Stormwater Management Study

Guelph Innovation District
City of Guelph
Project # 109088A/ 198141

Prepared for:

City of Guelph
1 Carden Street, Guelph, ON N1H 3A1

4/1/2020

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1 Carden Street, Guelph, ON N1H 3A1

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1.0 Introduction

The Guelph Innovation District (GID) comprises of approximately 436 ha (1,077 acres) on Guelph's east side (ref. Drawing 1). It is bounded by York Road, Victoria Road South, the York-Watson Industrial Park and the City's southern boundary. The GID is located in the south-eastern end of the Eramosa River watershed area where Torrance Creek, Clythe Creek and Hadati Creek confluence with the Eramosa River. The GID is also located within the Guelph Drumlin Field physiographic region (Chapman and Putman, 1984).

The Guelph Innovation District is being planned as a compact mixed-use community that integrates an urban village with an employment area, strives to be carbon neutral and offers meaningful places to live, work, shop, play and learn in a setting rich in natural and cultural heritage. The City identified objectives for the development of these lands, including:

- To provide employment lands;
- To meet the goals of the Growth Plan;
- To continue to host the Waste Resource Innovation Centre;
- To conserve natural and cultural heritage resources;
- To put the Community Energy Initiative into practice;
- To build partnerships with the Province and those with an interest in the lands.

Wood Environment & Infrastructure Solutions, a division of Wood Canada Limited (Wood) has been retained to assess stormwater management requirements for the Guelph Innovation District and provide guidance and policies to ensure these services meet the needs of the GID.

2.0 Background Review and Field Reconnaissance

2.1 Background Information

Background information has been provided by the City of Guelph, the Grand River Conservation Authority and other agencies. The following mapping and drawings have been provided:

i) Storm Sewers, 2008;
ii) 2008 Aerial and 0.5 m topographic mapping;
iii) Boundary mapping (Municipality, Property, Study Area Limits);
iv) Transportation Mapping (Roadway and Railways);
v) Wellington County Soils Mapping (Agriculture Canada)
vi) Natural Heritage System, Regulatory floodplain stormwater management facilities and watercourses.

The following reports have been provided by the City of Guelph and/or are internal to Wood.

1. York Road EIS, Wood Environment & Infrastructure, December 2019,

2. "The City of Guelph Official Plan", June 2002 (Updated March 2018).

   The City of Guelph's *Official Plan* has incorporated stormwater management policies consistent with the recommendations within the listed reports. The *Official Plan* requires the watershed planning process established by the Provincial government to be used in determining stormwater management requirements for development.

3. Grand River Source Protection Plan, Volume II, March 2015

   The Grand River Guelph Source Protection Plan provides policies regarding the protection of groundwater systems from contamination based on an assessment of the level of risk within each geographic area depicted as a vulnerability scoring. For the GID area (Schedule E, Map D of the Source Protection Plan) each significant drinking water threat category has been scored as either and 8 or 10 out of a maximum score of 10. As such, the GID area groundwater resources are at a significant risk to contamination from both existing development and future development, unless appropriate stormwater management measures are implemented.

4. Elizabeth Street Reconstruction, Victoria Road to Industrial Avenue, Amec Foster Wheeler, March 2015

   A new trunk sewer was proposed for Elizabeth Street that would outlet to Hadati Creek north of York Road under interim conditions with an ultimate outlet to Clythe Creek opposite Industrial Avenue. The new storm sewer is proposed to reduce flooding issues within Ward 1. The interim storm sewer outlet was subsequently constructed in approximately 2016, while the ultimate outlet was noted to require further assessment.

3. "Guelph Stormwater Management Master Plan", Amec, February 2012

   The Stormwater Management (SWM) Master Plan provides a long-term plan for the safe and effective management of stormwater runoff from Guelph's urban areas while improving the ecosystem health and ecological sustainability of the Eramosa and Speed Rivers and their tributaries. The SWM Master Plan integrates aspects of flood control, groundwater and surface water quality, natural environment and system drainage issues into a cohesive City-wide strategy. As part of the strategy prioritized recommendations were provided for improving the capacity of existing drainage systems, conducting water quality retrofits and low impact development pilot studies

4. Envision Guelph: Official Plan Amendment Number 42: Natural Heritage System, July 2010

5. Natural Heritage Strategy Phase 2 Reports, Dougan & Associates, March 2009.

6. "Stormwater Management Facility Inventory, Assessment and Maintenance Needs Plan, Final Report", Totten Sims Hubicki, October 2008.

   Based on the 2008 inventory, there are two existing stormwater management facilities, Facility No. 38 located on Watson Parkway South and Facility No. 96 located at the intersection of Watson Road and Stone Road. Facility No. 38 was constructed in 1996 and has a catchment area of 18.7 ha. It is a dry quantity control facility with a 100-year quantity control volume of 54,100 m^3. Facility No. 96 was constructed in 2005 and is a dry quantity/quality control facility with a catchment area of 8.57 ha.

7. "Rehabilitation of Clythe Creek Phase II Design Report, York Road between Watson Parkway and Elizabeth Street Speed Valley Watershed, Guelph, Ontario", UW 4th Year Engineering Students, March 28, 2008.

   This is a follow-up to the Phase 1 report and provides additional information regarding the creek characterization and creek improvement alternative evaluation.

8. "Assessment and Remedial Activities for Clythe Creek Phase I Report, York Road between Watson Parkway and Elizabeth Street Speed Valley Watershed, Guelph, Ontario", UW 4th Year Engineering Students, November 23, 2007.

   This document prepared by University of Waterloo students, assessed the existing Clythe Creek condition and evaluated alternatives for improving the creek. The report notes that York Road widening works would be conducted in the near future. Clythe Creek which has a 21 km^2 drainage area is noted as being approximately 1 km in length from the crossing at York Road to the confluence with the Eramosa River. The creek has been classified by MNRF as being a cool water fishery with the potential of being a coldwater fishery with appropriate improvements. Water quality testing of BOD, nitrate, phosphate, dissolved oxygen and temperatures resulted in parameters being below the PWQOs for a coldwater classification.

   The report recommends that the creek on the south side of York Road be realigned and lowered by removing the existing 20 +/- drop structures or weirs. Fish passage and habitat would be improved due to existing obstacles being eliminated and the creek being designed using natural channel techniques with riparian plantings.

9. "Storm & Sanitary Drainage Assessment Report for the City of Guelph Waste Resources Innovation Centre", Gartner Lee Limited, August 2007

   The report provides a detailed hydrologic assessment of the existing stormwater management facilities within the Waste Resources Innovation Centre. Two stormwater management facilities are assessed for stormwater quantity and quality requirements to ensure no offsite impacts result. The report also documents how the pumping station pumps stormwater collected onsite.

10. "York Road Improvements Wyndham Street South to East City Limits Class EA, Environmental Study Report, Volume Two: Appendices", TSH Engineers, Architects, Planners, February 2007.

    This report provides the details for stormwater management for the future road works and discusses opportunities for both Clythe Creek and Hadati Creek. Stormwater management has been noted as a combination of grassed swales and oil/grit chambers discharging to dry cells.

Approximately 135 m of Clythe Creek has been proposed to be realigned where the creek is currently lined with gabion baskets. The existing weirs within the 135 m creek reach have been proposed to be eliminated. The existing Clythe Creek 3 m by 2 m concrete culvert under York Road has been proposed to be extended by 6.5 m +/- when York Road is widened.

The Hadati Creek 5.5 m by 1.5 m concrete culvert has been recommended not to be extended.

11. Natural Heritage Strategy Phase 1 Final Report, Dougan & Associates, March 2005

The City of Guelph's Natural Heritage System identifies Significant Natural Areas for protection and includes policies for Natural Areas were development may by permitted once an Environmental Impact Study has been approved that demonstrates no negative impacts to existing natural heritage features and associated ecological and hydrological functions.

12. "Victoria Road (Clair Road to York Road) Class EA Study, Environmental Study Report", McCormick Rankin Corporation, Gamsby and Mannerow Limited in association with Ecoplans Limited and Archaeological Services Inc., January 2005.

Stormwater management for the proposed Victoria Road works would consist of the following:

- Future stormwater management facility at the north east corner of Stone Road and Victoria Road intersection to provide Enhanced water quality control for the intersection.
- Linear ditch system to provide stormwater quality control from Stone Road to vicinity of Eramosa River south bank.
- Stormwater quality measures (unknown) to be constructed at the storm sewer outlets draining Victoria Road from the Eramosa River to York Road.

13. "Grand River Tailwater Fisheries Management Plan: 2005-2010", Ontario Ministry of Natural Resources – Guelph District, 2004

14. "Phase I Environmental Site Assessment, Victoria Road and York Road, Guelph, Ontario", McCormick Rankin Corporation, Gamsby and Mannerow Limited in association with Ecoplans Limited and Archaeological Services Inc., August 2003.

15. "Stone Road Class EA, Environmental Study Report", McCormick Rankin Corporation, Gamsby and Mannerow Limited in association with Ecoplans Limited and Archaeological Services Inc., March 2002.

This report provides the background on the stormwater management proposed for the Stone Road resurfacing (Stage 1) which has been conducted prior to 2009 and the future road widening (Stage 2), yet to be conducted.

- Victoria Road to Detention Centre lands: Stage 1 – linear wetland providing Enhanced water quality control. Stage 2 – a future wetland quality facility located at the north east corner of Victoria Road and Stone Road would provide Enhanced water quality control with quantity control.
- Detention Facility lands to Eramosa River: Stage 1, linear wetland providing Enhanced water quality control. Stage 2 (west of rail tracks) a future wetland quality facility would provide Enhanced water quality control with quantity control.
- Railway tracks to Eramosa River, stormwater quality control would be provided by oil/grit chambers discharging to stilling basins.
- Eramosa River to 420 m west of Watson Road: Stage 1 – a linear stormwater management facility would provide Enhanced stormwater quality control. For Stage 2 a future wet pond/ wet land stormwater management facility would be built.

- 420 m west of Watson Road to Watson Road: Stage 1 – linear wetland. Stage 2 would require a wetland/ wet pond. It should be noted that a stormwater management facility has already been constructed on the north west corner of the intersection of Stone Road and Watson Road (Facility No. 96)

16. "Victoria Road and Watson Road Class EA Study, Detailed Work Plan", McCormick Rankin Corporation, Gamsby and Mannerow Limited in association with Ecoplans Limited and Archaeological Services Inc., December 2001.

17. "City of Guelph Stone Road Class EA Study, Study Design Draft", McCormick Rankin Corporation, Gamsby and Mannerow Limited in association with Ecoplans Limited and Archaeological Services Inc., October 16, 2000.

18. "Eramosa-Blue Springs Watershed Study", Beak International Incorporated and Aquafor Beech Limited et al, September and October 1999.

    The Eramosa-Blue Springs Watershed includes the York District study area and established general stormwater management recommendations for the watershed. Recommendations within the York District include restoration of the Clythe Creek to a complete coldwater fisheries habitat through stream corridor restoration. The York District is subdivided by part of the Eramosa River's Guelph-Eden Mills Reach'. General recommendations for this reach include groundwater recharge area protection and stream corridor restoration.

19. "Torrance Creek Subwatershed Study", Totten Sims Hubicki et al, November 1998.

    Torrance Creek outlets to the Eramosa River, immediately north of Stone Road East, within the southern area of the York District. The subwatershed study establishes a management strategy for stormwater management servicing. Stormwater management within the Torrance Creek portion of the York District would comprise the Ministry of Environment's Enhanced Level of water quality treatment and would have to consider infiltration measures to maintain or augment baseflows. Water quality control is required for flows entering infiltration devices. In the local recharge areas adjacent to the creek, the report recommends that fish barriers be removed along Torrance Creek.

20. "Clythe Creek Subwatershed Overview", Ecologistics Limited and Blackport & Associates, April 1998.

    Clythe Creek is a tributary of the Eramosa River. The subwatershed overview established recommendations for creek management corridor and groundwater management.

    With respect to the York District, recommendations include retaining and enhancing existing natural areas. The report recommends that the existing wetlands should be evaluated using the Ministry of Natural Resources Evaluation System. Fisheries habitat is to be improved by the removal of fish barriers and by the use of stormwater management practices that maintain low water temperatures. Recommendations, with respect to groundwater, include maintaining existing groundwater recharge quantity and quality. In addition, the impacts and mitigation of potential groundwater withdrawals within the York District would have to be established.

21. Evaluation of the Hadati-Clythe Creek Wetland Complex, Ecologistics Limited, 1992

22. Environmental Study of Hadati Creek Wetlands in the Eastview Planning Area

2.2 Background Synopsis

The above noted documents have been reviewed specifically for information related to stormwater management criteria and study area characteristics. Given the current focus on developing an existing land use hydrologic model, particular interest has been given to information related to detailed soils characterization (i.e. borehole logs or other direct field data) and drainage features, in particular stormwater management facilities. While detailed information has been found related to the design of SWM facilities and general drainage characteristics, very limited field data has been found related to soils conditions. Given the importance of accurately representing infiltration characteristics, observed data would be preferred; however other sources of data can be applied as required.

2.3 Photographic Reconnaissance

A photographic inventory has been conducted as of September 2009 and December 2012 of existing drainage systems including Clythe Creek, Hadati Creek, Eramosa River crossings and existing stormwater management facilities (ref. Appendix A).

3.0 Existing Systems

3.1 Overview of Existing Drainage System

Based on the background information review (Section 2), along with discussions with City Staff, a general understanding of the existing servicing infrastructure has been obtained and is described below:

The GID includes part of the Clythe Creek and Torrance Creek Subwatersheds, which are both tributary to the Eramosa River (ref. Drawing 1). Both the Clythe and Torrance Creeks have been studied within respective Subwatershed studies and the Eramosa River has been studied within the Eramosa-Blue Springs Watershed Study.

The City of Guelph's *Official Plan* has, based on the foregoing studies and the "Stormwater City of Guelph River Systems Management Study", considered the entire City to be a groundwater recharge area for public and private water supply. The York District is part of the 'Arkell Springs Water Resources Protection Area', which the *Official Plan* requires both ground and surface water protection. The Grand River Source Protection Plan for the GID area, has determined that each significant drinking water threat category is either an 8 or 10 out of a maximum score of 10, therefore groundwater needs to be protected from contamination. In addition, the Clythe and Torrance Creek Subwatershed Studies have also identified the majority of the York District to be a significant groundwater recharge/discharge area. Both the York District's surface and ground water quality and quantity are to be protected.

Clythe Creek is considered a coolwater fisheries habitat while Torrance Creek is both a warm water and coldwater fisheries habitat with Type 1 fish habitat located only at the outlet to the Eramosa River. Clythe Creek has been recommended for realignment when the future York Road widening occurs.

Existing stormwater management works within the York District are limited to the existing stormwater management facilities Nos. 38, 96 and 104, which service the Watson Parkway industrial area, a section of Stone Road east of the Eramosa River and the Victoria Road and Stone Road intersection (ref. Drawing 1). Stormwater management facility 38 has a drainage area of 83.3 ha, while facilities 96 and 104 provide stormwater quality treatment for the local Stone Road intersection improvements at Watson Parkway and Victoria Road respectively. The Waste Resource Innovation Centre (WRIC) has three (3) stormwater management facilities that provide stormwater quality and quantity controls in addition to infiltration ditches that reduce site runoff prior to discharge to the stormwater management facilities. In the northwest area of the GID at 256 Victoria Road South a private stormwater management facility exists at the PDI Plant; no details are available for the existing stormwater management facility based on discussions with City staff, who have pursued information about the PDI site from the landowners.

Stormwater quality management, in the way of swales, oil grit chambers and other best management practices have been proposed within the Victoria Road (Clair Road to York Road) Class EA Study, Environmental Study Report, 2005 for future Victoria Road and York Road improvements.

There are a number of on-line ponds located within the Clythe and Torrance Creek Subwatersheds and the York District study area, which have been determined, by the Natural Heritage Strategy as a Significant Wetland, with wetland boundaries based on ELC communities mapping. Within the Clythe Creek Subwatershed, the Royal City's Jaycee's Bicentennial Park wetland area located southeast of the York Road and Victoria Road intersection, requires an updated wetland evaluation to verify feature boundaries based on the Ontario Wetland System (OWES). As part of the Block Plan process, there would be opportunity to refine the wetland mapping. It should be noted that stormwater management facilities are not permitted within provincially or City classified significant wetlands, but may be permitted in the outer half of a wetland buffer if an Environmental Impact Study (EIS) has been conducted demonstrating no impact under Section 6A.2.5 of the City's Official Plan.

Along the Torrance Creek both the Mill and Barber Ponds, located south of Stone Road East beyond the GID study area, have been identified as fish barriers and should be removed.

The Clythe Creek has tributaries of Hadati Creek and Watson Creek. Part of the Hadati Creek subwatershed outlets to the downstream limit Clythe Creek at the Eramosa River (ref. Drawing 1). The drainage area has residential, commercial and industrial land uses, which do not receive storm quality treatment based on the Clythe Creek Subwatershed Study.

3.2 Hydrology

A PCSWMM hydrologic model of the GID study area has been developed to assess stormwater management targets for the GID. The hydrologic model has been executed in both the event-based mode, using City of Guelph 3 hour Chicago design storms (to determine peak flows), and continuous mode (to determine annual water balance) using the meteorological dataset compiled for September 17, 2013 technical memorandum to the City of Guelph (ref. Section 5.4.2.)

Soils information for the study area has been reviewed from available local Class EA's soil mapping and the City of Guelph Source Water Protection Plan and Assessment Report. The modelling has included the York Road EIS PCSWMM modelling and as such is consistent with both the Stormwater Master Plan and the York Road EIS. The current hydrologic modelling scope does not include the incorporation of a groundwater component to the modelling; the modelling would reflect surface water hydrology only. Notwithstanding, it would be possible to update PCSWMM to include a groundwater component in the future.

3.2.1 Existing Conditions Hydrology

The existing conditions PCSWMM modelling as per the York Road EIS, has been considered the following determining the hydrologic modelling parameterization.

- Imperviousness for existing land uses has been determined using measurements of impervious coverage from the 2016 aerial photography.
- Directly connected imperviousness (the value required by PCSWMM) has been calculated based on standard assumed values for different land uses. Total imperviousness has also been calculated in order to properly adjust infiltration parameters using the Green-Ampt methodology (i.e. to account for non-directly connected impervious areas). This approach has been applied rather than altering the percentage routed component of the impervious area. Base Green-Ampt infiltration parameters have been estimated using available soils data.
- Slopes and overland flow lengths have been calculated using available 2012 City of Guelph contour mapping, property boundaries, and 2016 aerial photography.
- Manning's roughness coefficients of 0.013 and 0.2 have been applied for impervious and pervious overland flow components respectively.
- Base depression storage depths of 1 and 5 mm have been applied for impervious and pervious catchment portions respectively.
- The recommended default value of 25% has been applied for the zero depression storage imperviousness ratio (the portion of the impervious area with no depression storage.

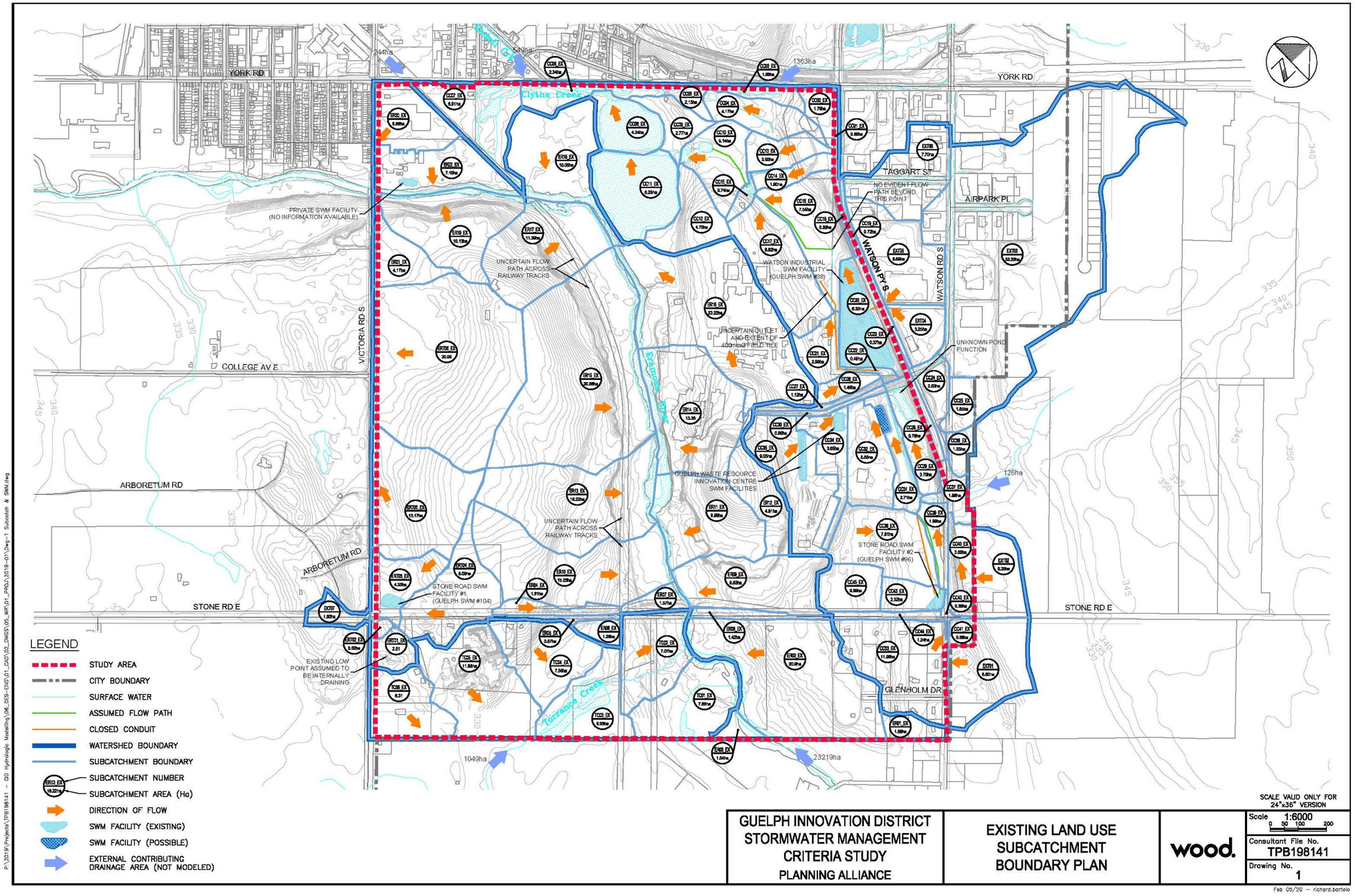
The large rural catchments within the GID require a method for determining subcatchment length. Subcatchment length is a key parameter within PCSWMM, as it is used to represent sheet flow/overland flow, and accounts for the expected degree of attenuation (i.e. is a surrogate for time of concentration or time to peak used in unit hydrograph methodologies). Given that in most cases flow is defined by the channel (i.e. ditch) length, the subcatchment length for the large rural areas has been defined using generally accepted relationships between channel length and flow path length, namely the Proctor &

Redfern method (Proctor and Redfern, Ltd. and MacLaren, J.F. Ltd, 1976, "Stormwater Management Model Study – Vol 1". Research Rep. No. 7, Canada-Ontario Research Program, Environmental Protection Service, Ottawa), which indicated that the subcatchment width (width of the kinematic wave plane) should be 1.7 times the channel length. Thus subcatchment length has been set equal to the drainage area divided by 1.7 times the channel length.

