FUNCTIONAL SERVICING & STORMWATER MANAGEMENT REPORT

CONFIDENTIAL

NORTHFIELD PROPERTIES LP

525-565 Conestogo Road, Waterloo
Project No.: 2019-0654-10

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1.0 INTRODUCTION

WalterFedy Inc. has been retained by Northfield Properties LP to provide civil engineering consulting services in support of an Official Plan and Zoning By-law Amendment and Draft Plan of Subdivision for the lands with municipal addresses of 525-565 Conestogo Road in Waterloo.

The purpose of this functional servicing and stormwater management report is to identify how the development will be serviced, including water, sanitary, and storm connections to the existing municipal infrastructure. The report will discuss existing boundary servicing conditions and the availability in the municipal system to accommodate the development. Preliminary stormwater management design has been included, demonstrating consistency with the City of Waterloo and Region of Waterloo design criteria.

1.1 Background

The 10.54-hectare site is located in Waterloo, Ontario, at the southeastern corner of the Northfield Drive and Conestoga Parkway interchanges. The site is bound by Northfield Drive West to the north, Conestoga Parkway to the west, Conestogo Road to the east, and an existing industrial property to the south. The entrance to the site is off of Conestogo Road. The site is currently zoned as "Future Determination," and a zone change application will be required to permit the uses of the proposed development.

The subject Site is the former home of Kraus Carpets and Flooring, a manufacturing facility for carpets and flooring material. The factory was shut down in 2019 and the Site is currently unoccupied except for limited warehousing uses. The Site is split into two parts by a utility corridor. Approximately two-thirds of the site area is located north of this utility corridor. This area contains the main manufacturing facility and associated parking and loading areas around the periphery. South of the utility corridor is an additional building and asphalt areas, with undeveloped lands further to the south.

The development concept for the Site envisions a mix of residential, office and retail uses spread across eight blocks. The development is expected to consist a mix of densities to support approximately 2177 residential units and approximately 850,000 ft^2 of office and retail space, and its associated parking and amenity spaces.

Additionally, the development is expected to convert an existing utility corridor into landscape and amenity space, providing pedestrian connectivity to Northfield Drive, Conestogo Road and the ION Light Rail Transit (LRT) system. As part of this network, a pedestrian bridge is proposed over abutting Conestoga Parkway for direct connectivity to the Northfield Drive LRT station.

1.2 Reference Reports and Drawings

In the preparation of this functional servicing and stormwater management report, the following reports/drawings were referenced:

1. Plan, Profile, Storm, Sanitary and Watermain Information from the City of Waterloo and Region of Waterloo.

2. Utility mapping information obtained from Waterloo North Hydro and ON1Call.

3. *City of Waterloo Sanitary Master Plan Volume 1,* by Stantec Consulting Ltd., dated August 2015.

4. *Phase I Environmental Site Assessment, 65 Northfield Drive West, Waterloo, Ontario,* by Trow Associates Inc., dated February 28, 2007.

5. *Draft Phase I Environmental Site Assessment, 65 Northfield Drive West, Waterloo, Ontario,* by exp Services Inc., dated February 8, 2012.

6. *Phase II Environmental Site Assessment, 65 Northfield Drive West, Waterloo, Ontario,* by S2S Environmental Inc., dated July 29, 2013.

7. *Phase I Conceptual Site Model, 65 Northfield Drive West, Waterloo, Ontario,* by S2S Environmental Inc., dated December 15, 2015.

8. *Phase Two Conceptual Site Model, 65 Northfield Drive West, Waterloo, Ontario,* by S2S Environmental Inc., dated February 7, 2020.

9. *525-564 Conestogo Road, Waterloo, Transportation Impact Study and Transportation Demand Management Report,* by Paradigm Transportation Solutions Limited, dated August 2020.

10. *Kraus Flooring Property, 525-565 Conestoga Road, Waterloo, Scoped Environmental Impact Study,* by Natural Resource Solutions Inc., dated August 14, 2020.

2.0 EXISTING INFORMATION

2.1 Existing Topography and Land Use

The subject lands have historically been used for manufacturing purposes and consist of two separate buildings, associated parking, and internal asphalt roadways. Existing topographic and legal information was obtained from Automated Engineering Technologists (AET), dated July 4, 2013. This topographic information was supplemented with additional survey along Northfield Drive to capture existing conditions that have been altered as a result of the LRT construction to the north of the site.

The centerline of Northfield Road along the frontage ranges in elevation from approximately 342-345 m while the Site is lower, ranging in elevation from approximately 339-340 m along the northern limits. The Site is approximately 335 m near the southern limits and generally falls from northeast-to-southwest.

Drainage from the site is directed towards Conestoga Parkway (ON-85) and outlets to a ditch along the western limits of the site, outside of the property limits. Drainage from within the site is directed to either the ditch directly, or collected in a storm sewer system connected to Conestogo Road or a municipal storm sewer within the utility corridor, which ultimately all discharge to the ditch along ON-85.

The ditch in question appears to be a drainage feature regulated by the Grand River Conservation Authority (GRCA). According to GRCA mapping (provided as Figure 1), a portion of this drainage feature appears to be a tributary of Forwell Creek and its associated floodplain and allowances. The floodplain within this regulation limit is at an elevation of approximately 334.05 m. Further discussion related to this drainage feature is provided within the body of this report.

2.2 Environmental Site Assessments (ESAs)

The site has been subject to numerous environmental assessments to identify potential sources of contaminating activities in or around the site. The Phase II ESA by S2S Environmental Inc. (S2S), dated July 2013, revolved around three specific items that had been identified through prior investigations:

- The use of the property as carpet manufacturing included hazardous waste generation on site and pooling of chemicals within the production areas on concrete slab-on-grade floors;

- A lack of information with respect to structural integrity of underground sewer lines in the vicinity of floor drains located within the production area, coupled with the pooling of chemicals identified;

- Observed exceedances of antimony concentrations in fill material recovered from one monitoring well on the site.

Additional sampling and boreholes on the site did not identify any other materially significant results from prior investigations.

The investigation concluded that the previously-identified antimony exceedance in the near surficial soils was limited and not considered a significant concern to the industrial operations on the property. The antimony exceedances could be remediated by excavation through conventional means and disposed offsite to a facility licensed to accept such material.

The investigations also found a single exceedance of petroleum hydrocarbons F4. The investigation concluded that additional sampling be completed to confirm the exceedance and, if confirmed, a remedial action plan be implemented to address the exceedance.

Lastly, the investigation found elevated levels of sodium and chlorides, attributed to the use of de-icing salts. The elevated levels of electrical conductivity (EC) and sodium adsorption ratio (SAR) are not considered to be harmful to human health.

The 2013 investigation was completed to understand whether the continued operation of the industrial facility was at risk, not for the purposes of redevelopment. To support the redevelopment of the site and the change in land use, a Record of Site Condition (RSC) is required pursuant to O. Reg 153/04 under Part XV.1 of the Environmental Protection Act.

An additional ESA Phase II is underway to support the filing of the RSC.

2.3 Geotechnical Conditions

While a site-specific geotechnical assessment has not been completed, the various environmental investigations did include numerous boreholes advanced throughout the site. Based on the information gathered on site, S2S reports that *"…the subsoils at the north and central portions of the Phase Two Property were found to generally consist of granular fill overlying sand overlying silt to a depth of approximately 11.0m bgs (328m amsl), overlying sand, clay and silt to a depth of approximately 35.4m bgs[1] (304 m amsl[2]). The subsoils in the south portion of the Phase Two Property were found to generally consist of sand with silt or gravel to a depth of approximately 12.2 m bgs (326 m amsl)."*

Additionally, through the investigations, S2S infers groundwater flow direction towards the southeast. A groundwater contour drawing is provided within the S2S Conceptual Phase Two Model, along with cross-sections depicting the site's stratigraphy.

2.4 Environmental Impact Study

A scoped environmental impact study (EIS) was completed for the subject site due to its proximity to natural features. The study concluded that the highly developed nature of the site does not provide any natural habitat. The study also notes that Forwell Creek, which is the immediate downstream watercourse is highly channelized. Habitat for species at risk (SAR) or any significant wildlife habitat (SWH) was not present in the study area. Marginal habitat for Wavy-rayed Lampmussel was noted in Forwell Creek, however, no negative impacts to this habitat are anticipated.

[1] *below ground surface (bgs)*
[2] *above mean sea level (amsl)*

2.5 Traffic Impact Study

A traffic impact study was completed for the subject development to analyse existing traffic conditions, and estimate the impact of the full build-out on the surrounding traffic infrastructure as well as recommend any improvements or mitigation measures to support the increased density.

The report recommends northbound left turn lanes on Conestogo Road at each of the entrances to the site, a northbound left turn lane on Conestogo Road at Northfield Drive and an eastbound right-turn lane on Conestogo Road at the signalized intersection with King Street North.

The proposed recommendations can likely be accommodated within the existing paved sections on Conestogo Road with repainting of the roadway and therefore no impacts to existing municipal servicing are anticipated.

2.6 Existing Servicing and Utilities

Existing services on and around the site were identified as part of the topographic survey by AET in 2013. Significant road reconstruction of Northfield Drive has since been completed as part of the Region of Waterloo's Light Rail Transit (LRT) project. The new servicing and utilities information was taken from the City of Waterloo's GIS data, as well as LRT plan and profile drawings and utility mapping provided by various agencies. WalterFedy also surveyed the new infrastructure with the assistance of private locators in May and June 2020.

Utility information collected from various sources is provided in Appendix A.

2.6.1 Water Servicing

As a previous industrial manufacturing facility, the Site is bound by significantly-sized infrastructure. On Northfield Drive, a 600-mm-diameter, Region-owned transmission watermain provides connections to local distribution mains. Local 300-mm-diameter watermains surround the subject Site on Northfield Drive and Conestogo Road, and as many as six separate connections exist to the facility. The status of the 300-mm-diameter watermain along Northfield Drive abutting the northern property limits is unclear; the main appears to only service the Site and a public hydrant for fire protection to the site.

Internal to the site, visual observations and surveyed data appear to note Post Indicator Valves (PIVs) around the buildings. Presumably, the PIVs are connected to an exterior fire water loop as would be typical for a high-hazard industrial facility.

Historical records of water usage for this site were unavailable, but it is understood to have been a large water user.

2.6.2 Sanitary Servicing

A 200-mm- to 300-mm-diameter sanitary sewer exists on Conestogo Road. This sewer crosses through the site within a utility corridor consisting of a Hydro One Inc. (HONI) right-of-way as well as City of Waterloo and Waterloo North Hydro (WNH) easements, that bisects the site, and continues under ON-85. The Site currently has multiple connections to the municipal infrastructure. This sewer ultimately connects to the Lower Forwell Creek Trunk Sanitary Sewer (LFCTSS).

Based on discussions with City staff, it is understood that there are no constraints within the existing local sanitary system; however, potential constraints may exist downstream within the trunk sewer.

Historical sanitary discharge rates from the site were unavailable, but they are understood to have been significant. At its peak as a heavy industrial site, the expected flow rate would have been roughly 16 L/s. The peak flow rate currently in the City of Waterloo sanitary sewer model is approximately 7 L/s.

2.6.3 Storm Servicing

Storm servicing for the site is provided through a 300-mm-diameter storm sewer within Conestogo Road, a 900-mm-diameter storm sewer within the HONI corridor, a ditch along Northfield Drive, and a ditch along ON-85. It is understood that the existing Site does not have any stormwater management features to limit discharge rates to surrounding infrastructure, with the exception of flow-control roof drains on the building south of the HONI corridor.

2.6.4 Gas Servicing (Enbridge Gas)

Based on locates obtained by WalterFedy, the Site is serviced by a 250-mm-diameter steel gas main located on the southern side of Northfield Drive. Additional services are provided to the Site on either side of the HONI corridor, from a 100-mm-diameter steel gas main on Conestogo Road, which appears to be located within the eastern boulevard. Both of the gas mains are noted to be coated and wrapped, and operating at 420 kPa (60 psi). A customer-owned station is located on the western side of the existing manufacturing facility.

2.6.5 Communications (Bell Canada)

Bell servicing is provided to the site via buried conduits on the southern side of Northfield Drive and on Conestogo Road. Of note, Bell servicing within Conestogo Road is split roughly at the HONI corridor and does not appear to be connected across it. North of the HONI corridor, Bell servicing appears to be connected to the Northfield Drive system. Servicing from the southern side of the HONI corridor appears to be connected elsewhere. Bell infrastructure appears to be right along the municipal property line.

2.6.6 Communications (Rogers Communications)

Rogers appears to have an aerial fiberoptic cable strung on the WNH-owned pole lines on Northfield Drive and Conestogo Road. Locates indicate that a buried cable provides service from Northfield Drive and an aerial service is provided to the building south of the HONI corridor. The aerial service was not visually evident; however, a dip pole located within the fenced compound at the rear of the site may be the location of an underground service to the building.

2.6.7 Power (Waterloo North Hydro)

WNH owns and operates a transformer station directly across from the site on Conestogo Road. As a result, the roadways surrounding the site have significant hydro infrastructure including multiple high-voltage circuits, above ground and below grade on both roadways. Overhead pole lines are located along the property lines shared with the site on both of the roadways.

WNH also owns three switchgears within an easement on the site at the corner of Northfield Drive and Conestogo Road. Additionally, WNH owns and operates an underground high-voltage line within the utility corridor in a 3-m-wide easement.

WNH provides service to the site from multiple connections from Northfield Drive and Conestogo Road.

3.0 REVIEW AGENCIES

3.1 City of Waterloo

The City of Waterloo will be responsible for the review and approval of this functional servicing design for the purposes of the zone change, the plan of subdivision, and subsequent site plan applications for the various blocks.

3.2 Region of Waterloo

As the property abuts Northfield Drive, a Region of Waterloo-owned road allowance, the subject development will require grading and stormwater management clearance by the Region. Additionally, the Region's Corridor Management division will be involved in infrastructure planning and approval decisions as it relates to servicing within the Northfield Drive municipal right-of-way.

The Region will also review and comment on Source Water Protection as it relates to the subject development.

3.3 Grand River Conservation Authority

As the overall site contains a regulated drainage feature and its flood plain, development within the regulated are will require approval from the GRCA through a permit pursuant to Ontario Regulation 150/06. The GRCA will also comment on storm servicing and stormwater management for the subject development as it relates to discharge to the regulated feature.

3.4 Ontario Ministry of Transportation (MTO)

Due to the site's proximity to ON-85 and the discharge of stormwater to lands within the jurisdiction of the MTO, the servicing and stormwater management for the development will be subject to development approvals by the MTO.

3.5 Ministry of the Environment, Conservation and Parks (MECP)

If the development consists of new municipal infrastructure, an Environmental Compliance Approval (ECA) from the MECP will be required. Such an approval can be obtained through a Transfer of Review process through the Region of Waterloo.

The MECP will also be responsible for review and approval for the RSC that is required to permit the change in land use. The RSC may include certain risk mitigation measures that may impact grading and servicing for the subject development.

4.0 PROPOSED PHASING AND DEVELOPMENT STRATEGY

The Site is subject to redevelopment under a Plan of Subdivision to create eight new blocks. As part of the redevelopment, a municipal roadway is not currently proposed; however, access to and from each block will be provided via a common, privately-owned, internal roadway. The roadway will straddle multiple blocks and will contain the required servicing infrastructure to support the development.

The proposed servicing strategy is complex as servicing is proposed to be shared between multiple, separately-owned blocks of land. The ownership structure of the overall plan of subdivision and of the individual blocks is currently not confirmed. It is possible that the individual blocks could have multiple, separate condominium corporations, which would form distinct property boundaries within the block itself at the time of registration. As such, the typical approach to provide separate individual services to individual properties may not be feasible.

It is also anticipated that the overall subdivision will be developed in phases. Specific phasing was not known at the time of writing; however, it is anticipated that the phasing of the development within the site is likely to follow the block numbering as presented in the proposed Draft Plan of Subdivision by GSP Group Inc.

5.0 SOURCE WATER PROTECTION

According to the Province of Ontario's *Source Protection Information Atlas*, the Site is located within an Intake Protection Zone 3, with a vulnerability score of 7.2. The site is not located within any other water quality-related

source protection zone or any water quantity-related source protection area. Table i provides the source protection details for the Site.

Table i: Source Protection Details

Source Protection Area	Grand River
Water Quality	
Wellhead Protection Area	No
Wellhead Protection Area E (GUDI):	No
Intake Protection Zone:	3; score of 7.2
Issue Contributing Area:	No
Significant Groundwater Recharge Area:	No
Highly Vulnerable Aquifer:	No
Event Based Area:	No
Water Quantity	
Wellhead Protection Area Q1:	No
Wellhead Protection Area Q2:	No
Intake Protection Zone Q:	No

Figure 3 provides the mapping for the subject site as exported from the Source Protection Information Atlas.

Based on a review of applicable Source Protection Policies for the Region of Waterloo under the Grand River Source Protection Plan and a review of *2017-2018 Table of Drinking Water Threats,* the activities proposed on this Site are not considered to be threats to drinking water at any risk level.

To ensure that infrastructure proposed as part of this development does not become a significant threat in the future, proposed infrastructure should be designed in accordance with MECP's publication titled *Design Guidelines for Sewage Works 2008* (updated May 2019). The design of sewers to this standard is done to maximize expected life and reduce the incidence of failure.

6.0 SANITARY SERVICING

6.1 Proposed Sanitary Servicing

In accordance with the City of Waterloo Engineering Standards and the Design Guidelines and Supplementary Specifications for Municipal Services (DGSSMS) 2020, the sanitary flows from the subject development were calculated based on the split in land uses between residential and commercial developments within the site.

Sanitary flows for the residential component were calculated using an average daily flow of 275 L/c/day, peaked using the Harmon Formula for a design population of 1.76 persons per unit (ppu). Similarly, the commercial flows were estimated using an average daily flow allowance of 0.5 L/s/ha for general commercial areas, peaked using a peaking factor of 2.5. The total domestic and commercial flow was supplemented with an extraneous flow allowance of 0.25 L/s/ha.

Table ii provides a summary of the total domestic flow expected to be generated from the overall development in accordance with DGSSMS 2020.

Table ii: Proposed Sanitary Flow

Site Area	10.72 ha
Number of Residential Units	2534 units
Design Population density	1.76 ppu
Design Population	4460 persons
Average Residential Daily Flow	275 L/c/d
Residential Peaking Factor	3.29
Total Residential Sanitary Peak Flow	**46.71 L/s**
Equivalent Commercial Area	2.79 ha
Average Commercial Daily Flow	0.5 L/s/ha
Commercial Peaking Factor	2.5
Commercial Sanitary Flow	**3.49 L/s**
Extraneous Flow Allowance	0.25 L/s/ha
Total Extraneous Flow	**2.68 L/s**
Total Sanitary Flow	**52.88 L/s**

At the time of writing, it is being proposed that Blocks 1, 2, and 4 share a sanitary service connection to Conestogo Road, Blocks 3, 5, 6, and 7 share another connection, and Block 8 will have its own service to Conestogo Road. Blocks 1, 2, and 4 account for approximately 44.8% of the effective population and 50.6% of the commercial floorspace. Blocks 3, 5, 6, and 7 account for approximately 50.6% of the effective population and 41.2% of the commercial floorspace. Block 8 accounts for approximately 4.6% of the effective population and 17.0% of the commercial floorspace. The extraneous flows were divided proportionally by area between the three services. The table below summarizes the proposed sanitary flow for each of the three services.

Table iii: Distribution of Sanitary Flow

Blocks	% Population	Domestic Flow (L/s)	% Commercial	Commercial Flow (L/s)	Extraneous Flow (L/s)	**Total Sanitary Flow (L/s)**
1, 2, 4	47.7	22.28	4.9	0.17	1.119	**23.57**
3, 5, 6, 7	52.3	24.43	4.9	0.17	1.105	**25.71**
8	0	0	90.2	3.15	0.456	**3.60**
	100%	**46.71 L/s**	**100%**	**3.49 L/s**	**2.68 L/s**	**52.88 L/s**

The flow to each of the connections can be accommodated via a 250-mm-diameter sanitary sewer, sloped at 0.6%.

6.2 Local Sanitary Constraints

The sanitary flow from the subject development is directed to a 300-mm-diameter municipal sanitary sewer located within the utility corridor crossing through the site. This municipal sewer crosses ON-85 and connects to the LFCTSS that directs wastewater to the Waterloo Waste Water Treatment Plant (WWTP).

The local municipal sanitary system is comprised of 200-mm-diameter to 300-mm-diameter sanitary sewers on Northfield Drive, Durward Place, and Conestogo Road, ultimately combining to a 300-mm-diameter sanitary sewer within the utility corridor on the subject site. Based on City of Waterloo plan and profile drawings dated February 1973, this sanitary sewer was designed to be installed at a slope of 0.61 to 0.62%.

Table iv provides capacities of the pipe calculated using the Chézy-Manning formula with a roughness coefficient of 0.013 for smooth walled concrete pipe in accordance with the DGSSMS.

Table iv: Hydraulic Properties of Local System

Diameter of Sewer	300	*mm*
Design Slope	0.61	*%*
Full Flow Velocity	75.53	*m/s*
Full Flow Capacity	1.07	*L/s*

In addition to the subject development, the local system conveys flows from approximately 34.36 ha of external drainage area bound by Northfield Drive to the north, King Street to the east, ON-85 to the south, and the subject site to the west. This external catchment is comprised primarily of Employment Lands (26.93 ha, zoned E2) and some commercial lands fronting onto King Street (7.43 ha, zoned C4).

Combined, the external drainage areas contribute approximately 39.42 L/s of flow to the local sanitary system. Appendix B provides the external drainage areas and their corresponding flow contributions.

It is recognized that the additive peak flows from the subject development and the external drainage area exceed the full flow capacity of the local system within the utility corridor. However, the flows from the proposed development are largely dominated by residential peak flow that is characterized by a diurnal pattern with an AM and PM peaks, whereas the flows from the external catchment are largely expected to be uniform with their peaks not coinciding with the AM and PM peaks from the subject development. As such, the peak flows cannot be considered to be additive and the local system has capacity to service the development.

To confirm this, the City of Waterloo was contacted to provide sanitary modelling results for the surrounding area that include actual flow monitoring results for existing conditions with the flow increase to account for the subject development. The model indicates that the sewers through the site have capacity to accommodate the proposed development; however, the trunk sewer immediately downstream is surcharged. The model is based on the 2014 Sanitary Master Plan modelling and is not a real-time, calibrated model and the surcharging is a known existing condition, not driven by this development.

6.3 Local Sanitary Hydraulic Grade Line Analysis

Although the combined flows are not considered additive, a simplified hydraulic grade line (HGL) analysis was completed to understand extent of surcharging, should the peak discharges ever combine. The simplified model assumes the following:

- Peak discharges occur simultaneously and no lag is present due to travel time in pipes. This includes the infiltration flows and is considered to be highly conservative.
- The offsite flow enters the Conestogo Road municipal sanitary sewer along the site frontage at 3 points. 10% of the flow occurs at the extreme north via Northfield Drive (node 51A), 20% of the flow occurs at Durward Place and 70% of the flow occurs via the southern leg of the sanitary sewer on Conestogo Road.
- No surcharging occurs at the connection to the LFCTSS under ON-85.

The purpose of this analysis was to establish surcharging depths to evaluate whether the surcharging has the potential to negatively impact upstream properties draining to the Conestogo Road sanitary sewer system. The model surcharging depths and link capacities are illustrated in Appendix B.

The analysis notes that surcharging occurs to a maximum depth of 1.07m and this occurs at the junction where the sanitary sewer at Conestogo Road turns into the utility corridor within the site. The surcharging is dissipated by the first manhole north of this junction (approximately 100m length) and two manholes south of this junction (approximately 165m length). No sanitary services exist within the surcharged lengths of sewers. As such, the theoretical surcharging does not negatively impact any properties upstream of the site.

6.4 Lower Forwell Creek Trunk Sanitary Sewer

The City of Waterloo Sanitary Master Plan Volume 1 identified a downstream constraint that may exist in the 2029 Wet Weather flow conditions in the Lower Forwell Creek Trunk Sanitary Sewer (Appendix B, Stantec Figure 6-5). The constraint is located in an environmentally sensitive area and has no direct connections from any other developments; the existence of wetlands will also prevent such development from occurring in the area.

The surcharging identified in the Stantec report was deemed to be acceptable since the surcharged elevation was sufficiently below the surface to cause any spills into the environmentally sensitive areas. As such, at the time, it was recommended that no further improvements be carried out to alleviate the Lower Forwell Creek Capacity Constraint (Appendix B, Stantec Table 6-12 and Table B4).

The proposed development will contribute a much higher peak flow than what is currently discharged from the site. According to Appendix K of *The City of Waterloo Sanitary Master Plan,* the modelled sanitary flow rate from the site was 6.94 L/s, and this flow rate was continued through the 2029 master planned scenario. Thus, the Sanitary Master Plan did not account for any potential growth of the site. With the anticipated flow from the developed Site of 52.9 L/s, the net increase from development is roughly 46 L/s.

While the development will contribute a larger flow than what was considered in the 2015 Sanitary Master Plan, the impact of this increase is not apparent. Due to the proximity of this site to the trunk sewer and to the WWTP itself, it is anticipated that the AM and PM peak discharges from the site will reach the WWTP much in advance of flows from neighboring St. Jacobs, whose flows are contemplated to be re-routed to the WWTP within the 2015 Sanitary Master Plan.

