater Elevation	279.92	m			

Sta (m)	Elev. (m)
0.00	281.96
20.00	281.92
40.00	281.84
44.00	281.94
60.00	281.86
80.00	281.90
100.00	281.94

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	275.29	m	Discharge	0.4400	m³/s
Inlet Control HW Elev.	275.25	m	Tailwater Elevation	274.50	m
Outlet Control HW Elev.	275.29	m	Control Type	Outlet Control	
Headwater Depth/Height	1.33				

Grades					
Upstream Invert	274.48	m	Downstream Invert	274.20	m
Length	23.66	m	Constructed Slope	0.011834	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.43	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.43	m
Velocity Downstream	1.98	m/s	Critical Slope	0.022065	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.61	m
Section Size	600 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	275.29	m	Upstream Velocity Head	0.12	m
Ke	0.90		Entrance Loss	0.11	m

Inlet Control Properties					
Inlet Control HW Elev.	275.25	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.3	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	288.10	m	Discharge	0.5049	m³/s
Inlet Control HW Elev.	288.00	m	Tailwater Elevation	287.12	m
Outlet Control HW Elev.	288.10	m	Control Type	Outlet Control	
Headwater Depth/Height	0.89				

Grades					
Upstream Invert	287.35	m	Downstream Invert	286.69	m
Length	150.00	m	Constructed Slope	0.004400	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.43	m
Slope Type	Mild		Normal Depth	0.63	m
Flow Regime	Subcritical		Critical Depth	0.42	m
Velocity Downstream	1.75	m/s	Critical Slope	0.014815	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.85	m
Section Size	850 mm		Rise	0.85	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	288.10	m	Upstream Velocity Head	0.06	m
Ke	0.90		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	288.00	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

PROPOSED CONDITION

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	7.5027	m³/s	Allowable HW Elevation	288.10	m
Roadway Width	9.10	m	Overtopping Coefficient	1.66	SI
Low Point	287.88	m	Headwater Elevation	288.10	m
Discharge Coefficient (Cr)	3.00		Submergence Factor (Kt)	1.00	
Tailwater Elevation	287.12	m			

Sta (m)	Elev. (m)
0.00	288.34
20.00	288.08
40.00	287.92
57.00	287.88
60.00	287.88
80.00	287.95
100.00	288.13

Culvert Calculator Report
Culvert_C4_Proposed_25_Year_ROP_2019_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	304.05	m	Headwater Depth/Height	0.63	
Computed Headwater Elev	302.17	m	Discharge	0.3800	m³/s
Inlet Control HW Elev.	302.14	m	Tailwater Elevation	301.72	m
Outlet Control HW Elev.	302.17	m	Control Type	Entrance Control	

Grades					
Upstream Invert	301.64	m	Downstream Invert	301.42	m
Length	26.00	m	Constructed Slope	0.008462	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.30	m
Slope Type	Steep		Normal Depth	0.30	m
Flow Regime	Supercritical		Critical Depth	0.36	m
Velocity Downstream	2.13	m/s	Critical Slope	0.004183	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	302.17	m	Upstream Velocity Head	0.14	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	302.14	m	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
Culvert_C4_Proposed_25_Year_ROP_2095_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	304.05	m	Headwater Depth/Height	0.70	
Computed Headwater Elev	302.22	m	Discharge	0.4500	m³/s
Inlet Control HW Elev.	302.19	m	Tailwater Elevation	301.72	m
Outlet Control HW Elev.	302.22	m	Control Type	Entrance Control	

Grades					
Upstream Invert	301.64	m	Downstream Invert	301.42	m
Length	26.00	m	Constructed Slope	0.008462	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.33	m
Slope Type	Steep		Normal Depth	0.33	m
Flow Regime	Supercritical		Critical Depth	0.40	m
Velocity Downstream	2.22	m/s	Critical Slope	0.004297	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	302.22	m	Upstream Velocity Head	0.15	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	302.19	m	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
Culvert_C5_Proposed_25_Year_ROP_2019_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	296.78	m	Headwater Depth/Height	0.57	
Computed Headwater Eleva	295.83	m	Discharge	1.3100	m³/s
Inlet Control HW Elev.	295.75	m	Tailwater Elevation	295.68	m
Outlet Control HW Elev.	295.83	m	Control Type	Outlet Control	

Grades					
Upstream Invert	295.20	m	Downstream Invert	295.13	m
Length	63.50	m	Constructed Slope	0.001102	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	0.52	m
Flow Regime	Subcritical		Critical Depth	0.35	m
Velocity Downstream	1.19	m/s	Critical Slope	0.003509	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	m
Section Size	2000 x 1100 mm		Rise	1.10	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	295.83	m	Upstream Velocity Head	0.08	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	295.75	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	2.2	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Calculator Report
Culvert_C5_Proposed_25_Year_ROP_2095_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	296.78	m	Headwater Depth/Height	0.64	
Computed Headwater Elev	295.91	m	Discharge	1.6600	m³/s
Inlet Control HW Elev.	295.85	m	Tailwater Elevation	295.68	m
Outlet Control HW Elev.	295.91	m	Control Type	Outlet Control	

Grades					
Upstream Invert	295.20	m	Downstream Invert	295.13	m
Length	63.50	m	Constructed Slope	0.001102	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	0.62	m
Flow Regime	Subcritical		Critical Depth	0.41	m
Velocity Downstream	1.51	m/s	Critical Slope	0.003528	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	m
Section Size	2000 x 1100 mm		Rise	1.10	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	295.91	m	Upstream Velocity Head	0.10	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	295.85	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	2.2	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Calculator Report
Culvert_C6_Proposed_25_Year_ROP_2019_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	299.48	m	Headwater Depth/Height	0.18	
Computed Headwater Eleva	297.32	m	Discharge	0.4000	m³/s
Inlet Control HW Elev.	297.31	m	Tailwater Elevation	297.31	m
Outlet Control HW Elev.	297.32	m	Control Type	Outlet Control	

Grades					
Upstream Invert	297.05	m	Downstream Invert	296.93	m
Length	25.85	m	Constructed Slope	0.004642	m/m

Hydraulic Profile					
Profile	S1		Depth, Downstream	0.38	m
Slope Type	Steep		Normal Depth	0.09	m
Flow Regime	Subcritical		Critical Depth	0.10	m
Velocity Downstream	0.25	m/s	Critical Slope	0.003834	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.27	m
Section Size	4267 X 1524		Rise	1.52	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	297.32	m	Upstream Velocity Head	0.01	m
Ke	0.70		Entrance Loss	0.00	m

Inlet Control Properties					
Inlet Control HW Elev.	297.31	m	Flow Control	Unsubmerged	
Inlet Type	0° wingwall flares		Area Full	6.5	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Calculator Report
Culvert_C6_Proposed_25_Year_ROP_2095_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	299.48	m	Headwater Depth/Height	0.18	
Computed Headwater Eleva	297.32	m	Discharge	0.4800	m³/s
Inlet Control HW Elev.	297.31	m	Tailwater Elevation	297.31	m
Outlet Control HW Elev.	297.32	m	Control Type	Outlet Control	

Grades					
Upstream Invert	297.05	m	Downstream Invert	296.93	m
Length	25.85	m	Constructed Slope	0.004642	m/m

Hydraulic Profile					
Profile	S1		Depth, Downstream	0.38	m
Slope Type	Steep		Normal Depth	0.10	m
Flow Regime	Subcritical		Critical Depth	0.11	m
Velocity Downstream	0.30	m/s	Critical Slope	0.003709	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.27	m
Section Size	4267 X 1524		Rise	1.52	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	297.32	m	Upstream Velocity Head	0.01	m
Ke	0.70		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	297.31	m	Flow Control	Unsubmerged	
Inlet Type	0° wingwall flares		Area Full	6.5	m²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Calculator Report
Culvert_C7_Proposed_25_Year_ROP_2019_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	294.68	m	Headwater Depth/Height	0.45	
Computed Headwater Elev	294.04	m	Discharge	0.7500	m³/s
Inlet Control HW Elev.	294.04	m	Tailwater Elevation	293.73	m
Outlet Control HW Elev.	294.04	m	Control Type	Entrance Control	

Grades					
Upstream Invert	293.63	m	Downstream Invert	293.28	m
Length	23.70	m	Constructed Slope	0.014768	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.45	m
Slope Type	Steep		Normal Depth	0.00	m
Flow Regime	N/A		Critical Depth	0.26	m
Velocity Downstream	0.91	m/s	Critical Slope	0.003626	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.83	m
Section Size	1830 x 910 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	294.04	m	Upstream Velocity Head	0.13	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	294.04	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	1.7	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Calculator Report
Culvert_C7_Proposed_25_Year_ROP_2095_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	294.68	m	Headwater Depth/Height	0.52	
Computed Headwater Elev	294.11	m	Discharge	0.9400	m³/s
Inlet Control HW Elev.	294.10	m	Tailwater Elevation	293.73	m
Outlet Control HW Elev.	294.11	m	Control Type	Entrance Control	

Grades					
Upstream Invert	293.63	m	Downstream Invert	293.28	m
Length	23.70	m	Constructed Slope	0.014768	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.45	m
Slope Type	Steep		Normal Depth	0.00	m
Flow Regime	N/A		Critical Depth	0.30	m
Velocity Downstream	1.14	m/s	Critical Slope	0.003614	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.83	m
Section Size	1830 x 910 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	294.11	m	Upstream Velocity Head	0.15	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	294.10	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	1.7	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Calculator Report
Culvert_C8_Proposed_25_Year_ROP_2019_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	281.88	m	Headwater Depth/Height	1.15	
Computed Headwater Elev	280.59	m	Discharge	0.8100	m³/s
Inlet Control HW Elev.	280.57	m	Tailwater Elevation	280.00	m
Outlet Control HW Elev.	280.59	m	Control Type	Outlet Control	

Grades					
Upstream Invert	279.71	m	Downstream Invert	279.62	m
Length	21.30	m	Constructed Slope	0.004225	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.56	m
Slope Type	Mild		Normal Depth	0.70	m
Flow Regime	Subcritical		Critical Depth	0.56	m
Velocity Downstream	2.27	m/s	Critical Slope	0.006249	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	280.59	m	Upstream Velocity Head	0.20	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties					
Inlet Control HW Elev.	280.57	m	Flow Control	Transition	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.5	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
Culvert_C8_Proposed_25_Year_ROP_2095_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	281.88	m	Headwater Depth/Height	1.34	
Computed Headwater Eleva	280.73	m	Discharge	0.9800	m³/s
Inlet Control HW Elev.	280.71	m	Tailwater Elevation	280.00	m
Outlet Control HW Elev.	280.73	m	Control Type	Outlet Control	

Grades					
Upstream Invert	279.71	m	Downstream Invert	279.62	m
Length	21.30	m	Constructed Slope	0.004225	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.61	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.61	m
Velocity Downstream	2.51	m/s	Critical Slope	0.007459	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	280.73	m	Upstream Velocity Head	0.24	m
Ke	0.20		Entrance Loss	0.05	m

Inlet Control Properties					
Inlet Control HW Elev.	280.71	m	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.5	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
Culvert_C9_Proposed_25_Year_ROP_2019_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	276.22 m		Headwater Depth/Height	0.56	
Computed Headwater Elev	275.11 m		Discharge	0.3000	m³/s
Inlet Control HW Elev.	275.08 m		Tailwater Elevation	274.46	m
Outlet Control HW Elev.	275.11 m		Control Type	Entrance Control	

Grades					
Upstream Invert	274.64 m		Downstream Invert	274.05	m
Length	49.40 m		Constructed Slope	0.011943	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.41	m
Slope Type	Steep		Normal Depth	0.24	m
Flow Regime	N/A		Critical Depth	0.32	m
Velocity Downstream	1.12	m/s	Critical Slope	0.004079	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	275.11 m		Upstream Velocity Head	0.12	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	275.08 m		Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
Culvert_C9_Proposed_25_Year_ROP_2095_IDF

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	276.22	m	Headwater Depth/Height	0.61	
Computed Headwater Elev	275.15	m	Discharge	0.3500	m³/s
Inlet Control HW Elev.	275.12	m	Tailwater Elevation	274.46	m
Outlet Control HW Elev.	275.15	m	Control Type	Entrance Control	

Grades					
Upstream Invert	274.64	m	Downstream Invert	274.05	m
Length	49.40	m	Constructed Slope	0.011943	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.41	m
Slope Type	Steep		Normal Depth	0.26	m
Flow Regime	N/A		Critical Depth	0.35	m
Velocity Downstream	1.30	m/s	Critical Slope	0.004140	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	275.15	m	Upstream Velocity Head	0.13	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	275.12	m	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	288.14	m	Discharge	0.5331	m³/s
Inlet Control HW Elev.	288.03	m	Tailwater Elevation	287.12	m
Outlet Control HW Elev.	288.14	m	Control Type	Outlet Control	
Headwater Depth/Height	0.92				

Grades					
Upstream Invert	287.35	m	Downstream Invert	286.69	m
Length	150.00	m	Constructed Slope	0.004400	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.43	m
Slope Type	Mild		Normal Depth	0.66	m
Flow Regime	Subcritical		Critical Depth	0.43	m
Velocity Downstream	1.83	m/s	Critical Slope	0.014999	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.85	m
Section Size	850 mm		Rise	0.85	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	288.14	m	Upstream Velocity Head	0.06	m
Ke	0.90		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	288.03	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	10.0392	m³/s	Allowable HW Elevation	288.14	m
Roadway Width	9.10	m	Overtopping Coefficient	1.66	SI
Low Point	287.88	m	Headwater Elevation	288.14	m
Discharge Coefficient (Cr)	3.01		Submergence Factor (Kt)	1.00	
Tailwater Elevation	287.12	m			

Sta (m)	Elev. (m)
0.00	288.34
20.00	288.08
40.00	287.92
57.00	287.88
60.00	287.88
80.00	287.95
100.00	288.13

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	302.29	m	Discharge	0.5500	m³/s
Inlet Control HW Elev.	302.26	m	Tailwater Elevation	301.83	m
Outlet Control HW Elev.	302.29	m	Control Type	Entrance Control	
Headwater Depth/Height	0.78				

Grades					
Upstream Invert	301.64	m	Downstream Invert	301.42	m
Length	26.00	m	Constructed Slope	0.008462	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.37	m
Slope Type	Steep		Normal Depth	0.37	m
Flow Regime	Supercritical		Critical Depth	0.44	m
Velocity Downstream	2.34	m/s	Critical Slope	0.004496	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	302.29	m	Upstream Velocity Head	0.18	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties					
Inlet Control HW Elev.	302.26	m	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	295.96	m	Discharge	1.9000	m³/s
Inlet Control HW Elev.	295.91	m	Tailwater Elevation	295.68	m
Outlet Control HW Elev.	295.96	m	Control Type	Outlet Control	
Headwater Depth/Height	0.69				

Grades					
Upstream Invert	295.20	m	Downstream Invert	295.13	m
Length	63.50	m	Constructed Slope	0.001102	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	0.68	m
Flow Regime	Subcritical		Critical Depth	0.45	m
Velocity Downstream	1.73	m/s	Critical Slope	0.003550	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	m
Section Size	2000 x 1100 mm		Rise	1.10	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	295.96	m	Upstream Velocity Head	0.12	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	295.91	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	2.2	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	297.76	m	Discharge	0.5900	m³/s
Inlet Control HW Elev.	297.74	m	Tailwater Elevation	297.31	m
Outlet Control HW Elev.	297.76	m	Control Type	Outlet Control	
Headwater Depth/Height	0.93				

Grades					
Upstream Invert	297.05	m	Downstream Invert	296.93	m
Length	25.85	m	Constructed Slope	0.004642	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.47	m
Slope Type	Mild		Normal Depth	0.49	m
Flow Regime	Subcritical		Critical Depth	0.47	m
Velocity Downstream	1.98	m/s	Critical Slope	0.005168	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	297.76	m	Upstream Velocity Head	0.18	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties					
Inlet Control HW Elev.	297.74	m	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.5	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	294.16	m	Discharge	1.0900	m³/s
Inlet Control HW Elev.	294.15	m	Tailwater Elevation	293.73	m
Outlet Control HW Elev.	294.16	m	Control Type	Entrance Control	
Headwater Depth/Height	0.58				

Grades					
Upstream Invert	293.63	m	Downstream Invert	293.28	m
Length	23.70	m	Constructed Slope	0.014768	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.45	m
Slope Type	Steep		Normal Depth	0.21	m
Flow Regime	N/A		Critical Depth	0.33	m
Velocity Downstream	1.32	m/s	Critical Slope	0.003617	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.83	m
Section Size	1830 x 910 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	294.16	m	Upstream Velocity Head	0.17	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	294.15	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	1.7	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	280.95	m	Discharge	1.1700	m³/s
Inlet Control HW Elev.	280.87	m	Tailwater Elevation	280.00	m
Outlet Control HW Elev.	280.95	m	Control Type	Outlet Control	
Headwater Depth/Height	1.63				

Grades					
Upstream Invert	279.71	m	Downstream Invert	279.62	m
Length	21.30	m	Constructed Slope	0.004225	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.66	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.66	m
Velocity Downstream	2.80	m/s	Critical Slope	0.009358	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	280.95	m	Upstream Velocity Head	0.34	m
Ke	0.20		Entrance Loss	0.07	m

Inlet Control Properties					
Inlet Control HW Elev.	280.87	m	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.5	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	275.21	m	Discharge	0.4300	m³/s
Inlet Control HW Elev.	275.18	m	Tailwater Elevation	274.46	m
Outlet Control HW Elev.	275.21	m	Control Type	Entrance Control	
Headwater Depth/Height	0.68				

Grades					
Upstream Invert	274.64	m	Downstream Invert	274.05	m
Length	49.40	m	Constructed Slope	0.011943	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.41	m
Slope Type	Steep		Normal Depth	0.29	m
Flow Regime	N/A		Critical Depth	0.39	m
Velocity Downstream	1.60	m/s	Critical Slope	0.004261	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	275.21	m	Upstream Velocity Head	0.15	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	275.18	m	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	288.16	m	Discharge	0.5496	m³/s
Inlet Control HW Elev.	288.04	m	Tailwater Elevation	287.12	m
Outlet Control HW Elev.	288.16	m	Control Type	Outlet Control	
Headwater Depth/Height	0.95				

Grades					
Upstream Invert	287.35	m	Downstream Invert	286.69	m
Length	150.00	m	Constructed Slope	0.004400	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.44	m
Slope Type	Mild		Normal Depth	0.68	m
Flow Regime	Subcritical		Critical Depth	0.44	m
Velocity Downstream	1.85	m/s	Critical Slope	0.015112	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	0.85	m
Section Size	850 mm		Rise	0.85	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	288.16	m	Upstream Velocity Head	0.06	m
Ke	0.90		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	288.04	m	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	0.6	m²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Analysis Report
Weir

Hydraulic Component(s): Roadway					
Discharge	11.8637	m³/s	Allowable HW Elevation	288.16	m
Roadway Width	9.10	m	Overtopping Coefficient	1.67	SI
Low Point	287.88	m	Headwater Elevation	288.16	m
Discharge Coefficient (Cr)	3.02		Submergence Factor (Kt)	1.00	
Tailwater Elevation	287.12	m			

Sta (m)	Elev. (m)
0.00	288.34
20.00	288.08
40.00	287.92
57.00	287.88
60.00	287.88
80.00	287.95
100.00	288.13

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	302.29	m	Discharge	0.5400	m³/s
Inlet Control HW Elev.	302.26	m	Tailwater Elevation	301.83	m
Outlet Control HW Elev.	302.29	m	Control Type	Entrance Control	
Headwater Depth/Height	0.77				

Grades					
Upstream Invert	301.64	m	Downstream Invert	301.42	m
Length	26.00	m	Constructed Slope	0.008462	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.37	m
Slope Type	Steep		Normal Depth	0.36	m
Flow Regime	Supercritical		Critical Depth	0.44	m
Velocity Downstream	2.33	m/s	Critical Slope	0.004474	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	302.29	m	Upstream Velocity Head	0.17	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	302.26	m	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	296.09	m	Discharge	2.4400	m³/s
Inlet Control HW Elev.	296.04	m	Tailwater Elevation	295.68	m
Outlet Control HW Elev.	296.09	m	Control Type	Outlet Control	
Headwater Depth/Height	0.81				

Grades					
Upstream Invert	295.20	m	Downstream Invert	295.13	m
Length	63.50	m	Constructed Slope	0.001102	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.55	m
Slope Type	Mild		Normal Depth	0.81	m
Flow Regime	Subcritical		Critical Depth	0.53	m
Velocity Downstream	2.22	m/s	Critical Slope	0.003614	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	m
Section Size	2000 x 1100 mm		Rise	1.10	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	296.09	m	Upstream Velocity Head	0.15	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	296.04	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	2.2	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Analysis Report
Culvert-1

Component:Culvert-1

Culvert Summary					
Computed Headwater Elev	297.34	m	Discharge	0.8000	m³/s
Inlet Control HW Elev.	297.31	m	Tailwater Elevation	297.31	m
Outlet Control HW Elev.	297.34	m	Control Type	Outlet Control	
Headwater Depth/Height	0.19				