There are four (4) stormwater management ponds within the GID lands which contribute to Clythe Creek. These ponds include City Ponds #38 and #96 as well as the Waste Resource Innovation Centre and PDI ponds (ref. Drawing 1).

An event-based methodology has been applied, based on the City of Guelph's standard 5 and 100 year design storms (Chicago storms with variable durations of approximately 3 hours). The City of Guelph does not have a specified design storm distribution for the other return periods; however the City's design storms are based on Chicago temporal distributions which have variable durations of approximately 3 hours. Accordingly, a 3 hour Chicago distribution storm event has been generated, using the City's current IDF parameters, and the same peaking factor (approximately 0.42) as was applied in the other storm distributions.

The existing drainage catchment plan for the GID is provided in Drawing 1. Table 3.1.1 provides a summary of the existing land use parametrization. Peak flows for the 2 year to 100 year return periods at key flow node locations are presented in Table 3.1.2.



Drawing 1. Existing Land Use Subcatchment Boundary Plan

Table 3.1.1. Subcatchment Parameters – Existing Condition

Subcatchment Name	Area (ha)	Imperv. (%)	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
CC04_EX	4.17	5	144	10.4	0.2
CC08_EX	4.34	64.1	144	7.4	0.2
CC09_EX	2.77	5.3	144	10.4	0.2
CC10_EX	5.14	6.5	144	10.4	0.2
CC11_EX	8.25	74.8	144.2	5.1	0.2
CC12_EX	4.7	11.7	144	10.3	0.2
CC13_EX	2.92	5	144	10.5	0.2
CC14_EX	1.9	5	144	10.5	0.2
CC15_EX	0.74	10.2	144	10.3	0.2
CC16_EX	7.54	5	144	10.5	0.2
CC20_EX	6.33	5	144	10	0.2
CC21_EX	2.99	5	144	9.5	0.2
CC22_EX	0.48	5	144	8.6	0.2
CC26_EX	1.465	5	144	10.5	0.2
CC27_EX	1.05	5	144.1	6.3	0.2
CC28_EX	0.76	10	144	1.6	0.2
CC29_EX	3.8188	7.2	144	10.3	0.2
CC30_EX	0.8485	6.5	144.4	4.7	0.2
CC31_EX	2.716	5	144	10.4	0.2
CC32_EX	5.55	49	144	9.7	0.2
CC34_EX	3.9876	66	144	9	0.2
CC35_EX	9.043	51	145.3	7.7	0.2
CC36_EX	1.33	0	144	10.5	0.2
CC37_EX	1.98	12.9	144	10.2	0.2
CC38_EX	7.46	5	144	10.5	0.2
CC39_EX	1.99	12.9	144	10.2	0.2
CC40_EX	3	1.3	144	9.5	0.2
CC41_EX	0.88	0	144.3	9.6	0.2
CC42_EX	0.38	80	144.8	2.9	0.2
CC43_EX	2.32	5	145.2	7.1	0.2
CC44_EX	1.24	10	144.9	1.4	0.2
CC45_EX	3.69	5	144	10.5	0.2
CC46_EX	11.06	6.3	144.8	8.2	0.2
ER01_EX	1.68	5	144	10.4	0.2
ER02_EX	20.9	7.4	144.7	8.3	0.2
ER03_EX	1.04	5	146	4.7	0.2
ER04_EX	1.81	41.22	203.9	4.7	0.2
ER05_EX	0.87	29.77	187.7	3.8	0.2
ER06_EX	1.28	5	144	10.5	0.2

Subcatchment Name	Area (ha)	Imperv. (%)	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
ER07_EX	1.57	17.27	145.6	5.7	0.2
ER08_EX	1.42	5.3	144.7	5	0.2
ER09_EX	9.63	5	145	7.3	0.2
ER10_EX	15.23	5	200.9	6.3	0.2
ER11_EX	9.99	8.1	146	4.7	0.2
ER12_EX	4.81	5	145.9	5.2	0.2
ER13_EX	16.22	5	219.9	4.9	0.2
ER14_EX	13.35	60	144.9	6.9	0.2
ER15_EX	30.58	5	199.1	5.8	0.2
ER17_EX	11.39	6.8	175.7	6.8	0.2
ER18_EX	10.05	7.2	144.3	9.5	0.2
ER19_EX	10.13	5	154.5	9.3	0.2
ER20_EX	7.16	41	144.4	9.9	0.2
ER21_EX	4.17	9.6	144	10.3	0.2
ER22_EX	5.5081	94	144	5.8	0.2
EXT01	8.6	3	144.4	9.2	0.2
EXT02	5.29	3.5	144	10.4	0.2
TC01_EX	7.85	5	145.8	5.3	0.2
TC02_EX	7.07	10.13	145.5	6.2	0.2
TC03_EX	6.93	8.23	144	10.3	0.2
TC04_EX	7.56	5	156.2	9.5	0.2
TC05_EX	11.88	5	192.1	5.9	0.2
TC06_EX	6.31	13.9	237	4.6	0.2
VR01_EX	2.01	5	237	4.8	0.2
VR02_EX	0.52	15.9	237	4.2	0.2
VR03_EX	4.35	9.9	237	4.7	0.2
VR04_EX	8.09	14.4	237	4.7	0.2
VR05_EX	13.17	5	236.6	4.8	0.2
VR06_EX	30.09	5	205.4	5.9	0.2
YRK-2-02	1.5335	61.6	144	7.7	0.2
CC07_2	5.54	5	144	9.7	0.2
YRK-EXT03	0.6237	60	144	1.6	0.2
YRK-EXT02	1.54	80	144	1.6	0.2
YRK-S-08	1.4841	13.8	147	7.1	0.2
YRK-S-05	0.426	14.3	144.2	7.8	0.2
YRK-S-06	0.5029	14.4	144	8.2	0.2
YRK-S-07	1.1428	14.7	144	8.8	0.2
YRK-S-03	1.5867	14.7	144	8.6	0.2
YRK-S-04	0.7571	14.3	144	8.1	0.2
YRK-N-05	0.1085	10	144	1.6	0.2

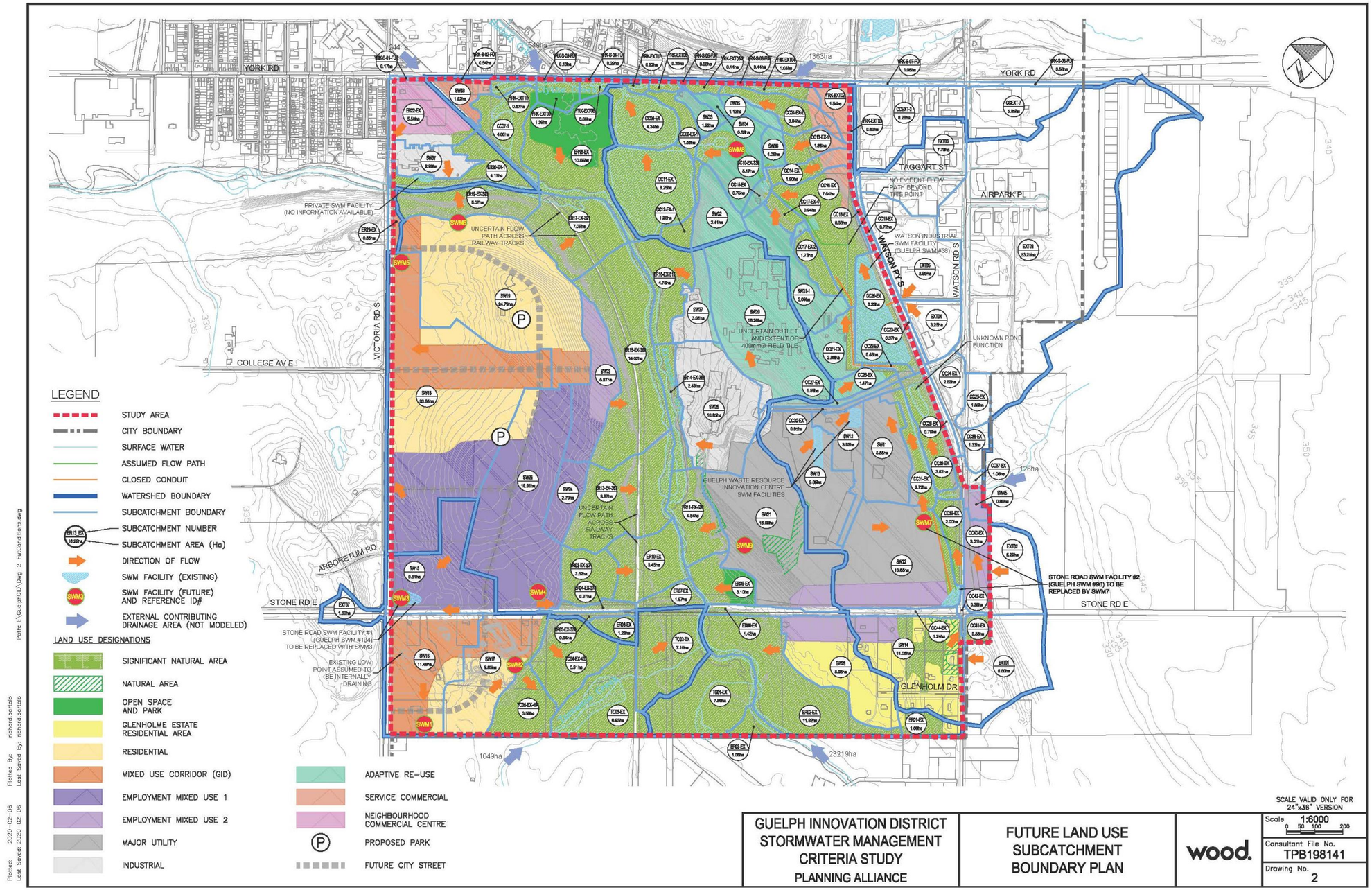
Subcatchment Name	Area (ha)	Imperv. (%)	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
YRK-N-07	0.5974	10	188.8	1.4	0.2
YRK-N-06	0.323	10	144	1.6	0.2
CC17_EX_1	7.7623	6.1	144	9.5	0.2
ER16_EX	24.0905	26	144.193	9.211	0.2

Table 3.1.2. Simulated Existing Conditions Peak Flows (m^3/s)

Flow Node	Location	Peak Flow (m^3/s) for Return Period (Years)						
		25 mm	2	5	10	25	50	100
J3	Eramosa River at Victoria Road South	1.37	2.40	7.00	12.09	18.65	24.55	31.37
J_ER10	Eramosa River and Clythe Creek Confluence	1.32	2.47	6.51	10.95	16.85	22.23	28.41
J4	Eramosa River upstream of the Clythe Creek Confluence	1.50	2.43	3.87	6.66	10.87	14.73	18.98
J6	Eramosa River adjacent to Cargill Meat Solutions Plant	0.51	1.25	3.76	6.30	9.86	13.18	16.60
J5	Eramosa River north of Stone Rd. E.	0.37	0.97	3.32	5.97	9.58	12.75	16.15
J_ER02	Eramosa River south of Stone Rd. E. and upstream of Torrance Creek Confluence	0.39	0.66	1.20	2.04	3.10	4.10	5.14
J_TC05	Torrance Creek south of Stone Rd. E. and upstream Confluence with Eramosa River	0.29	0.50	1.18	2.12	3.42	4.68	6.08
J_NorthPond	Clythe Creek Tributary upstream of the North Pond	1.61	2.65	3.79	5.00	6.06	7.16	8.23
J_CC06	Clythe Creek Tributary upstream of the North Pond	0.09	0.14	0.47	0.88	1.42	1.93	2.44
OF12	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	0.15	0.26	0.84	1.99	3.68	5.24	7.33
J_CC16	Clythe Creek Tributary north of Stone Rd. and south of Watson Pkwy.	0.14	0.21	0.70	1.67	3.08	4.38	5.78
J_CC20	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	0.34	0.54	0.78	1.05	1.72	2.84	4.36

3.2.2 Future Conditions Hydrology

The existing conditions PCSWMM modelling has been modified as per the GID future land use plan (ref. Drawing 2). Impervious coverages for the proposed land uses have been determined through consultation with City of Guelph staff. Table 3.2.1 indicates the future land use impervious coverages, while Table 3.2.2 presents a summary of the future land use catchment parameterization. Future subcatchments have been prepared based on conceptual grading as previously provided to the City of Guelph in 2015.



Drawing 2. Future Land Use Subcatchment Boundary Plan

Table 3.2.1. Future Land Use Impervious Coverages

GID Land Use Type	Total Imperviousness %
Adaptive Reuse	30
Corridor Mixed Use	100
Ecological Linkages	5
Employment Mixed Use 1	100
Employment Mixed Use 2	100
Industrial	100
Major Utility	100
Natural Areas Overlay	5
Neighbourhood Commercial Centre	100
Open Space and Park	10
Residential	70
Service Commercial	100
Significant Natural Areas	5
Special Residential Area	30
Ref: Development Engineering Manual, Version 2.0, January 2019	

Table 3.2.2. Subcatchment Parameters – Future Condition

Subcatchment Name	Area (ha)	Imperv. (%)	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
CC08_EX	4.34	64.1	144	7.4	0.2
CC11_EX	8.25	74.8	144.2	5.1	0.2
CC14_EX	1.90	6.32	144	10.5	0.2
CC16_EX	7.54	8.85	144	10.5	0.2
CC20_EX	6.33	0.6	144	10	0.2
CC22_EX	0.48	8.7	144	8.6	0.2
CC26_EX	1.47	27.09	144	10.5	0.2
CC27_EX	1.05	35.35	144.1	6.3	0.2
CC28_EX	0.76	10	144	1.6	0.2
CC29_EX	3.82	5	144	10.3	0.2
CC30_EX	0.85	90.43	144.4	4.7	0.2
CC31_EX	2.72	26.08	144	10.4	0.2
SW11	5.55	97.35	144	9.7	0.2
SW12	3.63	100	144	9	0.2
SW13	9.05	99.39	145.3	7.699	0.2
CC36_EX	1.33	0	144	10.5	0.2

Subcatchment Name	Area (ha)	Imperv. (%)	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
CC39_EX	2.00	17.16	144	10.2	0.2
CC40_EX	3.01	100	144	9.5	0.2
CC41_EX	0.88	6.65	144.3	9.6	0.2
CC42_EX	0.38	94.16	144.8	2.9	0.2
CC44_EX	1.24	85.51	144.9	1.4	0.2
SW14	11.05	33.35	144.799	8.198	0.2
ER01_EX	1.68	13.91	144	10.4	0.2
ER02_EX	11.92	5.2	144.7	8.3	0.2
ER03_EX	1.05	5	146	4.7	0.2
ER04_EX_378	0.97	41.22	203.843	4.697	0.2
ER05_EX_379	0.64	29.77	187.731	3.811	0.2
ER06_EX	1.28	8.63	144	10.5	0.2
ER07_EX	1.57	17.27	145.6	5.7	0.2
ER08_EX	1.42	75.14	144.7	5	0.2
ER13_EX_387	9.87	7.74	219.9	4.9	0.2
SW26	10.85	97.63	144.9	6.9	0.2
ER15_EX_389	14.02	9.32	199.07	5.802	0.2
ER17_EX_391	7.09	8.35	175.7	6.8	0.2
ER18_EX	10.05	7.66	144.3	9.5	0.2
ER19_EX_393	5.07	6.83	154.495	9.3	0.2
ER22_EX	5.50	95.61	144	5.8	0.2
EXT01	8.60	3	144.4	9.2	0.2
EXT02	5.29	3.5	144	10.4	0.2
TC01_EX	7.86	5	145.8	5.3	0.2
TC02_EX	7.10	10.13	145.5	6.2	0.2
TC03_EX	6.93	8.23	144	10.3	0.2
TC04_EX_407	5.91	5	156.238	9.496	0.2
SW15	9.61	100	236.912	4.722	0.2
YRK-EXT03	0.62	10	144	1.6	0.2
YRK-EXT02	1.54	80	144	1.6	0.2
YRK-EXT04	1.08	6.03	147	10.4	0.2
YRK-S-02-FUT	0.54	78.4	144	4.4	0.2
YRK-EXT10	0.95	43.88	144	7.7	0.2
YRK-EXT09	1.39	8.01	144	8.6	0.2
YRK-N-03-FUT	0.13	93.2	144	2.1	0.2
YRK-S-03-FUT	0.13	65.4	144	1.6	0.2

Subcatchment Name	Area (ha)	Imperv. (%)	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
YRK-EXT08	0.60	5.88	144	8.1	0.2
YRK-EXT07	0.32	5	144.2	7.8	0.2
YRK-EXT06	0.35	5.17	144	8.2	0.2
YRK-S-04-FUT	0.29	66.1	144	1.6	0.2
YRK-N-04-FUT	0.33	83.2	144	1.6	0.2
YRK-S-05-FUT	0.38	67.8	144	1.6	0.2
YRK-S-06-FUT	0.44	77.8	188	1.4	0.2
YRK-N-05-FUT	0.39	85.5	144	1.6	0.2
YRK-N-06-FUT	0.62	55.9	188	1.4	0.2
TC05_EX_494	3.56	5	192.007	5.909	0.2
ER10_EX	5.45	9.72	200.9	6.3	0.2
ER21_EX	0.85	82.51	144	10.3	0.2
ER16_EX_516	4.75	5	144.268	9.196	0.2
ER09_EX	3.10	46.55	145	7.3	0.2
ER11_EX_520	4.64	15.56	146	4.7	0.2
SW25	19.91	89.45	210.626	5.546	0.2
SW16	11.49	94.38	230.104	4.834	0.2
SW17	9.63	75.84	191.596	6.313	0.2
SW18	33.34	86.75	212.729	5.716	0.2
SW19	24.79	68.5	183.393	7.102	0.2
SW21	16.69	90.51	145.579	5.863	0.2
SW22	13.85	91.92	144.203	9.877	0.2
VR03_EX_521	3.62	5	200.9	6.3	0.2
ER14_EX_388	2.49	5	144.93	6.899	0.2
SW23	5.87	99.98	199.1	5.8	0.2
SW24	2.70	100	219.9	4.9	0.2
SW27	3.08	72.74	144.2	9.2	0.2
SW28	8.98	47.28	144.7	8.3	0.2
CC10_EX_339	5.17	25.77	144	10.4	0.2
CC15_EX	0.75	24.76	144	10.3	0.2
CC21_EX	2.99	25.14	144	9.5	0.2
SW35	1.13	29.91	144	10.4	0.2
CC04_EX_2	3.04	5.01	144	10.4	0.2
CC09_EX_1	1.56	5.02	144	10.4	0.2
SW33	1.22	29.87	144	10.4	0.2
SW34	0.53	29.69	144	8.8	0.2

Subcatchment Name	Area (ha)	Imperv. (%)	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)
YRK-EXT05_2	0.44	5.01	144	8.8	0.2
CC13_EX_1	1.86	5.02	144	10.5	0.2
SW36	1.06	29.19	144	10.5	0.2
CC17_EX_2	1.73	5.05	144	9.5	0.2
CC17_EX_4	0.94	5.05	144	9.5	0.2
CC12_EX_1	1.28	5.01	144	10.3	0.2
SW32	3.41	29.82	144	10.3	0.2
ER20_EX_1	4.17	9.43	144.4	9.9	0.2
SW37	2.99	99.79	144.4	9.9	0.2
CC07_1	4.00	5.36	144	9.7	0.2
SW38	1.54	99.56	144	9.7	0.2
SW31_1	5.09	29.9	144	9.5	0.2
SW20	16.26	31.682	144.093	9.488	0.2
SW45	0.90	100	144	10.2	0.2
CC37_EX	1.08	12.9	144	10.2	0.2

The future land use condition PCSWMM model has been used to generate peak flows at key nodes as indicated in Table 3.2.3 This scenario is "uncontrolled", or without any assumed stormwater management quantity controls in place. The differences in peak flows, actual and percentage difference, resulting from the future versus existing land use condition PCSWMM models are presented in Tables 3.2.4 and 3.2.5 respectively. The relative and percentage difference in peak flows is considered significant. The primary reason for the increase in peak flows compared to existing conditions is the extent and change in land use, coupled with the removal from the future land use PCSWMM model of the two (2) existing stormwater management facilities located adjacent to Stone Road East, at Victoria Road South and Watson Parkway South to allow for the proposed land use and stormwater management facilities to be located at lowest areas within drainage catchments. Based on the preceding, stormwater management is clearly warranted for the future development in the GID in order to mitigate the simulated increase in peak flows.