It is understood that the City is currently in the process of updating the Master Plan which and will re-assess the recommendations related to the identified constraint in the LFCTSS as a result of growth that has occurred within the City and anticipated future developments such as the one considered in this report. However, presently, the City is not prohibiting any new developments from proceeding.

7.0 WATER SERVICING

The proposed subdivision will have multiple connections from the existing infrastructure surrounding the Site. As the subdivision does not contain a municipal road right-of-way, a municipal watermain is not proposed and each block is anticipated to be serviced independently from the surrounding infrastructure.

The separate, independent servicing is proposed to ensure compliance with the Safe Drinking Water Act.

7.1 Design Criteria

The Region of Waterloo requires that watermain distribution systems be able to convey the larger of maximum daily demand and fire flow or the peak hourly demand. Additionally, the Region of Waterloo DGSSMS recommends that the average daily flow from any development be conveyed with a resulting pressure within the range of 350 kPa (50 psi) to 550 kPa (80 psi).

The Region also stipulates that the minimum resultant pressure under any non-fire demand scenario shall not be less than 275 kPa (40 psi). With the inclusion of fire flows, the minimum residual pressure in the distribution system shall not be less than 140 kPa (20 psi) and shall not cause velocities in the system to be greater than 5 m/s.

Should static pressures in the system exceed 550 kPa (80 psi), the Region requires the use of individual pressure-reducing valves for new developments. The distribution system is also required to be designed to ensure that pressures do not exceed 700 kPa (100 psi) at any point in the system.

7.2 Domestic Demand

Calculations of the water demand for the proposed development have been performed using the DGSSMS and *Design Guidelines for Drinking-Water Systems 2008*.

In accordance with the DGSSMS, the average residential demand for the proposed development was estimated using a demand of 225 L/c/day. A peaking factor of 1.42 was used to convert the average daily demand into a maximum day demand. This peaking factor is in accordance with the *Tri-City Water Distribution Masterplan*. Similarly, a peaking factor of 3.0 was used to convert the average daily demand into the peak hourly demand in accordance with Table 3-1 of the MECP guidelines for a design population between 3,001 and 10,000 persons.

For commercial uses, an allowance of 28 m^3/ha/day for the commercial uses was utilized, factored for a 16-hour operating period per day, resulting in a demand of 42 m^3/ha/operating hour. A maximum day demand peak factor of 1.5 and a peak hour factor of 2.0 were applied in accordance with MECP design guidelines.

The usage rates and detailed demand calculations for each node are provided in appended Table C-1 and graphically illustrated in appended Figure C-2. It is noted that the private distribution system within Block 8, past the water meter chamber has not been modelled within this network.

7.3 Fire Flow Demand

In addition to the daily domestic demand for the proposed development, fire flow demands were calculated to assess the adequacy of the proposed watermain system. The Region of Waterloo specifies that all fire flow requirements shall be determined in accordance with the current issue of Water Supply for Public Fire Protection published by the Fire Underwriters Survey (FUS), and the Ontario Building Code.

The FUS methodology results in a very conservative approach to calculating fire flows. These calculations are noted and summarized in appended Table C-3 for each block.

The *Fire Protection Water Supply Guidelines for Part 3 in the Ontario Building Code* (October 1999) requires that the buildings shall be provided with a supply of water not less than the total volume of the building, multiplied by the water supply coefficient from Table 1 of the technical bulletin, and the spatial coefficient values obtained from Figure 1 of the technical bulletin. Regardless of the size of the building, the maximum fire flow resulting from this methodology is 9,000 L/min, or 150 L/s.

As the FUS methodology results in fire flows greater than 150 L/s, additional calculations as per OBC were not completed for the subject development.

7.4 Service Design

As per the DGSSMS, the water service required shall be able to convey the combination of the Maximum Day Demand (MDD) and the Fire Demand, within the pressure and velocity ranges as specified. A service size was selected for each block to ensure that velocities in the MDD + Fire scenario do not exceed 5 m/s. This service size was increased as required to minimize hydraulic losses through the system to ensure the total demand can be delivered at acceptable pressure levels. The selected service size is presented in Table C-3.

Each block is proposed to have individual service connections to comply with the requirements of the *Safe Drinking Water Act* (SDWA). Should a connection be shared between multiple properties, such a system could be considered a designated non-municipal, year-round residential drinking water system under the SDWA and not plumbing under the OBC.

It is noted that, should any block contain multiple plans of condominiums, individual services to each condominium may be required resulting in additional water service connections to the municipal system as the

registration of a condominium results in a separate property under the Land Titles Act, R.S.O. 1990, CHAPTER L.5.

In accordance with Ontario Building Code Clause 3.2.9.4(4), "if a building is 84 m or more high, measured between grade and the ceiling level of the top storey, the building shall be served by no fewer than two sources of water supply from a public water system". As such, Blocks 1 and 2 are proposed to have two sources of water supply from the public system.

7.5 Modelling and Results

The Region of Waterloo was contacted to obtain modelling simulations to establish boundary conditions around the subject development. The hydraulic grade lines were obtained for the average day and maximum day, as well as data pertaining to maximum available fire flow. Correspondence from the Region is appended as Appendix C-4.

A reservoir was assigned the hydraulic grade line determined from the Region's model for each demand scenario. This reservoir was connected to a pump with a head loss curve to simulate the drop in pressure corresponding to the modelling obtained from the Region.

An EPANET model was created to model the distribution network within the subdivision. Each connection to Conestogo Road was directly made to the reservoir and pump system. This approach assumes that major losses in the pipe are negligible between the Region's model node at the intersection of Conestogo Road and Northfield Drive, as the municipal distribution system is looped and fed from many different locations. Changes in pressure due to elevation differences are captured in the system model.

Each of Block 1 and Block 2 were provided with a secondary, redundant, fire water connection to the watermain north of the site within the Northfield Drive right-of-way. As this watermain is not looped, it was modelled as an existing ductile iron main with a Hazen-Williams friction coefficient of C = 110, to represent a ductile iron watermain with sediment buildup due to its age.

Table v provides a summary of the hydraulic grade lines used in the analysis.

Table v: Hydraulic Grade Lines (Node JCT_18688 – Located at Northfield Drive/Conestogo Road)

Demand Scenario	Hydraulic Grade Line (m)
Average Day	379.42
Maximum Day	378.52
Peak Hour	375.73
Minimum Hour	383.21
Maximum Modelled Design Flow (798.9 L/s)	15.9

The model was run for average day demands and maximum day demands to understand residual pressures within the system. The results are tabulated in appended Tables C-5 and C-6. The results indicate that in non-fire conditions the residual pressures in the system are within acceptable ranges as specified in the DGSSMS.

Additionally, the maximum day model was evaluated to determine the maximum available flow at each node while ensuring that the remainder of the system remains at or above 140 kPa (20 psi). The results of this analysis are tabulated in Table C-7 for the complete system and summarized in Table vi below. The results indicate that sufficient flow is available to each block to provide maximum daily demand and fire flows concurrently, above the minimum pressure.

Table vi: Water Distribution Modelling Results

Block	Domestic Flow (L/s)	Fire Flow (L/s)	Total Flow (L/s)	Available Flow (L/s)	Velocity (m/s)
Block 1	4.11	133.33	137.45	213.30	4.38
Block 2	2.72	183.33	186.06	415.17	3.79
Block 3	2.66	200.00	202.66	371.49	4.13
Block 4	1.94	216.67	218.60	631.94	4.45
Block 5	1.79	200.00	201.79	670.08	4.11
Block 6	2.56	183.33	185.89	353.18	3.79
Block 7	2.54	183.33	185.88	654.31	3.79
Block 8	1.64	166.67	168.30	687.85	3.43

As such, it is concluded that the municipal system is sufficient to provide water servicing to the subdivision. A hydrant flow test should be conducted during detailed design to confirm the modelling results provided by the Region.

The complete EPANET model is provided as appendix C-8.

To maintain compliance with the Safe Drinking Water Act, the water supply sources shall remain independent and at no point shall be interconnected between separate parcels of land.

7.6 Water Quality

Blocks 1 and 2 have been provided with connections from Conestogo Road, with an additional redundant connection from the main on Northfield Drive. This configuration provides a worst-case estimate of available fire flow from the redundant connection for the purposes of modelling, due to potentially higher losses from the older, un-looped watermain.

As this watermain does not appear to have any domestic connections, it is unlikely that the watermain experiences any turnover and may be suffering in water quality. It is, therefore, recommended that the water within the main be thoroughly flushed through the public hydrant connected at its end prior to connections to the main.

Additionally, it is proposed that Blocks 1 and 2 have their primary domestic connections through the Northfield Drive main. The high density at these blocks will ensure constant turnover in the municipal system and alleviate water quality concerns. Should it not be possible to connect these blocks to Northfield Drive, it is recommended that the City implement a flushing program to ensure the water in the main does not stagnate and potentially contaminate distribution system. Alternatively, a check valve could be installed to prevent backflow from this dead end main.

8.0 STORM SERVICING

8.1 Local Servicing

As currently proposed, underground parking within the blocks in the subdivision does not extend under the proposed private roadway. As such, it is believed that the roadway will contain a private storm sewer system to collect runoff from within the road allowance as well as runoff from the buildings. It is expected that the subdivision will have two connections to the municipal storm sewer within the utility corridor, one on either side of the easement. It is assumed that drainage from the utility corridor itself will be split towards the two outlets, in line with the identified block limits.

Table illustrates the expected flow generated from a 5-year design storm event and associated pipe sizing for the catchment north of the utility corridor (Blocks 1-7). The flow is calculated using an estimated overall 90% imperviousness with a time of concentration of five minutes in accordance with City of Waterloo design standards.

Table vii: Proposed Storm Sewer Connection (North)

Site Area (Blocks 1-7)	7.27	*ha*
Runoff Coefficient	0.9	
Time of Concentration	5	*min*
5-Year Design Flow	2481.11	*L/s*
Proposed Pipe Diameter	1050	*mm*
Proposed Slope	0.85	*%*
Full Flow Capacity	2517.60	*L/s*
Full Flow Velocity	2.91	*m/s*

As this connection will be shared between multiple properties, it is expected that a joint maintenance agreement will be entered into to ensure that the service remains functional.

Table viii below illustrates a similar calculation for the catchment area south of the utility corridor (Block 8).

Table viii: Proposed Storm Sewer Connection (South)

Site Area (Block 8)	2.98	*ha*
Runoff Coefficient	0.70	
Time of Concentration	10	*min*
5-Year Design Flow	630.58	*L/s*
Proposed Pipe Diameter	675	*mm*
Proposed Slope	0.60	*%*
Full Flow Capacity	651.12	*L/s*
Full Flow Velocity	1.82	*m/s*

8.2 Major Overland Flow

Major overland flow from within the private roadway will be directed to the utility corridor and ultimately discharged to the ditch along ON-85. The grading of the road network within the subdivision permits for the conveyance of the major overland flow to its designated outlet with a maximum ponding depth of 0.3 m.

Additionally, major overland flow from approximately 22 ha of external drainage area east of the subject development appears to cross through the property. Elevations on Conestogo Road appear to allow for this major overland flow to enter the property at two locations, on either side of the southern standalone building. The external drainage area and the two low points on the site are illustrated on Figure 4.

The redevelopment plans allow for this major overland flow pathway to remain in its existing state. However, with minor regrading on Conestogo Road, the flow pathway could be consolidated within the utility corridor. This reconfiguration would ensure that no development would limit the conveyance of this external drainage in the future.

8.3 Northfield Drive Conveyance System

In the existing conditions, runoff from the Northfield Drive right-of-way appears to be directed to a roadside ditch along the shared property boundary between the site and the road. The ditch starts immediately west of the intersection of Northfield Drive and Conestogo Road and is approximately 2 m in depth at its deepest point as it meets the ditch along ON-85.

To activate the Northfield Drive frontage and promote pedestrian connections, it is proposed that this ditch be replaced with a municipal storm sewer system. This municipal storm sewer will be sized to accommodate the contributing catchment from the roadway in addition to any runoff from Blocks 1 and 2 that have their drainage directed towards Northfield Drive. The storm sewer system would remain at the same depth and slope as the existing swale and would continue to utilize the existing outlet structure at ON-85.

The design and construction of this storm sewer will require an ECA from the MECP in addition to approval from the Region of Waterloo.

8.4 Regulated Drainage Feature

Based on GRCA mapping, a portion of the ditch along ON-85 appears to be a regulated drainage feature and is considered to be a tributary of the Forwell Creek. Based on the mapping, the associated floodplains and allowances for this tributary encroach onto the development limits within the Site. Development within GRCA regulated areas require prior approval and authorization in the form of a permit pursuant to O.Reg 150/06.

Based on discussions with the GRCA, the subject lands are located within a Candidate Two Zone Floodplain Policy Area; however, its associated floodway and flood fringe have not been delineated to date.

To further study the hydrologic conditions and complete a two-zone technical analysis, WalterFedy obtained the HEC-RAS hydrologic model from the GRCA. A review of the model (without modifications), in conjunction with up-to-date survey information concluded the following:

- The flood plain noted within GRCA mapping is a result of backwater effects from downstream constraints. These constraints contribute to water pooling within the regulated drainage feature and are not caused by the size of the culvert under ON-85.

- The flood plain is a result of requiring flood storage volume and not a floodway conveying stormwater flows to Forwell Creek.

- The limits of the flood plain are not accurately defined within the GRCA mapping. Utilizing the Regional Flood Elevation of 334.05m amsl from the hydrologic model, the flood plain was mapped to be generally contained within the drainage channel with minor encroachment onto the subject lands in and around the utility corridor. This is illustrated in Figure 5.

The proposed development is expected to be contained largely outside of the flood plain as mapped using up-to-date survey information. More specifically, the development limits on this site are defined by a 14 m setback from the shared properly line with ON-85 and the flood plain is contained outside of this limit. Therefore, the proposed development is not expected to alter the watercourse or affect its storage volume in any significant way.

Lastly, as part of the development, a pedestrian promenade is contemplated along ON-85, although entirely located outside of the 14 m setback and the floodplain. Connected to this promenade is a proposed pedestrian bridge crossing over the highway. The design of the pedestrian bridge may require structural supports and bridge abutments to be constructed within the mapped floodplain. It is expected that any loss in volume will be compensated for by regrading activities in the vicinity of the support.

Further analysis of the effects of the support on flow path and flood elevations within the drainage feature located on the western side of the expressway may be warranted at the time of detailed design and approvals for this bridge structure.

9.0 STORMWATER MANAGEMENT

9.1 Stormwater Management Design

In accordance with the City of Waterloo's *Development Engineering Manual*, the post-development peak flow rates from this development are to be controlled to the pre-development rates for each design storm event and a Normal Level of Protection for water quality treatment (70% TSS removal) is required.

9.2 Hydrologic Modelling

Analysis of the stormwater on site was completed using the PCSWMM software. A hydrologic model was prepared to represent the existing and the proposed development conditions of the site.

Figures 6 and 8 provide the delineated catchments for existing and proposed conditions, respectively. Similarly, Figures 7 and 9 provide the PCSWMM model schematics for the existing and proposed conditions, respectively.

Table 1 provides a summary of the storm events used. The City of Waterloo's Intensity-Duration-Frequency (IDF) parameters were used. Tables 2 provide the existing and proposed conditions catchment parameters. Tables 3 and 4 provide a summary of the runoff volume and peak flow rates calculated for each catchment in existing and proposed conditions. Table 5 provides the routing performance summary for the stormwater management storage units for the proposed conditions. Table 6 provides a comparison of the site outlets in existing and proposed conditions. Table 7 provides the water quality calculations in accordance with MECP guidelines.

Further details on the stormwater management measures proposed are provided in the following sections. Design sizing calculations are provided in Appendix E. PCSWMM output files are provided in Appendix F.

9.3 Existing Conditions

The subject site has an area of 10.54 ha. Approximately 7.77 ha of the site is directed towards the hydro corridor on-site, where it is conveyed via 1500 mm by 965 mm elliptical pipe to a headwall at Forwell creek. Two external drainage areas also drain to this elliptical pipe via Conestogo Road and are conveyed to the Forwell creek outlet. These external areas are denoted as catchment 101 and 102 in the existing conditions model and are 11.41 and 10.45 hectares, respectively. The area adjacent to Forwell creek along the north and to the south of the hydro corridor sheet flow directly to the creek. Therefore, the existing site has three outlets: sheet flow north of the hydro corridor, sheet flow south of the hydro corridor and the area draining to the elliptical pipe's outlet. This drainage pattern is to remain in the proposed conditions. Stormwater management controls are provided in existing conditions for catchment 105 and a portion of catchment 103. The imperviousness of these catchments has been modified to account for the stormwater management controls presently in place. The overall imperviousness in existing conditions is approximately 61%.

Through an analysis completed in HEC-RAS, flood elevations of Forwell creek were determined as 333.235, 333.455 and 334.075 masl, for the 2-, 5- and 100-year design storm scenario, respectively. These flood elevations were incorporated into both the existing and proposed hydrological model to represent the tailwater effects at the site outlets.

9.4 Proposed Conditions

The proposed development comprises of the entire site area being largely impervious, with a total imperviousness of 76%.

9.4.1 Design of On-Site Stormwater Controls

The following sub-sections describe the design and preliminary sizing of the stormwater management strategy for the proposed site. Infiltration is not proposed on-site as the soils have been identified for potential contaminants.

To meet the stormwater management criteria for the site, the residential buildings and parking lot areas located south of the Hydro Corridor will be utilized for surface storage. Flow control is proposed at the buildings roof drains and prior to the connection to the existing 1500 mm by 965 mm elliptical pipe, to provide retention of runoff upstream. Two OGS units are proposed to be provided for water quality treatment and will be located upstream of the connections to the existing 1500 mm by 965 mm elliptical pipe from the drainage areas north and south of the Hydro Corridor.

Supporting stormwater design sizing calculations are provided in Appendix E. Details on the water quality (TSS removal) and water quantity (peak flow) targets and controls are provided in the following sections.

9.4.2 Stormwater Management Preliminary Sizing

To meet the post- to pre- peak flow attenuation requirements, on-site stormwater management storage is provided by utilizing the building rooftops and the parking lot areas located south of the Hydro corridor for surface storage. Four residential building rooftops are proposed to be used, and will each provide a storage volume of 228 m^3, with a maximum ponding depth of 150 mm. A preliminary estimate of 3 roof drains per building, 50 mm in diameter has been assumed. The parking lot area, south of the Hydro corridor will also provide an additional 747 m^3 of storage volume. A 140 mm diameter orifice will be provided at MH55 to provide attenuation.

Stormwater design sizing calculations are provided in Appendix E.

9.5 Water Quality Control

The City of Waterloo's guidelines stipulate that a minimum Normal Level of Protection be provided, as defined by the MECP design guidelines. This corresponds to a 70% long-term removal of total suspended solids (TSS). Table 7 provides a summary of the water quality calculations.

To meet this criterion, rooftop and parking lot surface ponding is proposed to act as dry ponds and provides sufficient storage to meet 60% TSS removal efficiency for catchment areas 205a,b,c,d, 205 and 204 as per MECP requirements. Runoff in excess of this surface ponding will drain toward an OGS unit (OGS2), proposed upstream of the connection to the existing 1500 mm by 965 mm elliptical pipe in the Hydro Corridor. A second OGS unit (OGS2), is proposed to service catchment area 203, to capture any oil and grit produced by the roadway and parking lot areas located north of the Hydro corridor. A third OGS unit (OGS3), is proposed to service catchment area 208, located in the western extent of the Hydro Corridor. All OGS units are to be sized for 80% TSS removal efficiency.

Table ix: Summary of OGS Performance

Catchment	OGS Unit	TSS Removal Efficiency (%)	Runoff Volume Captured (%)	Size
203	OGS1	83	>90	EFO6
205, 205abcd	OGS2	82	>90	EFO10
208	OGS3	83	>90	EFO6

The areas draining to the rooftop and parking lot surface ponding and OGS2 at the south extent of the site, make up 24% of the total site area. The area draining to OGS1 and OGS3 make up 55% and 6% of the total site, respectively. Removal efficiencies of 60% and 80% are attributed to the surface ponding and OGS units, respectively. This results in a calculated 71% overall removal efficiency for the site.

9.6 Water Quantity (Peak Flow) Control

The City of Waterloo guidelines indicate stormwater management controls are to match or reduce post-development peak flows to pre-development peak flows for the 2- through 100-year design storm events. The proposed stormwater management controls effectively provide peak flow control to meet the calculated pre-development flows for the 2- through 100-year return period storms. As presented in Table 6, the proposed conditions design provides reductions in peak flow rates from the existing conditions to the site outlet.

10.0 UTILITIES

10.1 Waterloo North Hydro

The proposed development may have a significant impact to surrounding WNH-owned distribution infrastructure. Of primary concern are overhead high-voltage distribution circuits along Northfield Drive and the underground high-voltage duct bank within the utility corridor.

Given the anticipated change to the existing elevations along Northfield Drive to provide better pedestrian connectivity, it is expected that the overhead wires will be at too low of an elevation and will require either burial or that the poles be raised to accommodate the change in elevation.

The underground high-voltage duct bank appears to have been installed at a typical depth at the top of a sloped embankment within the utility corridor. The proposed redevelopment is likely to eliminate this grade change within the utility corridor to provide conveyance and passage of major overland flow routes and connectivity to proposed amenities within the utility corridor. This regrading will require that the duct bank be lowered to depths sufficient to provide adequate cover over the infrastructure.

Preliminary discussions with WNH have occurred with respect to this development. Based on the preliminary energy loading estimates, it is expected that Blocks 3, 4, 5, and 8 will require individual transformers within Site boundaries. Additionally, Blocks 1, 2, and 7 may potentially require two transformers each. Every transformer would require a 6 m x 6 m piece of land that is accessible by a line truck, which would limit the amount of developable area for each block. Alternatively, each block could have indoor transformer vaults incorporated within the buildings themselves.

A looped connection serving all the transformers on site would be required. The wires would be encased in a concrete duct bank, for which a 3-m-wide easement is required for the entire length of the duct bank within the Site.

10.2 Other Utilities

While other utilities have not been engaged at this time, servicing availability and capacities are not expected to be of particular concern. Gas servicing within the area is likely sized to service larger industrial demands for the surrounding area and communication servicing appears to be widely available.

11.0 SITE GRADING

The grading of the site will respect the existing grades along all property lines. Proposed grading will conform with slopes outlined as part of the Accessibility for Ontarians with Disabilities Act (AODA) and City of Waterloo Development Engineering Guidelines.

The proposed grading also allows for conveyance of major overland flow towards the utility corridor and then ultimately west towards the drainage feature along ON-85.

11.1 Compliance with On-Site and Excess Soil Management Provincial Regulations

The MECP has introduced a new regulation, O.Reg. 406/19 titled "On-Site and Excess Soil Management" under the Environmental Protection Act. Portions of the regulation came into effect January 1, 2021 and as part of the phased implementation, additional requirements of the regulation come into effect in 2022 and beyond.

The excavation of excess material, and subsequent off-site disposal of excess soils from this Site, will require compliance with this new regulation should it be in force for subsequent phases. It is noted that requirements under this proposed regulation will be above and beyond requirements under the Certificate of Property Use (CPU) expected to be registered on title for this development.

A Qualified Person (QP), as defined within the O.Reg, should be retained to provide site specific guidance related to the Excess Soil regulation.

12.0 ADDITIONAL CONSTRUCTION CONSIDERATIONS FOR SERVICING

12.1 Short-Term Construction Dewatering

The construction of underground parking structures may require dewatering of perched ground water under the surficial layers of the site. Should shallow perched groundwater be encountered, depending on the quantity to be dewatered, the dewatering activity could be considered a water taking requiring additional permits and approvals from the MECP.

In the short term, the dewatering can replace inflow to the storm sewer network from the relevant pre-development catchment area, as the contributing catchment is expected to be replaced with a large excavation. The groundwater will require treatment and sediment removal to provincial standards, and to comply with the City of Waterloo sewer use bylaw for discharge to storm sewers.

Further details of construction dewatering (if required) shall be made available at the Site Plan Approval stage for the various phases of the development.

12.2 Building Underdrain System Discharge

Should lower levels of the proposed parking structures be constructed within perched layers of groundwater, building underdrain systems may be required to facilitate the development.

To avoid an active dewatering and groundwater management system, a caisson cut-off wall, keyed into the aquitard layer, can be constructed around the perimeter of the site to limit the ingress of groundwater. Details of such a caisson wall or equivalent watertight shoring system shall be provided to the City at the Building Permit stage as required for the various phases of the development.

Alternatively, the parking structure can be constructed as a watertight, tanked structure. A watertight structure does not require active ground water management and is designed to be resistant to hydrostatic pressure without the need of a subsurface drainage system.

Should it be determined that an underdrain system is required, the underdrain system shall include provisions to ensure discharge is acceptable within the storm sewer system, or an exception shall be sought from the Region and City to discharge to the sanitary sewer, subject to a successful application for a surcharge agreement. A Permit to Take Water may be required for such a system. The flow rate from this system shall be accounted for in the overall storm or sanitary discharge calculations from the site, as applicable.

12.3 Decontamination and Wash Water

Due to presence of Contaminants of Concern on Site, the potential CPU may require that a Qualified Person prepare a soil management plan for the review of the MECP district office a minimum of 14 days prior to any construction activity on the Site. Such a plan typically includes provisions for decontamination pads which are used to wash trucks and heavy equipment on site, to mitigate the movement of contaminated material.