Grades					
Upstream Invert	297.05	m	Downstream Invert	296.93	m
Length	25.85	m	Constructed Slope	0.004642	m/m

Hydraulic Profile					
Profile	S1		Depth, Downstream	0.38	m
Slope Type	Steep		Normal Depth	0.14	m
Flow Regime	Subcritical		Critical Depth	0.15	m
Velocity Downstream	0.49	m/s	Critical Slope	0.003398	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.27	m
Section Size	4267 X 1524		Rise	1.52	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	297.34	m	Upstream Velocity Head	0.03	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	297.31	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	6.5	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	294.33	m	Discharge	1.6400	m³/s
Inlet Control HW Elev.	294.31	m	Tailwater Elevation	293.73	m
Outlet Control HW Elev.	294.33	m	Control Type	Entrance Control	
Headwater Depth/Height	0.76				

Grades					
Upstream Invert	293.63	m	Downstream Invert	293.28	m
Length	23.70	m	Constructed Slope	0.014768	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.45	m
Slope Type	Steep		Normal Depth	0.27	m
Flow Regime	N/A		Critical Depth	0.43	m
Velocity Downstream	1.99	m/s	Critical Slope	0.003674	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.83	m
Section Size	1830 x 910 mm		Rise	0.91	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	294.33	m	Upstream Velocity Head	0.22	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties					
Inlet Control HW Elev.	294.31	m	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	1.7	m²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	280.87	m	Discharge	1.1000	m³/s
Inlet Control HW Elev.	280.80	m	Tailwater Elevation	280.00	m
Outlet Control HW Elev.	280.87	m	Control Type	Outlet Control	
Headwater Depth/Height	1.52				

Grades					
Upstream Invert	279.71	m	Downstream Invert	279.62	m
Length	21.30	m	Constructed Slope	0.004225	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.64	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.64	m
Velocity Downstream	2.69	m/s	Critical Slope	0.008581	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	280.87	m	Upstream Velocity Head	0.30	m
Ke	0.20		Entrance Loss	0.06	m

Inlet Control Properties					
Inlet Control HW Elev.	280.80	m	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.5	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Analysis Report
Culvert-1

Culvert Summary					
Computed Headwater Elev	275.22	m	Discharge	0.4400	m³/s
Inlet Control HW Elev.	275.19	m	Tailwater Elevation	274.46	m
Outlet Control HW Elev.	275.22	m	Control Type	Entrance Control	
Headwater Depth/Height	0.69				

Grades					
Upstream Invert	274.64	m	Downstream Invert	274.05	m
Length	49.40	m	Constructed Slope	0.011943	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.41	m
Slope Type	Steep		Normal Depth	0.30	m
Flow Regime	N/A		Critical Depth	0.39	m
Velocity Downstream	1.64	m/s	Critical Slope	0.004279	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	275.22	m	Upstream Velocity Head	0.15	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	275.19	m	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

APPENDIX J: HEC-RAS OUTPUTS

EXISTING CONDITION

Existing Culvert C1 (River Station: 2391.91) - Region of Peel 2019 IDF Curves

HEC-RAS Plan: Plan 01 (Existing C1 - ROP 2019 IDF) River: centreville_6_13 Reach: 6.13

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
6.13	2509.29	Regional	19.11	315.17	316.89		316.89	0.000019	0.07	287.69	215.97	0.02
6.13	2509.29	100-Year	2.99	315.17	316.56		316.56	0.000001	0.01	218.75	201.61	0.00
6.13	2509.29	50-Year	2.65	315.17	316.56		316.56	0.000001	0.01	218.73	201.61	0.00
6.13	2509.29	25-Year	2.34	315.17	316.56		316.56	0.000001	0.01	218.71	201.60	0.00
6.13	2509.29	10-Year	1.91	315.17	316.56		316.56	0.000000	0.01	218.69	201.60	0.00
6.13	2509.29	5-Year	1.57	315.17	316.33		316.33	0.000001	0.01	173.87	190.83	0.00
6.13	2509.29	2-Year	1.11	315.17	315.44		315.44	0.000115	0.04	25.57	137.82	0.03
6.13	2394.7	Regional	24.15	314.06	316.88	316.20	316.88	0.000126	0.19	127.54	162.68	0.07
6.13	2394.7	100-Year	4.72	314.06	316.56	315.36	316.56	0.000016	0.06	80.15	126.06	0.02
6.13	2394.7	50-Year	4.02	314.06	316.56	315.23	316.56	0.000012	0.05	80.16	126.07	0.02
6.13	2394.7	25-Year	3.25	314.06	316.56	315.07	316.56	0.000008	0.04	80.16	126.07	0.02
6.13	2394.7	10-Year	2.41	314.06	316.56	314.89	316.56	0.000004	0.03	80.16	126.07	0.01
6.13	2394.7	5-Year	1.98	314.06	316.33	314.79	316.33	0.000007	0.04	54.71	97.10	0.02
6.13	2394.7	2-Year	1.41	314.06	315.33	314.64	315.39	0.005698	1.08	1.30	18.86	0.31
6.13	2391.91		Culvert									
6.13	2389.127	Regional	24.15	313.74	315.61	315.61	315.78	0.039793	1.84	13.10	38.81	1.01
6.13	2389.127	100-Year	4.72	313.74	315.04	315.04	315.67	0.065283	3.54	1.33	1.06	1.00
6.13	2389.127	50-Year	4.02	313.74	314.90	314.90	315.48	0.063150	3.36	1.20	1.05	1.00
6.13	2389.127	25-Year	3.25	313.74	314.75	314.75	315.25	0.059457	3.12	1.04	1.05	0.99
6.13	2389.127	10-Year	2.41	313.74	314.57	314.57	314.98	0.056443	2.83	0.85	1.04	1.00
6.13	2389.127	5-Year	1.98	313.74	314.47	314.47	314.83	0.054823	2.65	0.75	1.04	1.00
6.13	2389.127	2-Year	1.41	313.74	314.32	314.32	314.61	0.053735	2.39	0.59	1.04	1.01
6.13	2328.361	Regional	24.15	312.18	313.40		313.47	0.022896	1.18	20.50	41.60	0.54
6.13	2328.361	100-Year	4.72	312.18	312.85		312.89	0.025044	0.94	5.03	15.32	0.52
6.13	2328.361	50-Year	4.02	312.18	312.80		312.85	0.024444	0.92	4.37	13.45	0.52
6.13	2328.361	25-Year	3.25	312.18	312.76		312.79	0.024255	0.87	3.74	12.50	0.51
6.13	2328.361	10-Year	2.41	312.18	312.69		312.73	0.024288	0.80	3.01	11.37	0.50
6.13	2328.361	5-Year	1.98	312.18	312.66		312.69	0.024426	0.76	2.60	10.64	0.49
6.13	2328.361	2-Year	1.41	312.18	312.60		312.63	0.024397	0.69	2.03	9.58	0.48

Existing Culvert C1 (River Station: 2391.91) - Region of Peel 2095 IDF Curves

HEC-RAS Plan: Plan 02 (Existing C1 - ROP 2095 IDF) River: centreville_6_13 Reach: 6.13

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
6.13	2509.29	Regional	19.11	315.17	316.89		316.89	0.000019	0.07	287.69	215.97	0.02
6.13	2509.29	100-Year	2.99	315.17	316.56		316.56	0.000001	0.01	219.51	201.78	0.00
6.13	2509.29	50-Year	2.65	315.17	316.56		316.56	0.000001	0.01	218.75	201.61	0.00
6.13	2509.29	25-Year	2.34	315.17	316.56		316.56	0.000001	0.01	218.73	201.60	0.00
6.13	2509.29	10-Year	1.91	315.17	316.56		316.56	0.000000	0.01	218.70	201.60	0.00
6.13	2509.29	5-Year	1.57	315.17	316.56		316.56	0.000000	0.01	218.70	201.60	0.00
6.13	2509.29	2-Year	1.11	315.17	315.53		315.53	0.000030	0.03	38.99	143.99	0.02
6.13	2394.7	Regional	24.15	314.06	316.88	316.20	316.88	0.000126	0.19	127.54	162.68	0.07
6.13	2394.7	100-Year	5.66	314.06	316.56	315.53	316.56	0.000023	0.07	80.61	126.49	0.03
6.13	2394.7	50-Year	4.83	314.06	316.56	315.38	316.56	0.000017	0.06	80.15	126.06	0.02
6.13	2394.7	25-Year	3.87	314.06	316.56	315.20	316.56	0.000011	0.05	80.16	126.07	0.02
6.13	2394.7	10-Year	2.84	314.06	316.56	314.98	316.56	0.000006	0.04	80.16	126.07	0.01
6.13	2394.7	5-Year	2.31	314.06	316.56	314.87	316.56	0.000004	0.03	80.17	126.08	0.01
6.13	2394.7	2-Year	1.49	314.06	315.46	314.66	315.52	0.004604	1.04	1.44	26.49	0.28
6.13	2391.91		Culvert									
6.13	2389.127	Regional	24.15	313.74	315.61	315.61	315.78	0.039793	1.84	13.10	38.81	1.01
6.13	2389.127	100-Year	5.66	313.74	315.20	315.20	315.92	0.067291	3.75	1.51	13.64	1.00
6.13	2389.127	50-Year	4.83	313.74	315.06	315.06	315.70	0.065582	3.56	1.36	1.06	1.00
6.13	2389.127	25-Year	3.87	313.74	314.87	314.87	315.44	0.063014	3.33	1.16	1.05	1.00
6.13	2389.127	10-Year	2.84	313.74	314.67	314.67	315.12	0.057944	2.99	0.95	1.05	0.99
6.13	2389.127	5-Year	2.31	313.74	314.55	314.55	314.94	0.055953	2.79	0.83	1.04	0.99
6.13	2389.127	2-Year	1.49	313.74	314.34	314.34	314.64	0.053771	2.43	0.61	1.04	1.00
6.13	2328.361	Regional	24.15	312.18	313.40		313.47	0.022896	1.18	20.50	41.60	0.54
6.13	2328.361	100-Year	5.66	312.18	312.90		312.95	0.025773	0.97	5.84	17.33	0.53
6.13	2328.361	50-Year	4.83	312.18	312.86		312.90	0.025270	0.94	5.12	15.54	0.53
6.13	2328.361	25-Year	3.87	312.18	312.79		312.84	0.024373	0.91	4.25	13.26	0.51
6.13	2328.361	10-Year	2.84	312.18	312.73		312.76	0.024293	0.84	3.39	11.99	0.50
6.13	2328.361	5-Year	2.31	312.18	312.69		312.72	0.024291	0.79	2.92	11.22	0.50
6.13	2328.361	2-Year	1.49	312.18	312.61		312.63	0.024413	0.70	2.12	9.73	0.48

Existing Culvert C3 (River Station: 7.662)

HEC-RAS Plan: Existing River: Centreville Cree Reach: Reach 5

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach 5	7.666	2-Year	5.49	287.00	288.32	287.79	288.37	0.001262	1.06	6.84	104.31	0.32
Reach 5	7.666	5-Year	8.01	287.00	288.51	287.96	288.55	0.001060	1.08	20.50	121.89	0.30
Reach 5	7.666	10-Year	9.78	287.00	288.53	288.04	288.58	0.001367	1.24	22.29	122.81	0.34
Reach 5	7.666	25-Year	12.54	287.00	288.76	288.17	288.77	0.000294	0.64	52.91	138.83	0.16
Reach 5	7.666	50-Year	14.48	287.00	288.92	288.55	288.92	0.000145	0.48	75.85	151.70	0.12
Reach 5	7.666	100-Year	16.49	287.00	288.64	288.57	288.68	0.001313	1.28	36.81	130.04	0.34
Reach 5	7.666	Regional	39.98	287.00	289.30	288.71	289.31	0.000196	0.64	140.01	183.50	0.14
Reach 5	7.665		Bridge									
Reach 5	7.664	2-Year	5.49	287.00	288.28		288.32	0.007772	0.91	6.28	108.28	0.33
Reach 5	7.664	5-Year	8.01	287.00	288.52		288.52	0.000978	0.39	32.89	133.14	0.12
Reach 5	7.664	10-Year	9.78	287.00	288.53		288.54	0.001198	0.43	35.14	134.58	0.13
Reach 5	7.664	25-Year	12.54	287.00	288.76	288.39	288.76	0.000252	0.23	67.86	154.60	0.06
Reach 5	7.664	50-Year	14.48	287.00	288.92	288.40	288.92	0.000122	0.17	93.27	168.01	0.05
Reach 5	7.664	100-Year	16.49	287.00	288.65		288.65	0.001099	0.44	50.73	144.17	0.13
Reach 5	7.664	Regional	39.98	287.00	289.30		289.31	0.000152	0.22	160.48	185.61	0.05
Reach 5	7.663	2-Year	5.49	287.00	288.20	287.73	288.28	0.002007	1.26	4.36	88.97	0.40
Reach 5	7.663	5-Year	8.01	287.00	288.34	287.89	288.47	0.002784	1.62	4.96	99.23	0.48
Reach 5	7.663	10-Year	9.78	287.00	288.43	287.99	288.50	0.003892	1.35	13.33	110.73	0.53
Reach 5	7.663	25-Year	12.54	287.00	288.14	288.14	288.61	0.012867	3.06	4.10	79.62	1.00
Reach 5	7.663	50-Year	14.48	287.00	288.23	288.23	288.76	0.012663	3.22	4.49	91.49	1.01
Reach 5	7.663	100-Year	16.49	287.00	288.62	288.50	288.64	0.001149	0.87	37.44	141.56	0.30
Reach 5	7.663	Regional	39.98	287.00	289.30	288.61	289.31	0.000118	0.41	153.65	193.95	0.10
Reach 5	7.662		Culvert									
Reach 5	7.661	2-Year	5.49	286.95	287.88		288.14	0.010096	2.26	2.44	14.74	0.79
Reach 5	7.661	5-Year	8.01	286.95	288.38		288.45	0.002483	1.35	12.70	112.52	0.42
Reach 5	7.661	10-Year	9.78	286.95	288.47		288.49	0.001139	0.96	22.46	126.74	0.29
Reach 5	7.661	25-Year	12.54	286.95	288.53		288.55	0.000843	0.86	30.91	136.76	0.25
Reach 5	7.661	50-Year	14.48	286.95	288.58		288.59	0.000686	0.79	37.16	143.56	0.23
Reach 5	7.661	100-Year	16.49	286.95	288.62		288.63	0.000553	0.73	44.26	150.89	0.20
Reach 5	7.661	Regional	39.98	286.95	289.30		289.31	0.000066	0.33	170.09	213.91	0.08

PROPOSED CONDITION

Proposed Culvert C1 (River Station: 2391.91) - Region of Peel 2019 IDF Curves

HEC-RAS Plan: Plan 01 (Proposed C1 - ROP 2019 IDF) River: centreville_6_13 Reach: 6.13

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
6.13	2509.29	Regional	19.11	315.17	316.82		316.82	0.000022	0.07	273.68	213.23	0.02
6.13	2509.29	100-Year	2.99	315.17	315.40	315.28	315.40	0.001640	0.14	20.74	136.42	0.12
6.13	2509.29	50-Year	2.65	315.17	315.38	315.28	315.38	0.002237	0.15	17.52	135.24	0.13
6.13	2509.29	25-Year	2.34	315.17	315.36	315.27	315.36	0.003162	0.16	14.59	134.05	0.16
6.13	2509.29	10-Year	1.91	315.17	315.34	315.26	315.34	0.004381	0.16	11.67	132.85	0.18
6.13	2509.29	5-Year	1.57	315.17	315.26	315.26	315.28	0.200740	0.59	2.66	77.71	1.02
6.13	2509.29	2-Year	1.11	315.17	315.25	315.25	315.26	0.194949	0.55	2.02	64.07	0.99
6.13	2404.913	Regional	24.15	314.06	316.82	315.71	316.82	0.000147	0.20	119.95	156.36	0.07
6.13	2404.913	100-Year	4.72	314.06	314.89	314.62	315.02	0.007613	1.55	3.05	3.69	0.54
6.13	2404.913	50-Year	4.02	314.06	314.81	314.56	314.92	0.007928	1.47	2.74	3.69	0.54
6.13	2404.913	25-Year	3.25	314.06	314.71	314.49	314.80	0.008409	1.37	2.37	3.68	0.54
6.13	2404.913	10-Year	2.41	314.06	314.59	314.41	314.67	0.009044	1.24	1.94	3.68	0.55
6.13	2404.913	5-Year	1.98	314.06	314.52	314.37	314.59	0.009515	1.17	1.70	3.68	0.55
6.13	2404.913	2-Year	1.41	314.06	314.43	314.31	314.48	0.010311	1.04	1.35	3.67	0.55
6.13	2391.913		Culvert									
6.13	2378.913	Regional	24.15	313.74	315.38	315.38	316.21	0.020730	4.01	6.02	26.72	1.00
6.13	2378.913	100-Year	4.72	313.74	314.29	314.29	314.57	0.029702	2.33	2.03	3.67	1.00
6.13	2378.913	50-Year	4.02	313.74	314.24	314.24	314.49	0.030756	2.20	1.82	3.67	1.00
6.13	2378.913	25-Year	3.25	313.74	314.17	314.17	314.39	0.032245	2.05	1.58	3.67	1.00
6.13	2378.913	10-Year	2.41	313.74	314.09	314.09	314.27	0.034940	1.87	1.29	3.67	1.00
6.13	2378.913	5-Year	1.98	313.74	314.05	314.05	314.21	0.035292	1.73	1.14	3.67	0.99
6.13	2378.913	2-Year	1.41	313.74	314.00	313.99	314.11	0.034657	1.50	0.94	3.66	0.95
6.13	2328.361	Regional	24.15	312.18	313.40		313.47	0.022896	1.18	20.50	41.60	0.54
6.13	2328.361	100-Year	4.72	312.18	312.85		312.89	0.025044	0.94	5.03	15.32	0.52
6.13	2328.361	50-Year	4.02	312.18	312.80		312.85	0.024444	0.92	4.37	13.45	0.52
6.13	2328.361	25-Year	3.25	312.18	312.76		312.79	0.024255	0.87	3.74	12.50	0.51
6.13	2328.361	10-Year	2.41	312.18	312.69		312.73	0.024288	0.80	3.01	11.37	0.50
6.13	2328.361	5-Year	1.98	312.18	312.66		312.69	0.024426	0.76	2.60	10.64	0.49
6.13	2328.361	2-Year	1.41	312.18	312.60		312.63	0.024397	0.69	2.03	9.58	0.48

Proposed Culvert C1 (River Station: 2391.91) - Region of Peel 2095 IDF Curves

HEC-RAS Plan: Plan 02 (Proposed C1 - ROP 2095 IDF) River: centreville_6_13 Reach: 6.13

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
6.13	2509.29	Regional	19.11	315.17	316.82		316.82	0.000022	0.07	273.68	213.23	0.02
6.13	2509.29	100-Year	2.99	315.17	315.44		315.44	0.000833	0.12	25.51	137.80	0.09
6.13	2509.29	50-Year	2.65	315.17	315.40	315.28	315.40	0.001368	0.13	20.37	136.32	0.11
6.13	2509.29	25-Year	2.34	315.17	315.37	315.27	315.37	0.002212	0.14	16.28	134.74	0.13
6.13	2509.29	10-Year	1.91	315.17	315.34	315.26	315.34	0.003449	0.15	12.55	133.21	0.16
6.13	2509.29	5-Year	1.57	315.17	315.33	315.26	315.33	0.004206	0.15	10.48	132.36	0.17
6.13	2509.29	2-Year	1.11	315.17	315.31	315.25	315.31	0.005522	0.15	7.65	123.29	0.19
6.13	2404.913	Regional	24.15	314.06	316.82	315.71	316.82	0.000147	0.20	119.95	156.36	0.07
6.13	2404.913	100-Year	5.66	314.06	315.05	314.69	315.18	0.006109	1.56	3.64	3.70	0.50
6.13	2404.913	50-Year	4.83	314.06	314.91	314.62	315.03	0.007573	1.56	3.10	3.69	0.54
6.13	2404.913	25-Year	3.87	314.06	314.79	314.54	314.90	0.008011	1.45	2.67	3.69	0.54
6.13	2404.913	10-Year	2.84	314.06	314.65	314.45	314.74	0.008684	1.31	2.16	3.68	0.55
6.13	2404.913	5-Year	2.31	314.06	314.57	314.40	314.65	0.009154	1.23	1.88	3.68	0.55
6.13	2404.913	2-Year	1.49	314.06	314.44	314.31	314.50	0.010167	1.06	1.40	3.67	0.55
6.13	2391.913		Culvert									
6.13	2378.913	Regional	24.15	313.74	315.38	315.38	316.21	0.020730	4.01	6.02	26.72	1.00
6.13	2378.913	100-Year	5.66	313.74	314.37	314.37	314.68	0.028269	2.46	2.30	3.67	0.99
6.13	2378.913	50-Year	4.83	313.74	314.30	314.30	314.58	0.029431	2.34	2.06	3.67	1.00
6.13	2378.913	25-Year	3.87	313.74	314.23	314.23	314.47	0.031150	2.18	1.78	3.67	1.00
6.13	2378.913	10-Year	2.84	313.74	314.13	314.13	314.33	0.033633	1.97	1.44	3.67	1.00
6.13	2378.913	5-Year	2.31	313.74	314.08	314.08	314.26	0.034639	1.83	1.26	3.67	1.00
6.13	2378.913	2-Year	1.49	313.74	314.00	314.00	314.13	0.034852	1.54	0.97	3.66	0.96
6.13	2328.361	Regional	24.15	312.18	313.40		313.47	0.022896	1.18	20.50	41.60	0.54
6.13	2328.361	100-Year	5.66	312.18	312.90		312.95	0.025773	0.97	5.84	17.33	0.53
6.13	2328.361	50-Year	4.83	312.18	312.86		312.90	0.025270	0.94	5.12	15.54	0.53
6.13	2328.361	25-Year	3.87	312.18	312.79		312.84	0.024373	0.91	4.25	13.26	0.51
6.13	2328.361	10-Year	2.84	312.18	312.73		312.76	0.024293	0.84	3.39	11.99	0.50
6.13	2328.361	5-Year	2.31	312.18	312.69		312.72	0.024291	0.79	2.92	11.22	0.50
6.13	2328.361	2-Year	1.49	312.18	312.61		312.63	0.024413	0.70	2.12	9.73	0.48