Table 3.2.3. Future Condition Flow – Uncontrolled (m^3/s)

Flow Node	Description	Peak Flow (m^3/s) for Return Period (Years)						
		25 mm	2	5	10	25	50	100
J3	Eramosa River at Victoria Road South	5.70	8.84	14.23	19.80	26.31	30.75	35.84
J_ER10	Eramosa River and Clythe Creek Confluence	4.43	7.42	14.17	20.12	27.26	32.04	36.99
J4	Eramosa River upstream of the Clythe Creek Confluence	3.50	5.82	11.12	15.79	21.27	25.16	29.90
J6	Eramosa River adjacent to Cargill Meat Solutions Plant	4.92	8.04	13.07	17.13	21.55	24.57	28.31
J5	Eramosa River north of Stone Rd. E.	5.51	8.97	13.13	16.95	22.12	25.10	28.66
J_ER02	Eramosa River south of Stone Rd. E. and upstream of Torrance Creek Confluence	1.04	1.68	2.64	3.79	4.97	6.15	7.32
J_TC05	Torrance Creek south of Stone Rd. E. and upstream Confluence with Eramosa River	2.20	3.63	6.95	10.04	12.32	13.35	14.30
J_NorthPond	Clythe Creek Tributary upstream of the North Pond	1.70	2.78	4.13	5.54	6.90	8.29	9.66
J_CC06	Clythe Creek Tributary upstream of the North Pond	0.36	0.57	0.96	1.49	2.13	2.72	3.36
OF12	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	2.20	3.72	7.16	9.56	11.40	17.79	20.21
J_CC16	Clythe Creek Tributary north of Stone Rd. and south of Watson Pkwy.	2.95	4.78	6.78	9.94	13.00	15.17	17.44
J_CC20	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	0.70	1.10	1.54	2.85	4.81	6.19	7.14

Table 3.2.4. Flow Difference – Existing Condition vs. Future Uncontrolled Condition (m^3/s)

Flow Node	Description	Peak Flow (m^3/s) for Return Period (Years)						
		25 mm	2	5	10	25	50	100
J3	Eramosa River at Victoria Road South	4.33	6.44	7.23	7.71	7.66	6.20	4.47
J_ER10	Eramosa River and Clythe Creek Confluence	3.11	4.94	7.66	9.17	10.41	9.81	8.58
J4	Eramosa River upstream of the Clythe Creek Confluence	2.00	3.40	7.25	9.13	10.40	10.43	10.92
J6	Eramosa River adjacent to Cargill Meat Solutions Plant	4.40	6.79	9.31	10.83	11.69	11.39	11.71
J5	Eramosa River north of Stone Rd. E.	5.14	8.00	9.81	10.98	12.54	12.35	12.51
J_ER02	Eramosa River south of Stone Rd. E. and upstream of Torrance Creek Confluence	0.64	1.02	1.45	1.75	1.87	2.05	2.18
J_TC05	Torrance Creek south of Stone Rd. E. and upstream Confluence with Eramosa River	1.91	3.13	5.77	7.92	8.90	8.67	8.22
J_NorthPond	Clythe Creek Tributary upstream of the North Pond	0.08	0.13	0.33	0.55	0.84	1.13	1.43
J_CC06	Clythe Creek Tributary upstream of the North Pond	0.27	0.43	0.49	0.60	0.71	0.80	0.91
OF12	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	2.05	3.46	6.32	7.56	7.72	12.55	12.88
J_CC16	Clythe Creek Tributary north of Stone Rd. and south of Watson Pkwy.	2.80	4.56	6.08	8.27	9.92	10.79	11.66
J_CC20	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	0.36	0.56	0.76	1.80	3.09	3.35	2.78

Table 3.2.5. Percentage Difference – Existing Condition vs. Future Condition with No Control (%)

Flow Node	Description	Return Period (Years)						
		25 mm	2	5	10	25	50	100
J3	Eramosa River at Victoria Road South	316	268	103	64	41	25	14
J_ER10	Eramosa River and Clythe Creek Confluence	235	200	118	84	62	44	30
J4	Eramosa River upstream of the Clythe Creek Confluence	134	140	188	137	96	71	58
J6	Eramosa River adjacent to Cargill Meat Solutions Plant	856	544	248	172	119	86	71
J5	Eramosa River north of Stone Rd. E.	1387	825	296	184	131	97	77
J_ER02	Eramosa River south of Stone Rd. E. and upstream of Torrance Creek Confluence	164	153	121	86	60	50	42
J_TC05	Torrance Creek south of Stone Rd. E. and upstream Confluence with Eramosa River	658	621	488	374	260	185	135
J_NorthPond	Clythe Creek Tributary upstream of the North Pond	5	5	9	11	14	16	17
J_CC06	Clythe Creek Tributary upstream of the North Pond	307	300	106	68	50	42	37
OF12	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	1329	1342	756	380	210	239	176
J_CC16	Clythe Creek Tributary north of Stone Rd. and south of Watson Pkwy.	1988	2141	875	496	323	247	202
J_CC20	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	104	104	97	172	180	118	64

4.0 Stormwater Management for the Guelph Innovation District (GID)

In consultation with the City of Guelph the following objectives and policies have been established for the stormwater management strategy for the Guelph Innovation District (GID).

4.1 Objectives

- To implement a groundwater infiltration strategy that maximizes the infiltration of clean water without impacts to adjacent servicing infrastructure.
- To protect the most significant groundwater recharge areas in order to protect and enhance the municipal water supply.
- To minimize chloride infiltration into the groundwater system.
- To mitigate negative impacts to peak flows, water balance and water quality resulting from urbanization.
- To prevent increased erosion within Clythe, Hadati, Torrance Creeks and the Eramosa River.

4.2 Policies

- Development within the GID will need to comply with current City of Guelph and Ministry of the Environment Conservation and Parks (MECP) stormwater management design requirements and any supplemental conceptual design standards established in the GID Stormwater Management Plan, such as seasonal stormwater management strategies for infiltration.
- Guelph Innovation District development shall comply with the City of Guelph polices for servicing, storm water management, including water quality and quantity and temperature and water balance. The City of Guelph's Official Plan policies introduced through OPA 48, under appeal, on Water Resources, Source Water Protection and related stormwater management policies should be adhered to.
- Stormwater management erosion controls should be designed to mitigate the impacts of development on the receiving drainage system. In the absence of determining critical erosion threshold flows for local watercourses (Clythe, Torrance and Hadati Creeks) stormwater erosion controls should be designed using the erosion control sizing guidelines in the MOE's 2003 Stormwater Management Planning and Design Manual. Stormwater erosion controls should be flexible and adaptive in design to facilitate potential changes once critical flows have been established and erosion controls assessed using continuous hydrologic modelling as part of future studies.
- GID development shall comply with the recommendations and requirements of the Proposed Grand River Source Protection Plan.
- Stormwater management criteria should meet the water quality, water quantity and natural environment objectives of the City of Guelph's Stormwater Management Master Plan.
- Reference monitoring requirements and targets to be established in subsequent management plans.
- As per the Clythe Creek Subwatershed Overview, GID development lands draining to Clythe Creek should maintain existing groundwater recharge quantity and quality. Fish barriers along Clythe Creek should be removed to improve fish habitat. Stormwater management practices in addition to providing as a minimum an Enhanced Level of water quality treatment are also to minimize temperature impacts to runoff discharging to Clythe Creek.

- As per the 1998 Torrance Creek Subwatershed Study, infiltration measures should be implemented to maintain or augment baseflows. Enhanced stormwater quality treatment of drainage considered not to be clean would be required prior to runoff entering infiltration best management practices. To improve fish habitat, fish barriers along Torrance Creek should be removed.
- As per the 1999 Eramosa Blue Springs Watershed Study, the Eramosa River corridor should be enhanced through stream corridor restoration.
- The City of Guelph should conduct studies to determine stormwater management requirements for the proposed GID development. Should the studies not be approved by the required agencies prior to development being implemented, the City of Guelph will require stormwater management infrastructure for GID to be flexible and adaptive in design in order to allow for recommendations from future studies to be incorporated. For instance, stormwater management blocks should incorporate an appropriate land buffer to implement potential additional storage requirements resulting from future study's stormwater storage requirement recommendations.
- The City shall minimize the amount of chloride (salt) infiltration into groundwater through best management practices when applying salt to streets during winter months in accordance with the City's salt management plan. In addition, the City may consider allowing the use of stormwater winter by-pass systems (bypassing the infiltration best management systems that receive treated runoff from roadways and parking areas); so long as it is demonstrated in technical studies submitted in support of development approvals that a balanced annual water budget (surface runoff, groundwater recharge, evapotranspiration) can still be obtained.
- Snow storage design within the GID will have to be designed for protection of water quality, including the associated melt water. Snow storage areas would be subject to the Source Water Protection Plan (SWPP) policies (ref. policy CG-MC-32.1 & 32.2 from the proposed SWPP). This report should encourage designs that would meet/address the requirements in the SWPP.
- In order to ensure that a balanced water budget is achieved post development, the City may require monitoring of stormwater management infrastructure for an appropriate period after development. Where infiltration targets (developed for a balanced water budget) are not being achieved, the City may require additional monitoring for an appropriate period to determine what modifications to the drainage system would be required to try to meet the infiltration targets. .
- Infiltration stormwater best management practices (BMPs) (other than increased topsoil depth) that are to be located on private lands are to be listed on land title agreements. The City should have easements for rights to access and maintenance over BMPs located on private lands.
- Stormwater management facilities shall be lined to prevent contaminants infiltrating into the groundwater system. Lining of stormwater management facilities may not be required under the following conditions:
    - Pre-treatment of runoff prior to drainage discharging to the facility; and
    - Winter bypass of first flush runoff to prevent contamination of groundwater by chloride (salt) laden runoff. Diversion of the first flush runoff shall not negatively impact the receiving GID drainage system due to potential increase in peak flows.

- Stormwater management measures to be implemented within the GID should include gray water reuse systems and green rooftop technologies for all industrial, commercial and institutional land uses. Development proponents may need to demonstrate that implementation of green roof and gray water reuse systems continue to result in balanced water budgets for area systems.
- Stormwater management facilities should be considered local focal points of interest, to be integrated where feasible into the planned open space, with functional compatible landscape features incorporated into the facility design.

5.0 Stormwater Management Opportunities

In addition to matching the objectives and policies presented in Section 3, future development within the GID will have to provide Enhanced stormwater quality control (80% average annual removal of Total Suspended Solids (TSS)). Stormwater quantity control will adhere to the stormwater management criteria determined herein and will be further assessed on a site by site basis to maintain existing peak flows and the water budget. Stormwater management measures will have to consider Source Water Protection Plan requirements in protecting surface and groundwater resources.

For larger size developments (i.e. greater than 5 ha), end-of-pipe wet ponds, wetlands, or hybrid facilities are considered appropriate, due to the drainage area limitations associated with other techniques. Preliminary stormwater management facilities have been located as per Drawing 2.

On-site stormwater management alternatives for future development, redevelopment and infill, would include but be not limited to: wetlands, wet ponds, oil/grit separators (OGS), low impact development best management practices or combinations thereof.

5.1 Conventional Stormwater Management

Wet ponds, Wetlands, Hybrids

These systems generally require the dedication of land that is typically located adjacent to creek systems. For the GID, there are a number of opportunities to consider the placement of an end-of-pipe stormwater management facility. Typically, these systems provide an excellent level of treatment and as end-of-pipe systems, the management and performance is more visible, hence less prone to failure. For groundwater protection, stormwater management facilities should be lined with an impermeable liner if drainage from parking areas and roadways is received, and/or drainage is to be pre-treated prior to discharge to the stormwater management facility. An alternative to this approach is to line the forebay where most of the sediments settle out, and then allow infiltration within the main cell of the stormwater management facility. This approach has been used by the City of Kitchener, which also uses winter bypasses of the infiltration cell during winter months, to prevent salt laden water from entering the groundwater system.

Enhanced Grassed Swales

Grassed swales designed with a trapezoidal geometry and flat longitudinal profiles with largely un-maintained turf can provide excellent filtration and treatment for storm runoff from roadways or small developable areas. It is generally conceded that treatment levels are at a minimum, Normal (formerly Level 2) treatment, and when combined with other practices can provide Enhanced treatment. Grassed swale application in linear corridors is also particularly appropriate and can be further enhanced through the introduction of check dams to provide additional on-line storage.

The application in urbanized roadway cross-sections (i.e. curb and gutter) often requires alternative grading and roadway configurations which can compromise the function of the roadway itself, and are therefore typically not preferred. Notwithstanding, gutter outlets along outside lanes have functioned effectively in the past where the right-of-way can accommodate the design. Enhanced swales receiving direct runoff from roads and parking lots would not prevent contaminants from being infiltrated, as such pre-treatment should be provided.

Filter Strips

Filter strips typically are designed for small drainage areas less than 2 ha, and are applied as part of a treatment train. Filter strips require flat areas with slopes ranging from 1 to 5% and are usually in the range of 10 to 20 m in length in the direction of flow. Flow leaving filter strips should be a maximum of 0.10 m depth, based on a 10 mm storm event.

Oil and Grit Separators

These systems tend to serve limited drainage areas up to 2 ha +/- and provide levels of treatment (less than Enhanced, formerly Level 1). They are typically encouraged as part of a "treatment train" approach. Disadvantages include the need for frequent maintenance, and the ability to serve relatively small drainage areas.

Cash-in-Lieu of On-Site Treatment

Often, due to the sensitivity of downstream systems (i.e. low habitat potential) and the difficulty of providing affordable and effective stormwater management on-site, municipalities have proposed the contribution of cash-in-lieu of on-site stormwater management, to be directed towards other environmental enhancement projects. These can either be identified in subwatershed planning studies or addressed on a site-specific basis. The priority of application usually relates first to improving watershed conditions in the directly affected watershed. This approach is supported by both Provincial and Municipal policy. That said, due to the requirement to provide stormwater quantity, quality and a balanced water budget, cash-in-lieu is considered not appropriate for the GID.

Provide On-site Stormwater Quality Management for Re-development & Infills

Traditionally, stormwater management for small areas has been designed for each separate development area, as the development applications and engineering submissions are completed for the individual sites. Approved techniques for the provision of on-site stormwater quality control are provided in the Stormwater Management Practices Planning and Design Manual (MOE, 2003) and the Low Impact Development Stormwater Management Planning and Design Guide, TRCA and CVC, 2011 . Various techniques for stormwater quality control include:

- Soakaway pits
- Infiltration trenches
- Grassed swales
- Pervious pipe systems
- Pervious catchbasins
- CB Sheilds
- Vegetated filter strips
- Buffer strips
- Bioretention systems
- Oil/Grit separators
- Wet ponds
- Wetlands
- Hybrids wet pond/wetland system

The application of grassed swales or oil/grit separators is generally the most common BMP for smaller size developments (i.e. less than 2 ha) due to reduced land requirements compared to the other alternatives, as well as their applicability regardless of soil conditions (i.e. infiltration technologies require relatively permeable soil conditions). Of these two options, oil/grit separators are commonly used for commercial/industrial applications, where the impervious coverage for the site is relatively high (i.e. greater than 85%) and the site plan is developed such that the maximum developable area is utilized. On-site stormwater management measures will have to consider groundwater protection as per the proposed SWPP, while also considering infiltration to maintain the water balance.

5.2 Stormwater Quality Retrofits

Existing/Planned SWM Facilities

This method of stormwater quality control involves modifying existing stormwater management facilities (quantity or quality control) to provide targeted water quality control. Although this method is primarily intended for existing stormwater facilities, it can also be considered during the planning stages for new quantity facilities, if it is expected that upstream stormwater runoff (i.e. pond outflow) would adversely affect downstream watercourses and habitat through water quality degradation. When possible, retrofitting existing/planned facilities is considered to be a cost-effective approach since land costs (if any) would generally be less than that required for a new facility. Also, the majority of the infrastructure of an existing facility is already in place (headwalls, access paths, berms) and hence would only require modification. A reduction in future maintenance costs could be realized since both quantity and quality control functions have been consolidated into one facility, therefore, the number of facilities requiring maintenance would be reduced.

There are four (4) methods generally considered available for the retrofitting of an existing or planned SWM facility:

i. Construct a permanent pool, or in the case of an existing quality facility, deepen or expand the existing permanent pool
ii. Modify the facility to provide for extended detention storage
iii. Provide longer, extended, flow paths through the facility to promote settling of suspended solids
iv. Provide additional, or enhanced vegetation within the facility to promote nutrient uptake, water polishing, and temperature control (shading)

In determining the feasibility of retrofitting an existing or planned stormwater management facility, a number of factors must be considered:

- Ability to physically enlarge/retrofit a facility. Is land available (i.e. public lands, parks etc.) adjacent to the facility? Is it possible to implement retrofits within the confines of the existing/planned facility?
- No impact to the existing NHS
- Tributary area draining to the facility
- Type of upstream land use
- Facility location versus groundwater resources sensitive to infiltrated contaminated runoff
- Sensitivity of downstream (receiving) watercourses and the need for improved stormwater quality
- Cost-benefit of retrofit. Is maximum benefit being realized from monies spent, or should monies be directed elsewhere to realize greater water quality benefits?

The retrofit design approach would be unique for each existing/planned stormwater management facility under consideration. Whenever possible, designs should work toward the "Water Quality Storage Requirements based on Receiving Waters" (MOE Stormwater Management Planning and Design Manual, 2003). However, given that limitations may exist in providing water quality storage volumes in strict compliance with the SWMP Manual, facilities can still be retrofitted to provide some level of stormwater quality control, as this would likely remain beneficial, subject to an economic review. The "criteria" in such cases when full quality volumes cannot be realized will take the form of runoff volumes expressed in millimetres (mm) of runoff; this would follow the equivalent removal principle.

Existing Storm Outfalls

Existing storm outfalls provide opportunities to implement online treatment of various upstream land uses within the context of new retrofit facilities typically constructed on existing available public lands. Water quality facilities in the form of wetlands, wet ponds or hybrids would provide both permanent pool and extended detention volumes. Possible sites would be evaluated on factors similar to those listed in the foregoing for retrofit of existing/ planned SWM facilities. Candidate sites for providing stormwater quality control at existing storm outfalls are generally evaluated based upon the following additional criteria (in no particular order):

i. Land availability, land use flexibility and ownership
ii. Storm outfall location within the available land
iii. Storm outfall tributary drainage area and respective characteristics
iv. Storm outfall location versus sensitive groundwater resources
v. Potential outlet location with respect to receiving waters
vi. Downstream aquatic resource benefit potential and water quality requirements
vii. Financial resource allotment and potential cost/benefit ratio

5.3 Low Impact Development (LID) Best Management Measures (BMPs)

Low Impact Development represents the application of a suite of BMPs normally related to source and conveyance stormwater management controls to promote infiltration and pollutant removal on a local site by site basis. These measures rely on eliminating the direct connection between impervious surfaces such as roofs, roads, parking areas, and the storm drainage system, as well as the promotion of infiltration on each development or redevelopment site. General design guidelines and considerations for source and conveyance controls have been advanced since the early 1990's as part of the MMAH "Making Choices" and in 1994 as part of the Ministry of the Environment's Best Management Practices Guidelines.

Subsequent to the 1994 MOE Guidelines, technologies and standards have been developed further for the application of source and conveyance controls. These have evolved into a class of Best Management Practices (BMPs) referred to as Low Impact Development (LID) practices, which have advanced as an integrated form of site planning and storm servicing to maintain water balance and providing stormwater quality control for urban developments. Initial results from studies in other settings have demonstrated that LID practices may also provide benefits by way of reducing the erosion potential within receiving watercourses and thereby reducing the total volume of end-of-pipe stormwater erosion control requirements. In addition, due to volumetric controls afforded by LID BMP's, water quality is also improved through a reduction in mass loading. The benefits from LID stormwater management practices are generally focused on the more frequent storm events (e.g. 2-year storm) of lower volumes as opposed to the less frequent storm events (e.g. 100 year storm) with higher volumes. It is also recognized that the forms of LID practices which promote infiltration or filtration through a granular medium provide thermal mitigation for storm runoff.

Guidelines regarding the application of LID practices and techniques have been developed within various jurisdictions in the United States and Canada. The Toronto and Region Conservation Authority and Credit Valley Conservation have released the 2011 Low Impact Development Stormwater Management Manual, for the design and application of LID measures. Various LID techniques, as well as their function, are summarized in Table 5.3.1. While LID includes additional planning to implement and can require changing of urban design standards, the information provided in Table 5.3.1 specifically addresses those techniques and technologies related to stormwater management practices.