Wash water generated during decontamination shall be collected and pumped into temporary storage tanks. Alternatively, depending on the quantity and quality of the wash water, on-site treatment and discharge to the City's sanitary sewer system, subject to a successful application for a discharge agreement, can be pursued. At no time shall the Contractor allow the wash water to enter into the natural environment.

13.0 EROSION AND SEDIMENT CONTROL

Sediment and erosion controls to be implemented during construction will include stabilized construction entrances, a perimeter silt fence, and sediment interceptor swales with installation of coir log check dams.

Prior to the start of any construction, all erosion and sediment control measures installed will be inspected by the Consultant. The controls will be maintained, and accumulated sediments removed once their capture capacity has been decreased by one-third. The measures will also be periodically inspected and upgraded/altered as Site conditions change. Periodic inspections will consist of visual observation of the effectiveness of the control measures and sediment migration offsite.

Any sediment tracked onto the roadway during the course of construction will be cleaned by the Contractor. To minimize the amount of mud tracked onto the roadway, a mud-mat will be installed at all construction exits and the Contractor will be required to ensure that vehicles leave through the exit. The mud-mat will be periodically inspected and cleaned/maintained as required to ensure it is functioning as intended.

To prevent sediment runoff from the Site, light-duty silt fencing (in accordance with OPSD 219.110) will be installed along the perimeter of the Site and at the base of all stockpiles. Stockpiles are to be visually monitored after rainfall events and will be hydraulically seeded if the stockpiles are to remain undisturbed for extended periods of time.

The outlets from the Site will be inspected for evidence of sediment migration offsite. In the event that sediments have migrated offsite, additional sediment controls shall be implemented as necessary to ensure that no additional sediment escapes from the Site. Any excessive sediment that has migrated offsite shall be removed and the area restored to pre-construction conditions.

As the servicing phase of the construction proceeds, each inlet structure will have an insert installed and/or filter fabric will be wrapped around the lids of all manholes to prevent intrusion of sediment into the storm sewer network. The inserts will be cleaned once they reach one-third their sediment accumulation capacity or as per the manufacturer's recommendations.

All erosion and sediment control measures will be removed at the end of construction.

14.0 CONCLUSIONS

Based on the analysis presented in this report it is concluded that:

- The existing 300-mm-diameter sanitary sewer running across the site through an easement is sufficient to accommodate the additional flows from the proposed development.

- Downstream capacity constraints are expected in the Lower Forwell Creek Trunk Sanitary Sewer in the City of Waterloo's 2029 Wet Weather flow conditions assessment. An additional 46 L/s of sanitary flow is expected from the site compared to what was assumed in the assessment. This may cause further surcharging in the trunk sewer.
- The existing 300-mm-diameter watermain on Conestogo Road is expected to be sufficient to provide domestic and fire flows to the proposed buildings, within the pressure and velocity constraints stipulated by the DGSSMS. Additional connections to the watermain on Northfield Drive may be required for the two blocks fronting Northfield due to their proposed heights.
- Pre-development flow rates for the 2-year, 5-year and 100-year storm events will be met in post-development conditions as the proposed development will result in overall less impervious area as compared to existing conditions. Quality control will be achieved through an oil/grit separator for the private roadway or through other low impact development measures. Existing municipal infrastructure surrounding the site is adequate to provide servicing for this development.
- The identified flood plain is a result of flood storage from backwater effects and not a floodway for conveyance. The flood plain is located outside of the development limits for the site and proposed buildings and structures will not affect the storage volume in any significant way.
- Pedestrian bridge abutments on the east side of Conestoga Parkway can be constructed by compensating for lost storage volume. Bridge abutments on the west side of Conestoga Parkway may require further investigations to ensure that flow paths in the western drainage feature are not impacted. The impacts are dependant on the geometry of the bridge abutment and therefore the analysis is proposed to be conducted once details are finalized.
- A storm sewer is proposed to replace the ditch along the northern property limits within the Northfield Drive right-of-way. This storm sewer will allow for the alteration of grades to provide better pedestrian connectivity to the site.
- WNH's distribution infrastructure may be significantly impacted as a result of this development and would require modifications to suit proposed conditions.
- Forthcoming regulations, the RSC, and associated CPU may impose additional restrictions on the site that will have to be followed during and after construction.
- Perimeter silt fence, silt fence at the base of all stockpiles, filter fabric over storm and sanitary structures, and construction entrance mud mats can provide erosion and sediment control. These will be designed during detailed design.

All of which is respectfully submitted,

WALTERFEDY

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FIGURES

- Figure 1 Regulated Area Mapping (GRCA)
- Figure 2 Inferred Groundwater Flow (S2S)
- Figure 3 Source Protection Mapping
- Figure 4 External Major Overland Drainage Area
- Figure 5 Corrected Flood Plain Mapping
- Figure 6 Existing Drainage Area Plan
- Figure 7 Existing Flow Schematic
- Figure 8 Proposed Drainage Area Plan
- Figure 9 Proposed Flow Schematic

Grand River Conservation Authority

Date: Jul 26, 2020

Author: 525-565 Conestogo Road W,

Figure 1: Regulated Area Mapping

Legend

- Lake Erie Shoreline Reach (GRCA)
- Lake Erie Flood (GRCA)
- Regulated Watercourse (GRCA)
- Parcel - Assessment Public (MPAC/MNRF)
- Floodplain - Special Policy Area (GRCA)

Floodplain (GRCA)

- Engineered
- Estimated
- Approximate
- Lake Erie Erosion (GRCA)
- Lake Erie Dynamic Beach (GRCA)
- Wetland (GRCA)

Slope Valley (GRCA)

- Steep
- Oversteep

Slope Erosion (GRCA)

- Steep

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0 30 60 120 180 Metres

N

Map Centre (UTM NAD83 z17): 537,441.40 4,816,157.21

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NAD 1983 UTM Zone 17N

Scale: 5,113

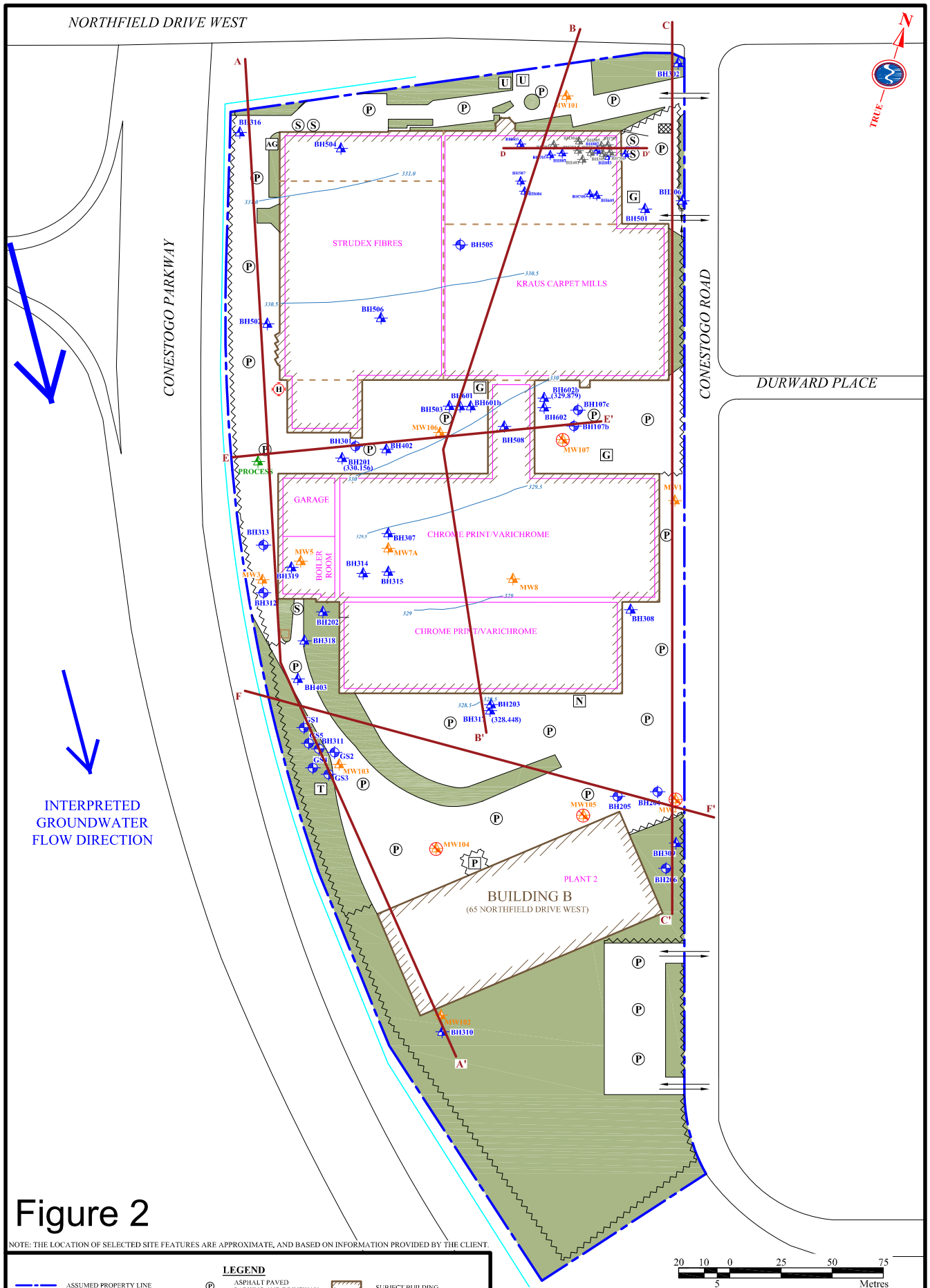

Figure 2

NOTE: THE LOCATION OF SELECTED SITE FEATURES ARE APPROXIMATE, AND BASED ON INFORMATION PROVIDED BY THE CLIENT.

LEGEND

- ASSUMED PROPERTY LINE
- SITE ACCESS
- CHAIN LINK FENCE
- DRAINAGE CHANNEL
- FIRE HYDRANT
- ASPHALT PAVED PARKING AND DRIVEWAY
- CATCH BASIN
- METAL GATE
- APPROXIMATE LOCATION OF MONITORING WELL INSTALLED BY S2S
- APPROXIMATE LOCATION OF BOREHOLE INSTALLED BY S2S
- APPROXIMATE LOCATION OF INJECTION WELLS INSTALLED BY S2S
- ASPHALT PAVED PARKING AND DRIVEWAY
- SILO
- GARBAGE BIN
- OUTDOOR AIR CONDITIONING UNIT
- NATURAL GAS INSTALLATION
- UTILITY BOX
- PROPANE TANK STORAGE AREA
- APPROXIMATE LOCATION OF PROCESS WATERING WELL
- APPROXIMATE LOCATION OF MONITORING WELLS INSTALLED BY OTHERS
- ESTIMATED CONTOUR LINE FOR GROUNDWATER ELEVATION
- SUBJECT BUILDING
- CONCRETE WALKWAY
- LANDSCAPED AREA
- CONCRETE RETAINING WALL
- TOOL SHED
- APPROXIMATE LOCATION OF DAMAGED OR NOT FOUND MONITORING WELL INSTALLED BY OTHERS

S2S Environmental Inc.

SCALE:	
AS SHOWN	
PROJECT NO:	SITE LOCATION: / DRAWING NO:
7883	65 NORTHFIELD DRIVE WEST, WATERLOO, ONTARIO / 5

SITE PLAN SHOWING INTERPRETED CONTOURS OF GROUNDWATER ELEVATIONS

DATE: AUG 26, 2019 | DRAWN BY: MS

Figure 3: 525-565 Conestogo Road - Source Protection Mapping

Legend

- Source Protection Areas
- Issue Contributing Areas
- WHPA Groundwater Under Direct Influence (WHPA-E)
- Wellhead Protection Area
  - A
  - B
  - C
  - C1
  - D
  - F
- Intake Protection Zone 1
- Event Based Areas
- Intake Protection Zone 2
- Assessment Parcel

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Map Created: 7/26/2020
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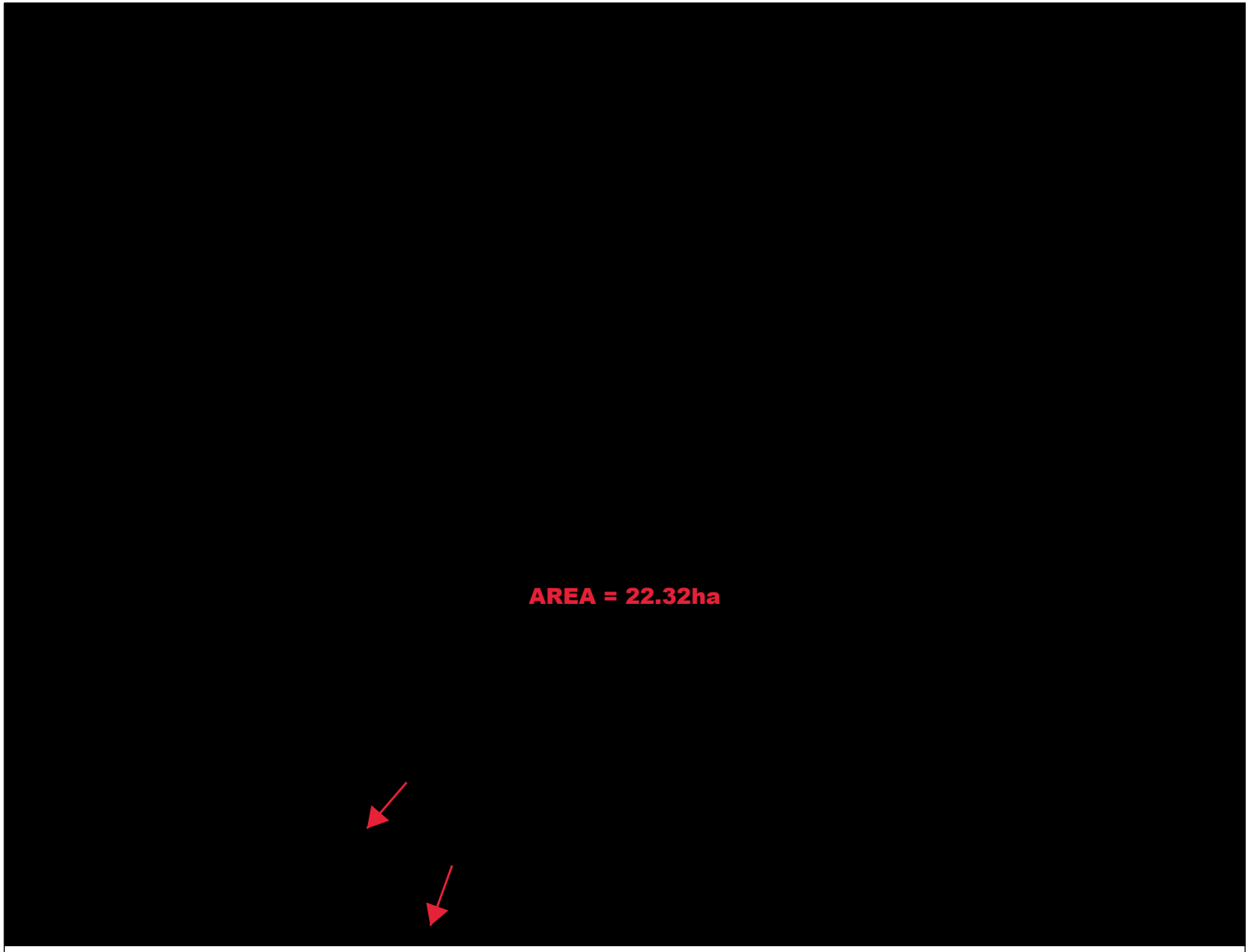

GRCA

Map Centre (UTM NAD83 z17): 537,700.38 4,816,267.12

This map is not to be used for navigation

Grand River Conservation Authority

Date: Jul 26, 2020

Author: 525-565 Conestogo Road W,

Figure 4: External Overland Flow Area

Drainage Flow Path

External Catchment Area

Legend

- Regulation Limit (GRCA)
- Regulated Watercourse (GRCA)
- Regulated Waterbody (GRCA)
- Wetland (GRCA)
- Floodplain (GRCA)
  - Engineered
  - Estimated
  - Approximate
  - Special Policy Area
- Slope Valley (GRCA)
  - Steep
  - Oversteep
  - Steep
- Slope Erosion (GRCA)
  - Oversteep
  - Toe
- Lake Erie Flood (GRCA)
- Lake Erie Shoreline Reach (GRCA)
- Lake Erie Dynamic Beach (GRCA)
- Lake Erie Erosion (GRCA)
- Parcel - Assessment (MPAC/MNRF)

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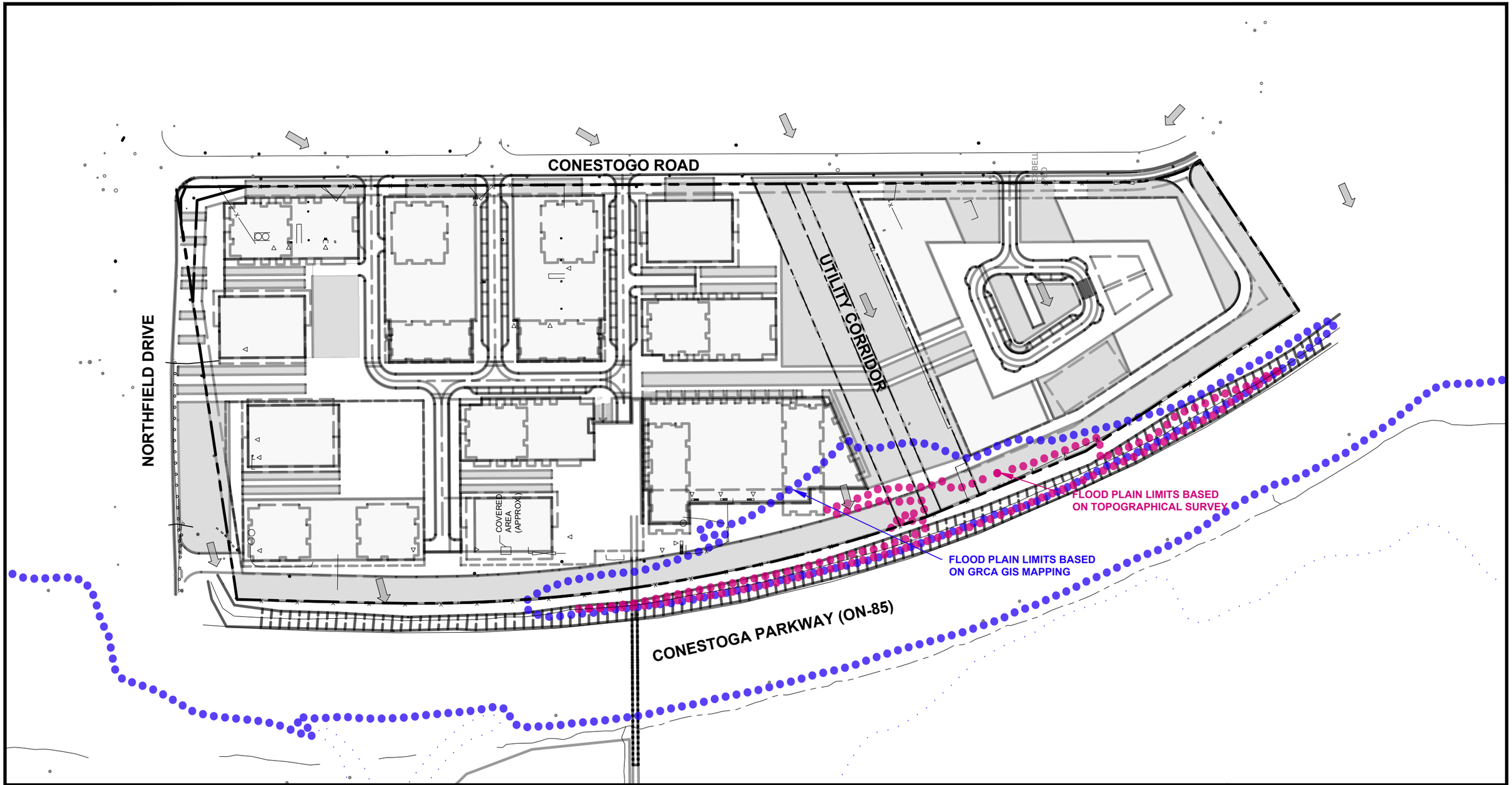
0 30 60 120 180 Metres

N

NAD 1983 UTM Zone 17N

Scale: 5,113



project:
NORTHFIELD PROPERTIES LP
525-565 CONESTOGO ROAD

title:
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drawn by:	R.K.	project no.:	2019-0000-00
checked by:	R.K.	file:	2019-0654-10 EX-FLOOD
sheet no.:	FIG-5		

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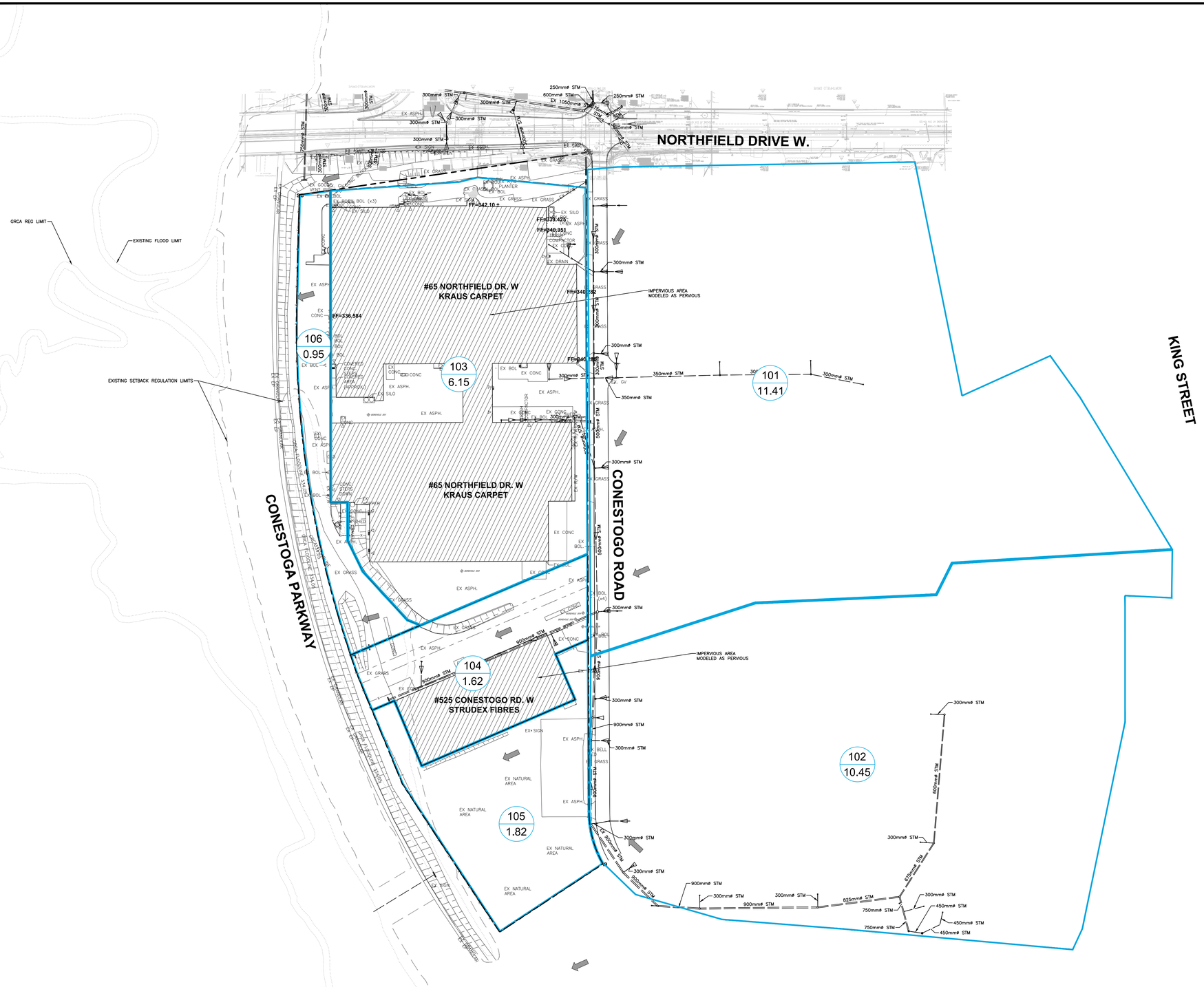

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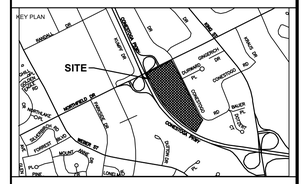

TRUE NORTH

PROJECT NORTH

DATE	ISSUANCE	NO.

LEGEND

EX CB	EXISTING CATCHBASIN
EX DCB	EXISTING DOUBLE CATCHBASIN
EX DI	EXISTING DITCH INLET CATCHBASIN
EX MH	EXISTING STORM MANHOLE
EX CBMH	EXISTING CATCHBASIN MANHOLE
EX DCBMH	EXISTING DOUBLE CBMH
EX STORM SERVICE	EXISTING STORM SERVICE
OVERLAND FLOW ROUTE	OVERLAND FLOW ROUTE
EXISTING/PROPOSED STORM DRAINAGE AREA	EXISTING/PROPOSED STORM DRAINAGE AREA
10	REACH #
0.75	AREA IN HECTARES

CLIENT

NORTHFIELD PROPERTIES LP.