Proposed Culvert C3 (River Station: 7.662)

HEC-RAS Plan: Proposed (09-24-2019) River: Centreville Cree Reach: Reach 5

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach 5	7.666	2-Year	5.49	287.00	288.11	287.79	288.19	0.002765	1.36	5.20	80.29	0.46
Reach 5	7.666	5-Year	8.01	287.00	288.30	287.95	288.41	0.002868	1.58	6.69	102.39	0.48
Reach 5	7.666	10-Year	9.78	287.00	288.40	288.04	288.53	0.003110	1.74	7.45	111.70	0.51
Reach 5	7.666	25-Year	12.54	287.00	288.69	288.17	288.70	0.000503	0.81	43.28	133.29	0.21
Reach 5	7.666	50-Year	14.48	287.00	288.83	288.55	288.83	0.000251	0.61	62.27	144.18	0.15
Reach 5	7.666	100-Year	16.49	287.00	288.57	288.57	288.66	0.002491	1.71	27.98	125.69	0.47
Reach 5	7.666	Regional	39.98	287.00	289.05	288.71	289.06	0.000570	1.00	96.01	161.72	0.24
Reach 5	7.665		Bridge									
Reach 5	7.664	2-Year	5.49	287.00	287.80	287.80	288.04	0.088333	2.16	2.54	60.31	1.01
Reach 5	7.664	5-Year	8.01	287.00	287.96	287.96	288.23	0.082726	2.32	3.45	66.62	1.00
Reach 5	7.664	10-Year	9.78	287.00	288.08	288.08	288.34	0.072772	2.28	4.37	86.38	0.95
Reach 5	7.664	25-Year	12.54	287.00	288.18	288.18	288.48	0.067293	2.44	5.32	97.18	0.94
Reach 5	7.664	50-Year	14.48	287.00	288.22	288.22	288.56	0.070644	2.62	5.76	102.06	0.98
Reach 5	7.664	100-Year	16.49	287.00	288.41	288.41	288.48	0.015715	1.44	19.76	120.73	0.48
Reach 5	7.664	Regional	39.98	287.00	289.05		289.05	0.000459	0.35	115.01	169.48	0.09
Reach 5	7.663	2-Year	5.49	286.71	287.31	286.98	287.34	0.001380	0.75	7.29	17.12	0.31
Reach 5	7.663	5-Year	8.01	286.71	287.48	287.06	287.52	0.001272	0.85	9.37	18.53	0.31
Reach 5	7.663	10-Year	9.78	286.71	287.56	287.11	287.61	0.001340	0.94	10.40	19.22	0.33
Reach 5	7.663	25-Year	12.54	286.71	288.00	287.18	288.04	0.000548	0.79	15.79	60.69	0.22
Reach 5	7.663	50-Year	14.48	286.71	288.14	287.24	288.18	0.000522	0.83	17.46	80.23	0.22
Reach 5	7.663	100-Year	16.49	286.71	288.30	287.28	288.34	0.000473	0.85	19.45	96.98	0.21
Reach 5	7.663	Regional	39.98	286.71	289.05	287.74	289.05	0.000076	0.40	160.03	178.27	0.09
Reach 5	7.662		Bridge									
Reach 5	7.661	2-Year	5.49	286.71	287.27	286.99	287.31	0.001691	0.80	6.86	13.94	0.34
Reach 5	7.661	5-Year	8.01	286.71	287.45	287.06	287.49	0.001462	0.89	8.99	14.48	0.33
Reach 5	7.661	10-Year	9.78	286.71	287.53	287.11	287.58	0.001530	0.98	9.99	14.73	0.35
Reach 5	7.661	25-Year	12.54	286.71	287.94		287.98	0.000648	0.84	15.01	43.60	0.24
Reach 5	7.661	50-Year	14.48	286.71	288.05		288.09	0.000649	0.88	16.36	75.88	0.24
Reach 5	7.661	100-Year	16.49	286.71	288.18		288.22	0.000619	0.92	17.94	93.39	0.24
Reach 5	7.661	Regional	39.98	286.71	289.04		289.05	0.000063	0.30	162.31	194.07	0.07

APPENDIX K: AIRPORT ROAD PROFILE CONSTRAINT AT CENTREVILLE CREEK CULVERT

CULVERT C2

0mm CSP
NGTH= 150m
INV.= 287.35M
T INV.= 286.69M

CULVERT C

4.35M x 1.0M BOX
LENGTH= 18.18m
IN INV.= 286.71M
OUT INV.= 286.80

CENTREVILLE CREEK

Road Segment To Be
Impacted by Profile Raise

Proposed Structure:
14.64m X 1.3m

APPENDIX L: STORM SEWER DESIGN SHEETS

EXISTING CONDITION

Airport Storm Sewer													R.O.P. Intensity 10yr = 1010/(tc+4.6)$^{0.78}$							
Storm Sewer		**Existing Road Subcatchment Data**								**Design Flow Peak Rate**			**Existing Storm Sewer Data**							
From Sta	To Sta	A Total ha	A1 Imperv. ha	Runoff Coeff. 1 C	A2 Perv. ha	Runoff Coeff.2 C	Avg. Runoff C	AC ha	Accum. AC ha	Tc min.	I 10 yr mm/hr	Q Exist. 10 Yr L/s	Type Pipe	Size m	Length Pipe m	S Slope %	Q Capacity L/s	V m/s	T min.	Q Exist. % of Full Capacity
OLD BASELINE ROAD -16+300 16+000																				
CB5675792335	Outlet	0.041	0.041	0.9	0	0.25	0.90	0.037	0.037	10	125	13								
													CONC	0.375	16.19	2.69	288	2.61	0.10	4%
CB5675792313	MH5676292312	0.028	0.028	0.9	0	0.25	0.90	0.025	0.025	10	125	9								
													CONC	0.300	16.31	2.35	148	2.10	0.13	6%
CB5675892318	MH5676292312	0.076	0.076	0.9	0	0.25	0.90	0.068	0.068	10	125	24								
													CONC	0.300	7.74	1.23	107	1.52	0.08	22%
DI5676292309	MH5676292316	0.775	0.189	0.9	0.586	0.25	0.41	0.317	0.317	10	125	110								
													CMP	0.300	10.93	4.97	216	3.06	0.06	51%
MH5676292312	MH5676292316	0.192	0.065	0.9	0.127	0.25	0.47	0.090	0.184	10.18	124	63								
													CONC	0.300	14.65	1.00	97	1.37	0.18	65%
MH5676292316	CB5678392327	0	0	0	0	0	0	0	0.500	10.46	122	169								
													CMP	0.750	15.07	0.13	395	0.90	0.28	43%

Airport Rd -Hilltop to C3 Mountcrest Road																				
MH5676291443	MH8577091391	0.223	0.223	0.9	0	0.25	0.9	0.2007	0.2007	10	125	70								
													CONC	0.300	43.21	0.72	82	1.2	0.6	85%
CB5760891482	MH8576191490	0.119	0.058	0.9	0.061	0.25	0.567	0.067	0.067	10	125	23								
													PVC	0.200	11.48	1.00	33	1.0	0.2	71%
EXCB	MH8577191354	0.074	0.044	0.9	0.03	0.25	0.636	0.047	0.047	10.0	125	16								
													PVC	0.200	11.48	1.00	33	1.0	0.2	50%
CB5768191410	MH8577091391	0.048	0.034	0.9	0.014	0.25	0.710	0.034	0.034	10	125	12								
													PVC	0.200	4.70	4.70	71	2.3	0.03	17%
CB5770491389	pipe	0.078	0.031	0.9	0.047	0.25	0.508	0.040	0.040	10	125	14								
													PVC	0.200	9.22	1.00	33	1.0	0.1	42%
CB5770491359	pipe	0.054	0.026	0.9	0.028	0.25	0.563	0.030	0.030	10	125	11								
													PVC	0.200	8.52	1.00	33	1.0	0.1	32%
MH8577091391	MH8576991416	0	0	0	0		0	0	0.2348	10.62	121	79								
													PVC	0.300	6.23	2.00	137	1.9	0.1	58%
MH8576191490	MH8576591454	0.087	0.046	0.9	0.041	0.25	0.594	0.052	0.119	10.38	122	40								
													PVC	0.300	50.66	2.58	156	2.2	0.4	26%
MH8576591454	MH8576991416	0.042	0.031	0.9	0.011	0.25	0.730	0.031	0.197	10.70	120	66								
													CONC	0.300	55.03	4.36	202	2.9	0.3	33%
MH8576991416	MH8577191388	0.08	0.053	0.9	0.027	0.25	0.681	0.054	0.486	11.02	118	160								
													CONC	0.300	38.91	6.52	247	3.5	0.2	65%
MH8577591388	MH8577591348	0.066	0.029	0.9	0.037	0.25	0.536	0.035	0.592	11.26	117	192								
													CONC	0.300	55.98	8.24	278	3.9	0.2	69%
MH8577591348	MH8577991307	0.096	0.034	0.9	0.062	0.25	0.480	0.046	0.638	11.53	115	205								
													CONC	0.300	57.90	7.00	256	3.6	0.3	80%
MH8577991307	MH8578191286	0.081	0.054	0.9	0.027	0.25	0.683	0.055	0.693	11.64	115	221								
													CONC	0.450	30.46	5.96	697	4.4	0.1	32%
MH8578191286	MH8578691245	0.026	0.019	0.9	0.007	0.25	0.725	0.019	0.712	11.93	113	224								
													CONC	0.450	57.75	3.61	542	3.4	0.3	41%
MH8578691245	MH8578791229	0.101	0.052	0.9	0.049	0.25	0.585	0.059	0.771	12.03	113	242								
													CONC	0.450	22.66	4.18	583	3.7	0.1	41%
MH8578791229	MH8578991210	0.0358	0.024	0.9	0.0118	0.25	0.686	0.025	1.405	12.52	110	430								
													CONC	0.825	25.14	0.09	431	0.8	0.5	100%
MH8577991314	PIPE	0.124	0.052	0.9	0.072	0.25	0.523	0.065	0.065	10	125	22								
													CONC	0.300	18.26	1.00	97	1.4	0.2	23%

Airport Storm Sewer													R.O.P. Intensity 10yr = 1010/(tc+4.6)$^{0.78}$							
Storm Sewer		**Existing Road Subcatchment Data**								**Design Flow Peak Rate**			**Existing Storm Sewer Data**							
From Sta	To Sta	A Total	A1 Imperv.	Runoff Coeff. 1	A2 Perv.	Runoff Coeff.2	Avg. Runoff	AC	Accum. AC	Tc	I 10 yr	Q Exist. 10 Yr	Type Pipe	Size	Length Pipe	S Slope	Q Capacity	V	T	Q Exist. % of Full
MH8577491354	MH8578191281	0.484	0.255	0.9	0.229	0.25	0.592	0.287	0.287	10	125	99								
													CONC	0.525	104.10	6.90	1131	5.2	0.3	9%
MH8578191281	MH8578791226	0.316	0.153	0.9	0.163	0.25	0.565	0.178	0.530	10.57	121	178								
													CONC	0.750	76.99	0.80	996	2.3	0.6	18%
MH8578791226	MH8578791229	0.132	0.071	0.9	0.061	0.25	0.600	0.079	0.609	10.59	121	205								
													CONC	0.750	6.57	2.89	1894	4.3	0.03	11%
MH8578891203	MH8578991210	0.024	0.015	0.9	0.009	0.25	0.656	0.016	0.016	10	125	5								
													PVC	0.200	8.44	3.79	64	2.0	0.07	9%
MH8578991210	OUTLET	0.041	0.021	0.9	0.02	0.25	0.583	0.024	1.444	12.56	110	442								
													CONC	0.825	9.46	1.90	1980	3.71	0.04	0.22
Airport Rd -Walker SBL to Culvert(West)																				
													PVC	0.200	23.43	2.66	54	1.7	0.23	88%
CB5823390853	MH8582490863	0.079	0.046	0.9	0.033	0.25	0.63	0.050	0.050	10	125	17								
													PVC	0.200	12.35	4.78	72	2.3	0.09	24%
CB5820490882	MH8582190890	0.067	0.035	0.9	0.032	0.25	0.59	0.040	0.040	10	125	14								
													PVC	0.200	12.29	4.85	72	2.3	0.09	19%
CB5817690910	MH851890923	0.105	0.041	0.9	0.065	0.25	0.50	0.053	0.053	10	125	18								
													PVC	0.200	14.14	4.92	73	2.3	0.10	25%
CB5813990947	MH8581490957	0.156	0.042	0.9	0.114	0.25	0.42	0.066	0.066	10	125	23								
													PVC	0.200	12.62	5.08	74	2.4	0.09	31%
CB5810990978	MH8581190987	0.120	0.038	0.9	0.082	0.25	0.46	0.055	0.055	10	125	19								
													PVC	0.200	12.48	8.33	95	3.0	0.07	20%
CB5807791009	MH8581190987A-PIPE	0.130	0.039	0.9	0.091	0.25	0.45	0.058	0.058	10	125	20								
													PVC	0.200	11.76	8.51	96	3.1	0.06	21%
CB5804191046	MH8580491056	0.154	0.050	0.9	0.104	0.25	0.46	0.071	0.071	10	125	24								
													PVC	0.200	12.59	4.14	67	2.1	0.10	37%
Mainline																				
Huntsmill Drive-Walker Rd																				
MH8582690813	MH8582890822	0.909	0.281	0.9	0.628	0.25	0.45	0.410	0.410	10	125	142								
													CONC	0.450	14.41	1.00	285	1.8	0.13	50%
MH8582890822	MH8582490863	0.945	0.228	0.9	0.717	0.25	0.41	0.385	1.111	11.17	118	363								
													CONC	0.525	57.49	0.17	177	0.8	1.17	204%
MH8582490863	MH8582190890	0.086	0.044	0.9	0.042	0.25	0.58	0.050	1.347	11.60	115	431								
													CONC	0.600	38.74	0.47	420	1.5	0.43	103%
MH8582190890	MH851890923	0.095	0.055	0.9	0.040	0.25	0.63	0.060	1.446	12.09	112	452								
													CONC	0.600	46.33	0.53	447	1.6	0.49	101%
MH851890923	MH8581490957	0.093	0.044	0.9	0.049	0.25	0.56	0.052	1.550	12.50	110	476								
													CONC	0.600	47.26	0.80	550	1.9	0.41	87%
MH8581490957	MH8581190987	0.120	0.099	0.9	0.021	0.25	0.79	0.094	1.711	12.78	109	518								
													CONC	0.600	42.17	1.30	701	2.5	0.28	74%
MH8581190987	MH8581190987A	0.127	0.109	0.9	0.018	0.25	0.81	0.102	1.868	13.11	107	557								
													CONC	0.600	44.23	0.80	550	1.9	0.38	101%
MH8581190987A	MH8580691035	0.109	0.109	0.9	0	0.25	0.9	0.098	2.024	13.26	107	600								
													CONC	0.600	25.00	0.34	356	1.3	0.33	169%

Airport Storm Sewer													R.O.P. Intensity 10yr = 1010/(tc+4.6)$^{0.78}$							
Storm Sewer		**Existing Road Subcatchment Data**								**Design Flow Peak Rate**			**Existing Storm Sewer Data**							
From Sta	To Sta	A Total	A1 Imperv.	Runoff Coeff. 1	A2 Perv.	Runoff Coeff.2	Avg. Runoff	AC	Accum. AC	Tc	I 10 yr	Q Exist. 10 Yr	Type Pipe	Size	Length Pipe	S Slope	Q Capacity	V	T	Q Exist. % of Full
Airport Rd-Fr Old Church to Bridge																				
MH8580691035	MH8580491056	0.028	0.010	0.9	0.018	0.25	0.48	0.014	2.866	13.42	106	844								
													CONC	0.900	28.93	1.22	2001	3.1	0.15	42%
MH8580491056	MH8580091100	0.047	0.035	0.9	0.012	0.25	0.74	0.034	2.971	13.80	104	860								
													CONC	0.900	61.47	0.86	1680	2.6	0.39	51%
MH8580091100	MH8579691144	0.335	0.279	0.9	0.056	0.25	0.79	0.265	3.236	14.88	100	896								
													CONC	1.350	63.49	0.07	1402	1.0	1.08	64%
MH8579691144	MH8579191191	0.657	0.395	0.9	0.262	0.25	0.64	0.421	3.657	15.88	96	974								
													CONC	1.350	65.85	0.09	1584	1.1	0.99	62%
MH8579191191	MH8579091201	0.276	0.206	0.9	0.070	0.25	0.74	0.203	3.860	15.98	95	1024								
													CONC	1.350	14.66	0.38	3291	2.3	0.11	31%
MH8579091201	OUTLET	0.074	0.048	0.9	0.026	0.25	0.67	0.050	3.910	15.99	95	1037								
													CONC	1.350	7.87	10.70	17463	12.2	0.01	6%

PROPOSED CONDITION

Airport Storm Sewer													R.O.P. Intensity 10yr = 2221/(tc+12)$^{0.908}$							
Storm Sewer		**Proposed Road Subcatchment Data**								**Design Flow Peak Rate**			**Existing & Proposed Storm Sewer Data**							
From Sta	To Sta	A Total ha	A1 Imperv. ha	Runoff Coeff. 1 C	A2 Perv. ha	Runoff Coeff.2 C	Avg. Runoff C	AC ha	Accum. AC ha	Tc min.	I 10 yr mm/hr	Q Prop. 10 Yr L/s	Type Pipe	Size m	Length Pipe m	S Slope %	Q Capacity L/s	V m/s	T min.	Q Prop. % of Full Capacity
Airport Rd - 12+820 - 13+320																				
MH6-1	MH6-3	0.091	0.091	0.9	0	0.2	0.90	0.08181	0.082	10.00	134	31								
													CONC	0.375	74.00	0.40	111	1.01	1.23	27%
MH6-3	MH6-5	0.254	0.254	0.9	0	0.2	0.90	0.22896	0.311	10.78	130	112								
													CONC	0.450	53.00	0.40	180	1.14	0.78	62%
MH6-5(OGS)	Outlet 7 DITCH	0.254	0.254	0.9	0	0.2	0.90	0.22896	0.229	10.92	129	82								
													CONC	0.450	10.00	0.40	180	1.14	0.15	46%
Airport Rd - OLD BASELINE ROAD -14+160 -16+000																				
CB5675792313	MH5676292312	0.032	0.032	0.9	0	0.2	0.9	0.029	0.029	10	134	11								
													CONC	0.250	16.31	2.35	91	1.86	0.15	12%
CB5675892318	MH5676292312	0.059	0.059	0.9	0.000	0.2	0.900	0.053	0.053	10	134	20								
													CONC	0.300	10.00	1.23	107	1.52	0.11	18%
MH5676292312	MH5676292316	0.193	0.095	0.9	0.098	0.2	0.545	0.105	0.187	10.18	133	69								
													CONC	0.300	14.65	1.00	97	1.37	0.18	71%
MH5676292316(MH3-9)	MH4-1	0.129	0.118	0.9	0.011	0.2	0.841	0.108	0.833	13.29	118	274								
													CONC	0.750	49.91	0.13	395	0.90	0.93	69%
MH4-1	MH4-3	0.158	0.158	0.9	0.000	0.2	0.90	0.142	0.975	14.51	113	307								
													CONC	0.750	71.7	0.15	431	0.98	1.22	71%
MH4-3 (OGS)	Outlet 4 DITCH	0.331	0.215	0.9	0.116	0.2	0.65	0.217	1.191	16.42	106	352								
													CONC	0.750	112.00	0.15	431	0.98	1.91	82%
Airport Rd - 14+584-14+170																				
MH3-1	MH3-3	0.119	0.096	0.9	0.023	0.2	0.766	0.091	0.091	10	134	34								
													CONC	0.375	100.10	2.50	278	2.51	0.66	12%
MH3-3	MH3-5	0.175	0.154	0.9	0.021	0.2	0.818	0.143	0.234	10.66	131	85								
													CONC	0.375	100.00	2.50	278	2.51	0.66	31%
MH3-5	MH3-7	0.177	0.149	0.9	0.028	0.2	0.791	0.140	0.374	11.63	126	131								
													CONC	0.375	103.42	1.25	196	1.78	0.97	67%
MH3-7	MH5676292316(MH3-9)	0.206	0.176	0.9	0.030	0.2	0.797	0.164	0.538	12.46	122	182								
													CONC	0.525	49.40	0.25	215	0.99	0.83	85%
Airport Rd - 15+270-14+710																				
MH2A-1	MH2A-3	0.292	0.200	0.9	0.092	0.2	0.680	0.198	0.198	10	134	74								
													CONC	0.375	39.48	2.20	260	2.36	0.28	28%
MH2A-3	MH2A-5	0.103	0.082	0.9	0.021	0.2	0.755	0.078	0.276	10.67	131	100								
													CONC	0.375	100.58	2.50	278	2.51	0.67	36%
MH2A-5	MH2A-7	0.296	0.171	0.9	0.125	0.2	0.605	0.179	0.455	11.54	126	160								
													CONC	0.375	99.00	1.40	208	1.88	0.88	77%
MH2A-7	MH2A-9	0.362	0.188	0.9	0.174	0.2	0.563	0.204	0.659	12.83	120	220								
													CONC	0.525	97.20	0.40	272	1.26	1.29	81%
MH2A-9	MH2A-11	0.791	0.699	0.9	0.092	0.2	0.818	0.648	1.306	14.10	115	417								
													CONC	0.675	113.20	0.40	532	1.49	1.27	78%
MH2A-11	OUTLET2A	0.067	0.060	0.9	0.006	0.2	0.833	0.055	1.362	14.19	115	433								
													CONC	0.675	9.00	0.50	595	1.66	0.09	73%