The MOECC published in 2016 the draft Runoff Volume Control Targets for Ontario and the Low Impact Development Stormwater Management Guidance Manual. The runoff control target for the GID, is 27 mm of rainfall depth based on an average runoff coefficient of 0.9. As such, low impact development is to target 27 mm rainfall capture unless the proponent can provide defendable reasons why 27 mm capture is not feasible, in that case a reduced rainfall capture of 75% of 27 mm (20.25 mm) or the maximum extent possible capture should be targeted. As such, low impact development BMPs should be implemented within the GID to facilitate capture of 27 mm drainage from impervious surfaces, from both private and public lands. The City, will need to establish LID BMPs that will be allowed within the GID, based on Guelph requirements for groundwater protection; further discussion of this is provided under the Water Quality Assessment.

Table 5.3.1. LID Source and Conveyance Controls

Technique	Function
Bio-retention Cell	• Vegetated technique for filtration of storm runoff • Stormwater quality control provided through filtration of runoff through soil medium and vegetation • Infiltration/water balance maintenance and additional erosion control may be achieved if no subdrain provided
Cistern	• Rainwater harvesting technique • Storm runoff volume reduced through capture/interception of runoff • Stormwater quality provided for captured runoff • Effectiveness is contingent upon available volume within cistern
Downspout Disconnection	• Effectiveness dependent upon soils and supplemental conveyance techniques • Storm runoff volume reduced by promoting infiltration through reducing direct connections of impervious surfaces • Benefits to stormwater quality control and erosion control are informal.
Grassed Swale	• Vegetated technique to provide stormwater quality control • Stormwater quality control provided by filtration through vegetated system • Runoff volume reduction may be achieved by supplementing with soil amendments
Green Roof	• Vegetated technique for reducing storm runoff volume • Informal stormwater quality control provided through reduction in runoff volume • No benefits provided by way of infiltration
Infiltration Trench	• Infiltration technique to provide stormwater quality control and maintain water balance • Erosion controls may be achieved depending upon soil conditions
Permeable Pavers/Pavement	• Infiltration technique to reduce surface runoff volume • Benefits to stormwater quality and erosion control are informal
Rain Barrel	• Rainwater harvesting technique • Storm runoff volume reduced through capture/interception of runoff • Stormwater quality provided for captured runoff • Effectiveness is contingent upon available volume within rain barrel
Soil Amendments	• Technique for reducing runoff volume through increased depth of topsoil • Stormwater quality control provided through increased soil storage and associated interception of storm runoff

Technique	Function
	• Increases water balance compared to existing conditions when applied in areas with low permeability soils • Possible erosion control benefits
Reduced Lot Grading	• Reduction in lot grading increases contact time between storm runoff and vegetation, also increases time of concentration for runoff (some reduction in peak flow rate) • Technique reduces runoff volume and improves on stormwater quality on an informal basis • Additional informal benefits to maintaining water balance and erosion control may be achieved depending upon soil conditions
Pervious Pipes	• Technique to reduce storm runoff through the implementation of perforated pipes within storm sewers • Promotion of infiltration maintains water balance and provides stormwater quality and erosion control benefits

5.4 Future Land Use Stormwater Management Assessment

5.4.1 Design Storms

Stormwater management has been assessed both for the currently proposed development as well as for existing development that could potentially re-develop For all development LID BMPs should be considered as a method of meeting the GID stormwater objectives and policies. That being said, the following should be considered when incorporating LID into GID stormwater management servicing.

i. Drainage from road or parking lots within the GID could be directed to infiltrative LID BMPs, as long as a salt management program is in place and some form of pre-treatment is provided. More specifically the salt management programs should be in line with Source Water Protection Plan policies CG-MC-28 to 31 that require consideration of salt handling, storage, distribution and application.

ii. Green Roofs could be considered in the GID, although GID OPA 54 Policy 11.2.3.2.4 states that "Within the GID, a majority of the available roof area for new development will be encouraged to be dedicated to roof top solar technologies such as photovoltaic or solar thermal."

iii. The City of Guelph will consider end-of-pipe infiltration facilities, without winter drainage bypass systems when a comprehensive salt management program is in place The City of Guelph will require a geotechnical investigation to determine the feasibility of implementing infiltrative BMPs.

iv. The City of Guelph will require as a minimum within the GID, total suspended solids (TSS) removal at 80% Enhanced Level using stormwater management measures.

Drainage areas for the GID future land use scenario have been developed and depicted on Drawing 2. The GID has been sub-divided into areas draining to the Eramosa River, Torrance Creek and Clythe Creek. Locations of proposed end-of-pipe stormwater management facilities have been determined based on existing topography, future grading, land use and existing stormwater management measures.

Low impact development best management practices have been sized for each catchment based on 27 mm runoff capture, for both private and public land uses. Low impact development receiving runoff from paved surfaces would require pre-treatment. Pre-treatment could be provided by way of CB Shield™ inserts, oil/ grit separators, lined filtration systems, forebays with bioretention systems or other methods approvable to the City of Guelph.

To understand the effectiveness of applying low impact development to capture 27 mm of runoff, the future uncontrolled conditions PCSWMM model has been modified to assess low impact development as the only stormwater management measure. Table 5.4.1 provides the future land use condition peak flows with low impact development with 27 mm runoff capture. The simulated low impact development is effective in controlling peak flows for the 2 year storm event, while reducing peak flows for the other storm events for most locations as indicated in Tables 5.4.2 and 5.4.3.

Table 5.4.1. Future Condition Flow – With LIDs (m^3/s)

Flow Node	Location	Simulated Peak Flow (m^3/s) for Return Period (Years)						
		25 mm	2	5	10	25	50	100
J3	Eramosa River at Victoria Road South	1.33	2.17	6.57	11.88	18.77	24.51	30.13
J_ER10	Eramosa River and Clythe Creek Confluence	1.07	1.85	6.05	11.46	18.38	24.86	31.73
J4	Eramosa River upstream of the Clythe Creek Confluence	0.30	0.51	4.15	8.00	13.38	18.24	23.34
J6	Eramosa River adjacent to Cargill Meat Solutions Plant	0.20	0.57	5.65	10.16	15.57	19.88	23.96
J5	Eramosa River north of Stone Rd. E.	0.44	0.94	4.95	9.47	14.69	19.61	24.31
J_ER02	Eramosa River south of Stone Rd. E. and upstream of Torrance Creek Confluence	0.21	0.38	1.82	3.30	4.75	6.02	7.25
J_TC05	Torrance Creek south of Stone Rd. E. and upstream Confluence with Eramosa River	0.25	0.43	1.65	3.56	6.18	9.41	11.99
J_NorthPond	Clythe Creek Tributary upstream of the North Pond	1.33	2.20	3.17	4.49	5.85	7.30	8.85
J_CC06	Clythe Creek Tributary upstream of the North Pond	0.07	0.14	0.73	1.36	1.95	2.57	3.21
OF12	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	0.19	0.30	2.34	4.20	8.24	10.75	14.70
J_CC16	Clythe Creek Tributary north of Stone Rd. and south of Watson Pkwy.	0.13	0.24	2.45	4.97	7.80	10.26	13.95
J_CC20	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	0.00	0.00	0.34	0.73	1.25	1.66	2.26

Table 5.4.2. Flow Difference – Existing Condition vs. Future Condition with LIDs (m^3/s)

Flow Node	Location	Difference in Peak Flow (m^3/s) Return Period (Years)						
		25 mm	2	5	10	25	50	100
J3	Eramosa River at Victoria Road South	-0.04	-0.23	-0.43	-0.21	0.12	-0.04	-1.24
J_ER10	Eramosa River and Clythe Creek Confluence	-0.25	-0.62	-0.46	0.51	1.53	2.63	3.32
J4	Eramosa River upstream of the Clythe Creek Confluence	-1.19	-1.92	0.28	1.34	2.51	3.51	4.36
J6	Eramosa River adjacent to Cargill Meat Solutions Plant	-0.31	-0.68	1.89	3.86	5.71	6.70	7.36
J5	Eramosa River north of Stone Rd. E.	0.07	-0.03	1.63	3.51	5.11	6.86	8.16
J_ER02	Eramosa River south of Stone Rd. E. and upstream of Torrance Creek Confluence	-0.18	-0.29	0.62	1.26	1.65	1.92	2.11
J_TC05	Torrance Creek south of Stone Rd. E. and upstream Confluence with Eramosa River	-0.04	-0.08	0.47	1.44	2.76	4.73	5.91
J_NorthPond	Clythe Creek Tributary upstream of the North Pond	-0.28	-0.45	-0.62	-0.51	-0.20	0.13	0.62
J_CC06	Clythe Creek Tributary upstream of the North Pond	-0.02	0.00	0.26	0.47	0.53	0.65	0.76
OF12	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	0.04	0.04	1.50	2.21	4.56	5.51	7.37
J_CC16	Clythe Creek Tributary north of Stone Rd. and south of Watson Pkwy.	-0.01	0.02	1.75	3.30	4.72	5.88	8.17
J_CC20	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	-0.34	-0.54	-0.45	-0.31	-0.47	-1.17	-2.10

Table 5.4.3. Percentage Difference – Existing Condition vs. Future Condition with LIDs (%)

Flow Node	Location	Difference in Peak Flows (%) for Return Period (Years)						
		25 mm	2	5	10	25	50	100
J3	Eramosa River at Victoria Road South	-3	-10	-6	-2	1	0	-4
J_ER10	Eramosa River and Clythe Creek Confluence	-19	-25	-7	5	9	12	12
J4	Eramosa River upstream of the Clythe Creek Confluence	-80	-79	7	20	23	24	23
J6	Eramosa River adjacent to Cargill Meat Solutions Plant	-61	-55	50	61	58	51	44
J5	Eramosa River north of Stone Rd. E.	19	-3	49	59	53	54	51
J_ER02	Eramosa River south of Stone Rd. E. and upstream of Torrance Creek Confluence	-46	-43	52	62	53	47	41
J_TC05	Torrance Creek south of Stone Rd. E. and upstream Confluence with Eramosa River	-14	-16	39	68	81	101	97
J_NorthPond	Clythe Creek Tributary upstream of the North Pond	-18	-17	-16	-10	-3	2	8
J_CC06	Clythe Creek Tributary upstream of the North Pond	-19	1	57	54	37	34	31
OF12	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	23	17	179	111	124	105	100
J_CC16	Clythe Creek Tributary north of Stone Rd. and south of Watson Pkwy.	-7	11	252	198	153	134	141
J_CC20	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	-100	-100	-57	-30	-27	-41	-48

As noted, the simulated low impact development is effective in controlling peak flows for the 2 year storm event, while reducing peak flows for the other storm events for most locations as indicated in Tables 5.4.2 and 5.4.3. Additional quantity controls would therefore be required.

Stormwater management quantity controls will be required in addition to the 27 mm capture within the distributed low impact development best management measures. Stormwater management facilities should receive pre-treated drainage either through LID BMPs, CB Shields™ and/or oil/ grit chambers. Based on the LID BMPs capture of 27 mm, extended detention for both stormwater quality and erosion controls are not considered required. The 27 mm capture also provides the required infiltration or either clean water or pre-treated drainage as per the pending provincial capture guidelines. Based on the foregoing, the end of pipe stormwater management facilities, would not need to provide additional infiltration. As such the end-of-pipe stormwater management facilities could be dry cells or could be wet

ponds. End-of-pipe wetlands have been screened from further consideration based on the available land within the GID for stormwater management facilities.

Stormwater quantity controls (end-of-pipe stormwater management facilities) have been sized and assessed using an iterative process to control post development peak flows to pre-development peak flows at key flow node locations. Stormwater quantity controls have been assessed for subareas/ subwatersheds within the GID (e.g. Clythe Creek) Table 5.4.4 provides the unitary storage and discharge rates for the 25 year and 100 year storm events, while Table 5.4.5 summarizes the sizing of each stormwater management facility (ref. Drawings 2 and 3).

Table 5.4.4. Summary of Stormwater Management (Quantity Control) with LID BMPs in Place

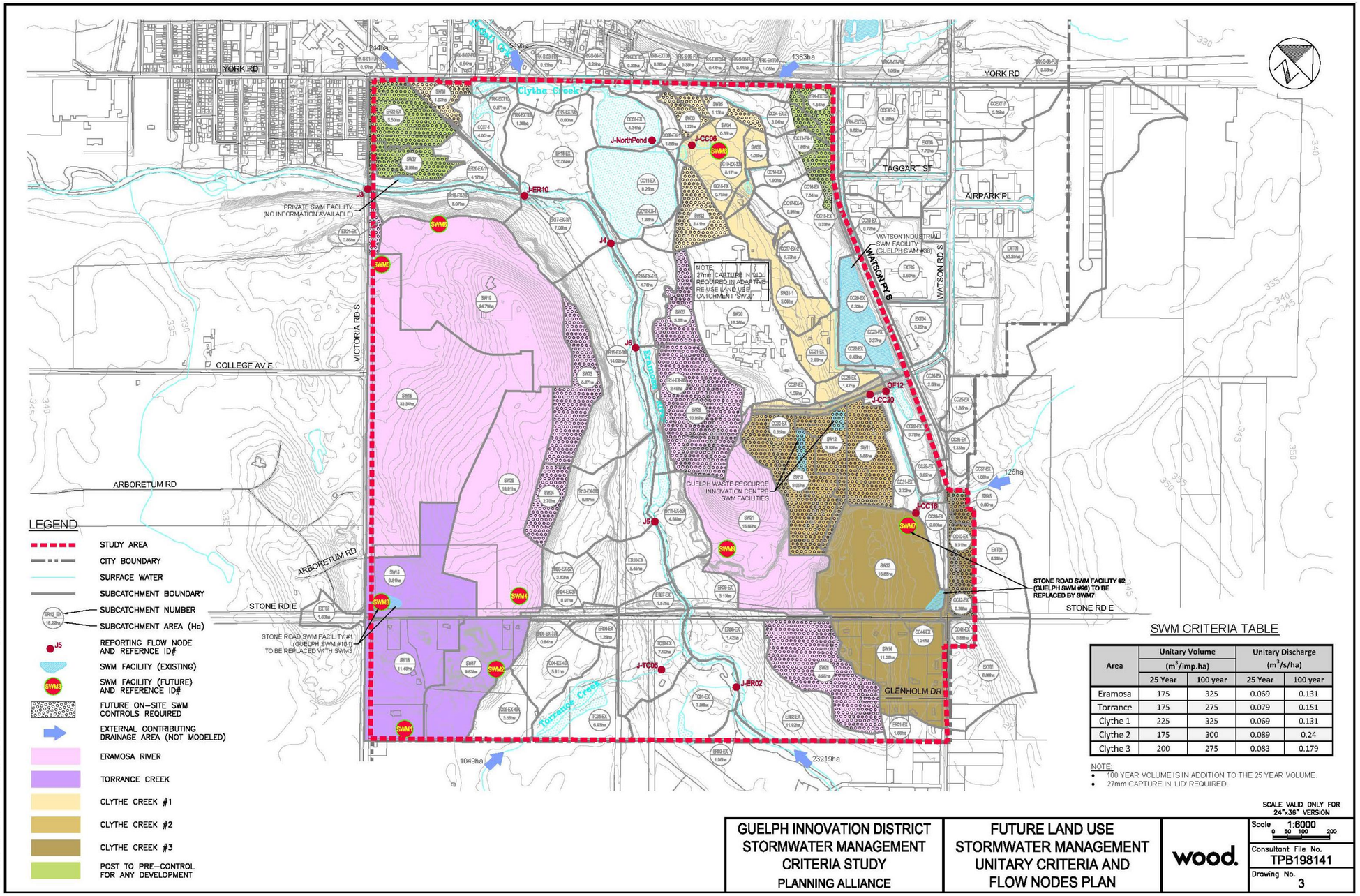
Subwatershed/ Sub Area	Unitary Storage Volumes (m^3/imp.ha)		Unitary Discharge (m^3/s/ha)	
	25 Year	100 Year	25 Year	100 Year
Eramosa River	175	325	0.069	0.131
Torrance Creek	175	275	0.079	0.151
Clythe Creek Sub Area 1	225	325	0.069	0.131
Clythe Creek Sub Area 2	175	300	0.089	0.240
Clythe Creek Sub Area 3	200	275	0.083	0.179

Table 5.4.5. Summary of End of Pipe Stormwater Management Facilities

Stormwater Management Facility/ Catchment (At Source Control)	Drainage Area (ha)		Storage Provided (m^3)	Storage (m^3)	
	Area	Imp. %		25 Year	100 Year
SWM6	24.79	69	6,132	3,425	5,478
SWM8	32.02	13	2,139	844	1,187
SWM7	44.29	5	6,520	3,388	4,906
SW23 At Source Control	5.87	100	2,121	1,010	1,600
SW24 At Source Control	2.70	100	975	480	732
SW28 At Source Control	8.98	47	1,533	1,125	1,650
SW45 At Source Control	0.90	100	274	154	227
ER22_EX At Source Control	5.50	96	1,754	397	489
SW37 At Source Control	2.99	100	995	231	313
SW26 At Source Control	10.85	98	3,824	1,793	2,853
SW13 At Source Control	9.05	99	2,999	1,368	2,048
SW12 At Source Control	3.63	100	1,211	572	849
SW11 At Source Control	5.55	97	1,801	849	1,264
CC40_EX At Source Control	3.01	100	918	508	752
SW34 At Source Control	0.53	30	57	51	53

Stormwater Management Facility/ Catchment (At Source Control)	Drainage Area (ha)		Storage Provided (m^3)	Storage (m^3)	
	Area	Imp. %		25 Year	100 Year
SW35 At Source Control	1.13	30	122	106	119
SW38 At Source Control	1.92	100	693	268	316
SW27 At Source Control	3.08	73	808	483	754
SW33 At Source Control	1.22	30	131	114	129
SW32 At Source Control	3.41	30	367	318	385
ER21_EX At Source Control	0.85	83	254	137	211

Table 5.4.6 summarizes the storage requirements for LID BMPs based on 27 mm capture (bolded values in table) from the impervious coverage for drainage catchments (ref. Drawings 2 and 3) and compares the storage volume provided to that for 25 mm erosion control as per the MOE's 2003 Stormwater Management Planning and Design Manual, and to the water quality extended detention storage volumetric requirement for wet ponds. For each catchment area, the distributed LID BMPs would provide more storage than either the 25 mm erosion control or the wet pond water quality storage (e.g. .FUTSWM 1, LID BMP volume of 2929 m^3 is greater than 2108 m^3 for detention of the 25 mm storm event and 2469 m^3 for water quality within a wet pond).



Area	Unitary Volume (m^3/imp.ha)		Unitary Discharge (m^3/s/ha)	
	25 Year	100 year	25 Year	100 year
Eramosa	175	325	0.069	0.131
Torrance	175	275	0.079	0.151
Clythe 1	225	325	0.069	0.131
Clythe 2	175	300	0.089	0.24
Clythe 3	200	275	0.083	0.179

Drawing 3. Future Land Use Stormwater Management Unitary Criteria and Flow Nodes Plan

Table 5.4.6. Low Impact Development Sizing Summary

SWM/Onsite Control Name	Connected LID	Subcatchment	Area (ha)	Imperviousness (%)	Imp. Area (ha)	Provided LID Volume (m^3)	Runoff Vol. for the 25mm storm event (m^3)	Additional Vol. available above 25mm event(m^3)	SWM Type	MOE Water Quality Requirement (m^3)	Provided - Required (m^3/s)
FUTSWM1	LID16	SW16	11.49	94.4	10.85	**2929**	2108	821	Wet pond	460	2469
FUTSWM2	LID17	SW17	9.63	75.8	7.30	**1971**	1385	586	Wet pond	385	1586
FUTSWM3	LID15	SW15	9.61	100.0	9.61	**2594**	1868	726	Wet pond	384	2210
FUTSWM4	LID25	SW25	19.91	89.5	17.81	**4808**	3418	1390	Wet pond	796	4012
FUTSWM5	LID18	SW18	33.34	86.8	28.92	**7808**	5525	2283	Wet pond	1333	6475
FUTSWM6	LID19	SW19	24.79	68.5	16.98	**4585**	3173	1412	Wet pond	992	3593
FUTSWM7	LID22	SW22	13.85	91.9	12.73	**3437**	2281	1156	Wet pond	554	2883
FUTSWM8	LID29	CC10_EX_339	5.17	25.8	1.33	**360**	236	124	Wet pond	207	153
FUTSWM9	LID21	SW21	16.69	90.5	15.11	**4078**	2940	1138	Wet pond	668	3411
FUTSWM_ATSOURCES1	LID23	SW23	5.87	100.0	5.87	**1586**	1124	462	Onsite Control	235	1351
FUTSWM_ATSOURCES2	LID24	SW24	2.70	100.0	2.70	**729**	525	204	Onsite Control	108	621
FUTSWM_ATSOURCES3	LID28	SW28	8.98	47.3	4.25	**1146**	786	361	Onsite Control	359	787
FUTSWM_ATSOURCES4	LID45	SW45	0.90	100.0	0.90	**242**	160	82	Onsite Control	36	206
FUTSWM_ATSOURCES5	LID42	ER22_EX	5.50	95.6	5.26	**1421**	1014	407	Onsite Control	220	1201
FUTSWM_ATSOURCES6	LID37	SW37	2.99	99.8	2.99	**806**	532	275	Onsite Control	120	687
FUTSWM_ATSOURCES7	LID26	SW26	10.85	97.6	10.59	**2859**	2015	844	Onsite Control	434	2425
FUTSWM_ATSOURCES8	LID13	SW13	9.05	99.4	9.00	**2430**	1683	747	Onsite Control	362	2067

SWM/Onsite Control Name	Connected LID	Subcatchment	Area (ha)	Imperviousness (%)	Imp. Area (ha)	Provided LID Volume (m^3)	Runoff Vol. for the 25mm storm event (m^3)	Additional Vol. available above 25mm event(m^3)	SWM Type	MOE Water Quality Requirement (m^3)	Provided - Required (m^3/s)
FUTSWM_ATSOURCES9	LID12	SW12	3.63	100.0	3.63	**981**	662	319	Onsite Control	145	835
FUTSWM_ATSOURCES10	LID11	SW11	5.55	97.4	5.40	**1459**	971	487	Onsite Control	222	1237
FUTSWM_ATSOURCES12	LID30	CC40_EX	3.01	100.0	3.01	**812**	543	269	Onsite Control	120	691
FUTSWM_ATSOURCES13	LID34	SW34	0.53	29.7	0.16	**43**	29	14	Onsite Control	21	21
FUTSWM_ATSOURCES14	LID35	SW35	1.13	29.9	0.34	**91**	60	31	Onsite Control	45	46

The approach to sizing stormwater management facilities has been to determine the 25 year and 100 year storage and discharge rates to result in pre-development peak flows throughout the GID for all storm events. Stormwater management facility storages during the iterative assessment have been changed in 25 m^3 increments. To obtain pre-development peak flows for most return periods, resulting peak flows at the downstream end of the GID for the Clythe Creek system or the Eramosa River would be slightly over controlled. Reductions in storm water quantity control storage volumes would result in a lack of peak flow control within the various local drainage systems within the GID, as such, the slight over control of peak flows at the downstream limits of the GID is considered acceptable. Table 5.4.7 provides the future conditions peak flows with stormwater management and LID capture. Tables 5.4.8 and 5.4.9 present the difference in peak flows.