65 NORTHFIELD DR. WATERLOO, ON

PROJECT

FORMER KRAUS CARPET LANDS

525-565 CONESTOGO RD.

TITLE

EXISTING STORM CATCHMENT AREAS

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CHECKED BY:	RK

SHEET NO.:

FIG-6

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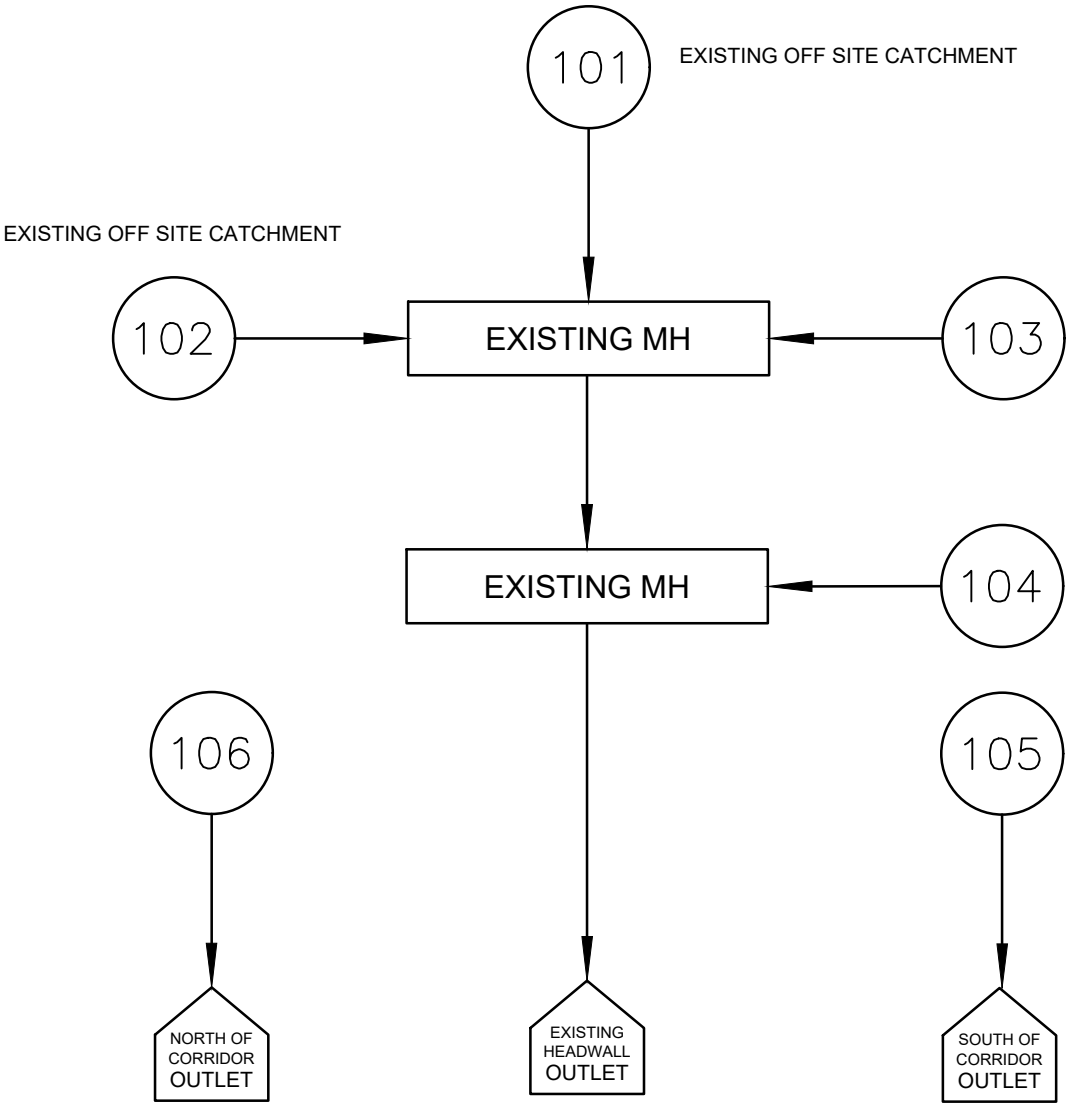

project:
NORTHFIELD PROPERTIES LP
WATERLOO, ONTARIO

title:
HYDROLOGIC MODEL SCHEMATIC
EXISTING CONDITIONS - PCSWMM

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checked by:	RK	file:	2018-0654-10_FIG_SCHEMATIC

sheet no.:
FIG 7.0

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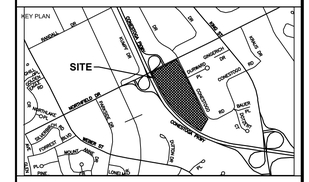

TRUE NORTH

PROJECT NORTH

DATE	ISSUANCE	NO.

LEGEND

- EXISTING CATCHBASIN
- EXISTING DOUBLE CATCHBASIN
- EXISTING DITCH INLET CATCHBASIN
- EXISTING STORM MANHOLE
- EXISTING CATCHBASIN MANHOLE
- EXISTING DOUBLE CBMH
- EXISTING STORM SERVICE
- OVERLAND FLOW ROUTE
- EXISTING/PROPOSED STORM DRAINAGE AREA
- 10 / 0.75 — REACH # / AREA IN HECTARES

CLIENT

NORTHFIELD PROPERTIES LP.

65 NORTHFIELD DR. WATERLOO, ON

PROJECT

FORMER KRAUS
CARPET LANDS

525-565 CONESTOGO RD.

TITLE

PROPOSED STORM
CATCHMENT AREAS

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CHECKED BY:	RK

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FIG-8

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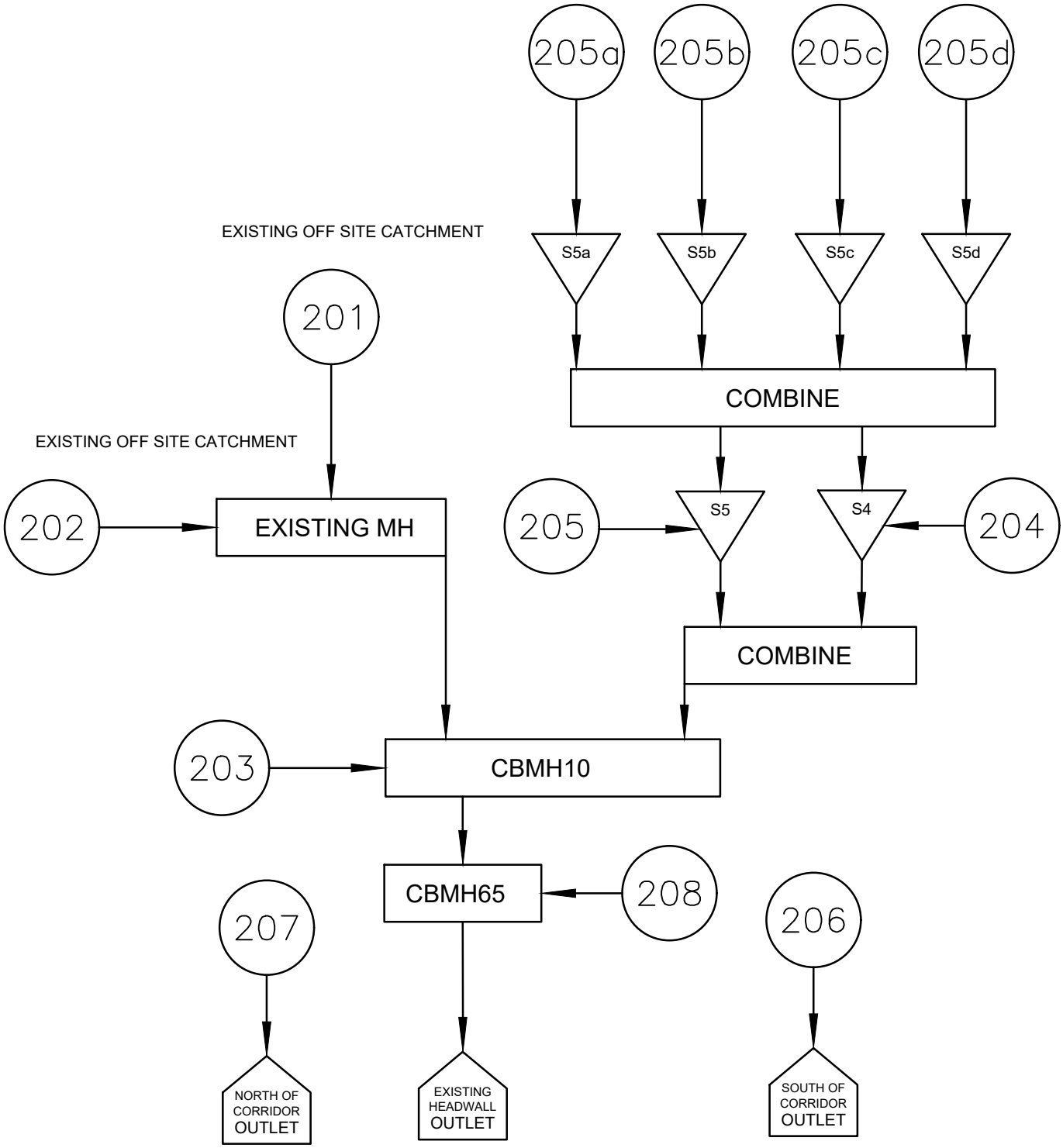

project:
NORTHFIELD PROPOERTIES LP
WATERLOO, ONTARIO

title:
HYDROLOGIC MODEL SCHEMATIC
PROPOSED CONDITIONS - PCSWMM

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drawn by:	MS	project no.:	2018-0654-10
checked by:	RK	file:	2018-0654-10_FIG_SCHEMATIC

sheet no.:
FIG 9.0

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TABLES

- Table 1 Design Storm Parameters
- Table 2 Sub-catchment Parameters
- Table 3 Runoff Volume Summary
- Table 4 Peak Flow Summary
- Table 5 Routing Performance Summary
- Table 6 Peak Flow Comparison at Outlets
- Table 7 Water Quality Summary

TABLE 1
DESIGN STORM PARAMETERS

FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT REPORT
NORTHFIELD PROPERTIES LP
WATERLOO, ONTARIO

		Design Storms		
Parameter		**2-Year**	**5-Year**	**100-Year**
IDF Parameters	A	1101	1755	4692
	B	9.258	12.347	17.437
	C	0.882	0.895	0.956
Time-to-peak ratio	r	0.4	0.4	0.4
Duration (minutes)	D	180	180	180

TABLE 2
EXISTING AND PROPOSED CONDITIONS SUB-CATCHMENT PARAMETERS

FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT REPORT
NORTHFIELD PROPERTIES LP
WATERLOO, ONTARIO

Subcatchment	Comment	Area (ha)	Percent Impervious (%)	Width (m)	Flow Length (m)	Slope (%)	Mannings Roughness		Pervious Curve Number	Depression Storage		Percent Zero Impervious (%)	Subarea Routing	Percent Routed (%)
							Impervious	Pervious		Impervious (mm)	Pervious (mm)			
Existing - To Forwell Creek														
101	Existing offsite catchment	11.41	70	1141	100	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
102	Existing offsite catchment	10.45	70	1045	100	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
103	Existing Kraus Carpet buildings north of hydro corridor	6.15	75	615	100	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
104	Hydro corridor and building roof south of corridor	1.62	50	324	50	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
105	Area south of hydro corridor	1.82	15	364	50	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
106	Area west of Kraus Carpet buildings north of hydro corridor	0.95	80	475	20	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
Total		**32.40**	**67**											
Proposed - To Forwell Creek														
201	Existing offsite catchment	11.41	73	1141	100	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
202	Existing offsite catchment	10.45	73	1045	100	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
203	Area to be developed north of hydro corridor	5.80	93	1450	40	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
204	Hydro corridor	0.68	80	170	40	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
205	Area to be developed south of hydro corridor	1.25	60	313	40	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
205a	Rooftop	0.15	100	76	20	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
205b	Rooftop	0.15	100	76	20	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
205c	Rooftop	0.15	100	76	20	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
205d	Rooftop	0.15	100	76	20	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
206	Area west of area to be developed south of hydro corridor	0.58	15	290	20	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
207	Area west of area to be developed north of hydro corridor	0.97	50	485	20	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
208	Hydro corridor	0.65	80	163	40	2.0	0.015	0.250	80	0.05	6.35	25	OUTLET	100
Total		**32.40**	**75**											

TABLE 3
RUNOFF VOLUME SUMMARY

FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT REPORT
NORTHFIELD PROPERTIES LP
WATERLOO, ONTARIO

Subcatchment	Chicago Design Storms		
	2-year (m^3)	5-year (m^3)	100-year (m^3)
Existing - To Forwell Creek			
Existing Headwall at Hydro Corridor			
101	2728	4256	8770
102	2499	3898	8032
103	1561	2404	4869
104	293	491	1100
South of Hydro Corridor			
105	140	322	942
North of Hydro Corridor			
106	255	388	774
Proposed - To Forwell Creek			
Existing Headwall at Hydro Corridor			
201	2728	4256	8770
202	2499	3898	8032
203	1726	2572	4980
204	173	266	539
205	209	358	823
205a	50	73	137
205b	50	73	137
205c	50	73	137
205d	50	73	137
208	165	255	515
South of Hydro Corridor			
206	47	107	305
North of Hydro Corridor			
207	177	296	662
Total			
Existing	7476	11759	24486
Proposed	7922	12299	25174
Difference	6%	5%	3%

TABLE 4
PEAK FLOW SUMMARY

FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT REPORT
NORTHFIELD PROPERTIES LP
WATERLOO, ONTARIO

Subcatchment	Chicago Design Storms		
	2-Year (m^3/s)	5-Year (m^3/s)	100-Year (m^3/s)
Existing - To Forwell Creek			
Existing Headwall at Hydro Corridor			
101	2.13	2.85	5.61
102	1.95	2.61	5.14
103	1.22	1.63	3.20
104	0.24	0.31	0.66
South of Hydro Corridor			
105	0.08	0.11	0.35
North of Hydro Corridor			
106	0.22	0.29	0.57
Proposed - To Forwell Creek			
Existing Headwall at Hydro Corridor			
201	2.13	2.85	5.61
202	1.95	2.61	5.14
203	1.49	1.96	3.67
204	0.15	0.19	0.38
205	0.16	0.22	0.49
205a	0.04	0.06	0.10
205b	0.04	0.06	0.10
205c	0.04	0.06	0.10
205d	0.04	0.06	0.10
208	0.14	0.18	0.37
South of Hydro Corridor			
206	0.03	0.03	0.15
North of Hydro Corridor			
207	0.14	0.19	0.45

TABLE 5
ROUTING PERFORMANCE SUMMARY
PROPOSED CONDITIONS

FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT REPORT
NORTHFIELD PROPERTIES LP
WATERLOO, ONTARIO

PCSWMM ID	Design Storm	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)	Total Inflow Volume (m^3)	Max. Storage Volume (m^3)	Max. Level (m)	Max. Surface Ponding Depth (m)
Roof Storage							
S5a							
	2-year	0.042	0.003	49.5	33	349.44	0.04
	5-year	0.056	0.003	72.6	62	349.46	0.06
	100-year	0.100	0.006	139	121	349.50	0.10
S5b							
	2-year	0.042	0.003	49.5	33	349.44	0.04
	5-year	0.056	0.003	72.6	62	349.46	0.06
	100-year	0.100	0.006	139	121	349.50	0.10
S5c							
	2-year	0.042	0.003	49.5	33	349.44	0.04
	5-year	0.056	0.003	72.6	62	349.46	0.06
	100-year	0.100	0.006	139	121	349.50	0.10
S5d							
	2-year	0.042	0.003	49.5	33	349.44	0.04
	5-year	0.056	0.003	72.6	62	349.46	0.06
	100-year	0.100	0.006	139	121	349.50	0.10
Parking Lot Storage							
S5							
	2-year	0.176	0.071	407	101	336.16	0.16
	5-year	0.228	0.091	649	185	336.21	0.21
	100-year	0.485	0.334	1390	285	336.25	0.25
S4							
	2-year	0.147	0.071	173	48	336.19	0.19
	5-year	0.193	0.080	266	89	336.25	0.25
	100-year	0.383	0.309	539	127	336.30	0.30

TABLE 6
PEAK FLOW COMPARISON AT SITE OUTLETS

FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT REPORT
NORTHFIELD PROPERTIES LP
WATERLOO, ONTARIO

Design Storm Event	Peak Flow		
	Existing (m^3/s)	Proposed (m^3/s)	Change (%)
North of Hydro Corridor			
2-year	0.222	0.142	-36%
5-year	0.291	0.187	-36%
100-year	0.575	0.449	-22%
Existing Headwall at Hydro Corridor			
2-year	4.605	4.603	0%
5-year	5.396	5.310	-2%
100-year	9.974	9.238	-7%
South of Hydro Corridor			
2-year	0.080	0.026	-68%
5-year	0.106	0.035	-67%
100-year	0.347	0.152	-56%

1. Flood elevations within Forwell Creek have been included at model outlets as per HEC RAS modelling (2 yr = 333.235, 5 yr = 333.455, 100 yr = 334.075 masl)

TABLE 7
WATER QUALITY SUMMARY

FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT REPORT
NORTHFIELD PROPERTIES LP
WATERLOO, ONTARIO

Areas Contributing

Subcatchment ID	Area (ha)	Percent Impervious (%)
Roof Ponding (S5a, S5b, S5c, S5d) and OGS2		
205a	0.152	100
205b	0.152	100
205c	0.152	100
205d	0.152	100
Total	**0.607**	**100**
South Parking Lot Ponding (S5) and OGS2		
205	1.253	45
CBMH63 Ponding (S4) and OGS2		
204	0.680	75
OGS1		
203	5.800	90
OGS3		
206	0.580	15
Other		
207	0.970	50
208	0.650	75
Total	**2.200**	**48**

MOE SWM Design Manual Table 3.2

Protection Level	SWMP Type	Storage Volume (m^3/ha) for Impervious Level			
		35%	*55%*	*70%*	*85%*
Basic (60% long-term S.S. removal)	Infiltration	20	20	20	20
	Wetlands	60	60	60	60
	Hybrid Wet Pond/Wetland	60	70	75	80
	Wet Pond	60	75	85	95
	Dry Pond (Continuous Flow)	90	150	200	240

1. Galleries are represented by dry ponds for basix (60% long-term S.S. Removal)

Roof Ponding (S5a, S5b, S5c, S5d) and OGS2

Contributing Drainage Area =	0.607	ha
Impervious Level =	100.0	%
Percentage of Total Site =	5.8	%
Total Required Water Quality Storage Volume Per Hectare =	285	m^3/ha
Total Required Water Quality Storage Volume =	173	m^3
Total Provided Storage Volume =	**911**	**m^3**

South Parking Lot Ponding (S5) and

Contributing Drainage Area =	1.253	ha
Impervious Level =	45.0	%
Percentage of Total Site =	11.9	%
Total Required Water Quality Storage Volume Per Hectare =	120	m^3/ha
Total Required Water Quality Storage Volume =	150	m^3
Total Provided Storage Volume =	**484**	**m^3**

CBMH63 Ponding (S4) and OGS2

Contributing Drainage Area =	0.680	ha
Impervious Level =	75.0	%
Percentage of Total Site =	6.5	%
Total Required Water Quality Storage Volume Per Hectare =	210	m^3/ha
Total Required Water Quality Storage Volume =	143	m^3
Total Provided Storage Volume =	**263**	**m^3**

North of Hydro Corridor: OGS1 (MH

Designed TSS Removal Efficiency =	80	%
Contributing Drainage Area =	5.80	ha
Percentage of Total Site =	55	%
Removal Efficiency =	44	%

South of Hydro Corridor: Surface Ponding

Primary Treatment: Gallery TSS removal Efficiency =	60	%
Contributing Drainage Area =	2.54	ha
Percentage of Total Site =	24	%
Removal Efficiency =	14	%
Remaining Influent to be Treated =	10	%

South of Hydro Corridor: OGS2

Secondary Treatment: OGS TSS Removal Efficiency =	80	%
Percentage of Total Site Remaining =	10	%
Total OGS Removal Efficiency =	8	%

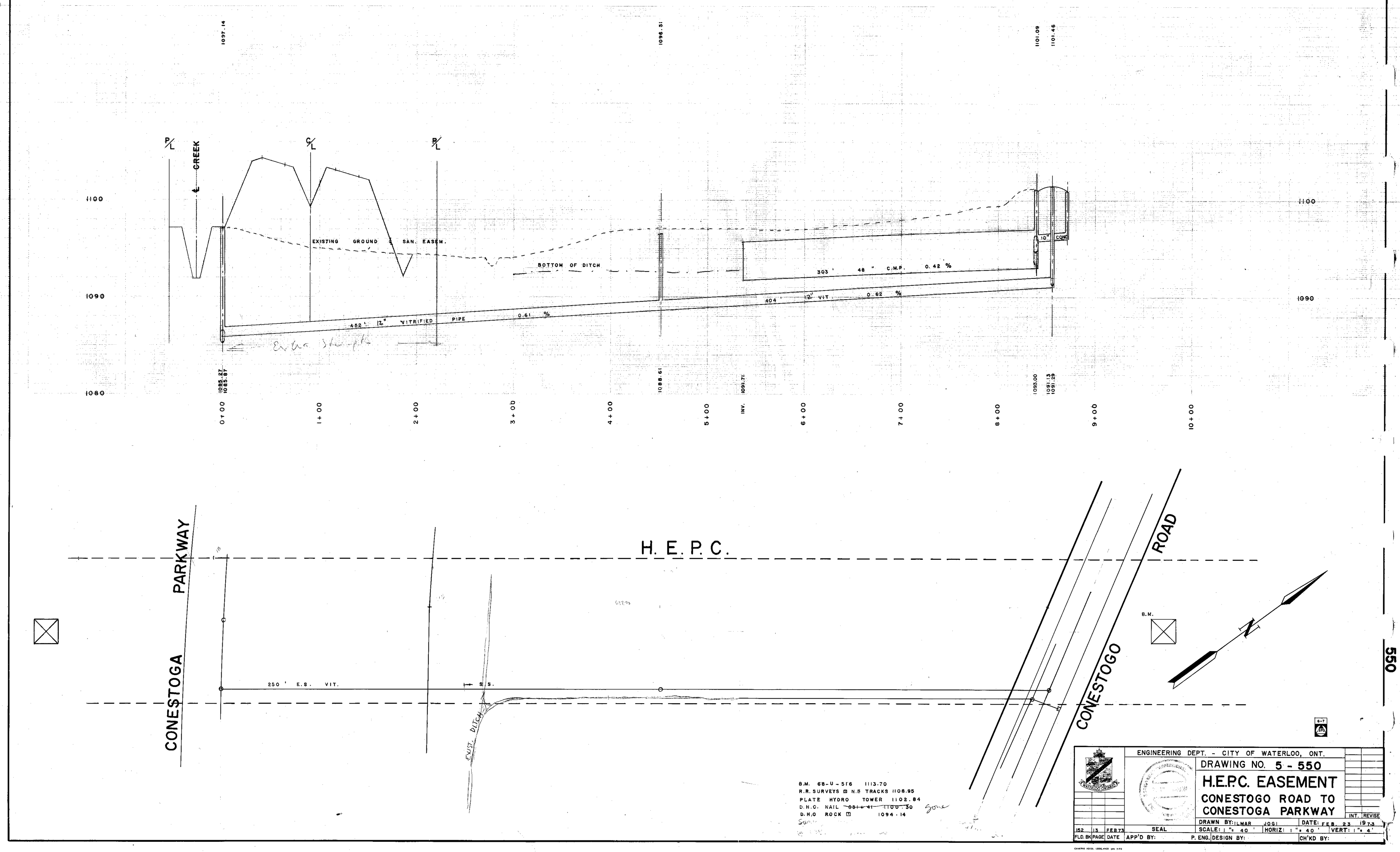
South of Hydro Corridor: OGS3

Secondary Treatment: OGS TSS Removal Efficiency =	80	%
Contributing Drainage Area =	0.650	ha
Percentage of Total Site =	6	%
Total OGS Removal Efficiency =	5	%
Total Site Removal Efficiency =	**71**	**%**