Airport Storm Sewer													R.O.P. Intensity 10yr = 2221/(tc+12)$^{0.908}$							
Storm Sewer		**Proposed Road Subcatchment Data**								**Design Flow Peak Rate**			**Existing & Proposed Storm Sewer Data**							
From Sta	To Sta	A Total ha	A1 Imperv. ha	Runoff Coeff. 1 C	A2 Perv. ha	Runoff Coeff.2 C	Avg. Runoff C	AC ha	Accum. AC ha	Tc min.	I 10 yr mm/hr	Q Prop. 10 Yr L/s	Type Pipe	Size m	Length Pipe m	S Slope %	Q Capacity L/s	V m/s	T min.	Q Prop. % of Full Capacity
Airport Rd - 15+584-14+711																				
MH2B-1	MH2B-3	0.095	0.084	0.9	0.011	0.2	0.817	0.078	0.078	10	134	29								
													CONC	0.375	39.48	2.50	278	2.51	0.26	10%
MH2B-3	OUTLET2B	0.105	0.089	0.9	0.016	0.2	0.791	0.083	0.161	10.67	131	58								
													CONC	0.375	100.58	2.50	278	2.51	0.67	21%
Airport Rd -Hilltop to C3 Mountcrest Road 15+340 15+740																				
MH5676291443	MH8577091391	0.223	0.223	0.9	0	0.2	0.9	0.201	0.201	10	134	75								
													CONC	0.300	43.21	0.72	82	1.16	0.62	91%
CB5760891482	MH8576191490	0.1238	0.058	0.9	0.0658	0.2	0.528	0.065	0.065	10	134	24								
													PVC	0.200	11.48	1.00	33	1.05	0.18	74%
EXCB	MH8577191354	0.074	0.044	0.9	0.03	0.2	0.616	0.046	0.046	10.0	134	17								
													PVC	0.200	11.48	1.00	33	1.05	0.18	52%
CB5768191410	MH8577091391	0.048	0.034	0.9	0.014	0.2	0.696	0.033	0.033	10	134	12								
													PVC	0.200	4.70	4.70	71	2.27	0.03	17%
CB5770491389	pipe	0.078	0.031	0.9	0.047	0.2	0.478	0.037	0.037	10	134	14								
													PVC	0.200	9.22	1.00	33	1.05	0.15	42%
CB5770491359	pipe	0.054	0.026	0.9	0.028	0.2	0.537	0.029	0.029	10	134	11								
													PVC	0.200	8.52	1.00	33	1.00	0.14	33%
MH8577091391	MH8576991416	0	0	0	0		0	0	0.234	10.62	131	85								
													PVC	0.300	6.23	2.00	137	1.94	0.05	62%
MH8576191490	MH8576591454	0.087	0.046	0.9	0.041	0.2	0.570	0.050	0.115	10.38	132	42								
													PVC	0.300	50.66	2.58	156	2.20	0.38	27%
MH8576591454	MH8576991416	0.0508	0.031	0.9	0.0198	0.2	0.627	0.032	0.192	10.70	130	70								
													CONC	0.300	55.03	4.36	202	2.86	0.32	34%
MH8576991416	MH8577191388	0.08	0.053	0.9	0.027	0.2	0.664	0.053	0.480	11.02	129	172								
													CONC	0.300	38.91	6.52	247	3.50	0.19	69%
MH8577191388	MH8577591348	0.066	0.029	0.9	0.037	0.2	0.508	0.034	0.579	11.26	128	205								
													CONC	0.300	55.98	8.24	278	3.93	0.24	74%
MH8577591348	MH8577991307	0.096	0.034	0.9	0.062	0.2	0.448	0.043	0.622	11.53	126	218								
													CONC	0.300	57.90	7.00	256	3.63	0.27	85%
MH8577991307	MH8578191286	0.081	0.054	0.9	0.027	0.2	0.667	0.054	0.676	11.64	126	236								
													CONC	0.450	30.46	5.96	697	4.38	0.12	34%
MH8578191286	MH8578691245	0.026	0.019	0.9	0.007	0.2	0.712	0.019	0.695	11.93	124	240								
													CONC	0.450	57.75	3.61	542	3.41	0.28	44%
MH8578691245	MH8578791229	0.101	0.052	0.9	0.049	0.2	0.560	0.057	0.752	12.03	124	259								
													CONC	0.450	22.66	4.18	583	3.67	0.10	44%
MH8578791229	MH8578991210(MH1B-1)	0.0358	0.024	0.9	0.0118	0.2	0.669	0.024	1.358	12.52	122	459								
													CONC	0.900	16.95	0.09	543	0.85	0.33	84%
MH8577991314	PIPE	0.124	0.052	0.9	0.072	0.2	0.494	0.061	0.061	10	134	23								
													CONC	0.300	18.28	1.00	97	1.37	0.22	24%
MH8577491354	MH8578191281	0.484	0.255	0.9	0.229	0.2	0.569	0.275	0.275	10	134	103								
													CONC	0.525	104.1	6.90	1131	5.23	0.33	9%
MH8578191281	MH8578791226	0.316	0.153	0.9	0.163	0.2	0.539	0.170	0.507	10.57	131	185								
													CONC	0.750	76.99	0.80	996	2.26	0.57	19%
MH8578791226	MH8578791229	0.132	0.071	0.9	0.061	0.2	0.577	0.076	0.583	10.59	131	212								
													CONC	0.750	6.57	2.89	1894	4.29	0.03	11%
MH8578891203	MH8578991210(MH1B-1)	0.024	0.015	0.9	0.009	0.2	0.638	0.015	0.015	10	134	6								

Airport Storm Sewer													R.O.P. Intensity 10yr = 2221/(tc+12)$^{0.908}$							
Storm Sewer		**Proposed Road Subcatchment Data**								**Design Flow Peak Rate**			**Existing & Proposed Storm Sewer Data**							
From Sta	To Sta	A Total ha	A1 Imperv. ha	Runoff Coeff. 1 C	A2 Perv. ha	Runoff Coeff.2 C	Avg. Runoff C	AC ha	Accum. AC ha	Tc min.	I 10 yr mm/hr	Q Prop. 10 Yr L/s	Type Pipe	Size m	Length Pipe m	S Slope %	Q Capacity L/s	V m/s	T min.	Q Prop. % of Full Capacity
													PVC	0.200	8.44	3.79	64	2.04	0.07	9%
MH8578991210(MH1B-1)	OUTLET 1B	0.03	0.021	0.9	0.009	0.2	0.690	0.021	1.394	12.58	121	470								
													CONC	0.900	14.20	1.90	2497	3.93	0.06	18.84%
Airport Rd -Walker SBL to Culvert(West)																				
CB5823390853	MH8582490863	0.079	0.046	0.9	0.033	0.2	0.61	0.048	0.048	10.0	134	18								
													PVC	0.200	12.35	4.78	72	2.29	0.09	25%
CB5820490882	MH8582190890	0.069	0.031	0.9	0.038	0.2	0.52	0.036	0.036	10.0	134	13								
													PVC	0.200	12.29	4.85	72	2.30	0.09	18%
CB5817690910	MH851890923	0.108	0.041	0.9	0.067	0.2	0.47	0.050	0.050	10.0	134	19								
													PVC	0.200	14.14	4.92	73	2.32	0.10	26%
CB5813990947	MH8581490957	0.161	0.042	0.9	0.119	0.2	0.38	0.062	0.062	10.0	134	23								
													PVC	0.200	12.62	5.08	74	2.36	0.09	31%
CB5810990978	MH8581190987	0.120	0.038	0.9	0.082	0.2	0.42	0.051	0.051	10.0	134	19								
													PVC	0.200	12.48	8.33	95	3.02	0.07	20%
CB5807791009	MH8581190987A-PIPE	0.130	0.022	0.9	0.108	0.2	0.32	0.041	0.041	10.0	134	15								
													PVC	0.200	11.76	8.51	96	3.05	0.06	16%
CB5804191046	MH8580491056	0.130	0.130	0.9	0.000	0.2	0.90	0.117	0.117	10.0	134	43								
													PVC	0.200	12.59	4.14	67	2.13	0.10	65%
Mainline																				
Huntsmill Drive-Walker Rd 16+760 15+980																				
EXCB	MH1A-1	0.205	0.121	0.9	0.084	0.2	0.61	0.125	0.125	10	134	47								
													CONC	0.375	16.75	1.00	176	1.59	0.18	27%
MH1A-1	MH1A-3	0.035	0.020	0.9	0.015	0.2	0.60	0.021	0.147	10.53	131	54								
													CONC	0.375	100.00	3.94	348	3.16	0.53	15%
MH1A-3	MH1A-5	0.163	0.046	0.9	0.118	0.2	0.40	0.065	0.211	11.13	128	75								
													CONC	0.375	100.00	3.00	304	2.75	0.61	25%
MH1A-5	MH1A-6	0.204	0.073	0.9	0.130	0.2	0.45	0.092	0.303	11.84	125	105								
													CONC	0.375	63.60	0.90	167	1.51	0.70	63%
MH1A-6	MH8582690813	0.190	0.119	0.9	0.072	0.2	0.64	0.121	0.424	12.20	123	145								
													CONC	0.450	37.10	0.90	271	1.70	0.36	20%
MH8582690813	MH8582890822	0.190	0.045	0.9	0.145	0.2	0.37	0.070	0.494	12.33	122	168								
													CONC	0.450	14.51	1.00	285	1.80	0.13	59%
MH8582890822	MH8582490863	0.945	0.356	0.9	0.589	0.2	0.46	0.438	1.247	13.25	118	410								
													CONC	0.750	57.49	0.17	459	1.04	0.92	89%
MH8582490863	MH8582190890(MH1A-7)	0.090	0.031	0.9	0.059	0.2	0.44	0.040	1.476	13.63	117	479								
													CONC	0.750	38.74	0.47	761	1.72	0.37	63%
MH8582190890(MH1A-7)	MH851890923(MH1A-8)	0.094	0.049	0.9	0.045	0.2	0.57	0.053	1.565	14.05	115	501								
													CONC	0.750	46.33	0.53	811	1.84	0.42	62%
MH858190923(MH1A-8)	MH8581490957(MH1A-9)	0.090	0.024	0.9	0.066	0.2	0.39	0.035	1.650	14.40	114	521								
													CONC	0.750	47.26	0.80	996	2.26	0.35	52%
MH8581490957(MH1A-10)	MH8581190987(MH1A-11)	0.117	0.101	0.9	0.016	0.2	0.80	0.094	1.806	14.64	113	566								
													CONC	0.750	42.17	1.30	1270	2.88	0.24	45%
MH8581190987(MH1A-11)	MH8581190987A	0.118	0.096	0.9	0.022	0.2	0.77	0.091	1.947	14.91	112	605								
													CONC	0.750	44.23	0.80	996	2.26	0.33	61%
MH8581190987A	MH8580691035	0.126	0.126	0.9	0	0.2	0.9	0.113	2.102	15.06	111	649								
													CONC	0.825	25.00	0.34	831	1.56	0.27	78%

Airport Storm Sewer													R.O.P. Intensity 10yr = 2221/(tc+12)$^{0.908}$							
Storm Sewer		**Proposed Road Subcatchment Data**								**Design Flow Peak Rate**			**Existing & Proposed Storm Sewer Data**							
From Sta	To Sta	A Total ha	A1 Imperv. ha	Runoff Coeff. 1 C	A2 Perv. ha	Runoff Coeff.2 C	Avg. Runoff C	AC ha	Accum. AC ha	Tc min.	I 10 yr mm/hr	Q Prop. 10 Yr L/s	Type Pipe	Size m	Length Pipe m	S Slope %	Q Capacity L/s	V m/s	T min.	Q Prop. % of Full Capacity
Fr Old Church 15+980 15+740																				
MH8580691035	MH8580491056	0.675	0.675	0.9	0.000	0.2	0.90	0.608	2.709	15.22	111	833								
													CONC	0.900	28.93	1.22	2001	3.15	0.15	42%
MH8580491056	MH8580091100	0.047	0.035	0.9	0.012	0.2	0.72	0.034	2.860	15.61	109	868								
													CONC	0.900	61.47	0.86	1680	2.64	0.39	52%
MH8580091100	MH8579691144	0.335	0.279	0.9	0.056	0.2	0.78	0.262	3.122	16.68	105	915								
													CONC	1.350	63.49	0.07	1402	0.98	1.08	65%
MH8579691144	MH8579191191	0.657	0.395	0.9	0.262	0.2	0.62	0.408	3.530	17.68	102	1003								
													CONC	1.350	65.85	0.09	1584	1.11	0.99	63%
MH8579191191	OUTLET 1A	0.276	0.206	0.9	0.070	0.2	0.72	0.199	3.729	17.81	102	1056								
													CONC	1.350	18.20	0.38	3291	2.30	0.13	32%
MH8579091201	OUTLET 1A	0.097	0.048	0.9	0.049	0.2	0.55	0.053	3.782	17.84	102	1070								
													CONC	1.350	7.87	1.30	6087	4.25	0.03	18%
Old Church -Fr Merilyn to Airport Rd																				
CB5821391141	CB5820891147	0.228	0.119	0.9	0.109	0.25	0.59	0.134	0.134	10	134	50								
													CONC	0.300	7.40	135.00	1125	15.9	0.01	4%
CB5820891147	MH5819791138	0.225	0.109	0.9	0.116	0.25	0.56	0.127	0.261	10.06	134	97								
													CONC	0.300	14.70	9.56	299	4.2	0.06	32%
MH5819791138	MH5817191117	0.204	0.173	0.9	0.031	0.25	0.80	0.163	0.424	10.32	132	156								
													CONC	0.375	33.30	1.82	237	2.1	0.26	66%
MH5817191117	MH5813591088	0.195	0.096	0.9	0.100	0.25	0.57	0.111	0.535	10.71	130	194								
													CONC	0.450	45.50	1.15	306	1.9	0.39	63%
MH5813591088	MH8580891046	0.167	0.096	0.9	0.071	0.25	0.62	0.104	0.639	11.15	128	228								
													CONC	0.450	68.20	2.06	410	2.6	0.44	56%
MH8580891046	MH8580691035	0.296	0.195	0.9	0.101	0.25	0.68	0.201	0.840	11.27	128	298								
													CONC	0.450	17.70	2.02	406	2.6	0.12	73%

Airport Storm Sewer													R.O.P. 2065-2095, 90% Intensity 10yr = 1208.7/(tc+8.8)0.7322							
Storm Sewer		**Proposed Road Subcatchment Data**								**Design Flow Peak Rate**			**Existing Storm Sewer Data**							
From Sta	To Sta	A Total ha	A1 Imperv. ha	Runoff Coeff. 1 C	A2 Perv. ha	Runoff Coeff.2 C	Avg. Runoff C	AC ha	Accum. AC ha	Tc min.	I 10 yr mm/hr	Q Prop. 10 Yr L/s	Type Pipe	Size m	Length Pipe m	S Slope %	Q Capacity L/s	V m/s	T min.	Q Prop. % of Full Capacity
Airport Rd - 12+820 - 13+320																				
MH6-1	MH6-3	0.091	0.091	0.9	0	0.2	0.90	0.08181	0.08181	10.00	141	32								
													CONC	0.375	74	0.40	111	1.01	1.23	29%
MH6-3	MH6-5	0.254	0.254	0.9	0	0.2	0.90	0.22896	0.31077	10.78	137	118								
													CONC	0.450	53	0.40	180	1.14	0.78	66%
MH6-5(OGS)	Outlet 7 DITCH	0.254	0.254	0.9	0	0.2	0.90	0.22896	0.22896	10.92	136	87								
													CONC	0.450	10	0.40	180	1.14	0.15	48%
Airport Rd - OLD BASELINE ROAD -14+160 -16+000																				
CB5675792313	MH5676292312	0.032	0.032	0.9	0	0.2	0.9	0.029	0.029	10	141	11								
													CONC	0.250	16.31	2.35	91	1.86	0.15	12%
CB5675892318	MH5676292312	0.059	0.059	0.9	0.000	0.2	0.900	0.053	0.053	10	141	21								
													CONC	0.300	10.00	1.23	107	1.52	0.11	19%
MH5676292312	MH5676292316	0.193	0.095	0.9	0.098	0.2	0.545	0.105	0.187	10.18	140	73								
													CONC	0.300	14.65	1.00	97	1.37	0.18	75%
MH5676292316(MH3-9)	MH4-1	0.129	0.118	0.9	0.011	0.2	0.841	0.108	0.669	13.20	126	234								
													CONC	0.750	49.91	0.13	395	0.90	0.93	59%
MH4-1	MH4-3	0.158	0.158	0.9	0.000	0.2	0.90	0.142	0.810	14.43	121	272								
													CONC	0.750	71.7	0.15	431	0.98	1.22	63%
MH4-3 (OGS)	Outlet 4 DITCH	0.331	0.215	0.9	0.116	0.2	0.65	0.217	1.027	16.34	114	326								
													CONC	0.750	112.00	0.15	431	0.98	1.91	75%
Airport Rd - 14+584-14+170																				
MH3-1	MH3-3	0.119	0.096	0.9	0.023	0.2	0.766	0.091	0.091	10	141	36								
													CONC	0.375	100.10	2.50	278	2.51	0.66	13%
MH3-3	MH3-5	0.175	0.154	0.9	0.021	0.2	0.818	0.143	0.234	10.66	138	89								
													CONC	0.375	100.00	2.50	278	2.51	0.66	32%
MH3-5	MH3-7	0.177	0.149	0.9	0.028	0.2	0.791	0.140	0.374	11.55	133	138								
													CONC	0.375	103.42	1.50	215	1.95	0.89	64%
MH3-7	MH5676292316(MH3-9)	0.206	0.176	0.9	0.030	0.2	0.797	0.164	0.538	12.38	129	193								
													CONC	0.525	49.40	0.25	215	0.99	0.83	90%
Airport Rd - 15+270-14+710																				
MH2A-1	MH2A-3	0.292	0.200	0.9	0.092	0.2	0.680	0.198	0.198	10	141	78								
													CONC	0.375	39.48	2.20	260	2.36	0.28	30%
MH2A-3	MH2A-5	0.103	0.082	0.9	0.021	0.2	0.755	0.078	0.276	10.67	137	106								
													CONC	0.375	100.58	2.50	278	2.51	0.67	38%
MH2A-5	MH2A-7	0.296	0.171	0.9	0.125	0.2	0.605	0.179	0.455	11.54	133	168								
													CONC	0.375	99.00	1.40	208	1.88	0.88	81%
MH2A-7	MH2A-9	0.362	0.188	0.9	0.174	0.2	0.563	0.204	0.659	12.83	127	233								
													CONC	0.525	97.20	0.40	272	1.26	1.29	86%
MH2A-9	MH2A-11	0.791	0.699	0.9	0.092	0.2	0.818	0.648	1.306	14.10	122	443								
													CONC	0.675	113.20	0.40	532	1.49	1.27	83%
MH2A-11	OUTLET2A	0.067	0.060	0.9	0.006	0.2	0.833	0.055	1.362	14.19	122	461								
													CONC	0.675	9.00	0.50	595	1.66	0.09	77%