Table 5.4.7. Simulated Future Condition Peak Flows – With LIDS and End of Pipe SWMFs (m^3/s)

Flow Node	Description	Peak Flow (m^3/s) for Return Period (Years)						
		25 mm	2	5	10	25	50	100
J3	Eramosa River at Victoria Road South	1.34	2.18	5.46	10.07	15.73	20.51	25.41
J_ER10	Eramosa River and Clythe Creek Confluence	1.07	1.86	4.55	8.23	13.12	17.32	21.81
J4	Eramosa River upstream of the Clythe Creek Confluence	0.30	0.51	2.83	5.58	9.26	12.51	16.04
J6	Eramosa River adjacent to Cargill Meat Solutions Plant	0.20	0.52	3.30	5.93	9.27	12.33	15.56
J5	Eramosa River north of Stone Rd. E.	0.44	0.94	2.76	5.38	9.02	12.12	15.54
J_ER02	Eramosa River south of Stone Rd. E. and upstream of Torrance Creek Confluence	0.21	0.38	0.99	1.85	2.94	3.91	5.26
J_TC05	Torrance Creek south of Stone Rd. E. and upstream Confluence with Eramosa River	0.25	0.43	0.83	1.70	2.93	4.15	5.56
J_NorthPond	Clythe Creek Tributary upstream of the North Pond	1.38	2.29	3.34	4.37	5.32	6.32	7.29
J_CC06	Clythe Creek Tributary upstream of the North Pond	0.03	0.05	0.53	0.97	1.40	1.69	1.96
OF12	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	0.19	0.30	1.23	2.30	3.55	4.54	6.25
J_CC16	Clythe Creek Tributary north of Stone Rd. and south of Watson Pkwy.	0.10	0.17	1.14	2.05	3.05	3.82	5.59
J_CC20	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	0.00	0.00	0.14	0.27	0.42	0.61	1.09

Table 5.4.8. Peak Flow Difference – Existing Condition vs. Future Condition with LIDs and End of Pipe SWMFs (m^3/s)

Flow Node	Description	Difference in Peak Flow (m^3/s) for Return Period (Years)						
		25 mm	2	5	10	25	50	100
J3	Eramosa River at Victoria Road South	-0.03	-0.22	-1.54	-2.02	-2.92	-4.04	-5.96
J_ER10	Eramosa River and Clythe Creek Confluence	-0.25	-0.61	-1.96	-2.72	-3.73	-4.91	-6.60
J4	Eramosa River upstream of the Clythe Creek Confluence	-1.19	-1.92	-1.04	-1.08	-1.61	-2.22	-2.94
J6	Eramosa River adjacent to Cargill Meat Solutions Plant	-0.32	-0.73	-0.46	-0.37	-0.59	-0.85	-1.04
J5	Eramosa River north of Stone Rd. E.	0.07	-0.03	-0.56	-0.58	-0.56	-0.63	-0.61
J_ER02	Eramosa River south of Stone Rd. E. and upstream of Torrance Creek Confluence	-0.18	-0.29	-0.21	-0.19	-0.16	-0.19	0.12
J_TC05	Torrance Creek south of Stone Rd. E. and upstream Confluence with Eramosa River	-0.04	-0.08	-0.36	-0.42	-0.49	-0.53	-0.53
J_NorthPond	Clythe Creek Tributary upstream of the North Pond	-0.24	-0.36	-0.46	-0.62	-0.74	-0.85	-0.94
J_CC06	Clythe Creek Tributary upstream of the North Pond	-0.06	-0.09	0.06	0.09	-0.02	-0.24	-0.48
OF12	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	0.03	0.04	0.40	0.31	-0.13	-0.71	-1.08
J_CC16	Clythe Creek Tributary north of Stone Rd. and south of Watson Pkwy.	-0.04	-0.04	0.44	0.38	-0.03	-0.56	-0.19
J_CC20	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	-0.34	-0.54	-0.64	-0.78	-1.29	-2.23	-3.27

Table 5.4.9. Percentage Difference – Existing Condition vs. Future Condition with LIDs and End of Pipe SWMFs (%)

Flow Node	Description	Relative Difference in Peak Flow (%) for Return Period (Years)						
		25 mm	2	5	10	25	50	100
J3	Eramosa River at Victoria Road South	-2	-9	-22	-17	-16	-16	-19
J_ER10	Eramosa River and Clythe Creek Confluence	-19	-25	-30	-25	-22	-22	-23
J4	Eramosa River upstream of the Clythe Creek Confluence	-80	-79	-27	-16	-15	-15	-15
J6	Eramosa River adjacent to Cargill eat Solutions Plant	-61	-59	-12	-6	-6	-6	-6
J5	Eramosa River north of Stone Rd. E.	19	-3	-17	-10	-6	-5	-4
J_ER02	Eramosa River south of Stone Rd. E. and upstream of Torrance Creek Confluence	-46	-43	-17	-9	-5	-5	2
J_TC05	Torrance Creek south of Stone Rd. E. and upstream Confluence with Eramosa River	-14	-16	-30	-20	-14	-11	-9
J_NorthPond	Clythe Creek Tributary upstream of the North Pond	-15	-13	-12	-12	-12	-12	-11
J_CC06	Clythe Creek Tributary upstream of the North Pond	-68	-64	13	10	-2	-12	-20
OF12	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	22	16	47	15	-4	-13	-15
J_CC16	Clythe Creek Tributary north of Stone Rd. and south of Watson Pkwy.	-27	-21	64	23	-1	-13	-3
J_CC20	Clythe Creek Tributary east of Dunlop Dr. and south of Watson Pkwy.	-100	-100	-82	-75	-75	-79	-75

5.4.2 Continuous Simulation

To assess annual water balance for existing, future and future with stormwater management and LID 27 mm capture, the previously developed PCSWMM modelling has been executed for a continuous hydrologic simulation. To conduct continuous simulation modelling a 50 year long-term climate data set has been used (1962-2011), as originally outlined in a September 17, 2013 technical memorandum to the City of Guelph. The following provides details of the 20 year long-term meteorological data set built from various sources:

- **Precipitation**
  - Complicated by the lack of hourly precipitation data – EC provides hourly rainfall only (i.e. non-winter – no hourly snowfall)
  - Daily snowfall data for local stations used (assumption of 10:1 ratio – 1 cm of snowfall = 1 mm of equivalent precipitation) and divided evenly over 24 hours
  - Multiple stations required to create a long-term dataset given gaps. Predominant stations used include:
    - Guelph OAC (1962-1973)
    - Guelph Arboretum (1975-1991)
    - Guelph Turfgrass (1993-2011)
  - Gap-filling applied closest station available; predominantly Waterloo Wellington Airport, however other local Guelph stations have been used where available as well as more distant stations (Fergus and Elora)
  - Resulting 50-year hourly precipitation dataset (1962-2011)
- **Temperature**
  - SWMM Climate file used for all other parameters, including temperature
  - Daily maximum and minimum temperatures required for climate file format (rather than hourly values); SWMM applies sinusoidal curve fit to estimate hourly values (required for snowmelt)
  - Data based off of same Guelph stations noted previously, with Waterloo Wellington Airport used as the predominant source for gap filling
  - Comparable 50-year dataset (1962-2011)
- **Evaporation**
  - Historic daily pan evaporation data available from a limited number of sites in Ontario
  - Base dataset from a number of stations; nearest station used when available
    - Guelph OAC (1962-1970)
    - Elora (1971-1983)
    - Waterloo Wellington Airport (1984-1995)
  - Other datasets used for gap filling as required (RBG, Blue Springs, Hornby)
  - No data available for any station for 1997 onwards (EC stopped collecting the data at that point) - "average day" approach employed for this period as well as any remaining missing periods – calculate average value for day of interest from available data
  - Evaporation assumed to be zero for winter period (December-March inclusive)
  - Resulting 50-year dataset (1962-2011)

- **Wind Speed**
  - Required for snowmelt calculations
  - Hourly data available; used to calculate daily average
  - Data applied using nearest available station:
    - Toronto Pearson (1962-1972)
    - Waterloo Wellington A (1972-2002)
    - Region of Waterloo A (2003-2006)
    - Guelph Turfgrass (2007-2011)
  - Other datasets used for gap filling as required (Toronto Pearson, Waterloo Wellington Airport, Hamilton Airport)
- **Snowmelt and Snowpack**
  - Default values generally applied for snowmelt values; site specific latitude\longitude and elevation values (used for sunrise\sunset calculations for the sinusoidal temperature fit and atmospheric pressure corrections respectively)
  - Areal depletion (accounts for snowfall accumulating\melting unevenly over different terrain) – applied no depletion for impervious areas (assume would fall consistently) and default "natural areas" depletion for pervious areas
  - Two snowpack types employed; one based on 100% of impervious area being plowable (applied for subcatchments where imperviousness is primarily due to roadways) and another based on 50% (for areas where buildings are a contributing factor)
  - All other snowpack parameters identical; generally default melt values. Assumption that all plowed snow (impervious areas) would be directed to pervious land use segment. Assume no plowing until 5 mm of precipitation equivalent (5 cm of snowfall).

The 50 year PCSWMM continuous simulation model has been executed to determine water balance conditions for existing, future uncontrolled and future with stormwater management and LID 27 mm capture. The PCSWMM hydrologic modelling determines annual evaporation conditions using pan-evaporation and temperature data series sets. The evaporation does not include transpiration from vegetation, as such the transpiration is inherently included with infiltration, as the drainage that is infiltrated within the vegetation root zone would also be available for transpiration.

Baseflow within the PCSWMM hydrologic model has not been added for the various subwatersheds and catchment areas with various stormwater management control criteria, based on a lack of flow data and no scope to assess baseflow conditions. As such, Outflow represents any other overland runoff response, but does not include Baseflow.

Tables 5.4.10 to 5.4.14 provide the water balance summaries for each subwatershed area and subareas (i.e. Clythe Creek CL1 to CL3) representing future development areas with different stormwater management control criteria (ref. Drawing 3). The values in brackets in the tables represent the percentage difference to existing condition results. The 27 mm capture within LID from impervious surfaces in the PCSWMM hydrologic model has been applied to new development and in an effort to restore water balance conditions to pre-development, to existing development. The 27 mm capture for existing development could be applied as redevelopment occurs, allowing for gradual implementation of the LID 27 mm capture.

Based on a comparison of the existing, future land use conditions, and future with stormwater management and 27 mm capture on a subwatershed and subarea basis, the following has been determined:

- The Eramosa River infiltration/ transpiration are maintained close to existing conditions, with a reduction in outflow, resulting from increased evaporation, as such water balance conditions, have not changed considerably.
- The Torrance Creek subwatershed would experience a 6% reduction in infiltration/ transpiration, but evaporation would increase from 10.05 mm to 54.56 mm, in other words total losses would remain similar to existing conditions.
- Clythe Creek Sub-Area 1 (CL1) water balance conditions with SWM and 27 mm capture in LID would not considerably change from existing conditions.
- Clythe Creek Sub-Area 2 (CL2) water balance conditions would change considerably from existing conditions. Infiltration/ transpiration would increase 29% from 582 mm to 753 mm, which is considered more in line with the existing infiltration/ transpiration amounts from the other areas.
- Clythe Creek Sub-Area 3 (CL3) would experience a 5% reduction in infiltration/ transpiration, but evaporation would increase from 6.27 mm to 41.27 mm, in other words total losses would remain similar to existing conditions.

Table 5.4.10. Eramosa River Subwatershed Annual Water Balance Summary for Existing, Future and Future with SWM and LID (mm)

Land Use Condition	Precipitation	Infiltration/ Transpiration	Evaporation	Outflow
Existing	836.71	760.14	10.83	84.04
Future	836.71	438.28 (-42%)	44.31 (309%)	361.34 (330%)
Future with SWM and LID 27mm Capture	836.71	765.42 (1%)	47.93 (343%)	40.55 (-52%)

Table 5.4.11. Torrance Creek Subwatershed Annual Water Balance Summary for Existing, Future and Future with SWM and LID (mm)

Land Use Condition	Precipitation	Infiltration/ Transpiration	Evaporation	Outflow
Existing	836.71	800.75	10.05	52.33
Future	836.71	400.63 (-50%)	47.82 (376%)	408.90 (681%)
Future with SWM and LID 27mm Capture	836.71	755.30 (-6%)	54.56 (443%)	50.41 (-4%)

Table 5.4.12. Clythe Creek (Area CL1) Annual Water Balance Summary for Existing, Future and Future with SWM and LID (mm)

Land Use Condition	Precipitation	Infiltration/ Transpiration	Evaporation	Outflow
Existing	836.71	652.40	21.58	177.57
Future	836.71	564.77 (-13%)	30.52 (41%)	249.67 (41%)
Future with SWM and LID 27mm Capture	836.71	638.70 (-2%)	31.49 (46%)	181.99 (2%)

Table 5.4.13. Clythe Creek (Area CL2) Annual Water Balance Summary for Existing, Future and Future with SWM and LID (mm)

Land Use Condition	Precipitation	Infiltration/ Transpiration	Evaporation	Outflow
Existing	836.71	581.72	56.90	210.96
Future	836.71	245.96 (-58%)	87.36 (54%)	512.26 (143%)
Future with SWM and LID 27mm Capture	836.71	752.98 (29%)	95.62 (68%)	11.14 (-95%)

Table 5.4.14. Clythe Creek (Area CL3) Annual Water Balance Summary for Existing, Future and Future with SWM and LID (mm)

Land Use Condition	Precipitation	Infiltration/ Transpiration	Evaporation	Outflow
Existing	836.71	800.82	6.27	48.38
Future	836.71	496.99 (-38%)	37.70 (501%)	255.59 (428%)
Future with SWM and LID 27mm Capture	836.71	763.67 (-5%)	41.27 (558%)	46.13 (-5%)

5.4.3 Water Quality Assessment

The stormwater quality management strategy (which should result in an Enhanced Level of water quality treatment – 80% average annual TSS removal) is to provide a treatment train approach. Low impact development BMPs would provide 27 mm capture within both private and public lands (with suitable pre-treatment quality control measures), with the additional uncaptured runoff discharging to the required quantity control end-of -pipe stormwater management facilities.

The 27 mm capture would be provided within LID BMPs that are approved by the City of Guelph for both private and public lands. Low impact development BMPs receiving drainage from paved areas will require pre-treatment such as CB Sheilds™, oil/grit separators, primary treatment cells for underground infiltration systems, lined forebays for above ground bioretention systems and other forms of pre-treatment as required. Pre-treatment water quality measures receiving runoff from paved surfaces and in a treatment train, should be able to provide a minimum of 60 % TSS removal (former Normal Level of water quality treatment) prior to discharging to infiltrative LID BMPs. The combination of pre-treatment water quality measures, LID BMPs, and subsequent end of pipe measures should be able to meet or exceed an Enhanced Level of Water Quality Treatment of 80% TSS removal.

Additional assessment will be required at the next stages of study to determine both groundwater and bedrock elevations and the potential areas that may restrict the form of LID BMPs to be constructed. Groundwater and bedrock elevations would also be required to determine the appropriate base elevations for the design of the end-of-pipe stormwater quantity control facilities. The stormwater quality control strategy will necessarily need to be flexible in order to account for on-site constraints, while still remaining consistent with the specified approach and required quality control targets.

Stormwater quantity control facilities should be lined with an impermeable liner to prevent long-term groundwater contamination, as additional infiltration within the quantity control facilities would not be required. An alternative to this approach is to line a forebay where most of the remaining sediments from the drainage that has been treated at and Enhanced Level would settle out, prior to discharging to the main cell that would not be lined. This approach has been used by the City of Kitchener, which also uses winter bypasses of the main unlined cell during winter months, to prevent salt laden water from entering the groundwater system. Winter bypasses within end-of-pipe stormwater quantity controls allow salt laden runoff to be redirected to watercourses instead of groundwater.

To control salt laden runoff from entering groundwater during the winter months, the City could consider bypasses of infiltrative LID BMPs that receive drainage from paved surfaces. The bypass systems are used on other infrastructure within southern Ontario. The City of Toronto requires automated bypass systems on new splash pads, which divert drainage away from the wastewater system, during rainfall events and during non-operational periods. Similar bypass systems could be applied to underground infiltrative LID BMPs. For above ground infiltrative LID BMPs that would receive drainage from paved surfaces, pretreatment water quality measures should already be in place, that said salt cannot be removed once in solution, as such above ground infiltrative LID BMPs, could be designed with winter bypasses (e.g. gated bioretention systems used in Kitchener).

Overall, the best approach to minimizing salt concentrations in stormwater is to reduce the amount of salt applied to road surfaces at the outset. Such a broader salt management program is however beyond the scope of the current study.

Other stormwater quality improvements that could be considered within the GID include the following:

i. Retrofit the existing Watson Industrial stormwater management facility #38 to include a permanent pool as per a wet pond (would have to be assessed as part of the ongoing Stormwater Management Master Plan Update.
ii. Storm sewer system at Cargill using oil/grit separators and/or CB Shields™ (would require City to discuss with Cargill, or to be implemented as part of property redevelopment or improvements.
iii. Retrofit existing catch basins on public lands with CB Shields™ or equivalent.

6.0 York Road and Clythe Creek Rehabilitation

Within the Guelph Innovation District there is an opportunity to improve Clythe Creek as per the recommendations of the Environmental Impact Report for the York Road Environmental Design Study (YREDS), August 2019. The YREDS has assessed improvements to Clythe Creek in the context of the recommended widening of York Road. To accommodate the proposed York Road widening, the YREDS recommends that Clythe Creek be realigned into a new channel from immediately downstream of the York Road crossing to the driveway to the former Reformatory. The realigned new channel would have a connection to the existing channel with cultural heritage features during storm events of a 2 year frequency or greater. West of the driveway proposed grading works would provide a natural form to the channel while maintaining the location of the channel and minimizing the impact to cultural heritage features. A realigned connection to the Eramosa River would provide improved sinuosity and maintain a connection to the existing natural heritage system, while improving the thermal regime, by no longer flowing through the online pond system.

The YREDs also provides direction on stormwater management for the proposed road widening, consisting of both filtrative and infiltrative LID BMPs, CB Sheilds™ and oil/grit separators. York Road currently drains directly to Clythe Creek and will continue to drain to the creek, once widened. It has been recommended that treated drainage will discharge to the existing creek upstream or east of the former Reformatory driveway to provide intermittent flow within the existing creek.

7.0 Conclusions and Recommendations

7.1 Conclusions

The following conclusions have been developed:

i. A full background review of the GID drainage features, patterns and existing stormwater management has been conducted.
ii. Stormwater management objectives and policies have been established to mitigate the impacts of the proposed GID development and redevelopment.
iii. GID stormwater management will need to meet all City of Guelph policies including NHS and SWPP policies.
iv. Preliminary locations for stormwater management facilities have been determined.
v. Low Impact Development BMPs will be required to meet the GID water balance objectives and policies.
vi. Clythe Creek will be realigned and improved to facilitate the proposed York Road improvements.

7.2 Recommendations

The following recommendations have been made:

i. Preliminary locations for stormwater management facilities should be assessed within the Block Plan stage, using all relevant City policies and GRCA and provincial requirements.
ii. Opportunities to improve the water quality from the existing Watson Industrial stormwater management facility (facility No. 38) should be investigated. The existing facility does not have permanent pool and a permanent pool could be created within part or all of the facility. This would require further assessment within the update to the Stormwater Management Master Plan.
iii. Enhanced Level of water quality treatment (80% average annual TSS removal) within the GID should be provided using a treatment train approach consisting of pre-treatment measures and various LID BMPs that provide 27 mm capture, followed by end of pipe treatment as required.
iv. Annual water balance within the GID should be maintained (or improved in existing developed areas) through implementing 27 mm capture in infiltrative LID BMPs.
v. Stormwater quantity controls would include 27 mm of capture within LID BMPs and end of pipe stormwater quantity control facilities with recommended unitary storage volumes and release rates.
vi. Salt management measures would include temporary bypasses of infiltrative LID BMPs and lining and/or bypasses of quantity control facilities. Other broader City programs to better manage the application of road salt are beyond the scope of the current study.
vii. The City should consider easements for access, operation and maintenance of privately owned LID BMPs.