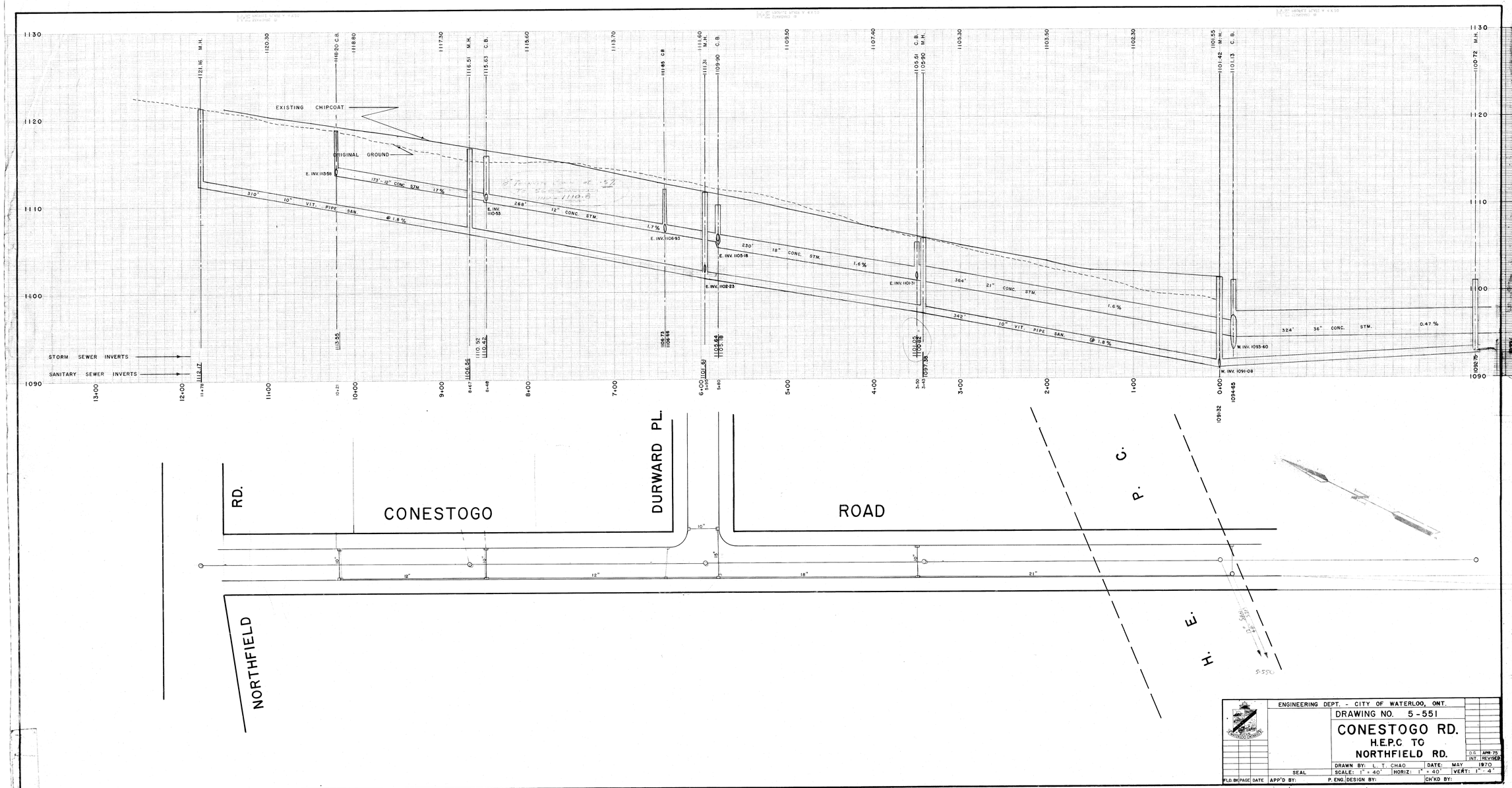
APPENDIX A

Existing Utility Information

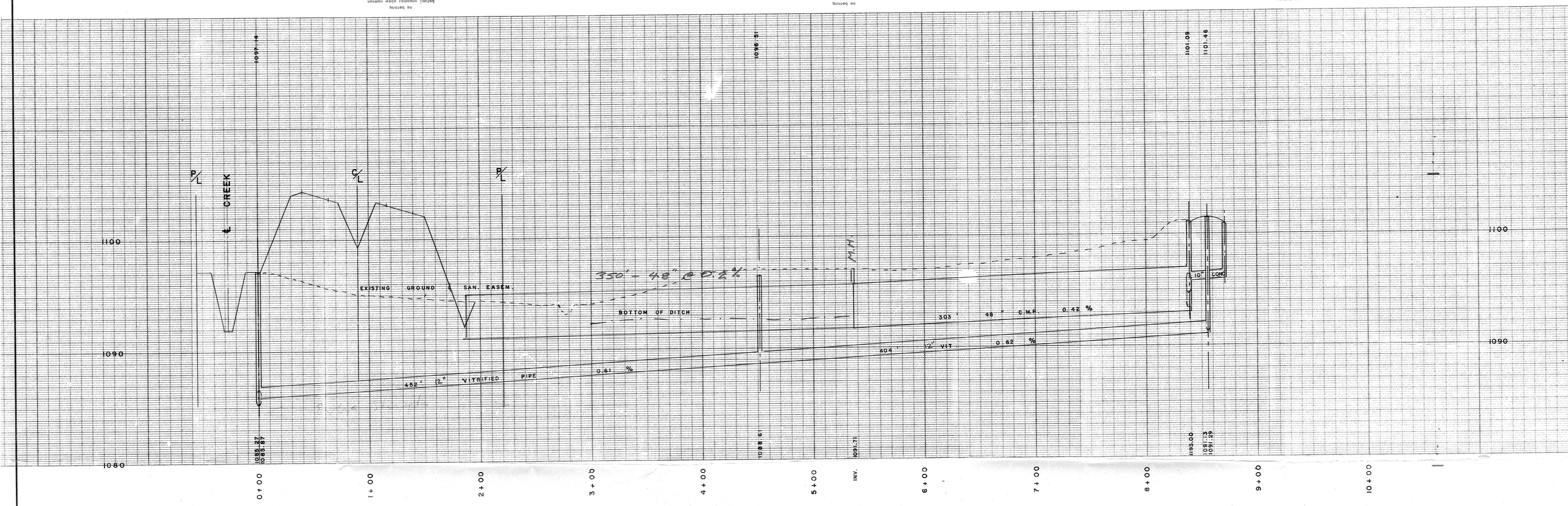
- City of Waterloo Plan and Profiles
- Region of Waterloo Plan and Profiles
- Region of Waterloo Street Lighting Locates
- Enbridge Gas Locates
- Bell Canada Locates
- Rogers Communications Locates
- Waterloo North Hydro Servicing

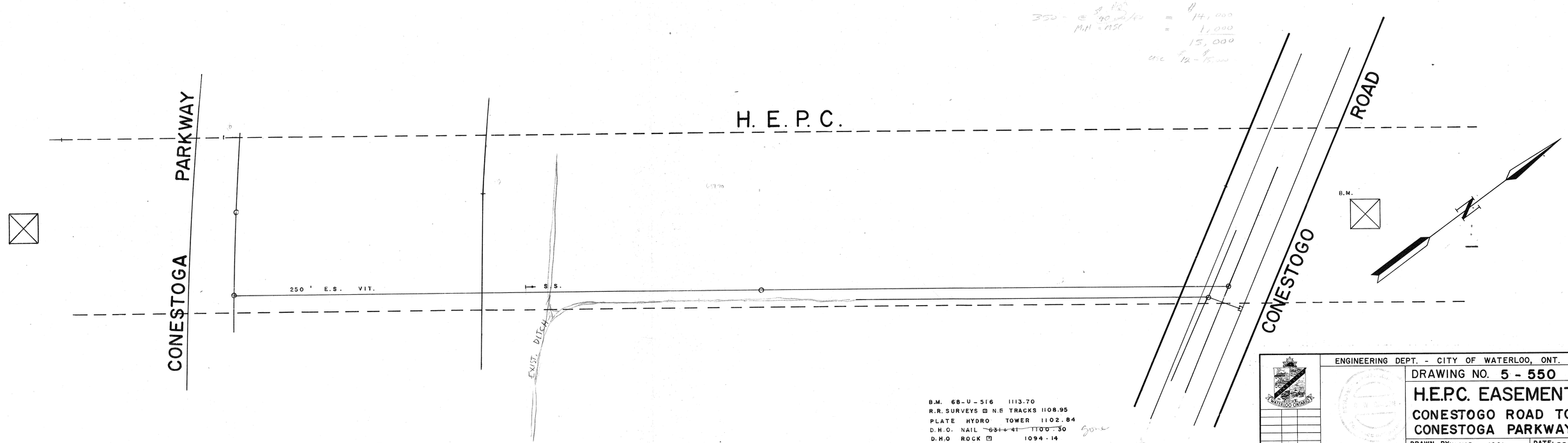


1097.14
1096.51
1101.09
1101.46
P/L
℄ CREEK
C/L
P/L
1100
1090
1080
EXISTING GROUND ℄ SAN. EASEM.
BOTTOM OF DITCH
303' 48" C.M.P. 0.42 %
10" CONC
404' 12" VIT. 0.62 %
452' 12" VITRIFIED PIPE 0.61 %
1085.27
1085.87
1088.61
1091.71
1093.00
1091.13
1091.29
0+00
1+00
2+00
3+00
4+00
5+00
INV.
6+00
7+00
8+00
9+00
10+00
H. E. P. C.
CONESTOGA PARKWAY
CONESTOGO ROAD
250' E.S. VIT.
S.S.
EXIST. DITCH
B.M.
N
B.M. 68-U-516 1113.70
R.R. SURVEYS ⊡ N.E TRACKS 1108.95
PLATE HYDRO TOWER 1102.84
D.H.O. NAIL ~~631+41 1100.30~~ Gone
D.H.O ROCK ⊡ 1094.14
ENGINEERING DEPT. - CITY OF WATERLOO, ONT.
DRAWING NO. 5 - 550
H.E.P.C. EASEMENT
CONESTOGO ROAD TO
CONESTOGA PARKWAY
INT. REVISE
DRAWN BY: ILMAR JOGI
DATE: FEB. 23 1973
SCALE: 1" = 40'
HORIZ: 1" = 40'
VERT: 1" = 4'
SEAL
APP'D BY:
P. ENG.
DESIGN BY:
CH'KD BY:
152 13 FEB 73
FLD. BK PAGE DATE
550


EXISTING CHIPCOAT
ORIGINAL GROUND
STORM SEWER INVERTS
SANITARY SEWER INVERTS
173' - 12" CONC. STM. 1.7%
310' 10" VIT. PIPE SAN. @ 1.8%
268' 12" CONC. STM. 1.7%
230' 18" CONC. STM. 1.6%
364' 21" CONC. STM. 1.6%
342' 10" VIT. PIPE SAN. @ 1.8%
324' 36" CONC. STM. 0.47%
CONESTOGO
ROAD
DURWARD PL.
RD.
NORTHFIELD
H. E. P. C.
ENGINEERING DEPT. - CITY OF WATERLOO, ONT.
DRAWING NO. 5-551
CONESTOGO RD.
H.E.P.C TO
NORTHFIELD RD.
DRAWN BY: L. T. CHAO
DATE: MAY 1970
SCALE: 1" = 40'
HORIZ: 1" = 40'
VERT: 1" = 4'
SEAL
APP'D BY:
P. ENG.
DESIGN BY:
CH'KD BY:
FLD. BK.
PAGE
DATE
D.G. APR-75
INT. REVISED

551





B.M. 68-U-516 1113.70
R.R. SURVEYS ⊡ N.E TRACKS 1108.95
PLATE HYDRO TOWER 1102.84
D.H.O. NAIL ~~631+41 1100.30~~
D.H.O ROCK ⊡ 1094.14

ENGINEERING DEPT. - CITY OF WATERLOO, ONT.

DRAWING NO. 5 - 550

H.E.P.C. EASEMENT

CONESTOGO ROAD TO CONESTOGA PARKWAY

FLD. BK	PAGE	DATE	APP'D BY:	P. ENG.	DESIGN BY:	CH'KD BY:
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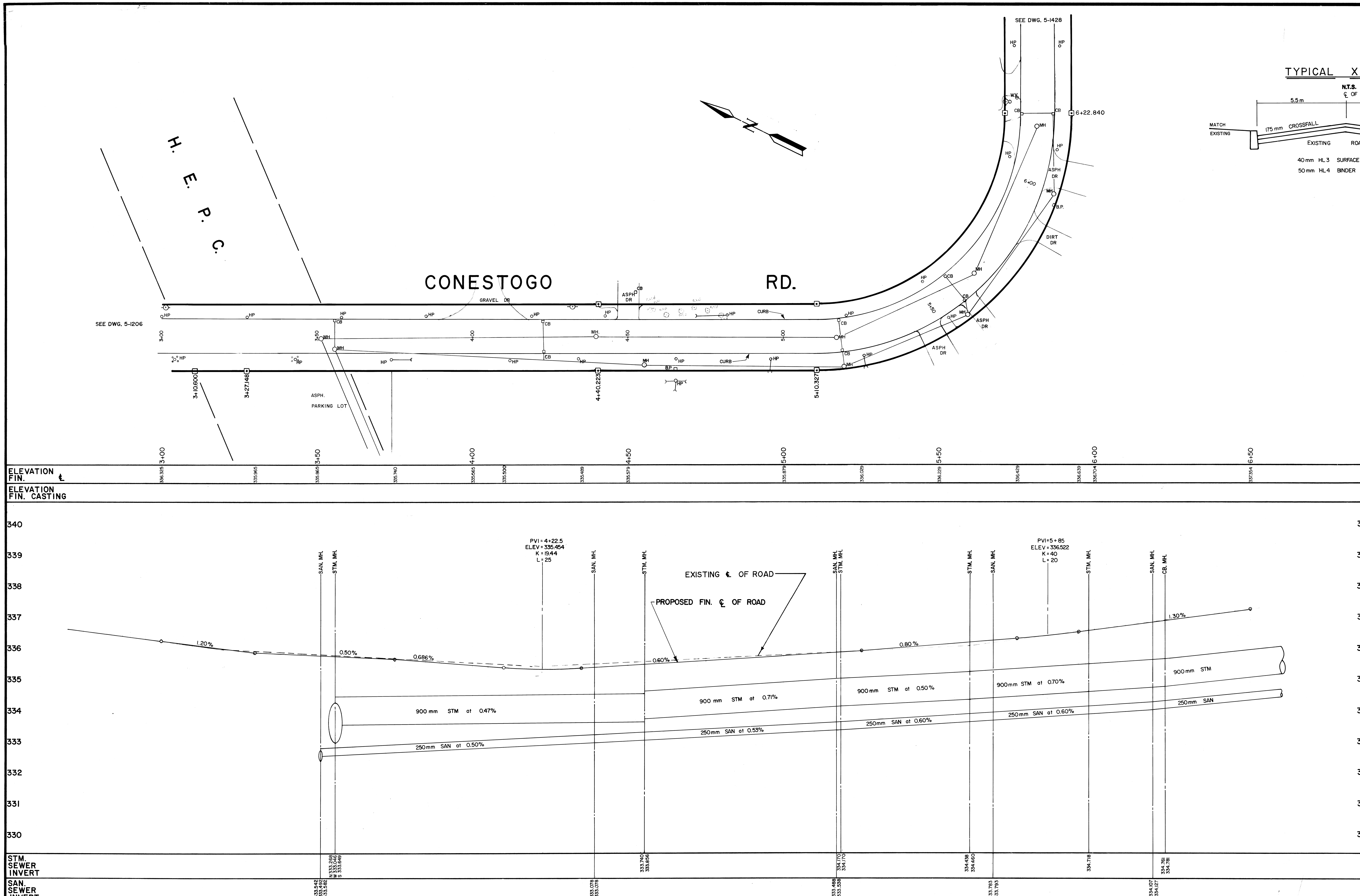
DRAWN BY: ILMAR JOGI DATE: FEB. 23
SCALE: 1" = 40' HORIZ: 1" = 40' VERT: 1" = 1



INT.	DATE	REVISIONS
D.H.K.	DEC 21/88	CORRECTED TYPO & INKED GIVEN INVERTS
D.H.K.	OCT 21/88	ADDED NEW ℄ of ROAD and NEW CURB

CITY OF WATERLOO
PUBLIC WORKS DEPARTMENT

REGISTERED PROFESSIONAL ENGINEER
P. G. LEMON
88 12 23
PROVINCE OF ONTARIO
SEAL

TITLE:

CONESTOGO RD.
H.E.P.C.
TO FIRST BEND

DATE: 88 04 26		DESIGNED BY: G.B.	
SCALE: HORIZ. 1:500 VERT. 1:50		DRAWN BY: L.C.	
		CHECKED BY:	
FIELD BK.	PAGE	DATE	DRAWING Nº
297	29		5-1427

6-7 SPD.

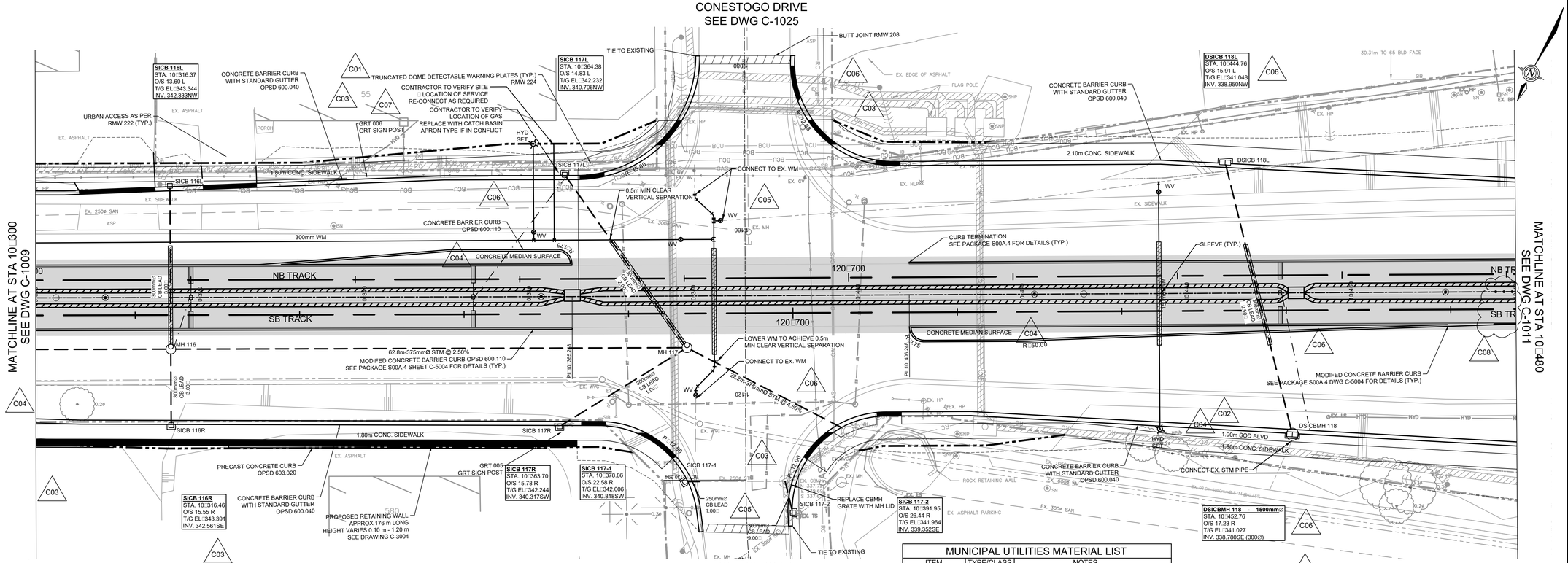
CONESTOGO DRIVE
SEE DWG C-1025

MATCHLINE AT STA 10□300
SEE DWG C-1009

MATCHLINE AT STA 10□480
SEE DWG C-1011

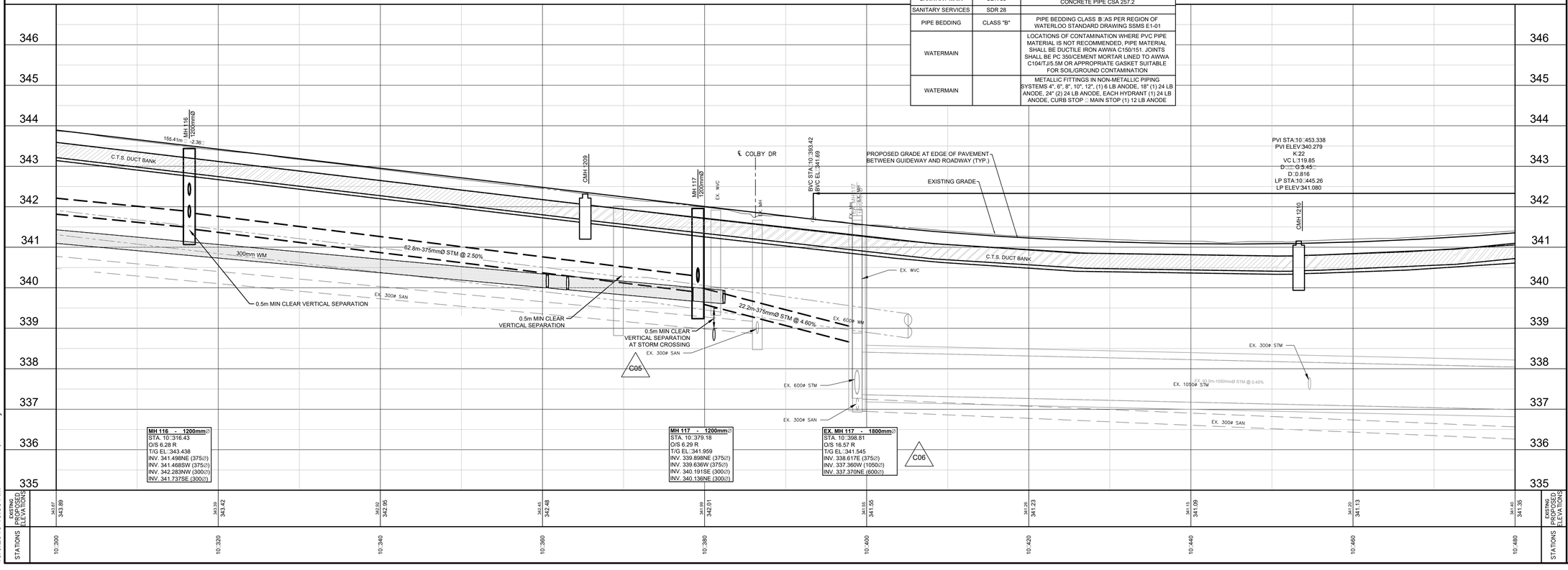
COLBY ROAD
SEE DWG C-1025

NORTHFIELD DRIVE



MUNICIPAL UTILITIES MATERIAL LIST

ITEM	TYPE/CLASS	NOTES
WATERMAIN	DR 18	
WATER SERVICES	DR 18	
STORM MAIN	SDR 35	GREATER THAN 450mm WILL BE REINFORCED CONCRETE PIPE CSA 257.2
STORM LEADS	SDR 35	
SANITARY MAIN	SDR 35	GREATER THAN 375mm WILL BE REINFORCED CONCRETE PIPE CSA 257.2
SANITARY SERVICES	SDR 28	
PIPE BEDDING	CLASS "B"	PIPE BEDDING CLASS 'B' AS PER REGION OF WATERLOO STANDARD DRAWING SSMS E1-01
WATERMAIN		LOCATIONS OF CONTAMINATION WHERE PVC PIPE MATERIAL IS NOT RECOMMENDED, PIPE MATERIAL SHALL BE DUCTILE IRON AWWA C150/151. JOINTS SHALL BE PC 350/CEMENT MORTAR LINED TO AWWA C104/T.I/5.5M OR APPROPRIATE GASKET SUITABLE FOR SOIL/GROUND CONTAMINATION
WATERMAIN		METALLIC FITTINGS IN NON-METALLIC PIPING SYSTEMS 4", 6", 8", 10", 12", (1) 6 LB ANODE, 18" (1) 24 LB ANODE, 24" (2) 24 LB ANODE. EACH HYDRANT (1) 24 LB ANODE, CURB STOP □ MAIN STOP (1) 12 LB ANODE



STATIONS	EXISTING ELEVATIONS	PROPOSED ELEVATIONS
10□300	343.87	343.89
10□320	343.19	343.42
10□340	342.60	342.95
10□360	342.45	342.48
10□380	341.99	342.01
10□400	341.55	341.55
10□420	341.26	341.23
10□440	341.15	341.09
10□460	341.20	341.13
10□480	341.40	341.35

PACKAGE NAME□

KING STREET □ NORTHFIELD DRIVE
CIVIL □ SYSTEMS

DISCLAIMER□
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DO NOT SCALE THIS DOCUMENT. ALL MEASUREMENTS MUST BE OBTAINED FROM STATED DIMENSIONS.

LEGEND□
- ℄ PROPOSED TRACK
- ℄ PROPOSED ROAD
- PROPOSED CURB
- PROPOSED DROPPED CURB
- PROPOSED RETAINING WALL
- PROPOSED GRADING LIMIT
- EXISTING R.O.W.
- PROPOSED R.O.W.
- UTILITY EXCLUSION □ONE
- FLOODLINE
- WETLAND LIMITS
- CONTAMINATION LIMITS
- OVERHEAD CONTACT SYSTEM

NOTES
1. MANHOLE LIDS AND LADDERS TO BE ORIENTATED AS SHOWN ON THE DRAWINGS.
2. CONTRACTOR TO VERIFY ALL SERVICE CONNECTIONS. DRAWINGS TO BE READ IN CONJUNCTION WITH CCTV FOR SANITARY/STORM PRE-CONSTRUCTION SURVEY.
3. SAWCUTTING OF EXISTING SIDEWALK TO BE AT JOINTS OR FULL PANELS REMOVED.
4. CONNECTIONS TO EXISTING CURBING TO BE CONFIGURED WITH COUNTERSUNK DOWELS WHERE REQUIRED. REFER TO SECTION 00A.04 PROJECT WIDE CIVIL
5. TRACK SIDE CATCH BASINS AND DOUBLE BASINS AT MOUNTABLE CURB WITH WIDE GUTTER, FRAMES TO BE OPSD 400.030.
6. CATHODIC PROTECTION SHALL BE AS PER SECTION 26 42 00 CATHODIC PROTECTION OF THE PROJECT SPECIFICATIONS AND DRAWING PACKAGE.
7. ANODES AS PER MUNICIPAL UTILITIES MATERIAL TABLE
8. CONNECTION DETAILS FOR TRACK DRAINS TO CB'S REFER TO CIVIL TRACK DRAWINGS.