Airport Storm Sewer													R.O.P. 2065-2095, 90% Intensity 10yr = 1208.7/(tc+8.8)0.7322							
Storm Sewer		**Proposed Road Subcatchment Data**								**Design Flow Peak Rate**			**Existing Storm Sewer Data**							
From Sta	To Sta	A Total ha	A1 Imperv. ha	Runoff Coeff. 1 C	A2 Perv. ha	Runoff Coeff.2 C	Avg. Runoff C	AC ha	Accum. AC ha	Tc min.	I 10 yr mm/hr	Q Prop. 10 Yr L/s	Type Pipe	Size m	Length Pipe m	S Slope %	Q Capacity L/s	V m/s	T min.	Q Prop. % of Full Capacity
Airport Rd - 15+584-14+711																				
MH2B-1	MH2B-3	0.095	0.084	0.9	0.011	0.2	0.817	0.078	0.078	10	141	30								
													CONC	0.375	39.48	2.50	278	2.51	0.26	11%
MH2B-3	OUTLET2B	0.105	0.089	0.9	0.016	0.2	0.791	0.083	0.161	10.67	137	61								
													CONC	0.375	100.58	2.50	278	2.51	0.67	22%
Airport Rd -Hilltop to C3 Mountcrest Road 15+340 15+740																				
MH5676291443	MH8577091391	0.223	0.223	0.9	0.000	0.2	0.90	0.201	0.201	10	141	79								
													CONC	0.300	43.21	0.72	82	1.16	0.62	96%
CB5760891482	MH8576191490	0.124	0.058	0.9	0.066	0.2	0.53	0.065	0.065	10	141	26								
													PVC	0.200	11.48	1.00	33	1.05	0.18	78%
EXCB	MH8577191354	0.074	0.044	0.9	0.030	0.2	0.62	0.046	0.046	10.0	141	18								
													PVC	0.200	11.48	1.00	33	1.05	0.18	54%
CB5768191410	MH8577091391	0.048	0.034	0.9	0.014	0.2	0.70	0.033	0.033	10	141	13								
													PVC	0.200	4.70	4.70	71	2.27	0.03	18%
CB5770491389	pipe	0.078	0.031	0.9	0.047	0.2	0.48	0.037	0.037	10	141	15								
													PVC	0.200	9.22	1.00	33	1.05	0.15	45%
CB5770491359	pipe	0.054	0.026	0.9	0.028	0.2	0.54	0.029	0.029	10	141	11								
													PVC	0.200	8.52	1.00	33	1.00	0.14	35%
MH8577091391	MH8576991416	0.000	0.000	0	0.000		0.00	0.000	0.234	10.62	138	90								
													PVC	0.300	6.23	2.00	137	1.94	0.05	65%
MH8576191490	MH8576591454	0.087	0.046	0.9	0.041	0.2	0.57	0.050	0.115	10.38	139	44								
													PVC	0.300	50.66	2.58	156	2.20	0.38	29%
MH8576591454	MH8576991416	0.051	0.031	0.9	0.020	0.2	0.63	0.032	0.192	10.70	137	73								
													CONC	0.300	55.03	4.36	202	2.86	0.32	36%
MH8576991416	MH8577191388	0.080	0.053	0.9	0.027	0.2	0.66	0.053	0.480	11.02	136	181								
													CONC	0.300	38.91	6.52	247	3.50	0.19	73%
MH8577591388	MH8577591348	0.066	0.029	0.9	0.037	0.2	0.51	0.034	0.579	11.26	135	217								
													CONC	0.300	55.98	8.24	278	3.93	0.24	78%
MH8577591348	MH8577991307	0.096	0.034	0.9	0.062	0.2	0.45	0.043	0.622	11.53	133	230								
													CONC	0.300	57.90	7.00	256	3.63	0.27	90%
MH8577991307	MH8578191286	0.081	0.054	0.9	0.027	0.2	0.67	0.054	0.676	11.64	133	249								
													CONC	0.450	30.46	5.96	697	4.38	0.12	36%
MH8578191286	MH8578691245	0.026	0.019	0.9	0.007	0.2	0.71	0.019	0.695	11.93	131	254								
													CONC	0.450	57.75	3.61	542	3.41	0.28	47%
MH8578691245	MH8578791229	0.101	0.052	0.9	0.049	0.2	0.56	0.057	0.752	12.03	131	273								
													CONC	0.450	22.66	4.18	583	3.67	0.10	47%
MH8578791229	MH8578991210	0.036	0.024	0.9	0.012	0.2	0.67	0.024	1.358	12.52	129	486								
													CONC	0.900	25.14	0.09	543	0.85	0.49	89%
MH8577991314	PIPE	0.124	0.052	0.9	0.072	0.2	0.49	0.061	0.061	10	141	24								
													CONC	0.300	18.28	1.00	97	1.37	0.22	25%
MH8577491354	MH8578191281	0.484	0.255	0.9	0.229	0.2	0.57	0.275	0.275	10	141	108								
													CONC	0.525	104.10	6.90	1131	5.23	0.33	10%
MH8578191281	MH8578791226	0.316	0.153	0.9	0.163	0.2	0.54	0.170	0.507	10.57	138	194								
													CONC	0.750	76.99	0.80	996	2.26	0.57	20%
MH8578791226	MH8578791229	0.132	0.071	0.9	0.061	0.2	0.58	0.076	0.583	10.59	138	223								
													CONC	0.750	6.57	2.89	1894	4.29	0.03	12%
MH8578891203	MH8578991210	0.024	0.015	0.9	0.009	0.2	0.64	0.015	0.015	10	141	6								

Airport Storm Sewer													R.O.P. 2065-2095, 90% Intensity 10yr = 1208.7/(tc+8.8)0.7322							
Storm Sewer		**Proposed Road Subcatchment Data**								**Design Flow Peak Rate**			**Existing Storm Sewer Data**							
From Sta	To Sta	A Total ha	A1 Imperv. ha	Runoff Coeff. 1 C	A2 Perv. ha	Runoff Coeff.2 C	Avg. Runoff C	AC ha	Accum. AC ha	Tc min.	I 10 yr mm/hr	Q Prop. 10 Yr L/s	Type Pipe	Size m	Length Pipe m	S Slope %	Q Capacity L/s	V m/s	T min.	Q Prop. % of Full Capacity
													PVC	0.200	8.44	3.79	64	2.04	0.07	9%
MH8578991210	OUTLET 1B	0.041	0.021	0.9	0.020	0.2	0.56	0.023	1.397	12.56	128	499								
													CONC	0.900	9.46	1.90	2497	3.93	0.04	19.98%
Airport Rd -Walker SBL to Culvert(West)																				
CB5823390853	MH8582490863	0.079	0.046	0.9	0.033	0.2	0.61	0.048	0.048	10.0	141	19								
													PVC	0.200	12.35	4.78	72	2.29	0.09	26%
CB5820490882	MH8582190890	0.069	0.031	0.9	0.038	0.2	0.52	0.036	0.036	10.0	141	14								
													PVC	0.200	12.29	4.85	72	2.30	0.09	19%
CB5817690910	MH851890923	0.108	0.041	0.9	0.067	0.2	0.47	0.050	0.050	10.0	141	20								
													PVC	0.200	14.14	4.92	73	2.32	0.10	27%
CB5813990947	MH8581490957	0.161	0.042	0.9	0.119	0.2	0.38	0.062	0.062	10.0	141	24								
													PVC	0.200	12.62	5.08	74	2.36	0.09	33%
CB5810990978	MH8581190987	0.120	0.038	0.9	0.082	0.2	0.42	0.051	0.051	10.0	141	20								
													PVC	0.200	12.48	8.33	95	3.02	0.07	21%
CB5807791009	MH8581190987A-PIPE	0.130	0.022	0.9	0.108	0.2	0.32	0.041	0.041	10.0	141	16								
													PVC	0.200	11.76	8.51	96	3.05	0.06	17%
CB5804191046	MH8580491056	0.130	0.130	0.9	0.000	0.2	0.90	0.117	0.117	10.0	141	46								
													PVC	0.200	12.59	4.14	67	2.13	0.10	68%
Mainline																				
Huntsmill Drive-Walker Rd 16+760 15+980																				
EXCB	MH1A-1	0.205	0.121	0.9	0.084	0.2	0.61	0.125	0.125	10	141	49								
													CONC	0.375	16.75	1.00	176	1.6	0.18	28%
MH1A-1	MH1A-3	0.035	0.020	0.9	0.015	0.2	0.60	0.021	0.147	10.53	138	56								
													CONC	0.375	100.00	3.94	348	3.2	0.53	16%
MH1A-3	MH1A-5	0.163	0.046	0.9	0.118	0.2	0.40	0.065	0.211	11.13	135	79								
													CONC	0.375	100.00	3.00	304	2.8	0.61	26%
MH1A-5	MH1A-6	0.204	0.073	0.9	0.130	0.2	0.45	0.092	0.303	11.84	132	111								
													CONC	0.375	63.60	0.90	167	1.5	0.70	67%
MH1A-6	MH8582690813	0.190	0.119	0.9	0.072	0.2	0.64	0.121	0.424	12.20	130	153								
													CONC	0.45	37.10	0.90	271	1.7	0.36	21%
MH8582690813	MH8582890822	0.190	0.045	0.9	0.145	0.2	0.37	0.070	0.494	12.33	129	178								
													CONC	0.450	14.51	1.00	285	1.8	0.13	62%
MH8582890822	MH8582490863	0.945	0.356	0.9	0.589	0.2	0.46	0.438	1.247	13.25	118	410								
													CONC	0.750	57.49	0.17	459	1.0	0.92	89%
MH8582490863	MH8582190890	0.090	0.031	0.9	0.059	0.2	0.44	0.040	1.476	13.63	117	479								
													CONC	0.750	38.74	0.47	761	1.7	0.37	63%
MH8582190890	MH851890923	0.094	0.049	0.9	0.045	0.2	0.57	0.053	1.565	14.05	115	501								
													CONC	0.750	46.33	0.53	811	1.8	0.42	62%
MH851890923	MH8581490957	0.090	0.024	0.9	0.066	0.2	0.39	0.035	1.650	14.40	114	521								
													CONC	0.750	47.26	0.80	996	2.3	0.35	52%
MH8581490957	MH8581190987	0.117	0.101	0.9	0.016	0.2	0.80	0.094	1.806	14.64	113	566								
													CONC	0.750	42.17	1.30	1270	2.9	0.24	45%
MH8581190987	MH8581190987A	0.118	0.096	0.9	0.022	0.2	0.77	0.091	1.947	14.91	112	605								
													CONC	0.750	44.23	0.80	996	2.3	0.33	61%
MH8581190987A	MH8580691035	0.126	0.126	0.9	0	0.2	0.90	0.113	2.102	15.06	111	649								
													CONC	0.825	25.00	0.34	831	1.6	0.27	78%

Airport Storm Sewer													R.O.P. 2065-2095, 90% Intensity 10yr = 1208.7/(tc+8.8)0.7322							
Storm Sewer		**Proposed Road Subcatchment Data**								**Design Flow Peak Rate**			**Existing Storm Sewer Data**							
From Sta	To Sta	A Total ha	A1 Imperv. ha	Runoff Coeff. 1 C	A2 Perv. ha	Runoff Coeff.2 C	Avg. Runoff C	AC ha	Accum. AC ha	Tc min.	I 10 yr mm/hr	Q Prop. 10 Yr L/s	Type Pipe	Size m	Length Pipe m	S Slope %	Q Capacity L/s	V m/s	T min.	Q Prop. % of Full Capacity
Fr Old Church 15+980 15+740																				
MH8580691035	MH8580491056	0.675	0.675	0.9	0	0.2	0.9	0.608	2.709	15.22	118	888								
													CONC	0.900	28.93	1.22	2001	3.1	0.15	44%
MH8580491056	MH8580091100	0.047	0.035	0.9	0.012	0.2	0.72	0.034	2.860	15.61	117	926								
													CONC	0.900	61.47	0.86	1680	2.6	0.39	55%
MH8580091100	MH8579691144	0.335	0.279	0.9	0.056	0.2	0.78	0.262	3.122	16.68	113	980								
													CONC	1.350	63.49	0.07	1402	1.0	1.08	70%
MH8579691144	MH8579191191	0.657	0.395	0.9	0.262	0.2	0.62	0.408	3.530	17.68	110	1077								
													CONC	1.350	65.85	0.09	1584	1.1	0.99	68%
MH8579191191	MH8579091201	0.276	0.206	0.9	0.070	0.2	0.72	0.199	3.729	17.78	109	1135								
													CONC	1.350	14.66	0.38	3291	2.3	0.11	34%
MH8579091201	OUTLET 1A	0.074	0.048	0.9	0.026	0.2	0.66	0.048	3.777	17.81	109	1148								
													CONC	1.350	7.87	1.30	6087	4.3	0.03	19%

APPENDIX M: PAVEMENT AREA ANALYSIS & WATER BALANCE CALCULATIONS

Airport Road From King Street to Huntsmill Drive Stormwater Management Summary

Location/Station	Drainage Catchment	Water Balance Control				
		Required (Yes/No)	Comments	Criteria		Reference
	Catchment ID			Storm Event (mm)	Requirement	
Airport Road (from King Street to Huntsmill Drive)	C1	Yes	vegetation infiltration	27	on-site storage of run-off from the storm event	Draft ROP Stormwater Design Criteria and Procedural Manual (June 2019) Section 4.2
	C2	Yes	vegetation infiltration	27	on-site storage of run-off from the storm event	Draft ROP Stormwater Design Criteria and Procedural Manual (June 2019) Section 4.2
	C3A	Yes	vegetation infiltration	27	on-site storage of run-off from the storm event	Draft ROP Stormwater Design Criteria and Procedural Manual (June 2019) Section 4.2
	C3B	Yes	vegetation infiltration	27	on-site storage of run-off from the storm event	Draft ROP Stormwater Design Criteria and Procedural Manual (June 2019) Section 4.2
	C4A	Yes	vegetation infiltration	27	on-site storage of run-off from the storm event	Draft ROP Stormwater Design Criteria and Procedural Manual (June 2019) Section 4.2
	C4B	Yes	vegetation infiltration	27	on-site storage of run-off from the storm event	Draft ROP Stormwater Design Criteria and Procedural Manual (June 2019) Section 4.2
	C4C	Yes	vegetation infiltration	27	on-site storage of run-off from the storm event	Draft ROP Stormwater Design Criteria and Procedural Manual (June 2019) Section 4.2
	C4D	Yes	vegetation infiltration	27	on-site storage of run-off from the storm event	Draft ROP Stormwater Design Criteria and Procedural Manual (June 2019) Section 4.2
	C5A	Yes	vegetation infiltration	27	on-site storage of run-off from the storm event	Draft ROP Stormwater Design Criteria and Procedural Manual (June 2019) Section 4.2
	C5B	Yes	vegetation infiltration	27	on-site storage of run-off from the storm event	Draft ROP Stormwater Design Criteria and Procedural Manual (June 2019) Section 4.2
	C6	Yes	vegetation infiltration	27	on-site storage of run-off from the storm event	Draft ROP Stormwater Design Criteria and Procedural Manual (June 2019) Section 4.2
	Total	-	-	-	-	-

[2] *Antecedent Precipitation Factor (Ca)*	
25-Year Storm:	1.10
50-Year Storm:	1.20
100-Year Storm:	1.25

Location/Station	Drainage Catchment	Pre-Development Condition																				
		Area (ha)				% Impervious	Runoff Coefficient (-)		Time of Concentration (min)	Rainfall Intensity (mm/hr)						Flow (m^3/s)						[2] Flow Adjustment for 25-100 Year Storms (m^3/s)		
	Catchment ID	Hard Surface	Vegetation	Compacted Gravel	Total		Actual C	C Used in Flow Calculation		i_2	i_5	i_{10}	i_{25}	i_{50}	i_{100}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{25}	Q_{50}	Q_{100}
Airport Road (from King Street to Huntsmill Drive)	C1	0.43	0.2517	0.1983	0.88	48.86	0.67	0.67	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.140	0.179	0.218	0.255	0.287	0.320	0.280	0.344	0.400
	C2	0.24	0.6223	0.1575	1.02	23.55	0.45	0.45	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.109	0.140	0.171	0.199	0.225	0.250	0.219	0.269	0.313
	C3A	2.00	1.3469	0.2851	3.63	55.05	0.63	0.63	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.543	0.695	0.850	0.992	1.117	1.246	1.091	1.340	1.557
	C3B	0.77	0.1462	0.0000	0.92	84.08	0.79	0.79	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.172	0.221	0.270	0.315	0.354	0.395	0.346	0.425	0.494
	C4A	0.63	1.1120	0.2897	2.03	30.94	0.50	0.50	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.239	0.306	0.374	0.437	0.492	0.549	0.480	0.590	0.686
	C4B	0.11	0.1696	0.0586	0.33	31.56	0.52	0.52	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.041	0.053	0.064	0.075	0.084	0.094	0.082	0.101	0.118
	C4C	0.73	0.7273	0.1853	1.64	44.46	0.57	0.57	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.224	0.287	0.351	0.409	0.461	0.514	0.450	0.553	0.643
	C4D	0.94	1.3164	0.4600	2.72	34.68	0.54	0.54	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.347	0.444	0.543	0.633	0.713	0.795	0.697	0.856	0.994
	C5A	0.48	0.8624	0.1364	1.48	32.50	0.48	0.48	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.168	0.216	0.264	0.308	0.346	0.386	0.338	0.416	0.483
	C5B	2.01	4.3120	1.3588	7.68	26.14	0.48	0.48	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.878	1.124	1.374	1.603	1.805	2.013	1.763	2.166	2.517
	C6	0.55	1.0841	0.3292	1.97	28.16	0.49	0.49	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.229	0.293	0.359	0.418	0.471	0.525	0.460	0.565	0.657
	Total	8.89	11.9508	3.4590	24.30	36.58	0.53	-	-	-	-	-	-	-	-	3.092	3.956	4.839	5.644	6.355	7.089	6.208	7.626	8.861

[2] *Antecedent Precipitation Factor (Ca)*	
25-Year Storm:	1.10
50-Year Storm:	1.20
100-Year Storm:	1.25

Location/Station	Drainage Catchment	Post-Development Condition																				
		Area (ha)				% Impervious	Runoff Coefficient (-)	Time of Concentration (min)	Rainfall Intensity (mm/hr)						Flow (m^3/s)						[2] Flow Adjustment for 25-100 Year Storms (m^3/s)		
	Catchment ID	Hard Surface	Vegetation	Compacted Gravel	Total				i_2	i_5	i_{10}	i_{25}	i_{50}	i_{100}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{25}	Q_{50}	Q_{100}
Airport Road (from King Street to Huntsmill Drive)	C1	0.43	0.4500	0.0000	0.88	48.86	0.54	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.114	0.145	0.178	0.207	0.233	0.260	0.228	0.280	0.326
	C2	0.29	0.7280	0.0000	1.02	28.63	0.40	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.097	0.124	0.152	0.178	0.200	0.223	0.195	0.240	0.279
	C3A	2.33	1.2983	0.0000	3.63	64.24	0.65	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.562	0.719	0.879	1.025	1.154	1.288	1.128	1.385	1.610
	C3B	0.76	0.1557	0.0000	0.92	83.05	0.78	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.171	0.219	0.267	0.312	0.351	0.392	0.343	0.421	0.490
	C4A	1.26	0.7720	0.0000	2.03	61.96	0.63	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.306	0.392	0.479	0.559	0.629	0.702	0.615	0.755	0.878
	C4B	0.19	0.1430	0.0000	0.33	57.12	0.60	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.048	0.061	0.075	0.087	0.098	0.109	0.096	0.117	0.136
	C4C	1.02	0.6270	0.0000	1.64	61.84	0.63	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.248	0.317	0.388	0.452	0.509	0.568	0.497	0.611	0.710
	C4D	1.10	1.6152	0.0000	2.72	40.60	0.48	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.314	0.401	0.491	0.572	0.644	0.719	0.630	0.773	0.899
	C5A	0.64	0.8349	0.0000	1.48	43.58	0.51	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.178	0.228	0.278	0.325	0.366	0.408	0.357	0.439	0.510
	C5B	1.66	6.0182	0.0000	7.68	21.61	0.35	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.642	0.822	1.005	1.172	1.320	1.473	1.290	1.584	1.841
	C6	0.55	1.4155	0.0000	1.97	28.06	0.40	10.00	85.72	109.68	134.16	156.47	176.19	196.54	0.186	0.238	0.291	0.339	0.382	0.426	0.373	0.458	0.532
	Total	10.24	14.0577	0.0000	24.30	42.15	0.50	-	-	-	-	-	-	-	2.864	3.665	4.483	5.228	5.887	6.567	5.751	7.065	8.209

[2] *Antecedent Precipitation Factor (Ca)*	
25-Year Storm:	1.10
50-Year Storm:	1.20
100-Year Storm:	1.25

Location/Station	Drainage Catchment	Required Storage Volume (m^3)	Provided Storage Volume (m^3)	Adequate Storage Provided?	Required Water Balance (m^3)
	Catchment ID				
Airport Road (from King Street to Huntsmill Drive)	C1	0.00	0.00	YES	237.60
	C2	0.00	0.00	YES	275.40
	C3A	120.92	126.00	YES	980.21
	C3B	0.00	0.00	YES	247.97
	C4A	124.91	127.00	YES	547.98
	C4B	14.93	15.00	YES	90.01
	C4C	66.69	70.00	YES	443.63
	C4D	0.00	0.00	YES	734.24
	C5A	41.46	42.24	YES	399.51
	C5B	0.00	0.00	YES	2072.99
	C6	0.00	0.00	YES	531.22
	Total	368.92	380.24	-	6560.76