Respectfully submitted,

Wood Environment & Infrastructure Solutions
a Division of Wood Canada Limited

Per: Steve Chipps, P.Eng.
Senior Engineer

Per: Matt Senior, M.A.Sc., P.Eng.
Project Engineer

SC/kf

Appendix A

Photo Reconnaissance

Guelph Innovation District, Stormwater Management Study
Appendix 'A'

Victoria Road over the Eramosa River

Victoria Road over the Eramosa River

Haditi Creek confluence with Clythe Creek

Royal City Jaycees Park driveway over Clythe Creek

Haditi Creek confluence with Clythe Creek

Drop structure on Clythe Creek

Drop structure on Clythe Creek

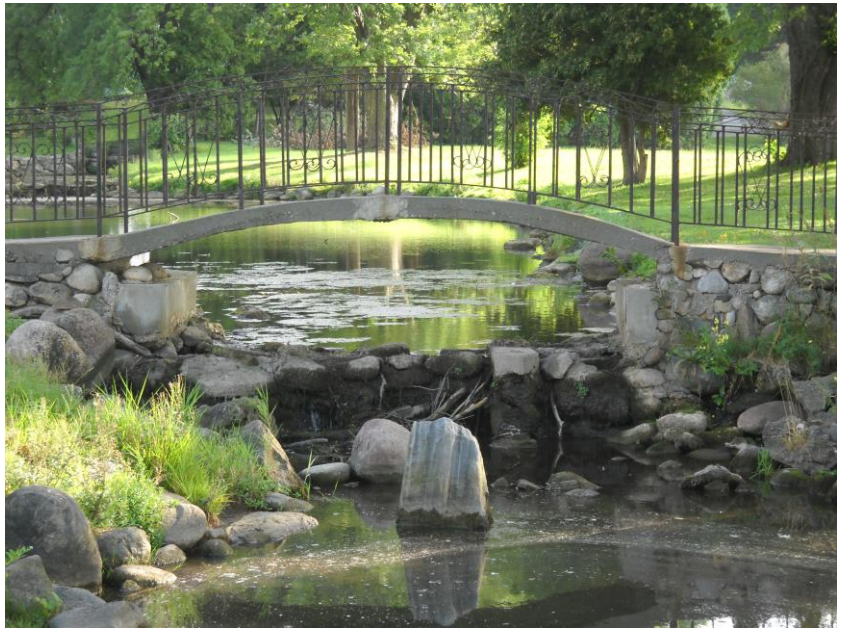
Clythe Creek upstream of park entrance

Pedestrian bridge over Clythe Creek

North and South ponds

York Road drainage outlet to Clythe Creek

North and South ponds



Pedestrian bridge and drop structure in Clythe Creek

Lined reach of Clythe Creek

Lined reach of Clythe Creek

Lined reach of Clythe Creek

Drop structure and driveway to Correctional Facility

Clythe Creek upstream of Correctional Facility entrance

Drop structure on Clythe Creek

Pond east of Correctional Facility driveway

Pond east of Correctional Facility driveway

Correctional Facility bridge over connection between east & west ponds

Unnamed Tributary to north pond in Royal City Jaycees Park

Unnamed Tributary to north pond in Royal City Jaycees Park

Unnamed Tributary to north pond in Royal City Jaycees Park

Clythe Creek next to York Road

York Road drainage outlet to Clythe Creek

Clythe Creek next to York Road

Clythe Creek next to York Road

Clythe Creek next to York Road

Clythe Creek under York Road

Watson Industrial SWM Facility No. 38

Watson Industrial SWM Facility No. 38 entrance to Cargill & Waste Resource Innovation Centre

Stone Road and Watson Parkway SWM Facility No. 96

SWM Facility No. 96 Outlet

Eramosa River at Stone Road

Eramosa River at Stone Road

Old Stone Road crossing of Eramosa River

Victoria Road and Stone Road SWM Facility No. 104

Victoria Road and Stone Road SWM Facility No. 104

Looking east from Correction Facility lands to Watson Parkway

Looking east from Correction Facility lands to Watson Parkway

Looking east from Correction Facility lands to Watson Parkway

Clythe Creek online pond

Bridge over Clythe Creek at Royal City Jaycees Park

Clythe Creek online pond

Channel around SWM Facility No 38

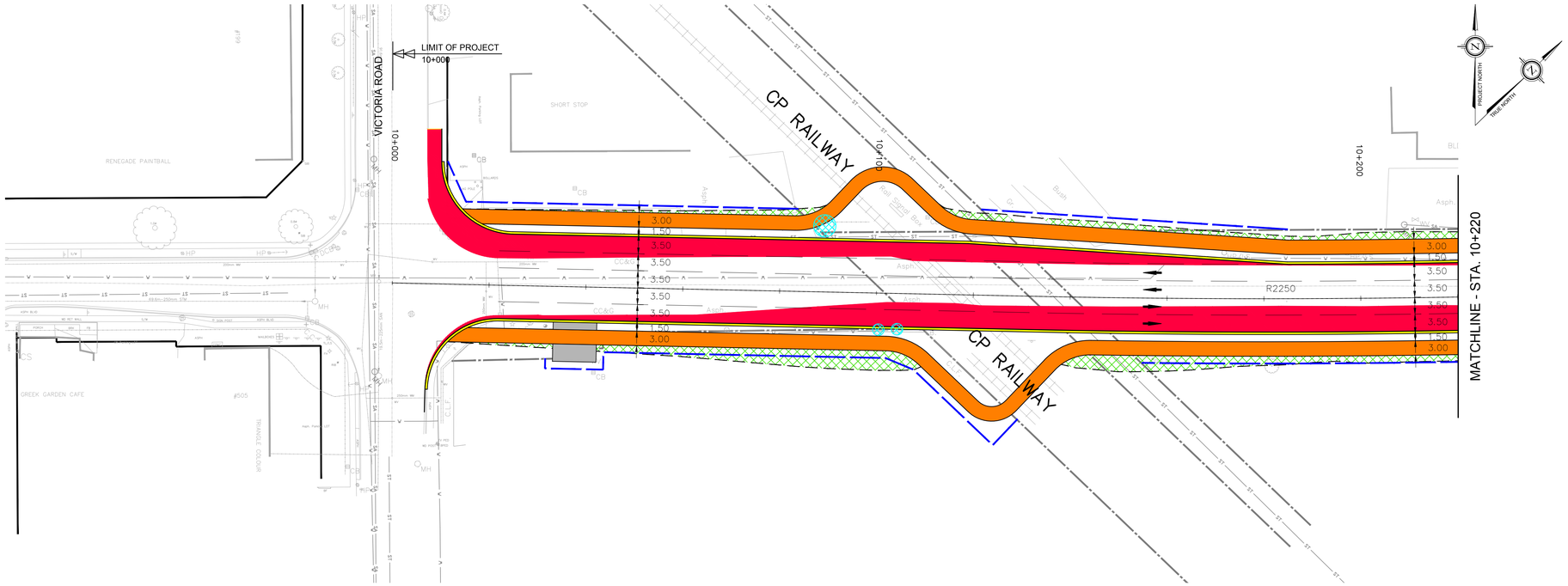
Channel around SWM Facility No 38

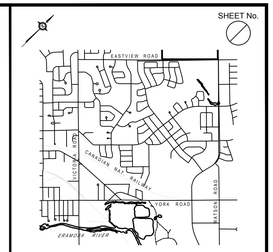
Channel adjacent to Watson Parkway south of Dunlop Drive

Dry pond adjacent to Waste Resource Innovation Centre

Appendix B

York Road Widening and Clythe Creek Realignment

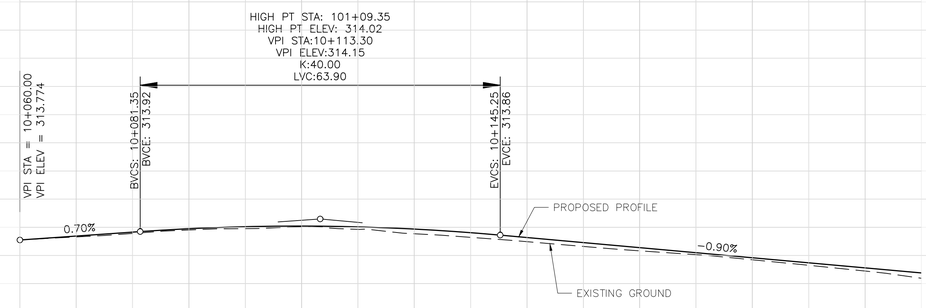




KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI–USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK
- PROPOSED BUS PAD



THE POSITION OF POLES, LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

CITY OF Guelph

ENGINEERING SERVICES

wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRE-LINE																		
PROP. GRADE																		
STORM SEWER																		
SANIT. SEWER																		
CHAINAGE						10+000	10+020	10+040	10+060	10+080	10+100	10+120	10+140	10+160	10+180	10+200	10+220	

EXISTING CENTRELINE

PROPOSED GRADE

STORM SEWER

SANITARY SEWER

CHAINAGE

SCALES: HOR: 1:500 VER: 1:50

DATE DRAWN: 2018-04-02

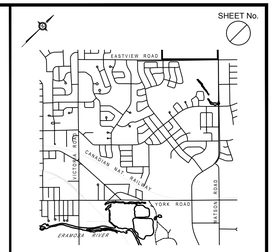
DRAWN BY: D.K. CHECKED BY: M.E.K.

CONSULTANT DRAWING No. ALT. 4

CITY CONTRACT No.

CITY REFERENCE No. SHEET 1 OF 9

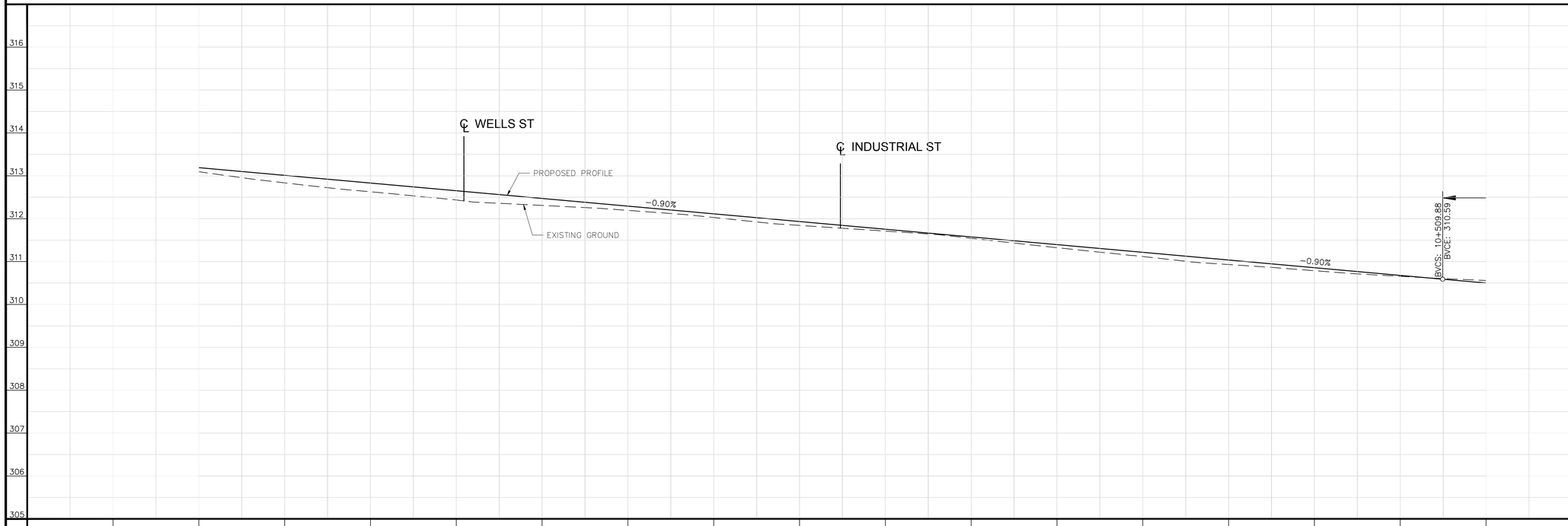
REV.



KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI–USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK
- PROPOSED BUS PAD



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No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

CITY OF Guelph

ENGINEERING SERVICES

wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE	
PROPOSED GRADE	
STORM SEWER	
SANITARY SEWER	
CHAINAGE	10+220, 10+240, 10+260, 10+280, 10+300, 10+320, 10+340, 10+360, 10+380, 10+400, 10+420, 10+440, 10+460, 10+480, 10+500, 10+520

SCALES: HOR: 1:500 VER: 1:50

DATE DRAWN: 2018-04-02

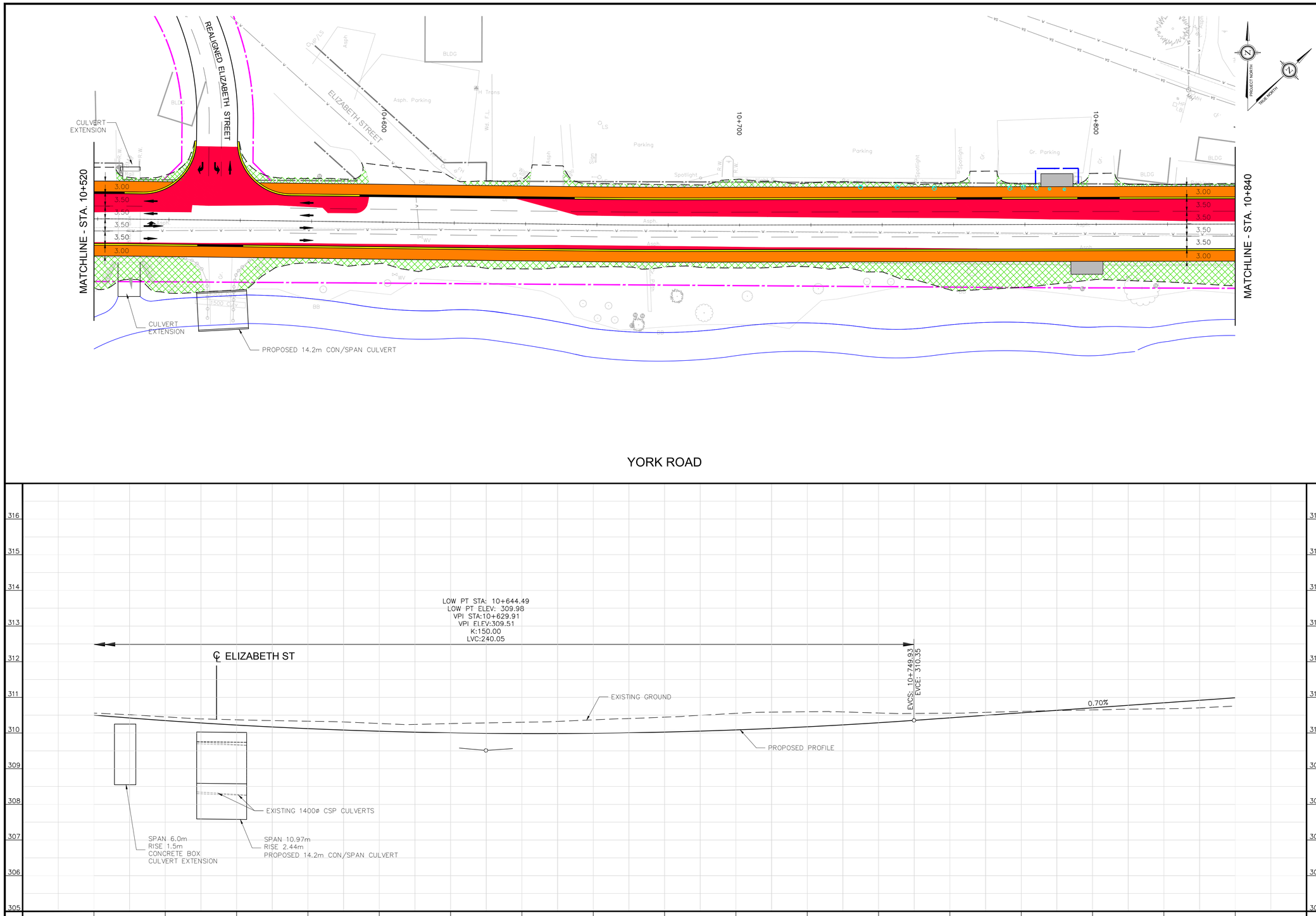
DRAWN BY: D.K. CHECKED BY: M.E.K.

CONSULTANT DRAWING No. ALT. 4

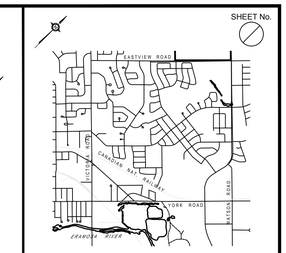
CITY CONTRACT No.

CITY REFERENCE No. SHEET 2 OF 9

REV.



SHEET No.



KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI–USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK
- PROPOSED BUS PAD

THE POSITION OF POLES, LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

CITY OF Guelph

ENGINEERING SERVICES

wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE

PROPOSED GRADE

STORM SEWER

SANITARY SEWER

CHAINAGE

SCALES: HOR: 1:500 VER: 1:50

DATE DRAWN: 2018-04-02

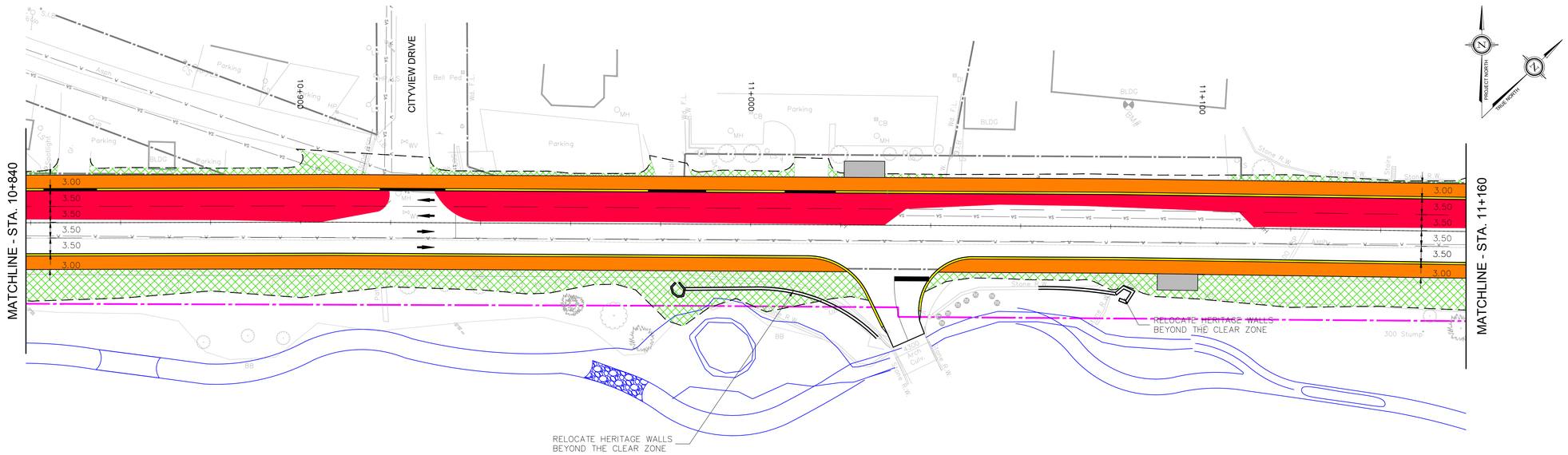
DRAWN BY: D.K. CHECKED BY: M.E.K.

CONSULTANT DRAWING No. ALT. 4

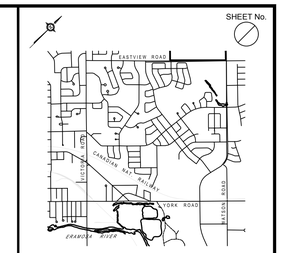
CITY CONTRACT No.

CITY REFERENCE No. SHEET 3 OF 9

REV.