D. J. McLEOD
REGISTERED PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO
STAMP□

Region of Waterloo

GRANDLINQ

REV	DESCRIPTION	BY	DATE
C08	RELEASED FOR CONSTRUCTION	TOR	2016-10-07
C07	RELEASED FOR CONSTRUCTION	TOR	2016-05-19
C06	RELEASED FOR CONSTRUCTION	TOR	2015-12-10
C05	RELEASED FOR CONSTRUCTION	TOR	2015-11-06
C04	RELEASED FOR CONSTRUCTION	TOR	2015-09-10
C03	RELEASED FOR CONSTRUCTION	TOR	2015-07-09
C02	RELEASED FOR CONSTRUCTION	TOR	2015-05-26
C01	RELEASED FOR CONSTRUCTION	TOR	2015-05-12

REGION OF WATERLOO
STAGE I
LRT PROJECT

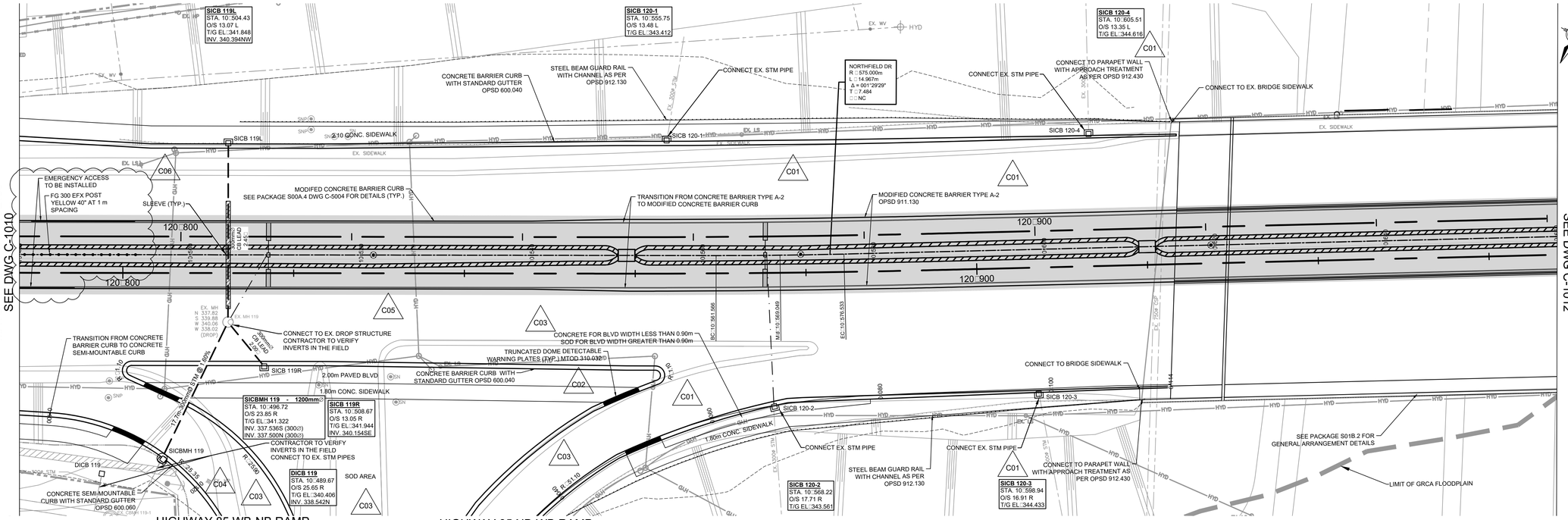
CIVIL ROADS/MUNICIPAL UTILITIES
PROPOSED NORTHFIELD DRIVE
STA 10□300 TO STA 10□480

DRAWN BY□	DESIGNED BY□	CHECKED BY□	SCALE□
CA/VY	CA/VY	DM/AS	HOR. 1:250 VERT. 1:50

PACKAGE□	DRAWING N□	SHEET□	REV.
S01B.1	C-1010	OF	C08

CADD FILE□ S-121-C-1010.d□□

10/6/2016 10:36 AM Reinert, Zachary



MUNICIPAL UTILITIES MATERIAL LIST

ITEM	TYPE/CLASS	NOTES
WATERMAIN	DR 18	
WATER SERVICES	DR 18	
STORM MAIN	SDR 35	GREATER THAN 450mm WILL BE REINFORCED CONCRETE PIPE CSA 257.2
STORM LEADS	SDR 35	
SANITARY MAIN	SDR 35	GREATER THAN 375mm WILL BE REINFORCED CONCRETE PIPE CSA 257.2
SANITARY SERVICES	SDR 28	
PIPE BEDDING	CLASS "B"	PIPE BEDDING CLASS B□AS PER REGION OF WATERLOO STANDARD DRAWING SSMS E1-01
WATERMAIN		LOCATIONS OF CONTAMINATION WHERE PVC PIPE MATERIAL IS NOT RECOMMENDED, PIPE MATERIAL SHALL BE DUCTILE IRON AWWA C150/151. JOINTS SHALL BE PC 350/CEMENT MORTAR LINED TO AWWA C104/TJ/5.5M OR APPROPRIATE GASKET SUITABLE FOR SOIL/GROUND CONTAMINATION
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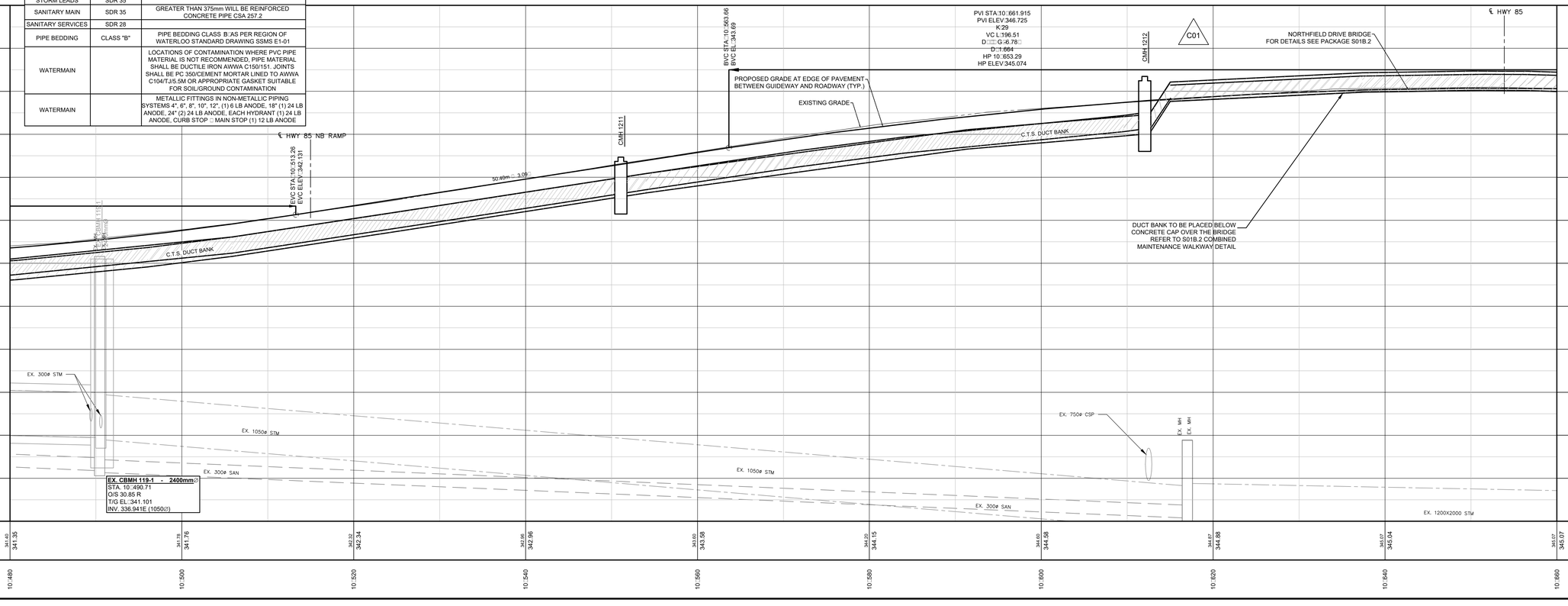

Reinert, Zachary
10/6/2016 11:03 AM

PACKAGE NAME□

KING STREET □ NORTHFIELD DRIVE
CIVIL □ SYSTEMS

DISCLAIMER□
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LEGEND□

- ℄ PROPOSED TRACK
- ℄ PROPOSED ROAD
- PROPOSED CURB
- PROPOSED DROPPED CURB
- PROPOSED RETAINING WALL
- PROPOSED GRADING LIMIT
- EXISTING R.O.W.
- PROPOSED R.O.W.
- UTILITY EXCLUSION □ONE
- FLOODLINE
- WETLAND LIMITS
- CONTAMINATION LIMITS
- OVERHEAD CONTACT SYSTEM

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7. ANODES AS PER MUNICIPAL UTILITIES MATERIAL TABLE
8. CONNECTION DETAILS FOR TRACK DRAINS TO CB'S REFER TO CIVIL TRACK DRAWINGS.

D. J. McLEOD
OCT. 6/16
REGISTERED PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO

STAMP□

Region of Waterloo

GRANDLINQ

C06	RELEASED FOR CONSTRUCTION	TOR	2016-10-07
C05	RELEASED FOR CONSTRUCTION	TOR	2015-12-10
C04	RELEASED FOR CONSTRUCTION	TOR	2015-11-02
C03	RELEASED FOR CONSTRUCTION	TOR	2015-09-10
C02	RELEASED FOR CONSTRUCTION	TOR	2015-05-26
C01	RELEASED FOR CONSTRUCTION	TOR	2015-05-12
C00	RELEASED FOR CONSTRUCTION	TOR	2015-05-07
REV.	DESCRIPTION	BY	DATE

REGION OF WATERLOO
STAGE I
LRT PROJECT

CIVIL ROADS/MUNICIPAL UTILITIES
PROPOSED NORTHFIELD DRIVE
STA 10□480 TO STA 10□660

DRAWN BY□	DESIGNED BY□	CHECKED BY□	SCALE□
CA/VY	CA/VY	DM/AS	HOR. 1:250 VERT. 1:50

PACKAGE□	DRAWING N□	SHEET□	REV.
S01B.1	C-1011	OF	C06

CADD FILE□ S-121-C-1011.d□□

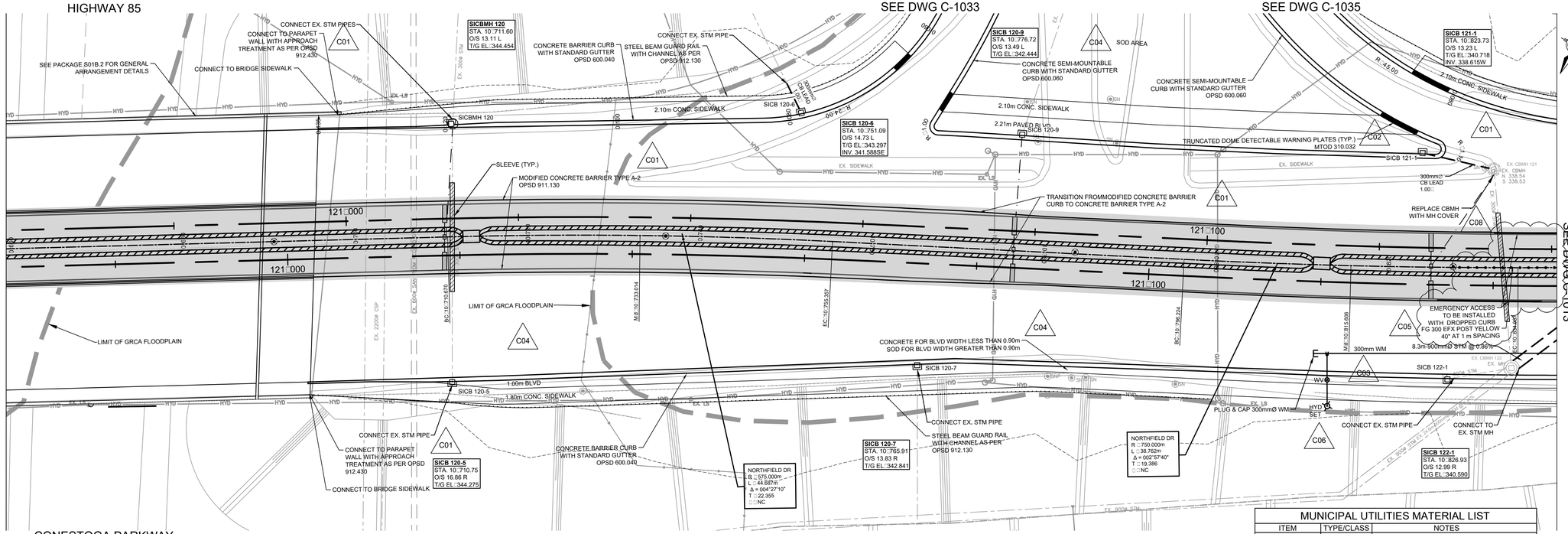
CONESTOGA PARKWAY
HIGHWAY 85

HIGHWAY 85 SB-EB RAMP
SEE DWG C-1033

HIGHWAY 85 EB-SB RAMP
SEE DWG C-1035

MATCHLINE AT STA 10□660
SEE DWG C-1011

MATCHLINE AT STA 10□840
SEE DWG C-1013



NORTHFIELD DRIVE

MUNICIPAL UTILITIES MATERIAL LIST

ITEM	TYPE/CLASS	NOTES
WATERMAIN	DR 18	
WATER SERVICES	DR 18	
STORM MAIN	SDR 35	GREATER THAN 450mm WILL BE REINFORCED CONCRETE PIPE CSA 257.2
STORM LEADS	SDR 35	
SANITARY MAIN	SDR 35	GREATER THAN 375mm WILL BE REINFORCED CONCRETE PIPE CSA 257.2
SANITARY SERVICES	SDR 28	
PIPE BEDDING	CLASS "B"	PIPE BEDDING CLASS B□AS PER REGION OF WATERLOO STANDARD DRAWING SSMS E1-01
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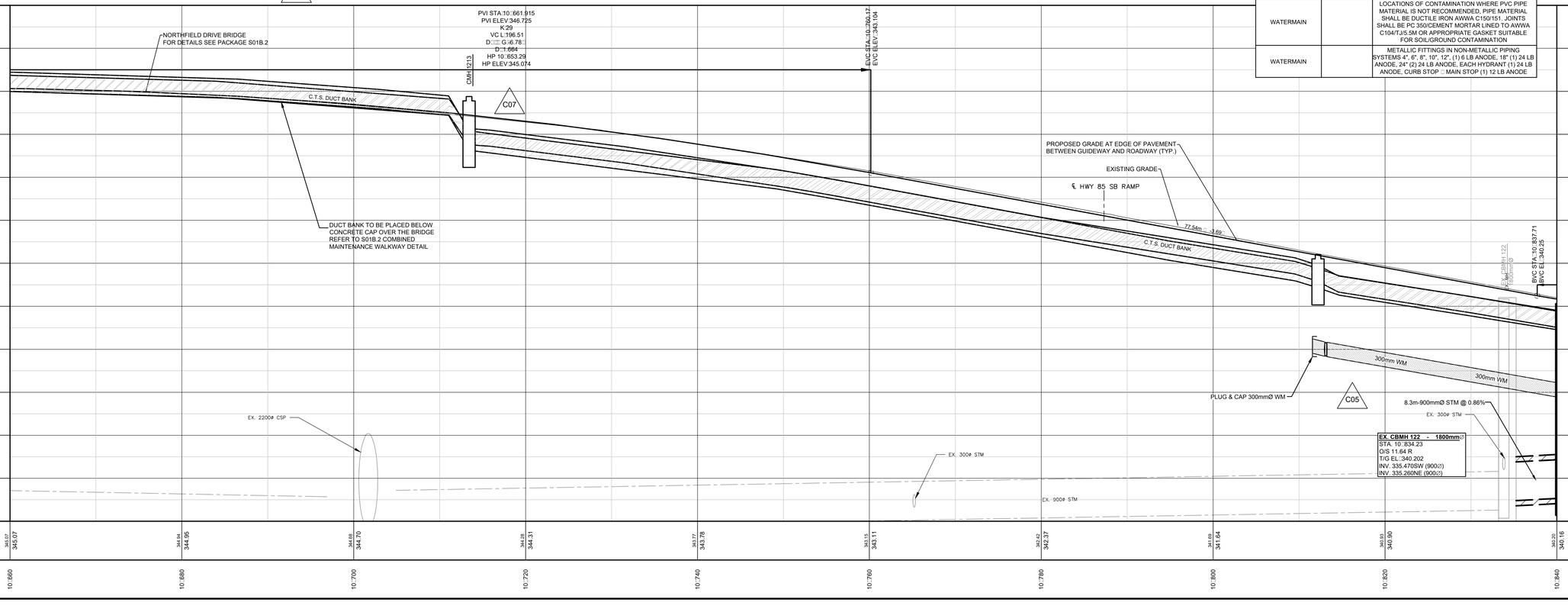

STATIONS	EXISTING	PROPOSED
10□660	346.07	345.07
10□680	344.96	344.95
10□700	344.66	344.70
10□720	344.26	344.31
10□740	343.77	343.78
10□760	343.15	343.11
10□780	342.42	342.37
10□800	341.69	341.64
10□820	340.93	340.90
10□840	340.20	340.16

PACKAGE NAME□

KING STREET □ NORTHFIELD DRIVE
CIVIL □ SYSTEMS

DISCLAIMER□
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LEGEND□

- ℄ PROPOSED TRACK
- ℄ PROPOSED ROAD
- PROPOSED CURB
- PROPOSED DROPPED CURB
- PROPOSED RETAINING WALL
- PROPOSED GRADING LIMIT
- EXISTING R.O.W.
- PROPOSED R.O.W.
- UTILITY EXCLUSION □ONE
- FLOODLINE
- WETLAND LIMITS
- CONTAMINATION LIMITS
- OVERHEAD CONTACT SYSTEM

NOTES
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8. CONNECTION DETAILS FOR TRACK DRAINS TO CB'S REFER TO CIVIL TRACK DRAWINGS.

STAMP□

Region of Waterloo

GRANDLINQ

C08	RELEASED FOR CONSTRUCTION	TOR	2016-10-07
C07	RELEASED FOR CONSTRUCTION	TOR	2016-06-06
C06	RELEASED FOR CONSTRUCTION	TOR	2015-12-10
C05	RELEASED FOR CONSTRUCTION	TOR	2015-10-30
C04	RELEASED FOR CONSTRUCTION	TOR	2015-09-10
C03	RELEASED FOR CONSTRUCTION	TOR	2015-07-09
C02	RELEASED FOR CONSTRUCTION	TOR	2015-05-26
C01	RELEASED FOR CONSTRUCTION	TOR	2015-05-12
REV	DESCRIPTION	BY	DATE

REGION OF WATERLOO
STAGE I
LRT PROJECT

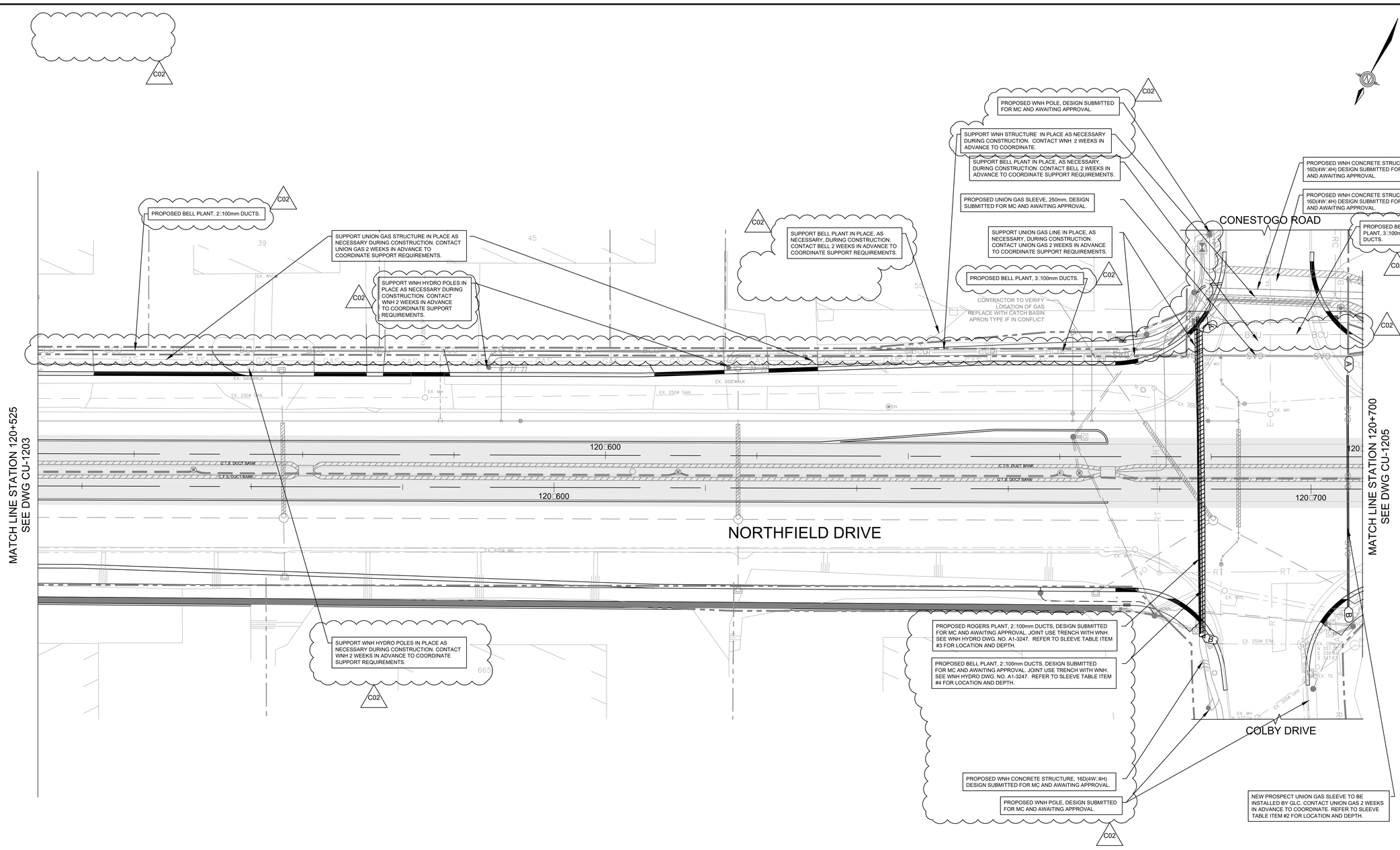
CIVIL ROADS/MUNICIPAL UTILITIES
PROPOSED NORTHFIELD DRIVE
STA 10□660 TO STA 10□840

DRAWN BY□	DESIGNED BY□	CHECKED BY□	SCALE□
CA/VY	CA/VY	DM/AS	HOR. 1:250 VERT. 1:50

PACKAGE□	DRAWING N□	SHEET□	REV.
S01B.1	C-1012	OF	C08

CADD FILE□ S-121-C-1012.d□□

10/6/2016 11:27 AM Reinert, Zachary



SLEEVE TABLE

ID #	OWNER	A EASTING	A NORTHING	A ELEVATION	B EASTING	B NORTHING	B ELEVATION	LENGTH	CROSSING DETAIL REFERENCE	CONFIGURATION	MATERIAL
1	WATERLOO NORTH HYDRO	537395.59	4816444.32	339.50	537377.08	4816480.42	339.50	41m	WNH DWG. NO. A1-3247	16D (4W□4H)	CONCRETE
2	UNION GAS	537361.67	4816468.10	339.45	537375.45	4816440.91	339.45	31m	N/A	150mm	STEEL, HEAVY WALL. SCH.40
3	ROGERS	537395.59	4816444.32	339.60	537377.08	4816480.42	339.60	41m	WNH DWG. NO. A1-3247	2□100mm	PVC - SCHED 80 OR DR25
4	BELL	537395.59	4816444.32	339.60	537377.08	4816480.42	339.60	41m	WNH DWG. NO. A1-3247	2□100mm	PVC - SCHED 80

NOTES□
1. SLEEVE ELEVATIONS ARE GIVEN FOR THE TOP OF THE STRUCTURE.

12.5 0 12.5 25m
SCALE 1□250

PACKAGE NAME□
KING STREET & NORTHFIELD DRIVE
CIVIL & SYSTEMS

DISCLAIMER□
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DO NOT SCALE THIS DOCUMENT. ALL MEASUREMENTS MUST BE OBTAINED FROM STATED DIMENSIONS.