[2] *Antecedent Precipitation Factor (Ca)*	
25-Year Storm:	1.10
50-Year Storm:	1.20
100-Year Storm:	1.25

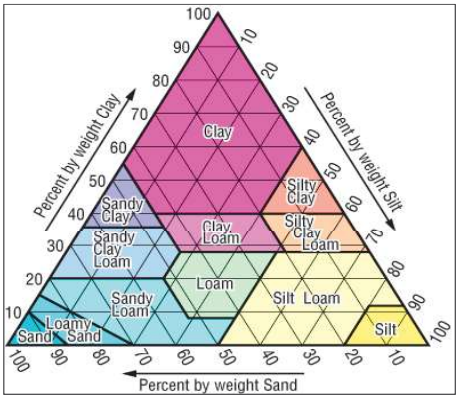
Water Balance Calculations

Water Balance Control - Infiltration							
Location/Station	Required Infiltration Volume (m^3)	Type of Infiltration	Infiltration Area (m^2)	(1) Soil Texture	(2) Infiltration Rate (mm/hr)	Detention Time (hr)	Provided Infiltration Volume (m^3)
Airport Road (from King Street to Huntsmill Drive)	6560.76	Vegetation	140577.01	Silty Clay	4.83	24	16282.19
		Total	140577.01	-	-	-	16282.19

Notes:

(1) *Soil texture along Airport Road corridor classified based on Grain Size Distribution of borehole BH5 from "PRELIMINARY PAVEMENT DESIGN REPORT - AIRPORT ROAD CLASS ENVIRONMENTAL ASSESSMENT (EA) FROM 1.0 KM NORTH OF MAYFIELD ROAD TO 0.6 KM NORTH OF KING STREET - REGIONAL MUNICIPALITY OF PEEL, ONTARIO" prepared by Terraproble and dated December 12, 2014.*

(2) *Infiltration rate of soils (0-4% slope) taken from* ***https://qcode.us/codes/sacramentocounty/view.php?topic=14-14_10-14_10_110***



Storage Calculation for 100-Year Storm

Location/Station: Airport Road (from King Street to Huntsmill Drive)
Catchment ID: C3A

Post-Development: 100-year storm Q_{100} (m^3/s) = 1.610
Pre-Development: 100-year storm Q_{100} (m^3/s) = 1.557

$Q_{control}$ (m^3/s) = **1.557**

Inflow Parameters (Post-Development)		
Area =	3.63	ha
R.C =	0.65	

IDF Curve Data (Region of Peel 100-Year)		
	A =	4688
	B =	0.9624
	C =	17.00

Time (min)	Intensity (mm/hr)	Peak Flow (m^3/s)	Inflow Volume (m^3)	Release Rate (m^3/s)	Outflow Volume (m^3)	Storage (m^3)
1.00	290.34	2.378	142.67	1.557	93.43	49.24
2.00	275.62	2.257	270.86	1.557	186.85	84.01
3.00	262.35	2.148	386.73	1.557	280.28	106.45
4.00	250.31	2.050	491.98	1.557	373.71	118.28
5.00	239.35	1.960	588.05	1.557	467.13	120.92
6.00	229.33	1.878	676.11	1.557	560.56	115.55
7.00	220.13	1.803	757.14	1.557	653.99	103.15
8.00	211.65	1.733	831.97	1.557	747.42	84.55
9.00	203.81	1.669	901.30	1.557	840.84	60.45
10.00	196.54	1.610	965.72	1.557	934.27	31.45
Storage required to control 100-year post-development peak flow to 100-year pre-development flow rate (m^3):						**120.92**

Storage Calculation for 100-Year Storm

Location/Station: Airport Road (from King Street to Huntsmill Drive)
Catchment ID: C4A

Post-Development: 100-year storm Q_{100} (m^3/s) = 0.878
Pre-Development: 100-year storm Q_{100} (m^3/s) = 0.686

$Q_{control}$ (m^3/s) = **0.686**

Inflow Parameters (Post-Development)		
Area =	2.03	ha
R.C =	0.63	

IDF Curve Data (Region of Peel 100-Year)		
	A =	4688
	B =	0.9624
	C =	17.00

Time (min)	Intensity (mm/hr)	Peak Flow (m^3/s)	Inflow Volume (m^3)	Release Rate (m^3/s)	Outflow Volume (m^3)	Storage (m^3)
1.00	290.34	1.297	77.80	0.686	41.14	36.66
2.00	275.62	1.231	147.71	0.686	82.28	65.43
3.00	262.35	1.172	210.89	0.686	123.42	87.47
4.00	250.31	1.118	268.29	0.686	164.56	103.73
5.00	239.35	1.069	320.68	0.686	205.70	114.98
6.00	229.33	1.024	368.70	0.686	246.84	121.86
7.00	220.13	0.983	412.89	0.686	287.98	124.91
8.00	211.65	0.945	453.70	0.686	329.12	124.58
9.00	203.81	0.910	491.50	0.686	370.26	121.24
10.00	196.54	0.878	526.63	0.686	411.40	115.23
Storage required to control 100-year post-development peak flow to 100-year pre-development flow rate (m^3):						**124.91**

Storage Calculation for 100-Year Storm

Location/Station: Airport Road (from King Street to Huntsmill Drive)
Catchment ID: C4B

Post-Development: 100-year storm Q_{100} (m^3/s) = 0.136
Pre-Development: 100-year storm Q_{100} (m^3/s) = 0.118

$Q_{control}$ (m^3/s) = **0.118**

Inflow Parameters (Post-Development)		
Area =	0.33	ha
R.C =	0.60	

IDF Curve Data (Region of Peel 100-Year)		
	A =	4688
	B =	0.9624
	C =	17.00

Time (min)	Intensity (mm/hr)	Peak Flow (m^3/s)	Inflow Volume (m^3)	Release Rate (m^3/s)	Outflow Volume (m^3)	Storage (m^3)
1.00	290.34	0.202	12.10	0.118	7.06	5.03
2.00	275.62	0.191	22.96	0.118	14.13	8.84
3.00	262.35	0.182	32.79	0.118	21.19	11.59
4.00	250.31	0.174	41.71	0.118	28.26	13.45
5.00	239.35	0.166	49.86	0.118	35.32	14.53
6.00	229.33	0.159	57.32	0.118	42.39	14.93
7.00	220.13	0.153	64.19	0.118	49.45	14.74
8.00	211.65	0.147	70.54	0.118	56.52	14.02
9.00	203.81	0.142	76.41	0.118	63.58	12.83
10.00	196.54	0.136	81.88	0.118	70.65	11.23
Storage required to control 100-year post-development peak flow to 100-year pre-development flow rate (m^3):						**14.93**

Storage Calculation for 100-Year Storm

Location/Station: Airport Road (from King Street to Huntsmill Drive)
Catchment ID: C4C

Post-Development: 100-year storm Q_{100} (m^3/s) = 0.710
Pre-Development: 100-year storm Q_{100} (m^3/s) = 0.643

$Q_{control}$ (m^3/s) = **0.643**

Inflow Parameters (Post-Development)		
Area =	1.64	ha
R.C =	0.63	

IDF Curve Data (Region of Peel 100-Year)		
	A =	4688
	B =	0.9624
	C =	17.00

Time (min)	Intensity (mm/hr)	Peak Flow (m^3/s)	Inflow Volume (m^3)	Release Rate (m^3/s)	Outflow Volume (m^3)	Storage (m^3)
1.00	290.34	1.048	62.90	0.643	38.56	24.33
2.00	275.62	0.995	119.42	0.643	77.13	42.29
3.00	262.35	0.947	170.50	0.643	115.69	54.81
4.00	250.31	0.904	216.91	0.643	154.26	62.65
5.00	239.35	0.864	259.26	0.643	192.82	66.44
6.00	229.33	0.828	298.08	0.643	231.39	66.69
7.00	220.13	0.795	333.81	0.643	269.95	63.85
8.00	211.65	0.764	366.80	0.643	308.52	58.28
9.00	203.81	0.736	397.36	0.643	347.08	50.28
10.00	196.54	0.710	425.77	0.643	385.65	40.12
Storage required to control 100-year post-development peak flow to 100-year pre-development flow rate (m^3):						**66.69**

Storage Calculation for 100-Year Storm

Location/Station: Airport Road (from King Street to Huntsmill Drive)
Catchment ID: C5A

Post-Development: 100-year storm Q_{100} (m^3/s) = 0.510
Pre-Development: 100-year storm Q_{100} (m^3/s) = 0.483

$Q_{control}$ (m^3/s) = **0.483**

Inflow Parameters (Post-Development)		
Area =	1.48	ha
R.C =	0.51	

IDF Curve Data (Region of Peel 100-Year)		
	A =	4688
	B =	0.9624
	C =	17.00

Time (min)	Intensity (mm/hr)	Peak Flow (m^3/s)	Inflow Volume (m^3)	Release Rate (m^3/s)	Outflow Volume (m^3)	Storage (m^3)
1.00	290.34	0.753	45.20	0.483	28.97	16.23
2.00	275.62	0.715	85.82	0.483	57.94	27.88
3.00	262.35	0.681	122.53	0.483	86.92	35.62
4.00	250.31	0.650	155.88	0.483	115.89	39.99
5.00	239.35	0.621	186.32	0.483	144.86	41.46
6.00	229.33	0.595	214.22	0.483	173.83	40.39
7.00	220.13	0.571	239.90	0.483	202.80	37.09
8.00	211.65	0.549	263.60	0.483	231.78	31.83
9.00	203.81	0.529	285.57	0.483	260.75	24.82
10.00	196.54	0.510	305.98	0.483	289.72	16.26
Storage required to control 100-year post-development peak flow to 100-year pre-development flow rate (m^3):						**41.46**

APPENDIX N: OGS SIZING CALCULATIONS

Stormceptor CD Sizing Program
Canada
Version 4.0.0

Project Details			
Project	Airport Rd, Region of Peel	Project #	109535
Location	OGS 1/C3A	Company	IBI
Date	Feb. 10, 2021	Contact	RP

Selected Rainfall Station	
State	Ontario
Name	TORONTO CENTRAL
ID #	100
Elev. (m)	100
Latitude	N 45 deg 30 min
Longitude	W 90 deg 30 min

Site Parameters	
Total Area (ha)	2.08
Imperviousness (%)	79
Impervious Area (ha)	1.64

Particle Size Distribution		
Diam. (um)	Percent (%)	Spec. Gravity
20	20	1.30
60	20	1.80
150	20	2.20
400	20	2.65
2000	20	2.65

Stormceptor Sizing Table		
Stormceptor Model	% Runoff Treated	% TSS Removal
STC 300	57	51
STC 750	77	65
STC 1000	77	66
STC 1500	77	67
STC 2000	86	71
STC 3000	86	73
STC 4000	92	77
STC 5000	92	78
STC 6000	94	81
STC 9000	97	85
STC 10000	97	85
STC 14000	98	88

Comments :

Stormceptor CD Sizing Program
Canada
Version 4.0.0

Project Details			
Project	Airport Rd, Region of Peel	Project #	109535
Location	OGS 2/C3B	Company	IBI
Date	Feb. 10, 2021	Contact	RP

Selected Rainfall Station	
State	Ontario
Name	TORONTO CENTRAL
ID #	100
Elev. (m)	100
Latitude	N 45 deg 30 min
Longitude	W 90 deg 30 min

Site Parameters	
Total Area (ha)	1.70
Imperviousness (%)	52
Impervious Area (ha)	.88

Particle Size Distribution		
Diam. (um)	Percent (%)	Spec. Gravity
20	20	1.30
60	20	1.80
150	20	2.20
400	20	2.65
2000	20	2.65

Stormceptor Sizing Table		
Stormceptor Model	% Runoff Treated	% TSS Removal
STC 300	71	60
STC 750	86	72
STC 1000	86	74
STC 1500	86	74
STC 2000	92	78
STC 3000	92	80
STC 4000	96	83
STC 5000	96	84
STC 6000	97	86
STC 9000	99	90
STC 10000	99	90
STC 14000	99	92

Comments :

Stormceptor CD Sizing Program
Canada
Version 4.0.0

Project Details			
Project	Airport Rd, Region of Peel	Project #	109535
Location	OGS 3/C4A & C4B	Company	IBI
Date	Feb. 10, 2021	Contact	RP

Selected Rainfall Station	
State	Ontario
Name	TORONTO CENTRAL
ID #	100
Elev. (m)	100
Latitude	N 45 deg 30 min
Longitude	W 90 deg 30 min

Site Parameters	
Total Area (ha)	2.11
Imperviousness (%)	75
Impervious Area (ha)	1.58

Particle Size Distribution		
Diam. (um)	Percent (%)	Spec. Gravity
20	20	1.30
60	20	1.80
150	20	2.20
400	20	2.65
2000	20	2.65

Stormceptor Sizing Table		
Stormceptor Model	% Runoff Treated	% TSS Removal
STC 300	57	52
STC 750	78	65
STC 1000	78	67
STC 1500	78	67
STC 2000	86	72
STC 3000	86	73
STC 4000	92	78
STC 5000	92	79
STC 6000	95	81
STC 9000	97	86
STC 10000	97	85
STC 14000	98	89

Comments :

Stormceptor CD Sizing Program
Canada
Version 4.0.0

Project Details			
Project	Airport Rd, Region of Peel	Project #	109535
Location	OGS 4/C4C	Company	IBI
Date	Feb. 10, 2021	Contact	RP

Selected Rainfall Station	
State	Ontario
Name	TORONTO CENTRAL
ID #	100
Elev. (m)	100
Latitude	N 45 deg 30 min
Longitude	W 90 deg 30 min

Site Parameters	
Total Area (ha)	1.25
Imperviousness (%)	83
Impervious Area (ha)	1.04

Particle Size Distribution

Diam. (um)	Percent (%)	Spec. Gravity
20	20	1.30
60	20	1.80
150	20	2.20
400	20	2.65
2000	20	2.65

Stormceptor Sizing Table

Stormceptor Model	% Runoff Treated	% TSS Removal
STC 300	68	58
STC 750	85	71
STC 1000	85	72
STC 1500	85	72
STC 2000	91	76
STC 3000	91	78
STC 4000	95	82
STC 5000	95	83
STC 6000	97	85
STC 9000	98	89
STC 10000	98	89
STC 14000	99	91

Comments :

Stormceptor CD Sizing Program
Canada
Version 4.0.0

Project Details			
Project	Airport Rd, Region of Peel	Project #	109535
Location	OGS 5/C5A	Company	IBI
Date	Feb. 10, 2021	Contact	RP

Selected Rainfall Station	
State	Ontario
Name	TORONTO CENTRAL
ID #	100
Elev. (m)	100
Latitude	N 45 deg 30 min
Longitude	W 90 deg 30 min

Site Parameters	
Total Area (ha)	0.354
Imperviousness (%)	100
Impervious Area (ha)	.35

Particle Size Distribution		
Diam. (um)	Percent (%)	Spec. Gravity
20	20	1.30
60	20	1.80
150	20	2.20
400	20	2.65
2000	20	2.65

Stormceptor Sizing Table		
Stormceptor Model	% Runoff Treated	% TSS Removal
STC 300	88	73
STC 750	95	82
STC 1000	95	83
STC 1500	95	84
STC 2000	98	87
STC 3000	98	88
STC 4000	99	91
STC 5000	99	91
STC 6000	100	93
STC 9000	100	95
STC 10000	100	95
STC 14000	100	96

Comments :

APPENDIX O: FLOW SPREAD ANALYSIS

Flow Spread Analysis Summary

Low Point		Major Storm			
No.	Station	Max Depth (m)	Max Spread (m)	Encroachment (m)	Clear Width (m)
5	14+182.253	0.041	2.057	2.057	1.443
6	14+854.431	0.065	3.251	3.251	0.749
7	15+817.424	0.063	3.137	0.737	1.863

Notes:

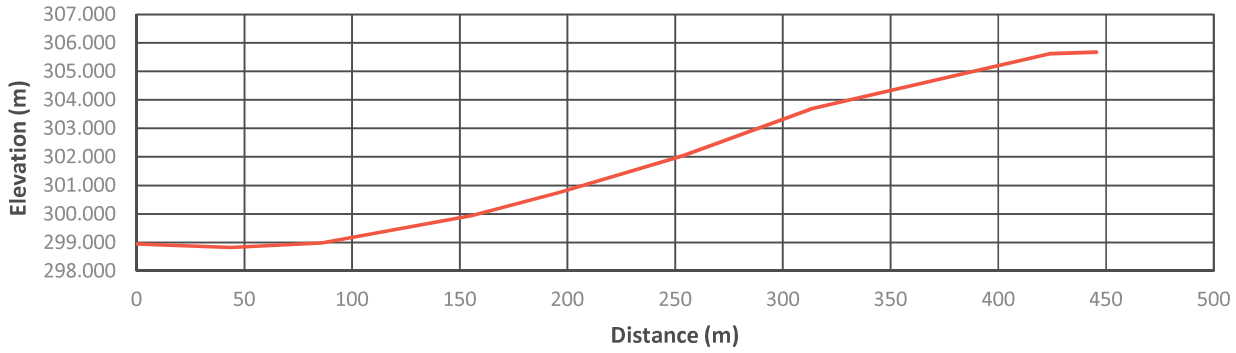
1. Major storm peak flows (100-year) were calculated by discounting the minor flow (10-year). Minor flows are conveyed by STM without surcharge.

2. No flooding of road during 10-year and 25 mm storm.

3. Major storm flooding depth is below the maximum allowable limit of 150 mm. Depth of flooding during major storm at low points will range from 41 mm to 65 mm. The road can still be used by vehicles.

Location 5 Lowpoint Spread				
Station Range	14+138.432	to	14+583.983	
Lowpoint Station	14+182.253			
PROPERTIES OF THE ROAD				
Crossfall	2.0%			
PROFILE DATA				
Station	**Distance from Start (m)**	**Span (m)**	**Elevation (m)**	**Slope**
14.138432	0.00	-	298.948	-
14.149682	11.25	11.25	298.920	0.25%
14.182253	43.82	32.57	298.827	0.29%
14.224253	85.82	42.00	298.986	0.38%
14.294253	155.82	70.00	299.947	1.37%
14.334682	196.25	40.43	300.756	2.00%
14.392182	253.75	57.50	302.050	2.25%
14.449682	311.25	57.50	303.631	2.75%
14.451983	313.55	2.30	303.700	3.00%
14.561983	423.55	110.00	305.623	1.75%
14.583983	445.55	22.00	305.680	0.26%
			Average Longitudinal Grade:	1.43%

Longitudinal Road Profile



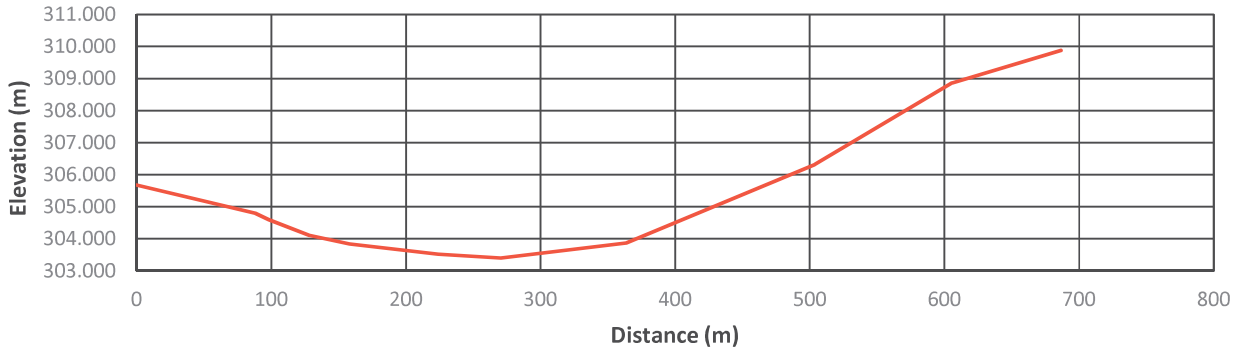
PARAMETERS			
S_X	0.0200	m/m	*Crossfall*
S_O	0.0143	m/m	*Longitudinal Grade*
i_{10}	134.16	mm/hr	*Rainfall Intensity 2019 ROP IDF (10-Year)*
i_{100}	196.54	mm/hr	*Rainfall Intensity 2019 ROP IDF (100-Year)*
n	0.013		*Manning's Roughness Coeff.*
C	0.95		*Runoff Coefficient*
W	4.70	m	*Drainage Area Width*
L	445.55	m	*Drainage Area Length*

DISCHARGE CALCULATIONS (from Eq.3.5)				
W (m)	**L (m)**	**C**	**I_{10} (mm/hr)**	**Q_{10} (m^3/s)**
4.70	445.55	0.95	134.16	0.075
W (m)	**L (m)**	**C**	**I_{100} (mm/hr)**	**Q_{100} (m^3/s)**
4.70	445.55	0.95	196.54	0.109
Q_{90} (m^3/s)	0.035			