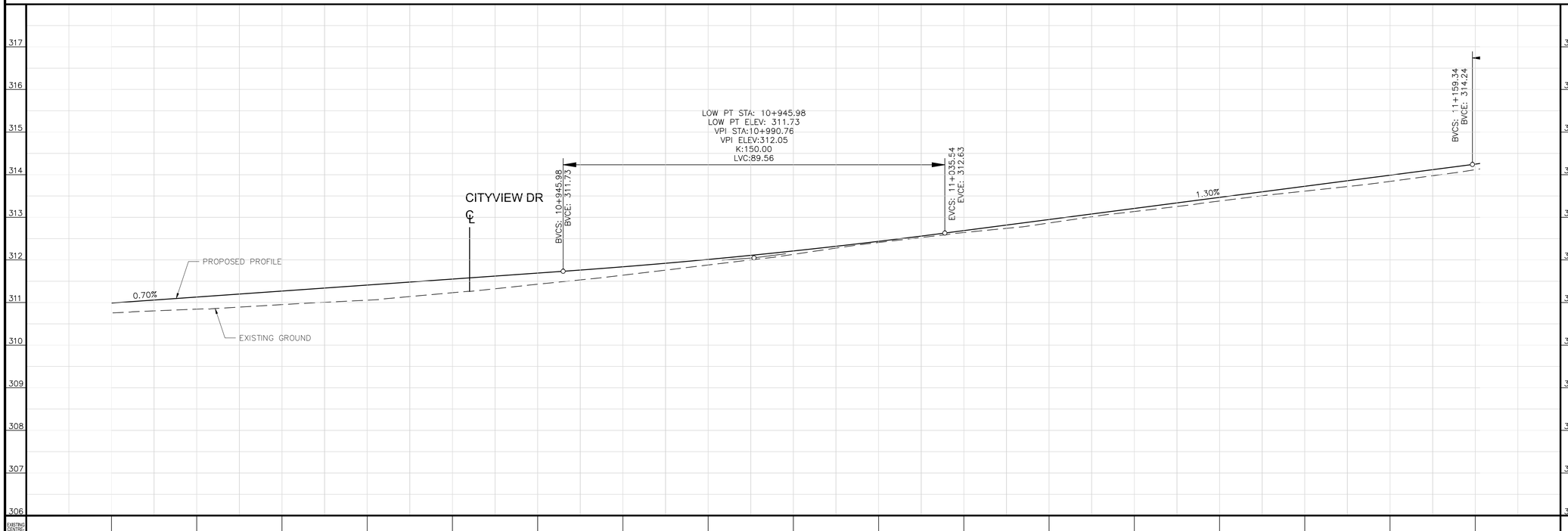
YORK ROAD



KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI–USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK
- PROPOSED BUS PAD



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No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

CITY OF Guelph

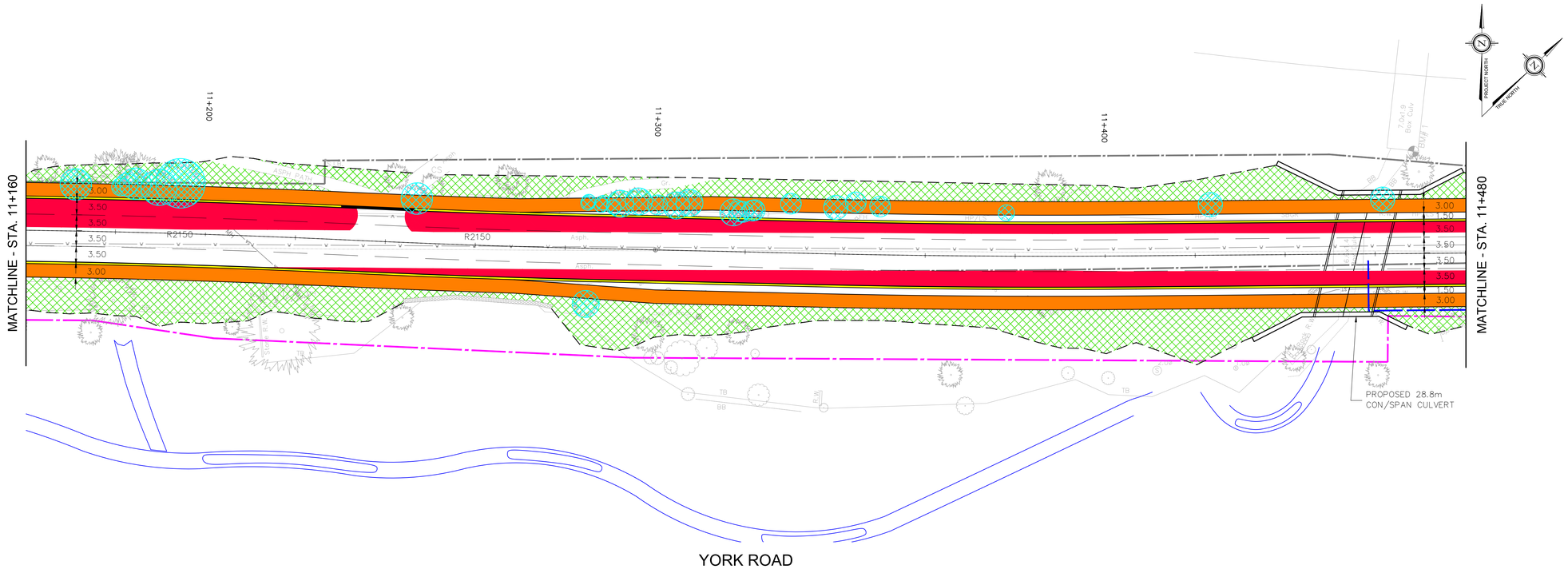
ENGINEERING SERVICES

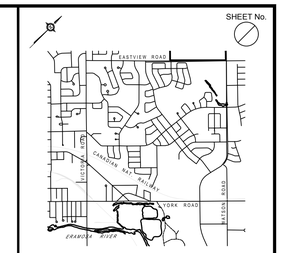
wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRE-LINE																			
PROP. GRADE																			
STORM SEWER																			
SANIT. SEWER																			
CHAINAGE	10+840	10+860	10+880	10+900	10+920	10+940	10+960	10+980	11+000	11+020	11+040	11+060	11+080	11+100	11+120	11+140	11+160		

EXISTING CENTRELINE	SCALES: HOR: 1:500 VER: 1:50
PROPOSED GRADE	DATE DRAWN: 2018-04-02
STORM SEWER	DRAWN BY: D.K. / CHECKED BY: M.E.K.
SANITARY SEWER	CONSULTANT DRAWING No. ALT. 4 / CITY CONTRACT No.
CHAINAGE	CITY REFERENCE No. SHEET 4 OF 9 / REV.

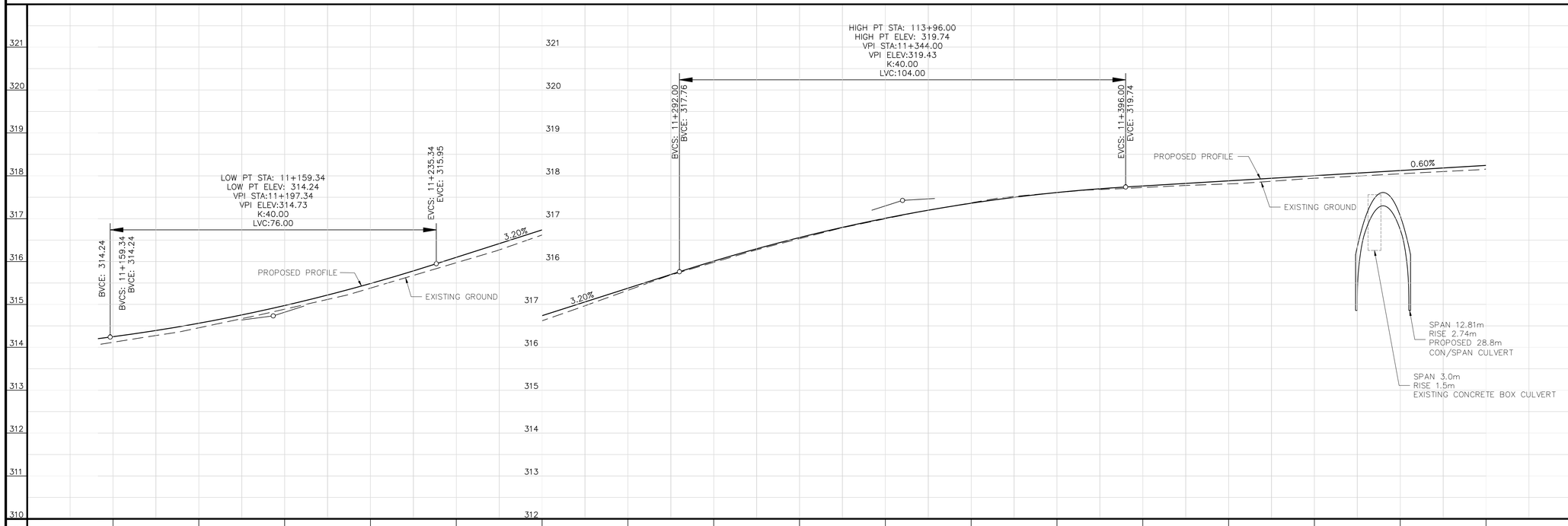




KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI–USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK
- PROPOSED BUS PAD



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No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

CITY OF Guelph

ENGINEERING SERVICES

wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRE-LINE																					
PROP. GRADE																					
STORM SEWER																					
SANIT. SEWER																					
CHAINAGE	11+160	11+180	11+200	11+220	11+240	11+260	11+280	11+300	11+320	11+340	11+360	11+380	11+400	11+420	11+440	11+460	11+480				

EXISTING CENTRELINE

PROPOSED GRADE

STORM SEWER

SANITARY SEWER

CHAINAGE

SCALES: HOR: 1:500 VER: 1:50

DATE DRAWN: 2018-04-02

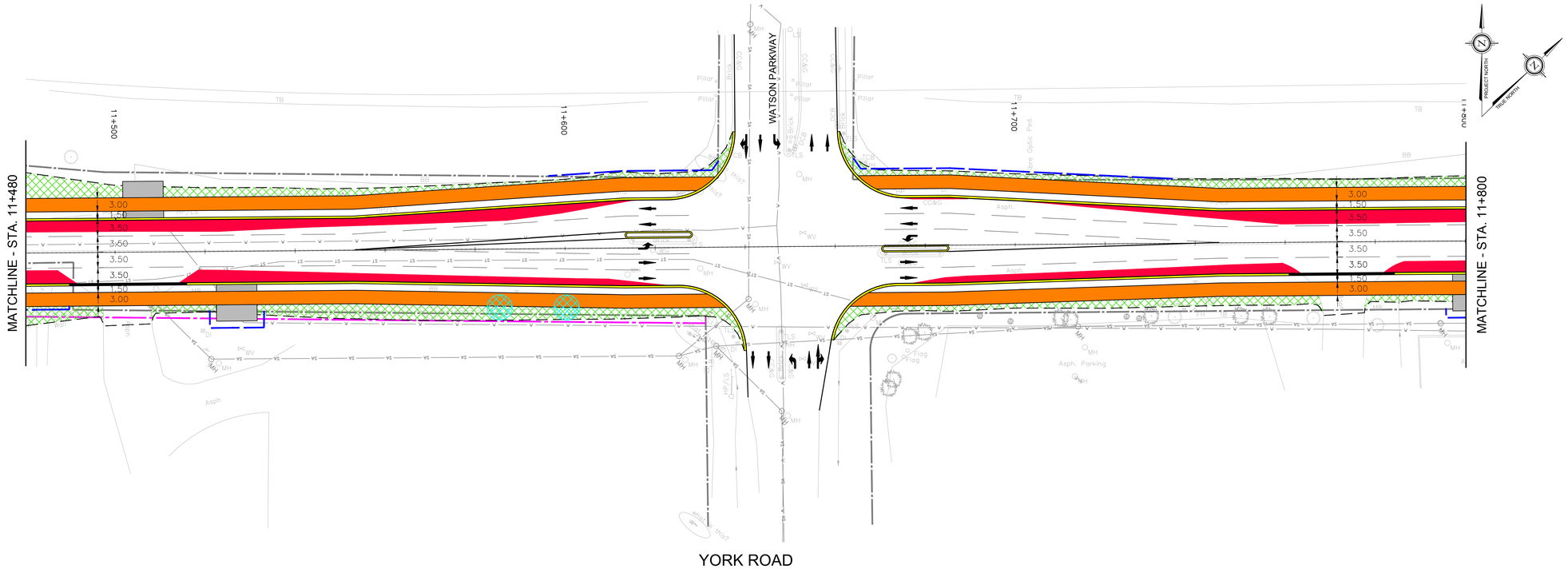
DRAWN BY: D.K. CHECKED BY: M.E.K.

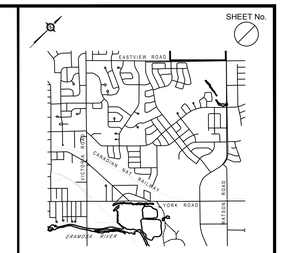
CONSULTANT DRAWING No. ALT. 4

CITY CONTRACT No.

CITY REFERENCE No. SHEET 5 OF 9

REV.

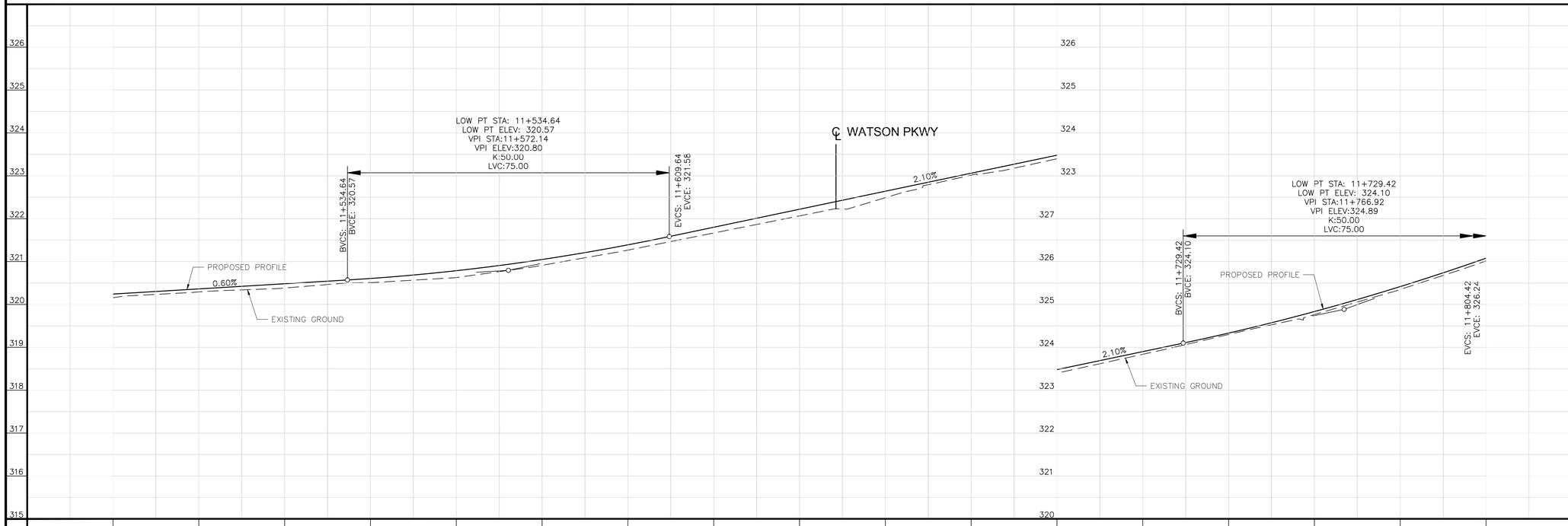




KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI–USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK
- PROPOSED BUS PAD



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No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

CITY OF Guelph

ENGINEERING SERVICES

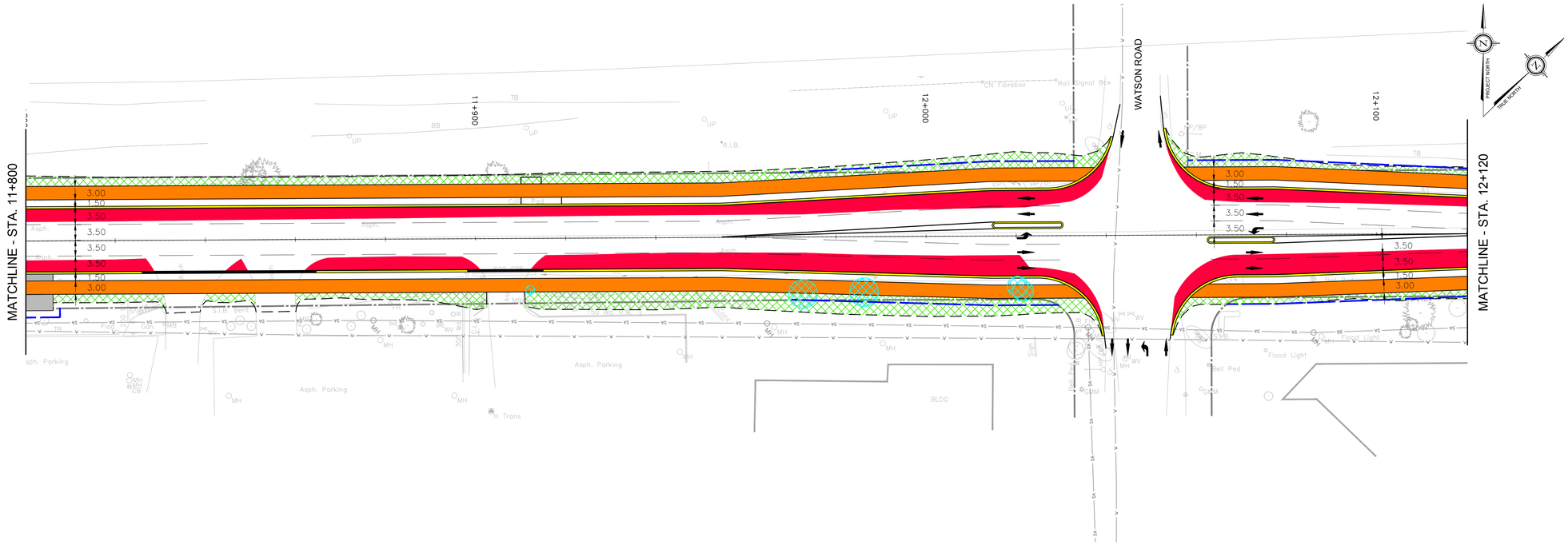
wood.

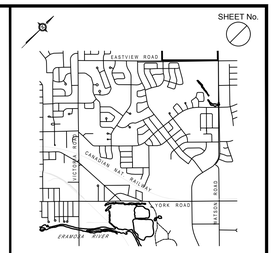
YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE	SCALES: HOR: 1:500 VER: 1:50
PROPOSED GRADE	DATE DRAWN: 2018-04-02
STORM SEWER	DRAWN BY: D.K. / CHECKED BY: M.E.K.
SANITARY SEWER	CONSULTANT DRAWING No. ALT. 4
CHAINAGE	CITY CONTRACT No.
	CITY REFERENCE No. SHEET 6 OF 9 / REV.

EXISTING CENTRE-LINE | PROP. GRADE | STORM SEWER | SANIT. SEWER | CHAINAGE

11+480 11+500 11+520 11+540 11+560 11+580 11+600 11+620 11+640 11+660 11+680 11+700 11+720 11+740 11+760 11+780 11+800

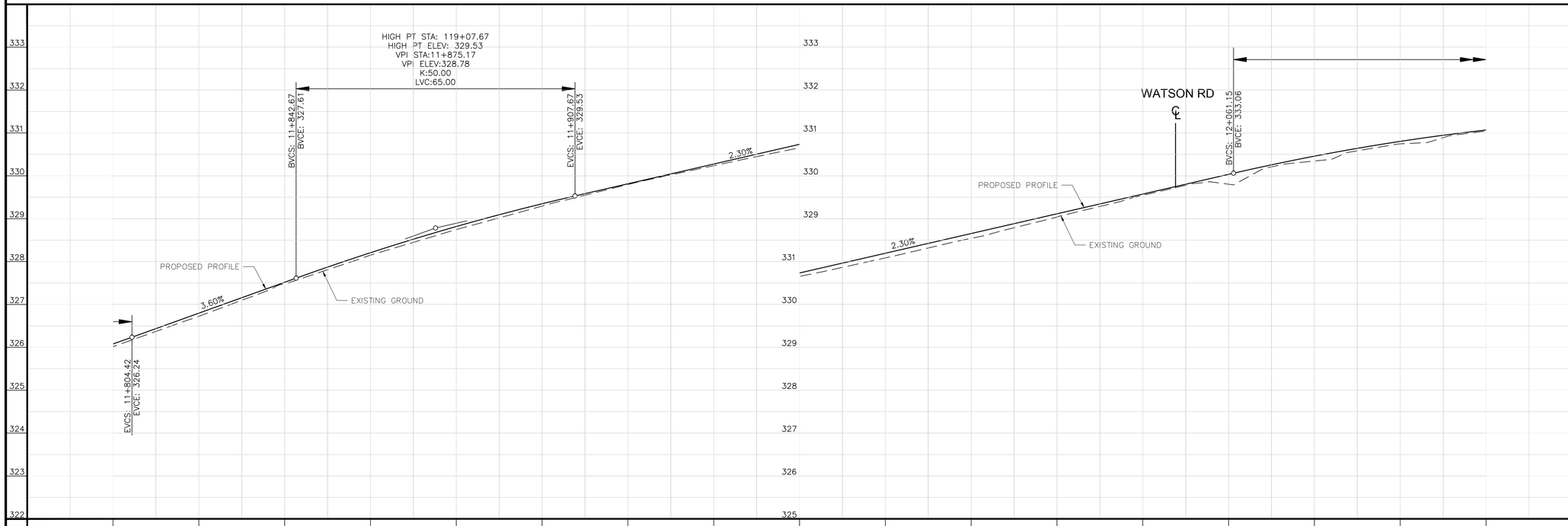




KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI–USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK
- PROPOSED BUS PAD



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No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

CITY OF Guelph

ENGINEERING SERVICES

wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE	
PROPOSED GRADE	
STORM SEWER	
SANITARY SEWER	
CHAINAGE	11+800, 11+820, 11+840, 11+860, 11+880, 11+900, 11+920, 11+940, 11+960, 11+980, 12+000, 12+020, 12+040, 12+060, 12+080, 12+100, 12+120

SCALES: HOR: 1:500 VER: 1:50

DATE DRAWN: 2018-04-02

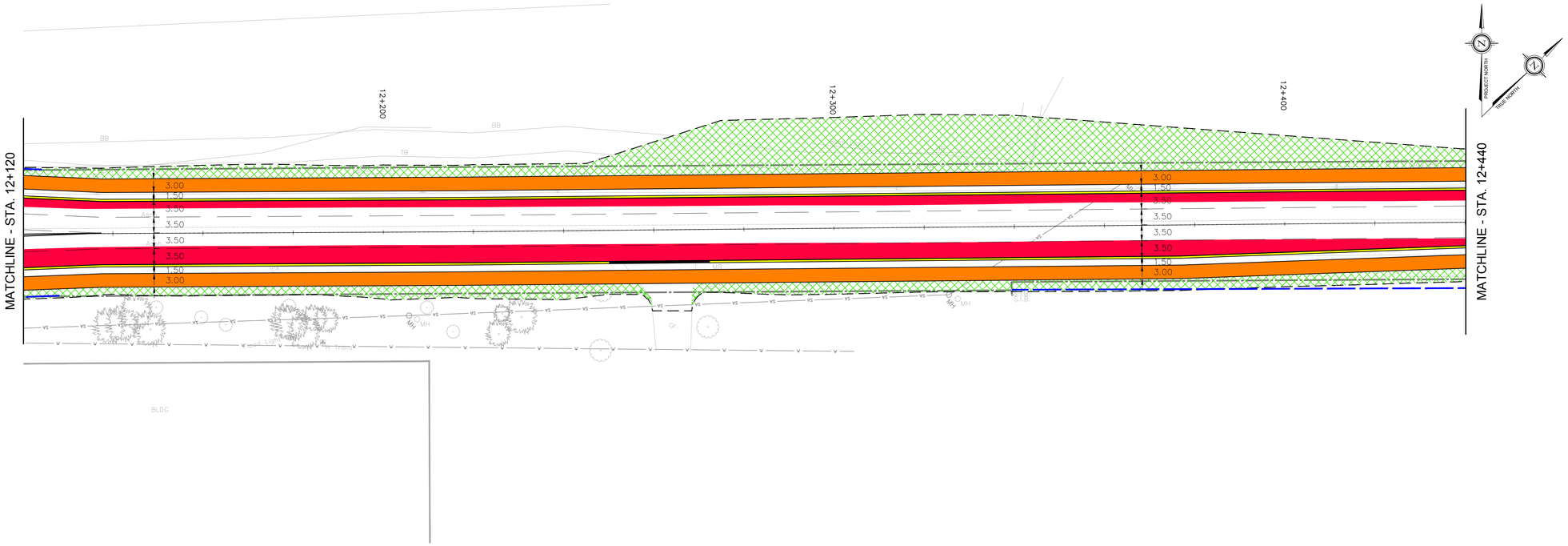
DRAWN BY: D.K. CHECKED BY: M.E.K.