LEGEND

- PROPOSED TRACK
- PROPOSED CULVERT
- PROPOSED RETAINING WALL
- EXISTING R.O.W.
- PROPOSED R.O.W.
- REMOVALS
- ALL STREAM LINE
- ATRIA FIBRE
- BELL LINE
- CITY OF WATERLOO
- GAS LINE
- HYDRO LINE
- ROGERS CABLE
- ROGERS FIBRE
- RES. IN MOTION
- TRAFFIC SIGNAL
- TELUS LINE
- U OF WATERLOO
- PROPOSED BASE MOUNTED OCTAGONAL STEEL TRAFFIC SIGNAL POLE
- PROPOSED BASE MOUNTED SECTIONAL STEEL TRAFFIC SIGNAL POLE
- PROPOSED DIRECT BURIED WOOD POLE
- EXISTING/RELOCATED DIRECT BURIED WOOD POLE
- PROPOSED DIRECT BURIED CONCRETE POLE
- EXISTING/RELOCATED DIRECT BURIED CONCRETE POLE
- PROPOSED OCS (OVERHEAD CONTACT SYSTEM) POLE
- STREET LIGHT HYDRO POLE
- PROPOSED HYDRO POLE

C01

LICENSED PROFESSIONAL ENGINEER J. J. HARROTT 18804504 Mar 31/16 PROVINCE OF ONTARIO

STAMP□

Region of Waterloo

GRANDLINQ

REV.	DESCRIPTION	BY	DATE
C02	RELEASED FOR CONSTRUCTION	TOR	2016-03-25
C01	RELEASED FOR CONSTRUCTION	TOR	2015-07-09
C00	RELEASED FOR CONSTRUCTION	TOR	2015-05-12

REGION OF WATERLOO
STAGE I
LRT PROJECT

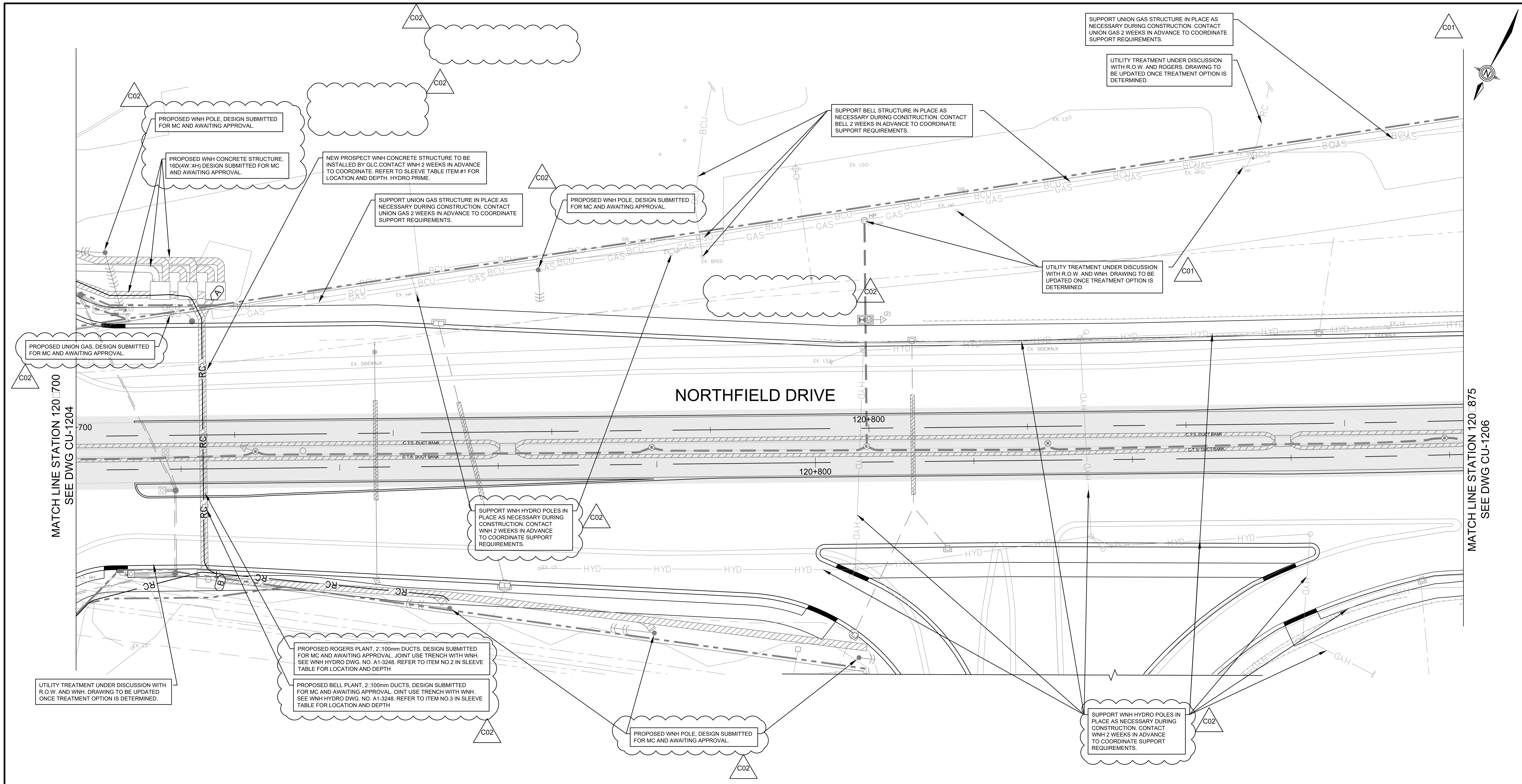
CIVIL UTILITIES
PRIVATE UTILITY RELOCATION PLAN
STA 120+525 TO STA 120+700

DRAWN BY□	DESIGNED BY□	CHECKED BY□	SCALE□
BH	BH	SH	1□250

PACKAGE□	DRAWING N□	SHEET□	REV.
S01B.1	CU-1204	OF	C02

CADD FILE□ S-121-CU-1204.dwg

3/31/2016 2:48 PM C□□□□, J□□□



SLEEVE TABLE

		A			B						
ID #	OWNER	EASTING	NORTHING	ELEVATION	EASTING	NORTHING	ELEVATION	LENGTH	CROSSING DETAIL REFERENCE	CONFIGURATION	MATERIAL
1	WATERLOO NORTH HYDRO	537387.53	4816480.44	339.50	537403.40	4816452.08	339.50	33.0m	WNH HYDRO DWG. NO. A1-3248	16D (4W 4H)	CONCRETE
2	ROGERS										
3	BELL										

NOTES:
1. SLEEVE ELEVATIONS ARE GIVEN FOR THE TOP OF THE STRUCTURE.

12.5 0 12.5 25m
SCALE 1:250

4/1/2016 1:59 PM C____, J___

PACKAGE NAME:
KING STREET & NORTHFIELD DRIVE
CIVIL & SYSTEMS

DISCLAIMER:
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DO NOT SCALE THIS DOCUMENT. ALL MEASUREMENTS MUST BE OBTAINED FROM STATED DIMENSIONS.

LEGEND

- PROPOSED TRACK
- PROPOSED CULVERT
- PROPOSED RETAINING WALL
- EXISTING R.O.W.
- PROPOSED R.O.W.
- REMOVALS
- ALL — ALL STREAM LINE
- AF — ATRIA FIBRE
- BCU — BELL LINE
- COW — CITY OF WATERLOO
- GAS — GAS LINE
- HYD — HYDRO LINE
- RC — ROGERS CABLE
- RF — ROGERS FIBRE
- RIM — RES. IN MOTION
- RT — TRAFFIC SIGNAL
- TEL — TELUS LINE
- UOW — U OF WATERLOO
- PROPOSED BASE MOUNTED OCTAGONAL STEEL TRAFFIC SIGNAL POLE
- PROPOSED BASE MOUNTED SECTIONAL STEEL TRAFFIC SIGNAL POLE
- PROPOSED DIRECT BURIED WOOD POLE
- EXISTING/RELOCATED DIRECT BURIED WOOD POLE
- PROPOSED DIRECT BURIED CONCRETE POLE
- EXISTING/RELOCATED DIRECT BURIED CONCRETE POLE
- PROPOSED OCS (OVERHEAD CONTACT SYSTEM) POLE
- HP STREET LIGHT HYDRO POLE
- PROPOSED HYDRO POLE

C01

DRAWINGS LIMITS ADJUSTED

LICENSED PROFESSIONAL ENGINEER J. J. HARROTT 18604504 MAR 23,16 PROVINCE OF ONTARIO
STAMP:

Region of Waterloo

GRANDLINQ

REV	DESCRIPTION	BY	DATE
C02	RELEASED FOR CONSTRUCTION	TOR	2016-03-25
C01	RELEASED FOR CONSTRUCTION	TOR	2015-07-09
C00	RELEASED FOR CONSTRUCTION	TOR	2015-05-12

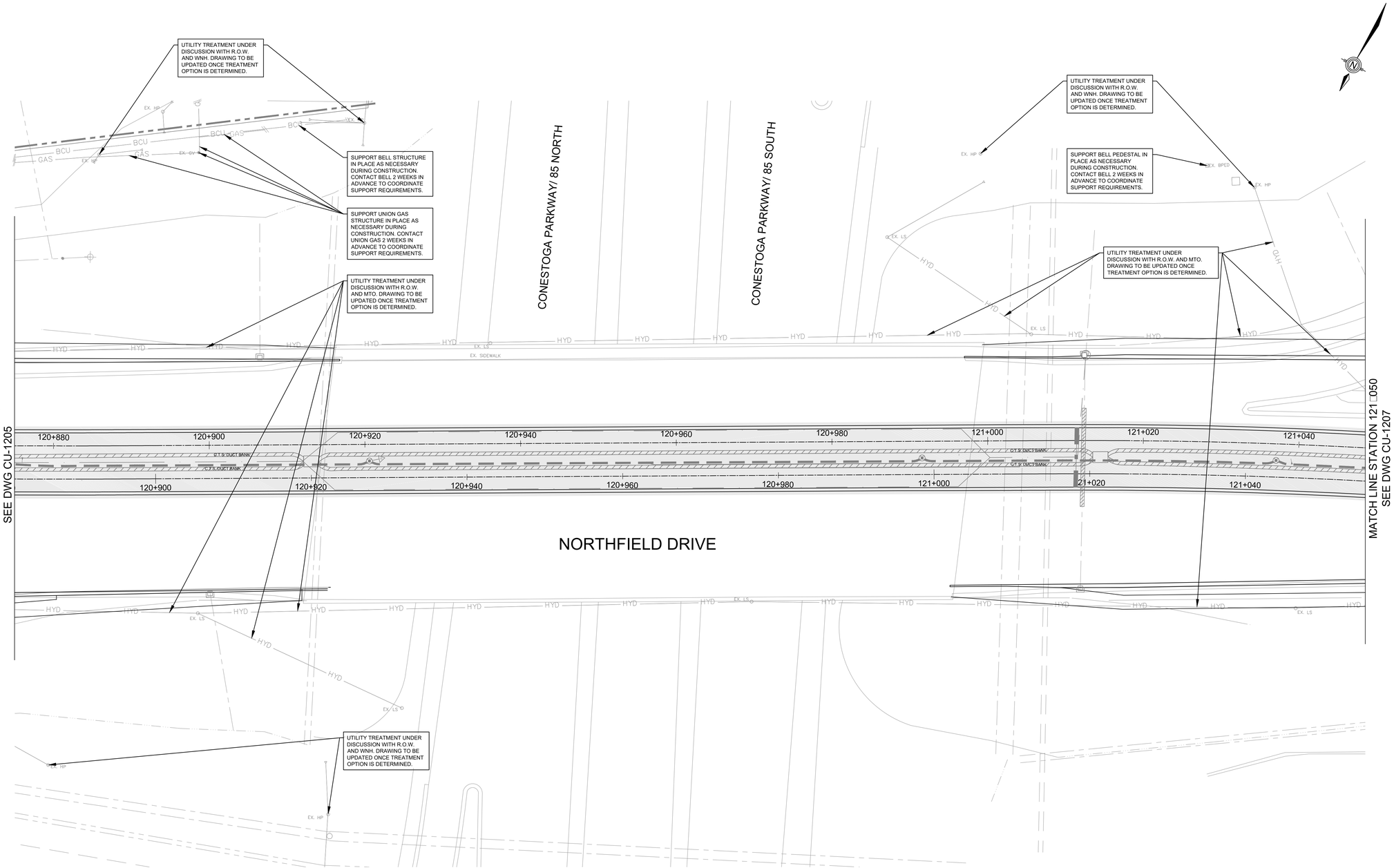
REGION OF WATERLOO
STAGE I
LRT PROJECT

CIVIL UTILITIES
PRIVATE UTILITY RELOCATION PLAN
STA 120+700 TO STA 120+875

DRAWN BY:	DESIGNED BY:	CHECKED BY:	SCALE:
BH	BH	SH	1:250

PACKAGE:	DRAWING NO.:	SHEET:	REV.
S01B.1	CU-1205	OF	C02

CADD FILE: S-121-CU-1205.dwg



12.5 0 12.5 25m

SCALE 1:250

PACKAGE NAME:

KING STREET & NORTHFIELD DRIVE
CIVIL & SYSTEMS

DISCLAIMER:
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LEGEND

- PROPOSED TRACK
- PROPOSED CULVERT
- PROPOSED RETAINING WALL
- EXISTING R.O.W.
- PROPOSED R.O.W.
- REMOVALS
- ALL STREAM LINE
- ATRIA FIBRE
- BELL LINE
- CITY OF WATERLOO
- GAS LINE
- HYDRO LINE
- ROGERS CABLE
- ROGERS FIBRE
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- EXISTING/RELOCATED DIRECT BURIED CONCRETE POLE
- PROPOSED OCS (OVERHEAD CONTACT SYSTEM) POLE
- STREET LIGHT HYDRO POLE
- PROPOSED HYDRO POLE

C01

DRAWINGS LIMITS ADJUSTED

LICENSED PROFESSIONAL ENGINEER
July 9/15
J. J. HARROTT
100504
PROVINCE OF ONTARIO

STAMP:

Region of Waterloo

GRANDLINQ

REV.	DESCRIPTION	BY	DATE
C01	RELEASED FOR CONSTRUCTION	TOR	2015-07-09
C00	RELEASED FOR CONSTRUCTION	TOR	2015-05-12

REGION OF WATERLOO
STAGE I
LRT PROJECT

CIVIL UTILITIES
PRIVATE UTILITY RELOCATION PLAN
STA 120+875 TO STA 121+050

DRAWN BY	DESIGNED BY	CHECKED BY	SCALE
BH	BH	SH	1:250

PACKAGE	DRAWING N	SHEET	REV.
S01B.1	CU-1206	OF	C01

CADD FILE: S-121-CU-1206.dwg

7/9/2015 9:41 AM H:\...\...Br...

Region of Waterloo

Call Date: 01/24/2020 Due Date: 01/31/2020

UNDERGROUND TRAFFIC SIGNAL LOCATE

Phone: 519-650-8201 Fax: 519-650-8209

Ticket No.: 2020048760 Page ____ of ____

City/Township: Waterloo

Meet Location and Date

Meet Date & Time: N/A

Location: Northfield Dr W & Conestogo Rd

Nature of Work: Design and Planning

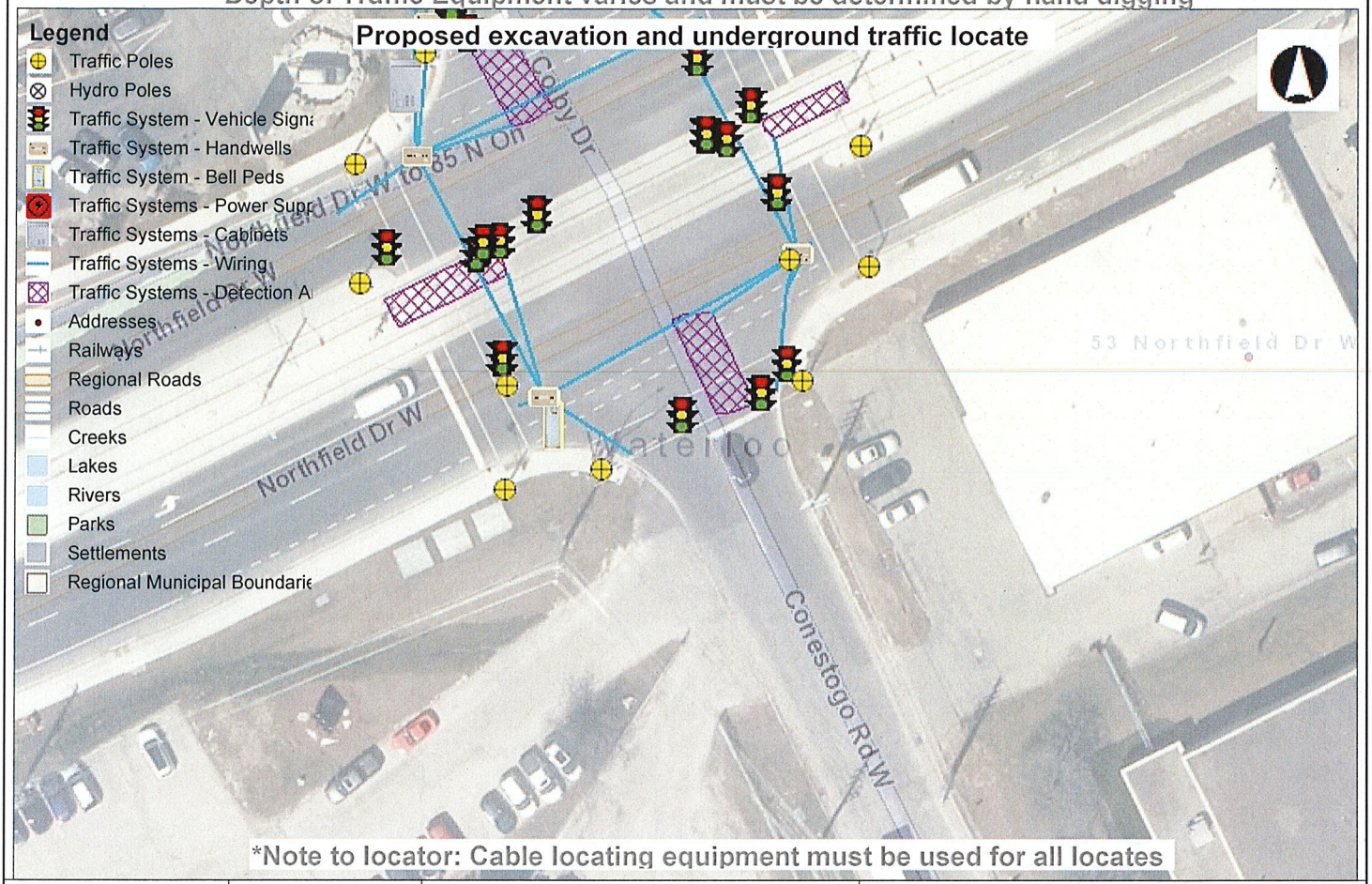
Fax/Email: zschnurr@walterfedy.com

Phone: (519) 576-2150

Requested By: WalterFedy

CAUTION: Hand dig within 1m of marking

Depth of Traffic Equipment varies and must be determined by hand digging



*Note to locator: Cable locating equipment must be used for all locates

Traffic Installation

Cable: ☐

Power Supply: ☐

Loops: ☐

System Loops: ☐

Puck Detection: ☐

Contact 519-650-8201 prior to PAVEMENT REMOVAL to allow removal of puck detection system.

Marking Method

Paint: ☐

Other: ☐

Locate Given

Date: Jan 24/20 Time: ____

Located By: ____

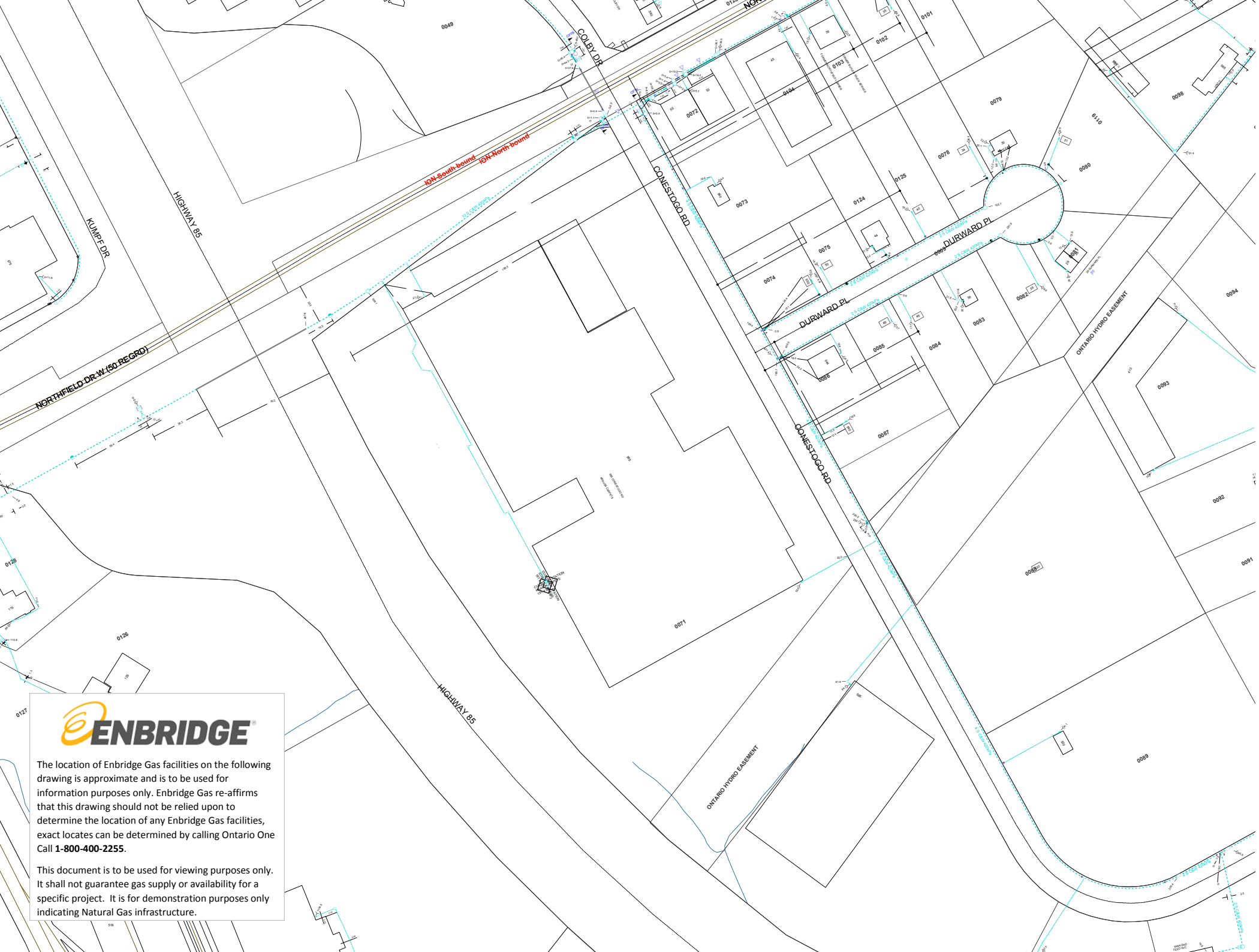
Accepted By: ____

Notes

Locate is valid for 60 days

Request for traffic locate should be at least five working days prior to digging.

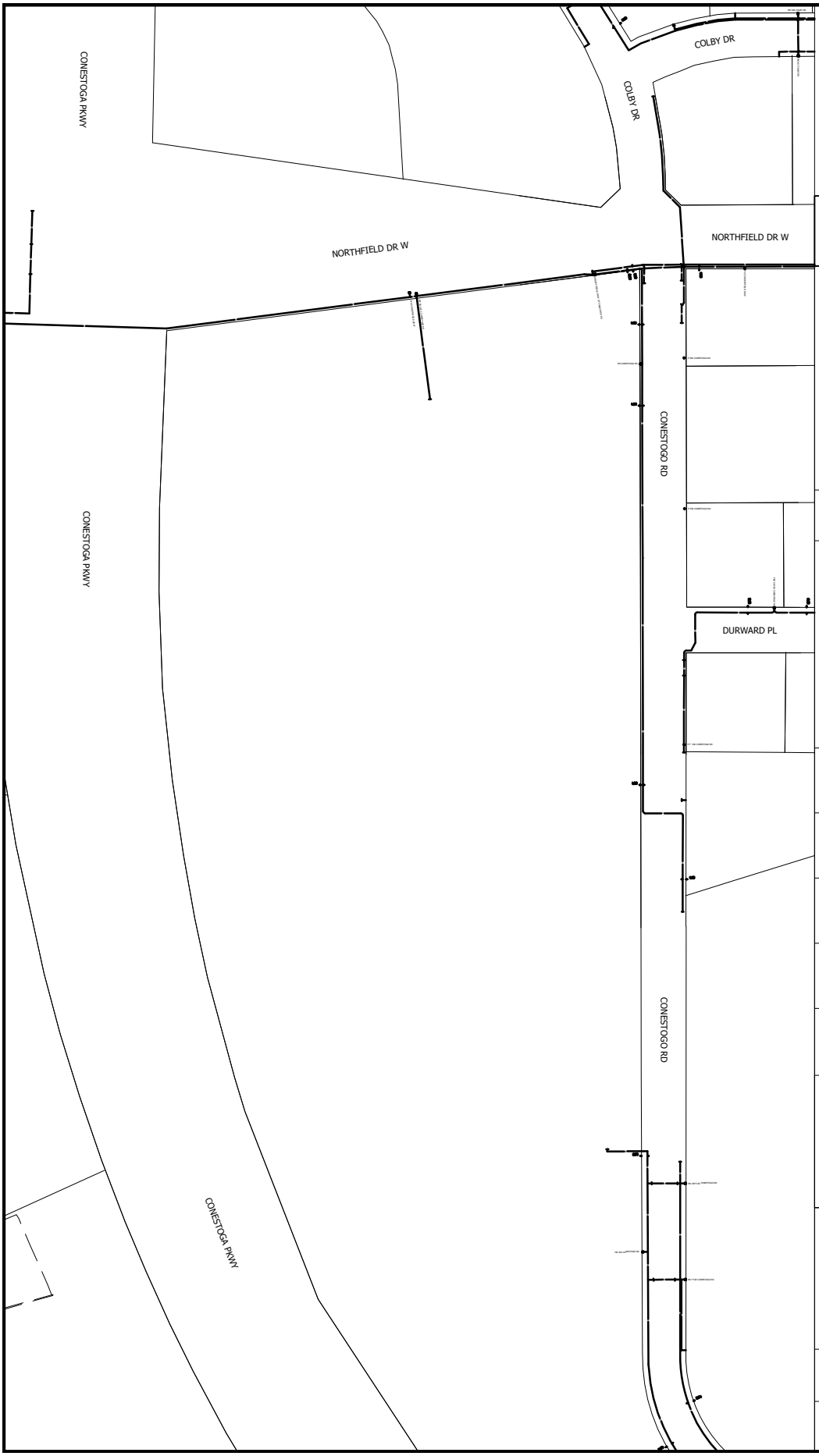
Thank you for calling before you dig.