SPREAD CHECK (MAJOR SYSTEM)				
Maximum Flow Depth Calculation (from Eq.3.4)				
Q_{90} (m^3/s)	n	S_X (m/m)	S_O (m/m)	d (m)
0.035	0.013	0.0200	0.0143	0.041
Max Spread of Flow Calculation (from Figure 1)				
d (m)	S_X (m/m)	T (m)		
0.041	0.0200	2.057		
Encroachment into Traffic Lane				
Shoulder Width (m)	T (m)	E (m)		
0.000	2.0570	2.057		
Clear Width of Traffic Lane				
1st Traffic Lane Width (m)	E (m)	C (m)		
3.500	2.0570	1.443		

Location 6 Lowpoint Spread				
Station Range	14+583.983	to	15+270.650	
Lowpoint Station	14+854.431			
PROPERTIES OF THE ROAD				
Crossfall	2.0%			
PROFILE DATA				
Station	**Distance from Start (m)**	**Span (m)**	**Elevation (m)**	**Slope**
14.583983	0.00	-	305.680	-
14.671983	88.00	88.00	304.800	1.00%
14.681983	98.00	10.00	304.600	2.00%
14.711983	128.00	30.00	304.113	1.62%
14.741983	158.00	30.00	303.850	0.88%
14.807764	223.78	65.78	303.521	0.50%
14.854431	270.45	46.67	303.404	0.25%
14.947764	363.78	93.33	303.873	0.50%
15.087764	503.78	140.00	306.321	1.75%
15.189697	605.71	101.93	308.869	2.50%
15.270650	686.67	80.95	309.881	1.25%
			Average Longitudinal Grade:	1.23%

Longitudinal Road Profile



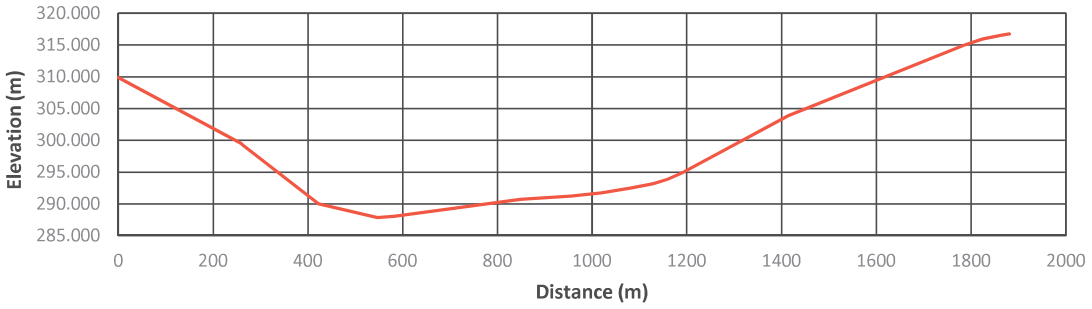
PARAMETERS			
S_X	0.0200	m/m	*Crossfall*
S_O	0.0123	m/m	*Longitudinal Grade*
i_{10}	134.16	mm/hr	*Rainfall Intensity 2019 ROP IDF (10-Year)*
i_{100}	196.54	mm/hr	*Rainfall Intensity 2019 ROP IDF (100-Year)*
n	0.013		*Manning's Roughness Coeff.*
C	0.95		*Runoff Coefficient*
W	9.57	m	*Drainage Area Width*
L	686.67	m	*Drainage Area Length*

DISCHARGE CALCULATIONS (from Eq.3.5)				
W (m)	**L (m)**	**C**	**I_{10} (mm/hr)**	**Q_{10} (m^3/s)**
9.57	686.67	0.95	134.16	0.235
W (m)	**L (m)**	**C**	**I_{100} (mm/hr)**	**Q_{100} (m^3/s)**
9.57	686.67	0.95	196.54	0.344
Q_{90} (m^3/s)	0.109			

SPREAD CHECK (MAJOR SYSTEM)				
Maximum Flow Depth Calculation (from Eq.3.4)				
Q_{90} (m^3/s)	n	S_X (m/m)	S_O (m/m)	d (m)
0.109	0.013	0.0200	0.0123	0.065
Max Spread of Flow Calculation (from Figure 1)				
d (m)	S_X (m/m)	T (m)		
0.065	0.0200	3.251		
Encroachment into Traffic Lane				
Shoulder Width (m)	T (m)	E (m)		
0.000	3.2510	3.251		
Clear Width of Traffic Lane				
1st Traffic Lane Width (m)	E (m)	C (m)		
4.000	3.2510	0.749		

Location 7 Lowpoint Spread				
Station Range	15+270.650	to	17+151.506	
Lowpoint Station	15+817.424			
PROPERTIES OF THE ROAD				
Crossfall	2.0%			
PROFILE DATA				
Station	Distance from Start (m)	Span (m)	Elevation (m)	Slope
15.270650	0.00	-	309.881	-
15.529697	259.05	259.05	299.519	4.00%
15.532980	262.33	3.28	299.257	7.98%
15.692980	422.33	160.00	290.064	5.75%
15.817424	546.77	124.44	287.879	1.76%
15.852980	582.33	35.56	288.057	0.50%
16.120000	849.35	267.02	290.727	1.00%
16.225000	954.35	105.00	291.252	0.50%
16.290000	1019.35	65.00	291.740	0.75%
16.355000	1084.35	65.00	292.552	1.25%
16.400000	1129.35	45.00	293.227	1.50%
16.430000	1159.35	30.00	293.865	2.13%
16.460000	1189.35	30.00	294.877	3.37%
16.685000	1414.35	225.00	303.877	4.00%
17.054944	1784.29	369.94	314.975	3.00%
17.094944	1824.29	40.00	315.975	2.50%
17.134944	1864.29	40.00	316.575	1.50%
17.151506	1880.86	16.56	316.741	1.00%
			Average Longitudinal Grade:	2.50%

Longitudinal Road Profile



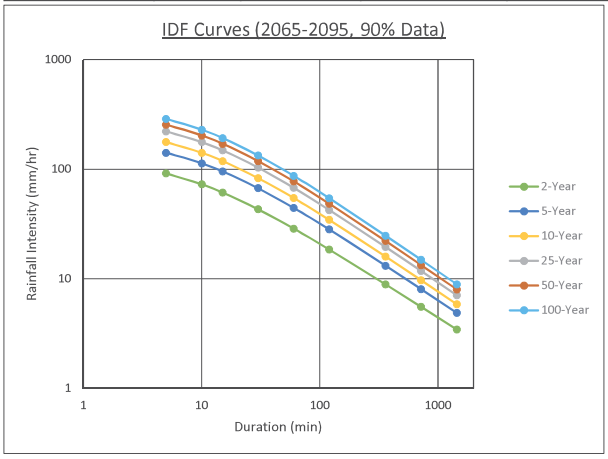
PARAMETERS			
S_X	0.0200	m/m	*Crossfall*
S_O	0.0250	m/m	*Longitudinal Grade*
i_{10}	134.16	mm/hr	*Rainfall Intensity 2019 ROP IDF (10-Year)*
i_{100}	196.54	mm/hr	*Rainfall Intensity 2019 ROP IDF (100-Year)*
n	0.013		*Manning's Roughness Coeff.*
C	0.95		*Runoff Coefficient*
W	9.07	m	*Drainage Area Width*
L	1880.86	m	*Drainage Area Length*

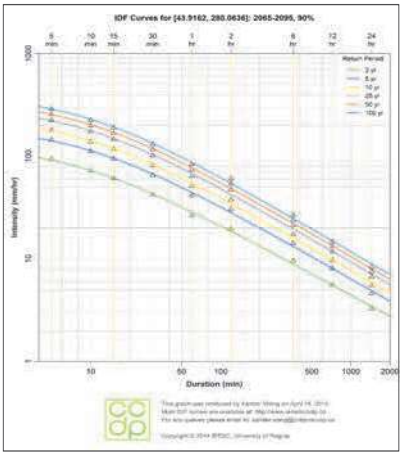
DISCHARGE CALCULATIONS (from Eq.3.5)				
W (m)	L (m)	C	I_{10} (mm/hr)	Q_{10} (m^3/s)
9.07	1880.86	0.95	134.16	0.609
W (m)	L (m)	C	I_{100} (mm/hr)	Q_{100} (m^3/s)
9.07	1880.86	0.95	196.54	0.892
Q_{90} (m^3/s)	0.283			

SPREAD CHECK (MAJOR SYSTEM)				
Maximum Flow Depth Calculation (from Eq.3.4)				
Q_{90} (m^3/s)	n	S_X (m/m)	S_O (m/m)	d (m)
0.142	0.013	0.0200	0.0250	0.063
Max Spread of Flow Calculation (from Figure 1)				
d (m)	S_X (m/m)	T (m)		
0.063	0.0200	3.137		
Encroachment into Traffic Lane				
Shoulder Width (m)	T (m)	E (m)		
2.400	3.1365	0.737		
Clear Width of Traffic Lane				
1^{st} Traffic Lane Width (m)	E (m)	C (m)		
2.600	0.7365	1.863		

APPENDIX P: CLIMATE CHANGE CALCULATIONS

Rainfall Intensity (mm/hr) (2065-2095, 90% Data)									
Return Period	Duration (min)								
	5	10	15	30	60	120	360	720	1440
2_yrs	91.64	72.75	61.2	43.04	28.69	18.48	8.89	5.54	3.45
5_yrs	141.43	113.31	95.64	67.23	44.44	28.22	13.16	8.03	4.88
10_yrs	176.74	141.09	118.76	83.01	54.57	34.49	15.96	9.69	5.86
25_yrs	221.82	176.7	148.48	103.44	67.64	42.45	19.5	11.79	7.09
50_yrs	255.29	203.12	170.54	118.58	77.38	48.45	22.12	13.34	8.01
100_yrs	288.52	229.36	192.43	133.62	87.04	54.4	24.72	14.88	8.92





2-Year													
Rainfall Intensity (mm/hr)	Duration (min)	log [Intensity] (mm/hr)	log [Duration + B] (min)						log [Intensity] (mm/hr)				
			-	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
91.64	5	1.9621	log [5 + B]	1.0934	1.0969	1.1004	1.1038	1.1072	3.4716	3.4778	3.4841	3.4903	3.4965
72.75	10	1.8618	log [10 + B]	1.2405	1.2430	1.2455	1.2480	1.2504	3.5730	3.5788	3.5845	3.5902	3.5959
61.2	15	1.7868	log [15 + B]	1.3502	1.3522	1.3541	1.3560	1.3579	3.6487	3.6541	3.6596	3.6650	3.6704
43.04	30	1.6339	log [30 + B]	1.5729	1.5740	1.5752	1.5763	1.5775	3.8022	3.8073	3.8125	3.8176	3.8227
28.69	60	1.4577	log [60 + B]	1.8287	1.8293	1.8299	1.8306	1.8312	3.9785	3.9836	3.9886	3.9937	3.9987
18.48	120	1.2667	log [120 + B]	2.1052	2.1055	2.1059	2.1062	2.1065	4.1692	4.1743	4.1794	4.1845	4.1896
8.89	360	0.9489	log [360 + B]	2.5651	2.5653	2.5654	2.5655	2.5656	4.4864	4.4918	4.4972	4.5026	4.5080
5.54	720	0.7435	log [720 + B]	2.8618	2.8618	2.8619	2.8620	2.8620	4.6909	4.6966	4.7023	4.7079	4.7136
3.45	1440	0.5378	log [1440 + B]	3.1606	3.1606	3.1606	3.1607	3.1607	4.8970	4.9030	4.9089	4.9148	4.9207

Trial No.	Assumed B	logA	C	Correlation Coefficient
1	7.4	2.7176	-0.6896	-0.9999987
2	7.5	2.7204	-0.6906	-0.9999996
3	7.6	2.7231	-0.6916	-0.9999999
4	7.7	2.7259	-0.6926	-0.9999995
5	7.8	2.7286	-0.6935	-0.9999986
			MIN (closest to -1):	-0.9999999

IDF Curve Parameters	
A	528.6
B	7.6
C	0.6916

5-Year													
Rainfall Intensity (mm/hr)	Duration (min)	log [Intensity] (mm/hr)	log [Duration + B] (min)						log [Intensity] (mm/hr)				
			-	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
141.43	5	2.1505	log [5 + B]	1.1399	1.1430	1.1461	1.1492	1.1523	3.8017	3.8079	3.8139	3.8200	3.8261
113.31	10	2.0543	log [10 + B]	1.2742	1.2765	1.2788	1.2810	1.2833	3.8989	3.9046	3.9102	3.9158	3.9214
95.64	15	1.9806	log [15 + B]	1.3766	1.3784	1.3802	1.3820	1.3838	3.9730	3.9784	3.9838	3.9892	3.9945
67.23	30	1.8276	log [30 + B]	1.5888	1.5899	1.5911	1.5922	1.5933	4.1267	4.1318	4.1368	4.1419	4.1469
44.44	60	1.6478	log [60 + B]	1.8376	1.8382	1.8388	1.8395	1.8401	4.3067	4.3117	4.3166	4.3216	4.3265
28.22	120	1.4506	log [120 + B]	2.1099	2.1103	2.1106	2.1109	2.1113	4.5038	4.5088	4.5138	4.5189	4.5238
13.16	360	1.1193	log [360 + B]	2.5668	2.5669	2.5670	2.5671	2.5673	4.8344	4.8398	4.8451	4.8504	4.8556
8.03	720	0.9047	log [720 + B]	2.8626	2.8627	2.8627	2.8628	2.8628	5.0485	5.0541	5.0597	5.0652	5.0707
4.88	1440	0.6884	log [1440 + B]	3.1610	3.1610	3.1611	3.1611	3.1611	5.2645	5.2703	5.2762	5.2820	5.2878

Trial No.	Assumed B	logA	C	Correlation Coefficient
1	8.8	2.9768	-0.7237	-0.9999991
2	8.9	2.9795	-0.7247	-0.9999998
3	9.0	2.9822	-0.7257	-1.0000000
4	9.1	2.9849	-0.7267	-0.9999997
5	9.2	2.9876	-0.7276	-0.9999988
			MIN (closest to -1):	-1.0000000

IDF Curve Parameters	
A	959.9
B	9.0
C	0.7257

10-Year													
Rainfall Intensity (mm/hr)	Duration (min)	log [Intensity] (mm/hr)	log [Duration + B] (min)						log [Intensity] (mm/hr)				
			-	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
176.74	5	2.2473	log [5 + B]	1.1335	1.1367	1.1399	1.1430	1.1461	3.9045	3.9107	3.9169	3.9231	3.9292
141.09	10	2.1495	log [10 + B]	1.2695	1.2718	1.2742	1.2765	1.2788	4.0037	4.0095	4.0152	4.0209	4.0266
118.76	15	2.0747	log [15 + B]	1.3729	1.3747	1.3766	1.3784	1.3802	4.0792	4.0847	4.0902	4.0957	4.1011
83.01	30	1.9191	log [30 + B]	1.5866	1.5877	1.5888	1.5899	1.5911	4.2353	4.2404	4.2456	4.2508	4.2559
54.57	60	1.7370	log [60 + B]	1.8363	1.8370	1.8376	1.8382	1.8388	4.4176	4.4227	4.4277	4.4328	4.4378
34.49	120	1.5377	log [120 + B]	2.1092	2.1096	2.1099	2.1103	2.1106	4.6169	4.6220	4.6271	4.6322	4.6373
15.96	360	1.2030	log [360 + B]	2.5666	2.5667	2.5668	2.5669	2.5670	4.9508	4.9562	4.9616	4.9670	4.9724
9.69	720	0.9863	log [720 + B]	2.8625	2.8625	2.8626	2.8627	2.8627	5.1669	5.1726	5.1782	5.1839	5.1895
5.86	1440	0.7679	log [1440 + B]	3.1609	3.1610	3.1610	3.1610	3.1611	5.3848	5.3908	5.3967	5.4026	5.4085

Trial No.	Assumed B	logA	C	Correlation Coefficient
1	8.6	3.0768	-0.7302	-0.99999847
2	8.7	3.0796	-0.7312	-0.99999948
3	8.8	3.0823	-0.7322	-0.99999994
4	8.9	3.0851	-0.7332	-0.99999987
5	9.0	3.0878	-0.7341	-0.99999927
			MIN (closest to -1):	-0.99999994

IDF Curve Parameters	
A	1208.7
B	8.8
C	0.7322

25-Year													
Rainfall Intensity (mm/hr)	Duration (min)	log [Intensity] (mm/hr)	log [Duration + B] (min)						log [Intensity] (mm/hr)				
			-	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
221.82	5	2.3460	log [5 + B]	1.1335	1.1367	1.1399	1.1430	1.1461	4.0214	4.0277	4.0340	4.0402	4.0465
176.7	10	2.2472	log [10 + B]	1.2695	1.2718	1.2742	1.2765	1.2788	4.1218	4.1276	4.1334	4.1391	4.1449
148.48	15	2.1717	log [15 + B]	1.3729	1.3747	1.3766	1.3784	1.3802	4.1981	4.2036	4.2092	4.2147	4.2202
103.44	30	2.0147	log [30 + B]	1.5866	1.5877	1.5888	1.5899	1.5911	4.3558	4.3611	4.3663	4.3715	4.3767
67.64	60	1.8302	log [60 + B]	1.8363	1.8370	1.8376	1.8382	1.8388	4.5402	4.5453	4.5504	4.5555	4.5606
42.45	120	1.6279	log [120 + B]	2.1092	2.1096	2.1099	2.1103	2.1106	4.7416	4.7468	4.7520	4.7571	4.7623
19.5	360	1.2900	log [360 + B]	2.5666	2.5667	2.5668	2.5669	2.5670	5.0792	5.0847	5.0902	5.0956	5.1010
11.79	720	1.0715	log [720 + B]	2.8625	2.8625	2.8626	2.8627	2.8627	5.2977	5.3034	5.3091	5.3148	5.3205
7.09	1440	0.8506	log [1440 + B]	3.1609	3.1610	3.1610	3.1610	3.1611	5.5180	5.5240	5.5300	5.5360	5.5419

Trial No.	Assumed B	logA	C	Correlation Coefficient
1	8.6	3.1846	-0.7382	-0.9999985
2	8.7	3.1874	-0.7392	-0.9999994
3	8.8	3.1902	-0.7402	-0.9999997
4	8.9	3.1930	-0.7412	-0.9999996
5	9.00	3.1958	-0.7422	-0.9999989
			MIN (closest to -1):	-0.9999997

IDF Curve Parameters	
A	1549.7
B	8.8
C	0.7402

50-Year														
Rainfall Intensity (mm/hr)	Duration (min)	log [Intensity] (mm/hr)	log [Duration + B] (min)						log [Intensity] (mm/hr)				
			-	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
255.29	5	2.4070	log [5 + B]	1.1335	1.1367	1.1399	1.1430	1.1461	4.0920	4.0984	4.1047	4.1110	4.1172
203.12	10	2.3078	log [10 + B]	1.2695	1.2718	1.2742	1.2765	1.2788	4.1930	4.1988	4.2046	4.2104	4.2162
170.54	15	2.2318	log [15 + B]	1.3729	1.3747	1.3766	1.3784	1.3802	4.2697	4.2753	4.2809	4.2864	4.2919
118.58	30	2.0740	log [30 + B]	1.5866	1.5877	1.5888	1.5899	1.5911	4.4283	4.4336	4.4389	4.4441	4.4493
77.38	60	1.8886	log [60 + B]	1.8363	1.8370	1.8376	1.8382	1.8388	4.6137	4.6189	4.6240	4.6292	4.6343
48.45	120	1.6853	log [120 + B]	2.1092	2.1096	2.1099	2.1103	2.1106	4.8163	4.8216	4.8268	4.8319	4.8371
22.12	360	1.3448	log [360 + B]	2.5666	2.5667	2.5668	2.5669	2.5670	5.1558	5.1613	5.1668	5.1723	5.1778
13.34	720	1.1252	log [720 + B]	2.8625	2.8625	2.8626	2.8627	2.8627	5.3755	5.3813	5.3870	5.3928	5.3985
8.01	1440	0.9036	log [1440 + B]	3.1609	3.1610	3.1610	3.1610	3.1611	5.5971	5.6031	5.6092	5.6152	5.6212

Trial No.	Assumed B	logA	C	Correlation Coefficient
1	8.6	3.2505	-0.7424	-0.9999982
2	8.7	3.2534	-0.7434	-0.9999992
3	8.8	3.2562	-0.7444	-0.9999996
4	8.9	3.2590	-0.7454	-0.9999995
5	9	3.2618	-0.7464	-0.9999989
			MIN (closest to -1):	-0.9999996