CONSULTANT DRAWING No. ALT. 4

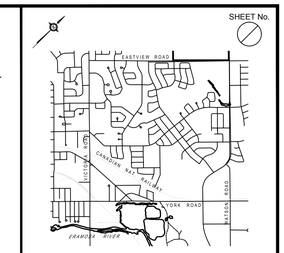
CITY CONTRACT No.

CITY REFERENCE No. SHEET 7 OF 9

REV.



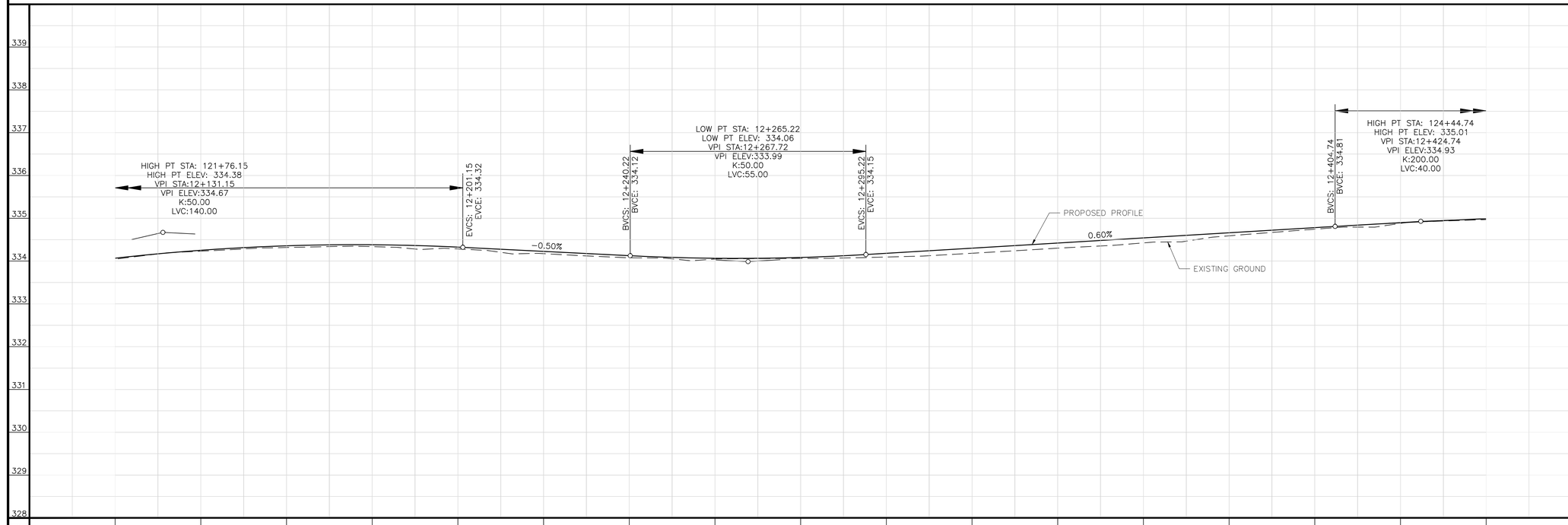
YORK ROAD



KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI–USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
- REALIGNED CREEK
- PROPOSED BUS PAD



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No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

CITY OF Guelph

ENGINEERING SERVICES

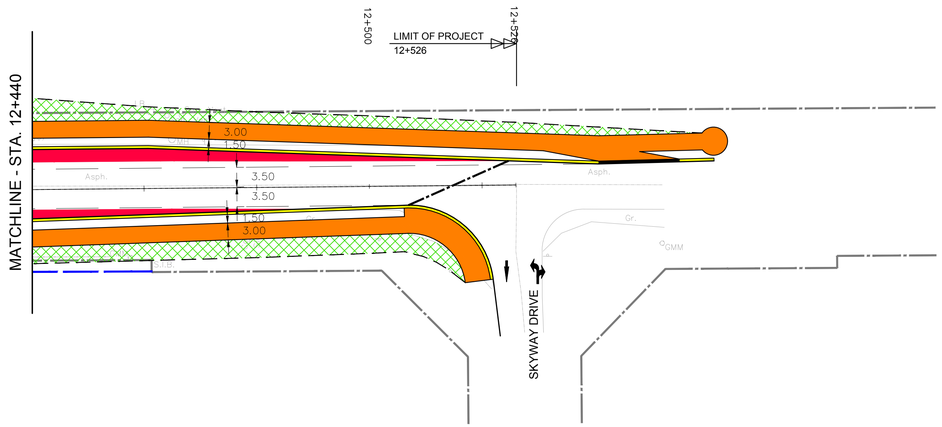
wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

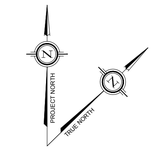
EXISTING CENTRE-LINE	
PROP. GRADE	
STORM SEWER	
SANIT. SEWER	
CHAINAGE	12+120, 12+140, 12+160, 12+180, 12+200, 12+220, 12+240, 12+260, 12+280, 12+300, 12+320, 12+340, 12+360, 12+380, 12+400, 12+420, 12+440

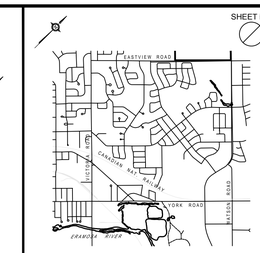
EXISTING CENTRELINE
PROPOSED GRADE
STORM SEWER
SANITARY SEWER
CHAINAGE

SCALES: HOR: 1:500 VER: 1:50
DATE DRAWN: 2018-04-02
DRAWN BY: D.K.
CHECKED BY: M.E.K.
CONSULTANT DRAWING No. ALT. 4
CITY CONTRACT No.
CITY REFERENCE No. SHEET 8 OF 9
REV.



YORK ROAD





SHEET No.

KEY PLAN Scale : NOT TO SCALE

LEGEND

- EXISTING PROPERTY LIMIT
- CLASS EA PROPOSED PROPERTY LIMIT
- EIS–PROPOSED PROPERTY LIMITS
- PROPOSED CURB
- PROPOSED GRADE SLOPE
- PROPOSED PAVEMENT WIDENING
- PROPOSED MULTI–USE PATH
- PROPOSED TREE REMOVAL
- GRADING LINE
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No.	DATE	DESCRIPTION	BY:	CHKD.

ISSUES/REVISIONS

CITY OF Guelph

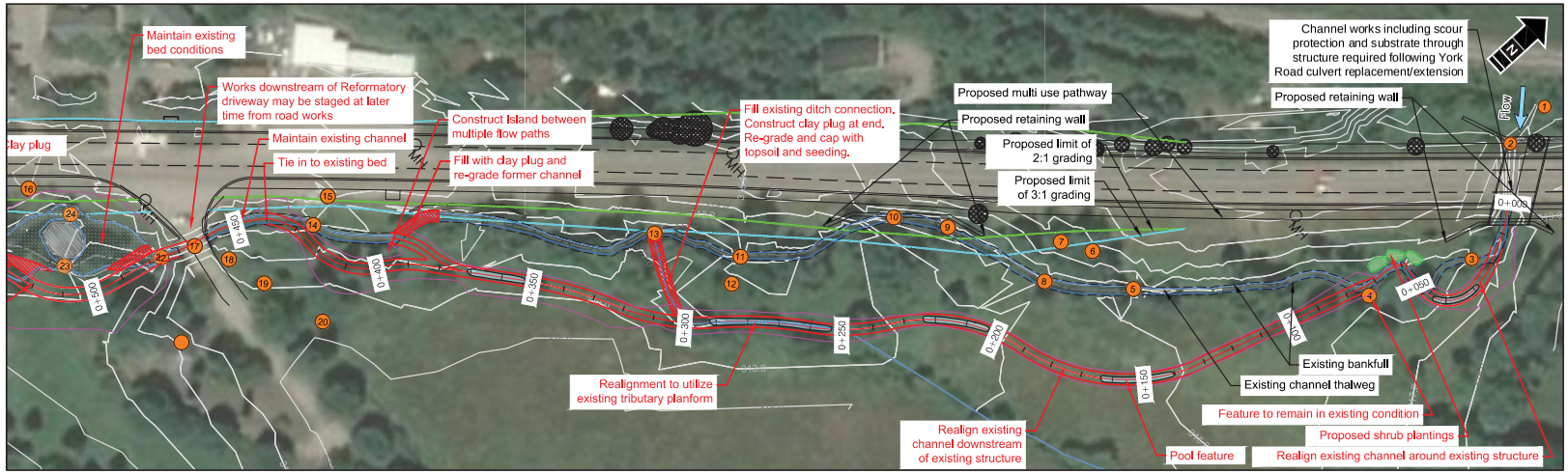
ENGINEERING SERVICES

wood.

YORK ROAD ENVIRONMENTAL DESIGN STUDY

EXISTING CENTRELINE	SCALES: HOR: 1:500 VER: 1:50	
PROPOSED GRADE	DATE DRAWN: 2018-04-02	
STORM SEWER	DRAWN BY: D.K.	CHECKED BY: M.E.K.
SANITARY SEWER	CONSULTANT DRAWING No. ALT. 4	
	CITY CONTRACT No.	
CHAINAGE	CITY REFERENCE No. SHEET 9 OF 9	REV.

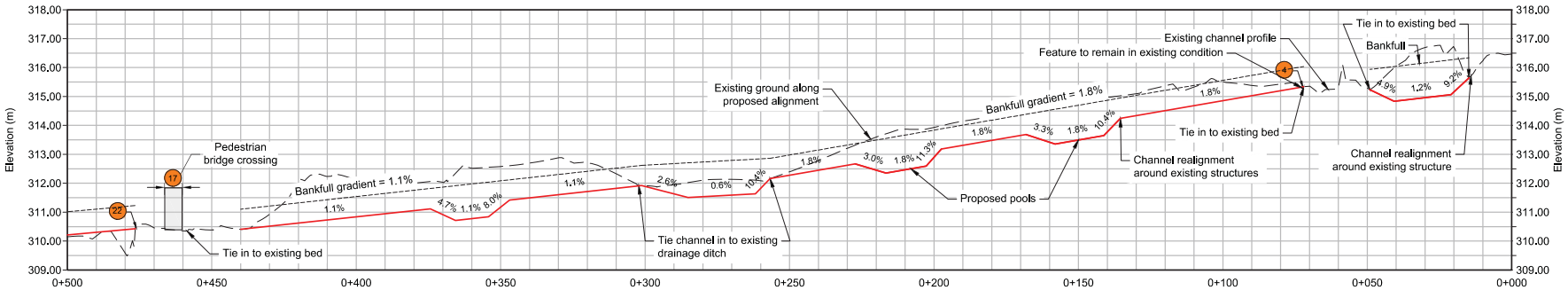
EXISTING CENTRE-LINE																			
PROP. GRADE																			
STORM SEWER																			
SANIT. SEWER																			
CHAINAGE	12+440	12+460	12+480	12+500	12+520	12+526													



1:1500 Meters
15 0 15 30
Datum

Legend
Surveyed edge of water
Surveyed bankfull
Toe of 2:1 road grading
Toe of 3:1 road grading
Proposed realignment
Proposed fill/bank treatment
Proposed shrubs and plantings
Cultural heritage feature/structure
Maintain existing bed
Proposed pool
Approximate grading limit

Notes:
1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
6. Bank treatments to be confirmed in detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

REVISION					
04	11 22 2017	Revised design based on updated road grading	JH	JP	ED
03	03 08 2017	Revised based on client comments	JH	JP	ED
02	01 17 2017	Revised based on client comments	JH	JP	ED
01	12 09 2016	Revised based on client comments	JH	JP	ED
00	09 15 2016	Draft for client review	JH	JP	ED
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

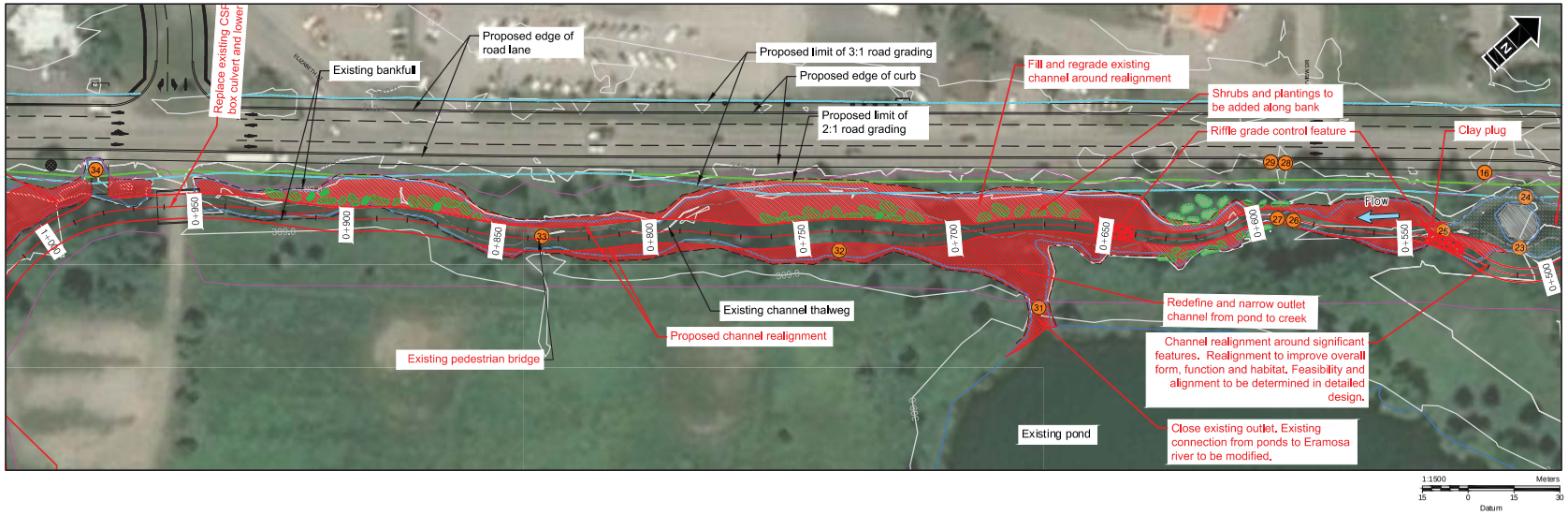
AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 0+000-0+500m

Date:	Project:	Technical:	Reviewer:	Drawn:
11 22 2017	22257 York Road	J. Henshaw	J. Parish	E. Drost

Figure 04

N:\PROJECTS\22257 - York Road Guelph\145912 - AMEC - York Road Environmental Design Study\03 Data\CAD\Matrix CAD\22257 York Road - Concept Option 2_11-21-2017.dwg , Option 2 (R4) - Thursday, November 23, 2017 1:13:19 PM - Eric Drost
Plot 1:1 = Tabloid (L)



Legend	
	Surveyed edge of water
	Surveyed bankfull
	Toe of 2:1 road grading
	Toe of 3:1 road grading
	Proposed realignment
	Proposed fill/bank treatment
	Proposed shrubs and plantings
	Cultural heritage feature/structure
	Maintain existing bed
	Proposed pool
	Approximate grading limit

Notes:

1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air imagery provided by others.
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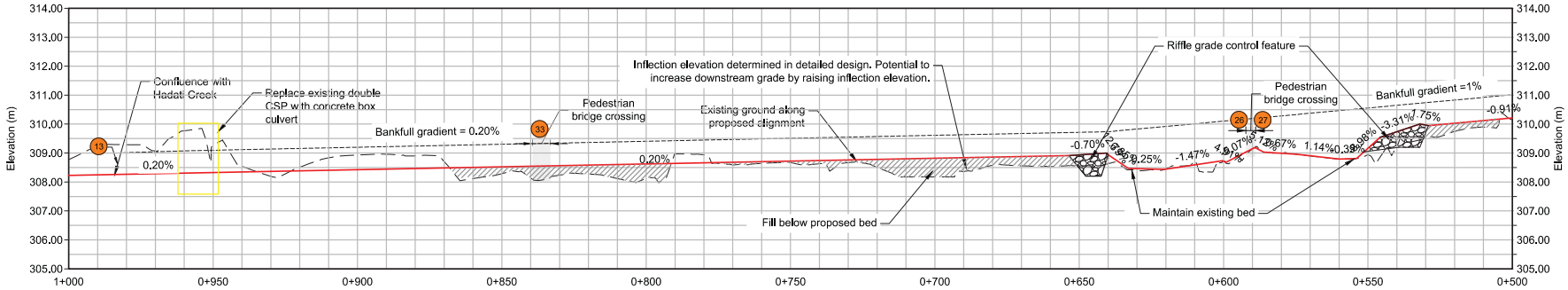
6. Bank treatments to be confirmed in detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

REVISION					
04	11 22 2017	Revised design based on updated road grading	JH	JP	ED
03	03 08 2017	Revised based on client comments	JH	JP	ED
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No.	DATE	DESCRIPTION	BY	CHK.	DRN.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 0+500-1+000m

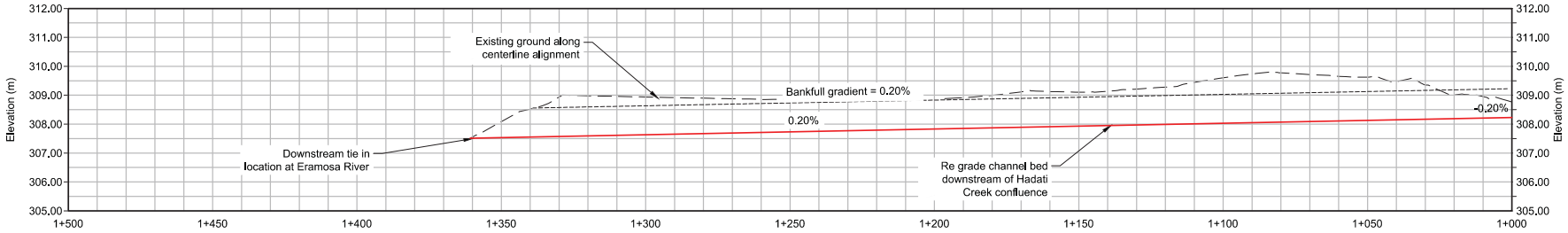
Date:	Project:	Technical:	Reviewer:	Drawn:
11 22 2017	22257 York Road	J. Henshaw	J. Parish	E. Drost

Figure 05

Legend	
	Surveyed edge of water
	Surveyed bankfull
	Toe of 2:1 road grading
	Toe of 3:1 road grading
	Proposed realignment
	Proposed fill/bank treatment
2	Cultural heritage feature/structure
	Approximate grading limit

Notes:

1. Channel survey completed by Matrix Solutions Inc. on May 2, 3, and 5, 2016.
2. Road and property survey completed by others.
3. Air imagery provided by others.
4. Features displayed are in UTM Nad 83 Zone 17 coordinate system.
5. Heritage feature location and information provided by others.
6. Bank treatments to be confirmed in detailed design.



Channel Profile
Horizontal Scale 1:1500
Vertical Scale 1:150

REVISION					
04	11 22 2017	Revised design based on updated road grading	JH	JP	ED
03	03 08 2017	Revised based on client comments	JH	JP	ED
02	01 17 2017	Revised based on client comments	JH	JP	ED
01	12 09 2016	Revised based on client comments	JH	JP	ED
00	09 15 2016	Draft for client review	JH	JP	ED
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

AMEC Foster Wheeler
York Road Widening

York Road Improvements
Clythe Creek - Road Widening Option 2
Preliminary Plan and Profile 1+000-1+500m

Date:	Project:	Technical:	Reviewer:	Drawn:
11 22 2017	22257 York Road	J. Henshaw	J. Parish	E. Drost

Figure 06