IDF Curve Parameters	
A	1803.7
B	8.8
C	0.7444

100-Year														
Rainfall Intensity (mm/hr)	Duration (min)	log [Intensity] (mm/hr)	log [Duration + B] (min)						log [Intensity] (mm/hr)				
			-	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
288.52	5	2.4602	log [5 + B]	1.1335	1.1367	1.1399	1.1430	1.1461	4.1527	4.1591	4.1654	4.1718	4.1780
229.36	10	2.3605	log [10 + B]	1.2695	1.2718	1.2742	1.2765	1.2788	4.2541	4.2600	4.2658	4.2717	4.2775
192.43	15	2.2843	log [15 + B]	1.3729	1.3747	1.3766	1.3784	1.3802	4.3312	4.3368	4.3424	4.3480	4.3535
133.62	30	2.1259	log [30 + B]	1.5866	1.5877	1.5888	1.5899	1.5911	4.4905	4.4958	4.5011	4.5064	4.5116
87.04	60	1.9397	log [60 + B]	1.8363	1.8370	1.8376	1.8382	1.8388	4.6768	4.6819	4.6871	4.6922	4.6974
54.4	120	1.7356	log [120 + B]	2.1092	2.1096	2.1099	2.1103	2.1106	4.8803	4.8855	4.8907	4.8959	4.9011
24.72	360	1.3930	log [360 + B]	2.5666	2.5667	2.5668	2.5669	2.5670	5.2212	5.2268	5.2323	5.2378	5.2433
14.88	720	1.1726	log [720 + B]	2.8625	2.8625	2.8626	2.8627	2.8627	5.4419	5.4477	5.4535	5.4592	5.4650
8.92	1440	0.9504	log [1440 + B]	3.1609	3.1610	3.1610	3.1610	3.1611	5.6644	5.6705	5.6766	5.6826	5.6887

Trial No.	Assumed B	logA	C	Correlation Coefficient
1	8.6	3.3075	-0.7456	-0.9999978
2	8.7	3.3104	-0.7467	-0.9999989
3	8.8	3.3132	-0.7477	-0.9999994
4	8.9	3.3160	-0.7487	-0.9999994
5	9.0	3.3188	-0.7497	-0.9999989
			MIN (closest to -1):	-0.9999994

IDF Curve Parameters	
A	2056.7
B	8.8
C	0.7477

IDF Curve Parameters (2065-2095, 90% Data)			
Return Period	A	B	C
2-Year	528.6	7.6	0.6916
5-Year	959.9	9.0	0.7257
10-Year	1208.7	8.8	0.7322
25-Year	1549.7	8.8	0.7402
50-Year	1803.7	8.8	0.7444
100-Year	2056.7	8.8	0.7477

Rainfall Intensity (mm/hr) (2065-2095, 90% Data) CALCULATED USING IDF CURVE PARAMETERS AS A CHECK									
Return Period	Duration (min)								
	5	10	15	30	60	120	360	720	1440
2_yrs	91.66	72.74	61.19	43.03	28.68	18.48	8.89	5.55	3.45
5_yrs	141.41	113.30	95.63	67.24	44.44	28.22	13.16	8.03	4.88
10_yrs	176.91	141.07	118.70	82.99	54.57	34.48	15.96	9.69	5.86
25_yrs	222.08	176.65	148.36	103.32	67.62	42.51	19.51	11.79	7.09
50_yrs	255.66	203.10	170.40	118.43	77.32	48.48	22.16	13.34	8.00
100_yrs	289.01	229.36	192.28	133.43	86.95	54.40	24.78	14.89	8.91

Table N-1: Hydrologic Assessment of Airport Road Culverts (2095 IDF Curves)

Drainage Outlet	Station	Drainage Area	Catchment Length	Watershed US Elev.	Watershed DS Elev.	Slope	Time of Concentration		Composite Runoff Coefficient	Rainfall Intensity (mm/hr)						Flow (m^3/s)						
		A	L	m	m	S	T_C															
		ha	m			%	min	hr	C	I_2	I_5	I_{10}	I_{25}	I_{50}	I_{100}	Q_2	Q_5	Q_{10}	Q_{25} [6]	Q_{50} [6]	Q_{100} [6]	$Q_{REGIONAL}$
C1	17+151	68.59	1080	372	316	5.19	52.90	0.88	0.25	31.0	48.1	59.1	73.3	83.8	94.3	1.49	2.31	2.84	3.87	4.83	5.66	[1]
C2	15+900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[2]	[2]	[2]	[2]	[2]	[2]	[2]
C3	15+750	-	-	-	-	-	-	-	-	-	-	-	-	-	-	[2]	[2]	[2]	[2]	[2]	[2]	[2]
C4	14+700	4.90	410	305	302	0.73	51.22	0.85	0.40	31.6	49.1	60.3	74.8	85.6	96.3	0.17	0.27	0.33	0.45	0.56	0.66	[3]
C5	13+950	36.85	660	299	296	0.45	89.08	1.48	0.28	22.4	34.4	42.2	52.1	59.5	66.8	0.65	0.99	1.22	1.66	2.06	2.41	[3]
C6	13+350	8.30	320	299	297	0.63	56.52	0.94	0.27	29.7	46.1	56.7	70.3	80.4	90.4	0.19	0.29	0.36	0.48	0.61	0.71	[3]
C7	12+350	21.71	680	299	294	0.74	79.98	1.33	0.25	24.0	37.0	45.3	56.0	64.0	71.9	0.36	0.56	0.69	0.94	1.17	1.37	[3]
C8	10+600	12.75	700	286	281	0.71	67.47	1.12	0.40	26.7	41.2	50.6	62.7	71.6	80.5	0.38	0.59	0.72	0.98	1.23	1.44	[3]
C9	9+950	3.76	460	280	275	1.09	48.30	0.80	0.39	32.7	50.9	62.5	77.6	88.8	100.0	0.13	0.21	0.26	0.35	0.44	0.51	[4]

Notes:

[1] Regional storm flow at C1 not available for climate change analysis using 2095 IDF curve data since flow rate is taken from TRCA's HEC-RAS model.

[2] Flow rates at C2 and C3 not available for climate change analysis using 2095 IDF curve data since flow rates are taken from TRCA's HEC-RAS model.

[3] Regional storm flows are not available for climate change analysis using 2095 IDF curve data since flow rates are calculated based on transposition and interpolation of adjacent C9 Regional flow value using MTO Method.

[4] Regional storm flow at C9 not available for climate change analysis using 2095 IDF curve data since flow rate was calculated in previous Airport Road EA study from Mayfield Road to King Street.

[5] All other flow rates calculated using Rational Method and Region of Peel 2095 IDF curve parameters determined through regression analysis of rainfall data taken from the Ontario Climate Change Data Portal (http://ontarioccdp.ca/index_a1b.html).

[6] 25-year, 50-year, and 100-year flow rates calculated using Rational Method were multiplied by runoff coefficient adjustment factors to account for increase in runoff due to saturation of catchment surface as stipulated in Region of Peel Draft Stormwater Design Criteria and Procedural Manual (June 2019).

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

$$I = \frac{A}{(T_C + B)^C}$$

[5] Region of Peel 2095 IDF Curve Parameters			
Return Period	A	B	C
2-Year	528.6	7.6	0.6916
5-Year	959.9	9.0	0.7257
10-Year	1208.7	8.8	0.7322
25-Year	1549.7	8.8	0.7402
50-Year	1803.7	8.8	0.7444
100-Year	2056.7	8.8	0.7477

[6] Runoff Coefficient Adjustment Factor	
Design Storm Frequency	Adjustment Factor
10-Year	1.0
25-Year	1.1
50-Year	1.2
100-Year	1.25

Use Airport Equation to calculate time of concentration (T_C) for C < 0.4, and Bransby-Williams Equation for C > 0.4

Airport Equation:

$$T_C = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_W{}^{0.33}}$$

Where:

T_C = time of concentration (min)

C = rational method runoff coefficient

L = length of overland flow (m)

S_W = surface slope (%)

Bransby-Williams Equation:

$$T_C = \frac{0.057 \times L}{S_W{}^{0.2} \times A^{0.1}}$$

Where:

T_C = time of concentration (min)

A = catchment area (ha)

L = length of overland flow (m)

S_W = surface slope (%)

MTO's Transposition of Flood Discharge Method:

$$Q_2 = Q_1 \times \left(\frac{A_2}{A_1}\right)^{0.75}$$

Where:

Q_1 = known peak discharge

Q_2 = unknown peak discharge

A_1 = known basin area

A_2 = unknown basin area

Table N-2: Hydraulic Assessment of Existing Airport Road Culverts (2095 IDF Curves)

Crossing / Structure	Drainage Area	Size (mm)		Type	U/S Invert	D/S Invert	Length	Roadway Elevation	Design Return Period	2095 Region of Peel IDF Curves			
										Design Storm			
										Design Flow	Design Headwater Elevation	Design Freeboard	Design HW/D Ratio
	ha	Span	Rise		m	m	m	m		m^3/s	m	m	
C1 [1]	68.59	-	900	CSP	314.06	313.74	22.35	316.65	25 Year	3.87	316.56	0.09	-
C2 [3]	-	-	850	CSP	287.35	286.69	150.00	288.15	25 Year	-	-	-	-
C3 [3]	-	4300	870	Concrete Box	286.75	286.79	18.18	288.20	25 Year	-	-	-	-
C4 [2]	4.90	-	450	CSP	301.10	300.62	24.05	303.81	25 Year	0.45	303.67	0.14	5.63
C5 [2]	36.85	2000	1100	Concrete Box	295.20	295.13	63.50	297.00	25 Year	1.66	295.91	1.09	0.64
C6 [2]	8.30	-	700	CSP	296.68	296.62	21.22	299.21	25 Year	0.48	297.51	1.70	1.19
C7 [2]	21.71	-	450	CSP	293.28	293.61	23.19	294.64	25 Year	0.94	294.76	-0.12	3.23
C8 [2]	12.75	-	600	CSP	279.71	279.62	21.24	281.84	25 Year	0.98	281.90	-0.06	3.59
C9 [2]	3.76	-	600	CSP	274.48	274.20	23.66	275.80	25 Year	0.35	275.15	0.65	1.10

Notes:

[1] Design headwater elevation obtained from TRCA's HEC-RAS model.

[2] Design headwater elevation obtained from CulvertMaster.

[3] C2 and C3 are not included in climate change analysis using 2095 IDF curve data since flow rates are taken from TRCA's HEC-RAS model.

Table N-3: Hydraulic Assessment of Proposed Airport Road Culverts (2095 IDF Curves)

Crossing / Structure	Drainage Area	Size (mm)		Type	U/S Invert	D/S Invert	Length	Roadway Elevation	Design Return Period	2095 Region of Peel IDF Curves			
										Design Storm			
										Design Flow	Design Headwater Elevation	Design Freeboard	Design HW/D Ratio
	ha	Span	Rise		m	m	m	m		m^3/s	m	m	
C1 (1)	68.59	3658	1067	Open Footing Concrete Box	314.06	313.74	24.10	316.62	25 Year	3.87	314.79	1.83	-
C2 (3)	-	-	850	CSP	287.35	286.69	150.00	287.88	25 Year	-	-	-	-
C3 (3)	-	12192	1372	Open Footing Concrete Box	286.71	286.71	18.40	288.54	50 Year	-	-	-	-
C4 (2)	4.90	-	825	Concrete Pipe	301.64	301.42	26.00	304.05	25 Year	0.45	302.22	1.83	0.7
C5 (2) (5)	36.85	2000	1100	Concrete Box	295.20	295.13	63.50	296.78	25 Year	1.66	295.91	0.87	0.64
C6 (2)	8.30	-	750	Concrete Pipe	297.05	296.93	25.85	299.48	25 Year	0.48	297.68	1.80	0.83
C7 (2) (4)	21.71	1830	900	Concrete Box	293.63	293.28	23.70	294.68	25 Year	0.94	294.11	0.57	0.52
C8 (2)	12.75	-	750	Concrete Pipe	279.71	279.62	21.30	281.88	25 Year	0.98	280.73	1.15	1.34
C9 (2)	3.76	-	825	Concrete Pipe	274.64	274.05	49.40	276.22	25 Year	0.35	275.15	1.07	0.61

Notes:

(1) Design headwater elevation obtained from TRCA's HEC-RAS model.

(2) Design headwater elevation obtained from CulvertMaster.

(3) C2 and C3 are not included in climate change analysis using 2095 IDF curve data since flow rates are taken from TRCA's HEC-RAS model.

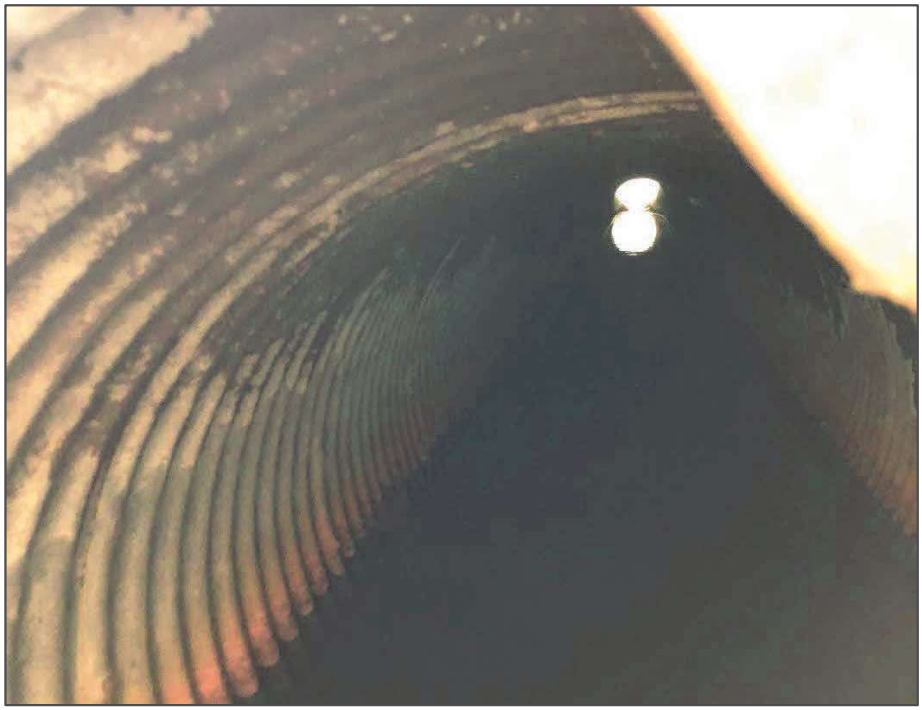
(4) Due to road profile restrictions and criteria for minimum cover, C7 cannot be upsized further to meet hydraulic criteria.

(5) Due to road profile decrease at C5, freeboard is below 1.0 m, however, it is still within acceptable limit.

APPENDIX Q: SITE PHOTOGRAPHS

C1 – Downstream (1 of 3)

C1 – Downstream (2 of 3)



C1 – Downstream (3 of 3)

C1 – Upstream (1 of 3)

C1 – Upstream (2 of 3)

C1 – Upstream (3 of 3)

C2 – Downstream (1 of 6)

C2 – Downstream (2 of 6)

C2 – Downstream (3 of 6)

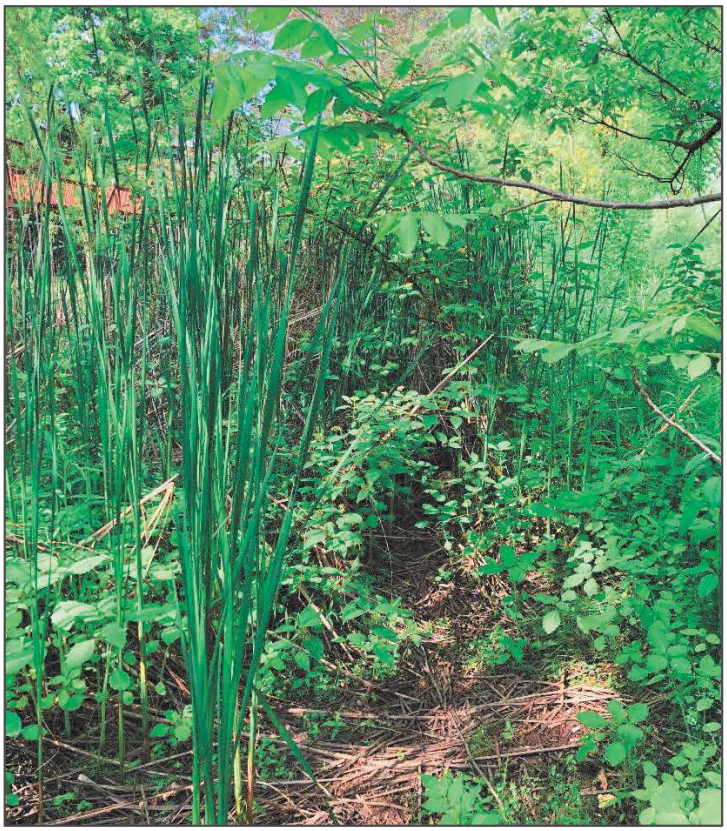
C2 – Downstream (4 of 6)

C2 – Downstream (5 of 6)

C2 – Downstream (6 of 6)

C2 DS Tributary (Allison Creek - looking DS) 1 of 5

C2 DS Tributary (Allison Creek - looking DS) 2 of 5



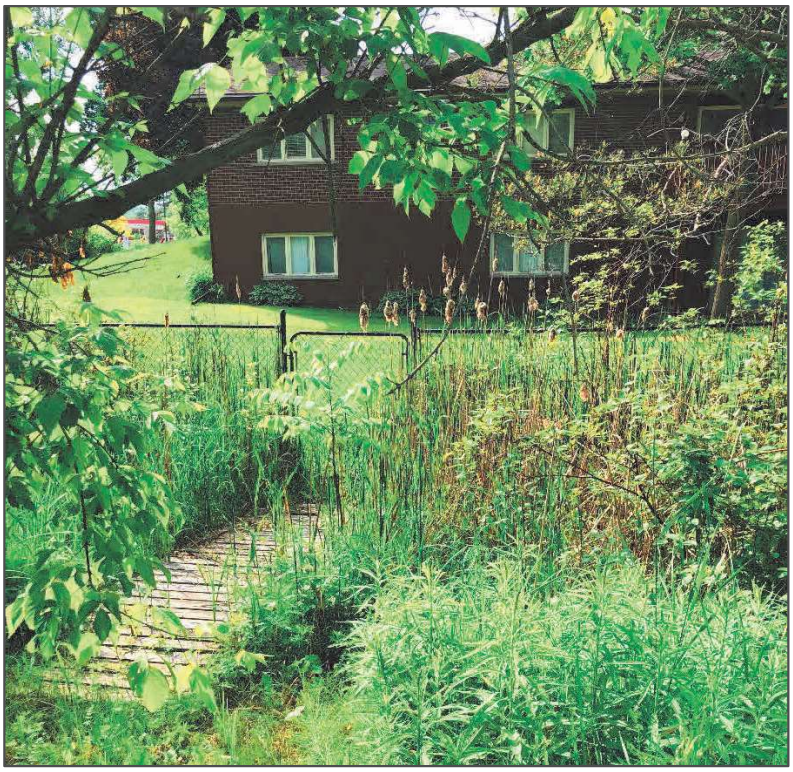
C2 DS Tributary (Allison Creek - looking DS) 3 of 5

C2 DS Tributary (Allison Creek - looking DS) 4 of 5

C2 DS Tributary (Allison Creek - looking DS) 5 of 5

C2 DS Tributary (Allison Creek - looking US) 1 of 2

C2 DS Tributary (Allison Creek - looking US) 2 of 2



Culvert DS of C2 (US end) 1 of 2

Culvert DS of C2 (US end) 2 of 2

Culvert DS of C2 (DS end) 1 of 8

Culvert DS of C2 (DS end) 2 of 8

Culvert DS of C2 (DS end) 3 of 8

Culvert DS of C2 (DS end) 4 of 8

Culvert DS of C2 (DS end) 5 of 8

Culvert DS of C2 (DS end) 6 of 8

Culvert DS of C2 (DS end) 7 of 8

Culvert DS of C2 (DS end) 8 of 8

C2 – Upstream (1 of 5)

C2 – Upstream (2 of 5)

C2 – Upstream (3 of 5)

C2 – Upstream (4 of 5)

C2 – Upstream (5 of 5)

C3 – Downstream (1 of 2)

C3 – Downstream (2 of 2)

C3 – Upstream (1 of 3)

C3 – Upstream (2 of 3)

C3 – Upstream (3 of 3)

C4 – Downstream (1 of 2)

C4 – Downstream (2 of 2)

C4 – Upstream (1 of 2)

C4 – Upstream (2 of 2)

C5 – Downstream (1 of 2)

C5 – Downstream (2 of 2)

C5 – Upstream (1 of 2)

C5 – Upstream (2 of 2)

C6 – Upstream (1 of 2)

C6 – Upstream (2 of 2)

C7 – Downstream (1 of 2)

C7 – Downstream (2 of 2)

C7 – Upstream (1 of 2)

C7 – Upstream (2 of 2)

C8 – Downstream (1 of 1)

C8 – Upstream (1 of 2)

C8 – Upstream (2 of 2)

C9 – Downstream (1 of 3)

C9 – Downstream (2 of 3)

C9 – Downstream (3 of 3)

C9 – Upstream (1 of 3)

C9 – Upstream (2 of 3)

C9 – Upstream (3 of 3)