ENBRIDGE

The location of Enbridge Gas facilities on the following drawing is approximate and is to be used for information purposes only. Enbridge Gas re-affirms that this drawing should not be relied upon to determine the location of any Enbridge Gas facilities, exact locates can be determined by calling Ontario One Call **1-800-400-2255**.

This document is to be used for viewing purposes only. It shall not guarantee gas supply or availability for a specific project. It is for demonstration purposes only indicating Natural Gas infrastructure.



PLEASE NOTE:

THIS DRAWING IS FOR MARKUP ONLY - NOT FOR PERMIT TO PROCEED CONSTRUCTION. BELL CANADA PLANT LOCATION IS APPROXIMATE.

BELL CANADA

Municipal Operations Department
Floor 5 Blue, 100 Borough Drive
Scarborough, Ontario, M1P 4W2
Ph. 416-296-6929

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Bell Canada Legend Info

C	Existing Conduit
B	Existing Buried Cable
HH	Existing Handhole / GLB
BP	Existing Bell Pole
	Existing Pedestal

CALL FOR LOCATES
1-800-400-2255

HAND DIG
if within 1m of Bell plant

HAND DIG
when crossing Bell plant

Maintain clearance of 0.6m

If further details required
You must acquire Locates or Test Pits

telecon design MEMBER OF TELECON GROUP
7777 WESTON RD
VAUGHAN, ONT, CANADA L4L 0G9
TEL: (905) 569-2882

Dwg # - 1

Mark Up # - 83003

CAD Tech - Alexandra Dabu

ROGERS

telecon
design · build · connect

7777 WESTON RD
VAUGHAN, ONT, CANADA, L4L0G9
TEL: 905-569-2882

- Existing Buried Fibre cable
- Existing Aerial Fibre cable
- Existing Rogers Ground Level Box
- Existing Rogers Bldg Attachement
- Existing Joint Use Pole
- Existing Hydro Pole

CAUTION

HAND DIG WHEN CROSSING ROGERS
HAND DIG IF WITHIN 1M OF ROGERS PLANT

CALL FOR LOCATES

1-800-400-2255

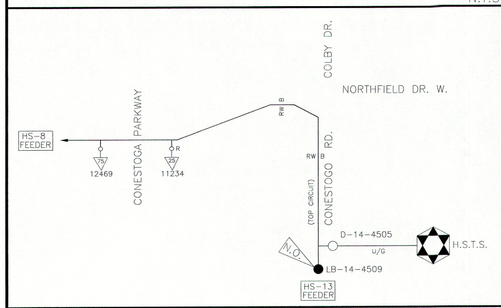
NOTE:

PLANT IS TO APPROXIMATION
PLAN NOT TO SCALE

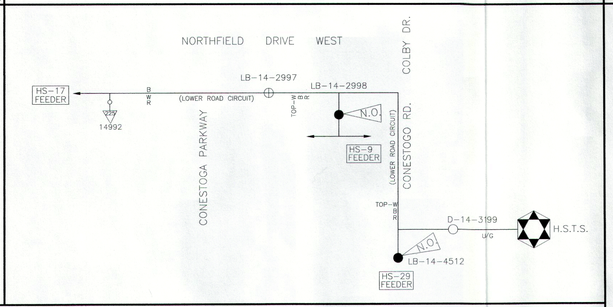
Rogers File # - G200526

CAD Tech - Simi Sunny

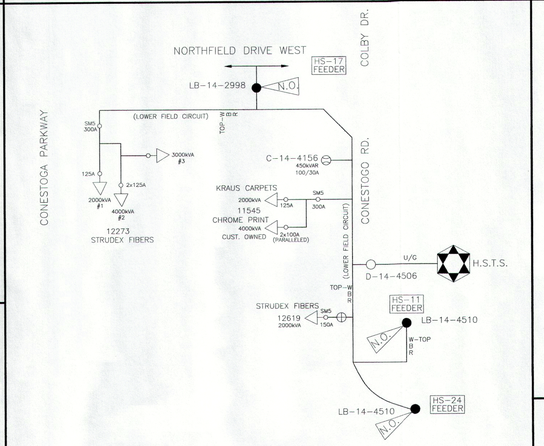
13.8kV PRIMARY SCHEMATIC (HS-8 FEEDER) N.T.S



13.8kV PRIMARY SCHEMATIC (HS-17 FEEDER) N.T.S

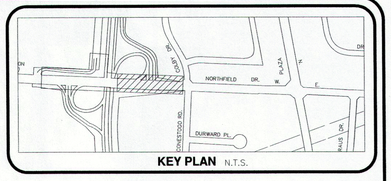


13.8kV PRIMARY SCHEMATIC (HS-9 FEEDER) N.T.S



LEGEND

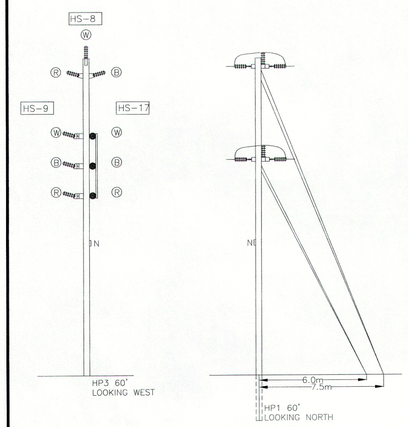
- 3ø 13.8/8.0kV PRIMARY (NEW)
- 3ø 13.8/8.0kV PRIMARY (EXISTING)
- 3ø SECONDARY (NEW)
- 3ø SECONDARY (EXISTING)
- STREET LIGHT CONTROL (EXISTING)
- 120V STREET LIGHT FEED (NEW)
- STREET LIGHT BREAKER (NEW)
- 100W HPS STREET LIGHT W/PHOTOCELL (NEW)
- 150W HPS STREET LIGHT (EXISTING)
- 150W HPS STREET LIGHT (NEW)
- (8') ARM LENGTH
- TRANSFORMER (NEW)
- TRANSFORMER (EXISTING)
- TRANSFORMER (REMOVE)
- 12345 / 50 / 222 TRANSFORMER LOC. NO. / TRANSFORMER KVA SIZE / ADDRESS NUMBER
- HYDRO POLE (NEW)
- HYDRO POLE (EXISTING)
- HYDRO POLE (REMOVE)
- HP HYDRO POLE
- CP CUSTOMER POLE
- GUY AND ANCHOR (NEW)
- GUY AND ANCHOR (EXISTING)
- GUY AND ANCHOR (REMOVE)
- DOUBLE GUY AND ANCHOR (NEW)
- DOUBLE GUY AND ANCHOR (EXISTING)
- DOUBLE GUY AND ANCHOR (REMOVE)
- TRIPLE GUY AND ANCHOR (NEW)
- SPAN GUY (NEW)
- DOUBLE SPAN GUY (NEW)



KEY PLAN N.T.S.

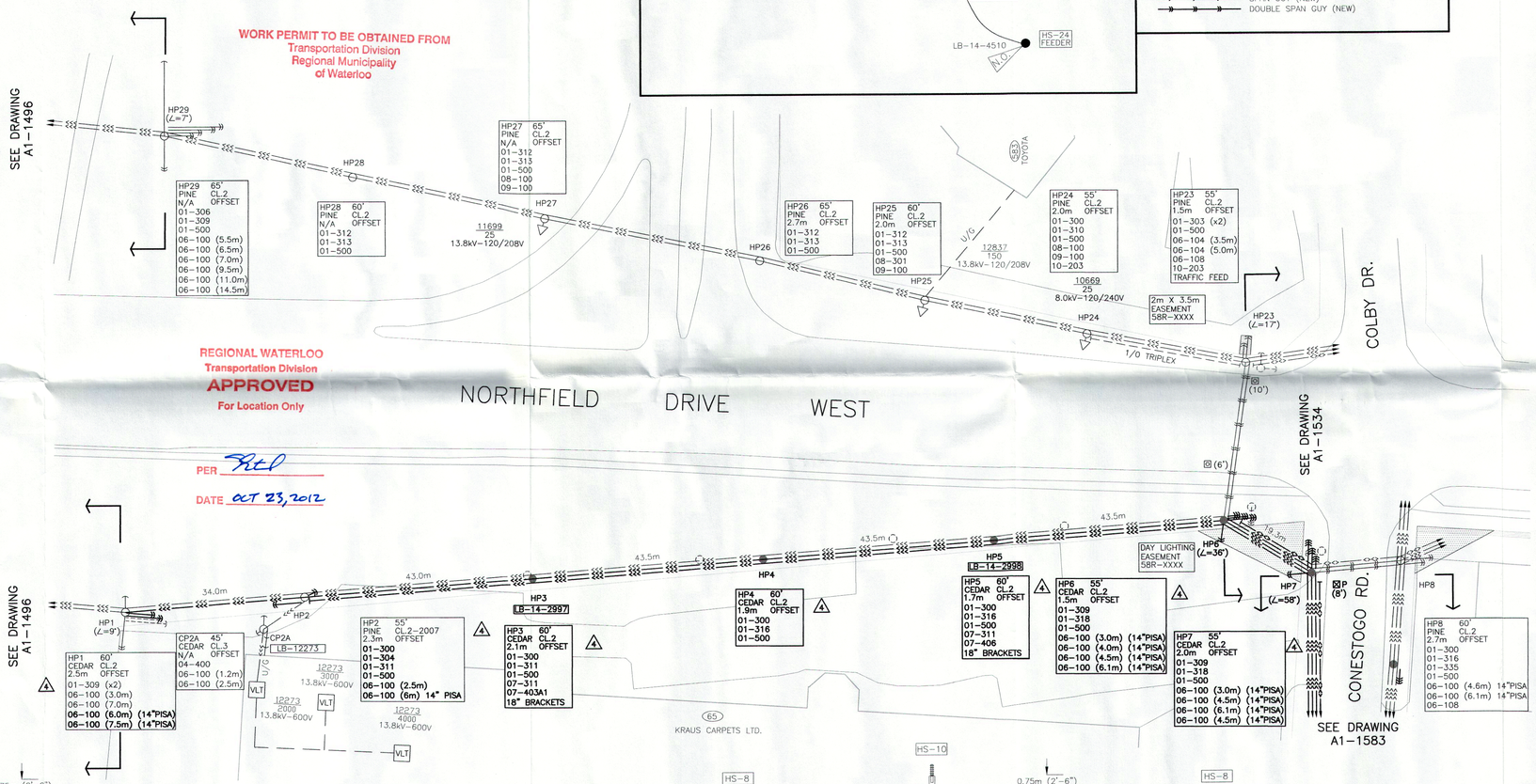
ROADWAY LIGHTING DESIGN

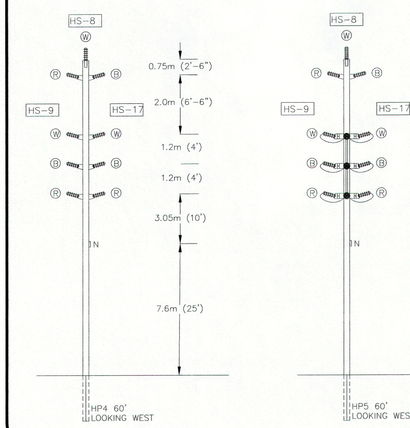
THE PHOTOMETRIC DESIGN OF THE ROADWAY LIGHTING PLANT IS PLACED BY WATERLOO NORTH HYDRO INC. ONLY AT THE DIRECTION AND APPROVAL OF THE OWNER AND MAY NOT BE DESIGNED IN ACCORDANCE WITH ANY ROADWAY LIGHTING STANDARDS

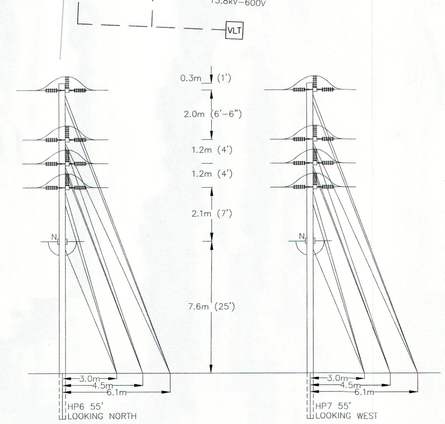


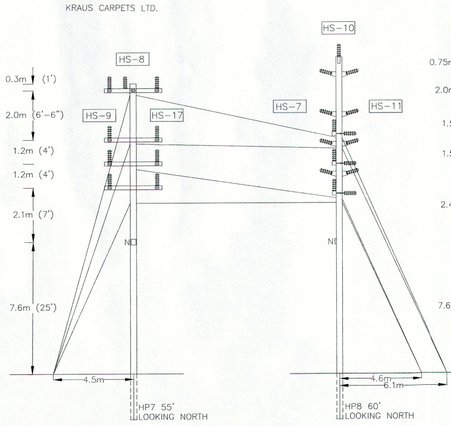
WORK PERMIT TO BE OBTAINED FROM
Transportation Division
Regional Municipality
of Waterloo

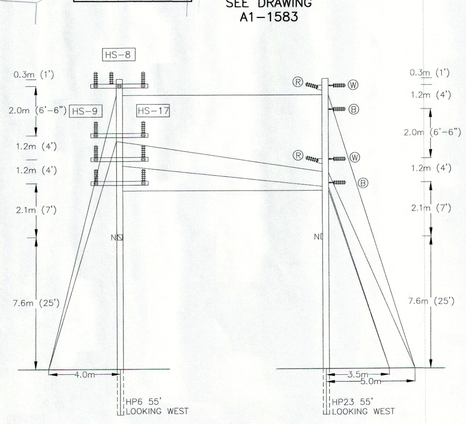
SEE DRAWING A1-1496











PROJECT NOTES

1. OBTAIN APPROVAL FROM THE ENGINEERING DEPARTMENT BEFORE MAKING ANY CHANGES TO THIS DESIGN.
2. ALL POLE OFFSETS ARE FROM NEW OR EXISTING PROPERTY LINE UNLESS OTHERWISE NOTED.
3. ALL POLES TO BE SET IN ACCORDANCE WITH USF STANDARD 05-100, 05-101 AND TABLE 05-04.
4. SPECIFIED ANCHOR LEAD LENGTHS ARE +/- 10% MEASURED FROM CENTRE OF POLE AND ANCHOR AT GRADE. STANDARD 10" PISA ANCHORS TO BE INSTALLED TO A MINIMUM TORQUE OF 2,750 FT-LBS. WHERE 14" PISA ANCHORS ARE SPECIFIED, THESE SHALL BE INSTALLED TO A MINIMUM TORQUE OF 4,000 FT-LBS.
5. GUYS TO BE 3/8" GRADE 180 INSTALLED AS PER USF STANDARDS 06-105 AND 06-106.
6. POLE LINE TO BE BUILT USING USF 15kV STANDARDS ON NORTHFIELD DRIVE WEST. LINE TO BE INSULATED FOR 13.8kV OPERATING VOLTAGE AND ENERGIZED AT 13.8kV OPERATING VOLTAGE.
7. CHARGE ALL LABOUR, LABOUR SAVING DEVICES AND MATERIAL TO:
   - # 5388-1 DISTRIBUTION
   - # 5388-2 TRANSFORMATION
8. TENSION STRING 6-556 ASC PRIMARY CONDUCTORS FROM HP2-HP6 INCLUSIVE USING 43.5m RULING SPAN (USF TABLE 03-14). STRING 9-556 ACS PRIMARY CONDUCTORS FROM HP6 TO HP7. RELOCATE EXISTING TOP CIRCUIT HS-8 FEEDER TO NEW POLES FROM HP3-HP6 INCLUSIVE.
9. TENSION STRING 1-556 ASC NEUTRAL CONDUCTOR FROM HP1-HP7 INCLUSIVE (USF TABLE 03-14).
10. REGIONAL WORK PERMIT REQUIRED TO WORK ON NORTHFIELD DRIVE WEST (REG # 22) BEFORE START OF CONSTRUCTION.
11. CITY OF WATERLOO WORK PERMIT REQUIRED TO WORK ON CONESTOGO ROAD BEFORE START OF CONSTRUCTION.

No.	REVISION	DATE	INITIALS
4	DRAWING CONVERTED TO AUTOCAD AND UPDATED. POLE LINE REBUILD ON SOUTH SIDE WITH LOAD BREAK TIES AS PER WR# 5388.	12.10.09	DMW JR
3	DRAWING CHANGED AS PER W.O. #129990.	93.06.07	JWS WM
2	DRAWING UPDATED. NEW 13.8kV CIRCUIT ADDED (UNIVERSITY OF WATERLOO FEEDER).	93.06.07	JWS WM
1	CHANGES AS PER FIELD INSTALLATION.	91.11.10	RPG WM

REFERENCE DRAWINGS
- A1-1496 NORTHFIELD DR. W. AND EXPRESSWAY INTERCHANGE, WATERLOO
- A1-1534 NORTHFIELD DR. W., CONESTOGO RD./COLBY DR. TO KING ST., WATERLOO
- A1-1583 CONESTOGO RD., NORTHFIELD DR. TO DOTZERT CT., WATERLOO
- ENG DRAWING FILE: OHENGDWT, REV. 15.02.07

WATERLOO NORTH HYDRO INC.

CERTIFICATE OF APPROVAL

THE INSTALLATION WORK COVERED BY THIS DOCUMENT MEETS THE SAFETY REQUIREMENTS OF SECTION 4 OF REGULATION 22/04.

NORTHFIELD DRIVE WEST

CONESTOGO RD TO CONESTOGA PARKWAY

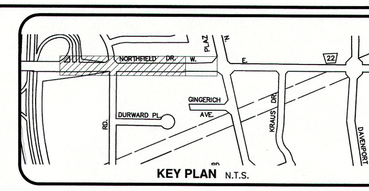
WATERLOO

SCALE: 1 : 500

DRAWING NO. A1-1497

DESIGNED	ROBERT PAUL GUDZAK	91.08.06
DRAWN	ROBERT PAUL GUDZAK	91.08.06
CHECKED	WJM, GGH, RDB	95.02.22
FILE #	WA-014-OH-N5	

MUNICIPAL CONSENT



ROADWAY LIGHTING DESIGN

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WORK PERMIT TO BE OBTAINED FROM
Transportation Division
Regional Municipality
of Waterloo

REGIONAL WATERLOO
Transportation Division
APPROVED
For Location Only

PER _____
DATE Nov 28/15

SEE DRAWING A1-1535

NORTHFIELD DRIVE WEST

HP27 65' PINE CL.2 N/A OFFSET 01-111 (x2) 01-300 01-310 01-500 06-100 (3.0m) 08-100 09-100 10-203

HP26 65' CEDAR CL.1 2.1m OFFSET 01-300 01-311 (18"BRKTS) 01-500 06-100 (2.0m) 08-303 09-100 10-203

HP25 65' CEDAR CL.2 1.4m OFFSET 01-300 01-305 01-345B (18"BRKTS) 01-500 06-100 (4.0m) 06-100 (5.5m) 09-100 10-203

HP24 60' CEDAR CL.3 0.8m OFFSET 01-305 01-345B (18"BRKTS) 01-500 06-100 (4.0m) 06-100 (5.5m) 09-100 10-203

HP12 50' PINE CL.3 3.2m OFFSET 01-309 01-500 06-100 (3.1m) 06-100 (3.3m) 06-100 (5.8m) 08-301 09-100 10-301

HP11 55' PINE CL.3 4.0m OFFSET 01-301 01-306 01-329 01-500 06-100 (2.0m) 06-100 (4.0m) 06-100 (4.0m)

HP10 55' CEDAR CL.2 3.9m OFFSET 01-303 01-306 01-500 06-100 (2.5m)x2 06-100 (3.5m)x2 06-100 (4.5m) 09-100

HP9 55' CEDAR CL.3 1.8m OFFSET 01-306 01-343A1 01-500 06-100 (6.5m) 09-100

HP8 65' CEDAR CL.1 3.0m OFFSET 01-306 01-321 01-343A4 01-500 06-100 (5.0m) 06-100 (6.5m) 06-100 (8.0m) 09-100

HP6 65' CEDAR CL.1 N/A OFFSET 01-302A 01-320 01-500 06-100 (3.0m)x2 06-100 (4.5m)x2 06-100 (6.0m)x2

HP5 60' CEDAR CL.1 1.7m OFFSET 01-301 01-316A 01-500 06-100 (4.0m)

HP4 60' CEDAR CL.2 1.9m OFFSET 01-300 01-316 01-500 07-311 07-406 09-100 18" BRACKETS

HP3 60' CEDAR CL.2 2.1m OFFSET 01-300 01-311 01-500 07-104 07-311 07-403A1 09-100 18" BRACKETS

HP2 65' CEDAR CL.1 4.0m OFFSET 01-300 01-316 01-343A4 01-500 06-104 (3.0m) 06-104 (4.5m) 06-104 (6.0m) 09-100 10-203 10-400 6-18" BRACKETS

HP21 60' CEDAR CL.2 4.0m OFFSET 01-301 01-316A 01-343A4 01-500 06-100 (4.0m) 06-108 (x2) 09-100 14-500 6-18" BRACKETS

HP22 60' CEDAR CL.2 4.0m OFFSET 01-300 01-316 01-331 01-500

HP15 55' CEDAR CL.2 2.6m OFFSET 01-324 01-345B (18"BRKTS) 01-500 06-100 (3.5m) 06-100 (5.0m) 09-100 10-203

HP16 55' CEDAR CL.2 3.0m OFFSET 01-316 01-500 08-303 09-100 10-203

HP17 55' CEDAR CL.2 3.0m OFFSET 01-316 01-343A4 01-500 08-301 09-100 10-203 18" BRACKETS SEE COMMERCIAL LAYOUT

HP18 55' CEDAR CL.2 3.0m OFFSET 01-316 01-500 10-203 SEE COMMERCIAL LAYOUT

HP14 55' CEDAR CL.3 2.6m OFFSET 01-305 01-345B (18"BRKTS) 01-500 06-100 (3.5m) 06-100 (5.0m) 09-100 10-203

HP3 65' CEDAR CL.1 4.0m OFFSET 01-300 01-316 01-343 01-345 01-500 09-100 10-203

HP4 60' CEDAR CL.2 4.0m OFFSET 01-300 01-316 01-343A4 01-500 06-100 (3.0m) 08-301 09-100 10-203 6-18" BRACKETS

LB-14-2997 D-14-4535

LB-14-2998

C-14-4156

C-14-177

11693 / 25 13.8kV-120/208V

11611 / 150 13.8kV-600/347V

11913 / 150 13.8kV-347/600

11835 / 150 13.8kV-120/208V

LOC. # 12837

LOC. # 10669

LOC. # 11872

2mX3m EASEMENT

TO LOC # 11945

INSTALL 1/0 TRIPLEX

INSTALL 4/0 QUADRUPLEX

EX. 1/0 TRIPLEX

U/G

BLANKET

HS-26 FUTURE

HS-7 BOTTOM ROAD

HS-10 TOP

HS-10 BOTTOM

HS-11 BOTTOM

HS-7 ROAD BOTTOM

HS-11 FIELD BOTTOM

HS-9 FIELD BOTTOM

HS-11 ROAD HP14

HS-7 FIELD HP15

COLBY DR.

CONESTOGO RD.

KRAUS CARPETS LTD.

GOLDEN TRIANGLE COLLISION LTD.

NORTHFIELD LUMBER

KING'S AUTO SALES

JAY FENCING LTD.

SMENCO

KRAUS CARPETS 2000kVA

CHROME PRINT 4000kVA

200A 347/600V

400A 120/208V

400A 600/347V

MUNICIPAL CONSENT
FOR OFFSET LOCATION ONLY
SIGNATURE _____
PER _____
DATE _____

LEGEND

- 3ø 13.8/8.0kV PRIMARY (EXISTING)
- 3ø 13.8/8.0kV PRIMARY (NEW)
- 3ø SECONDARY (EXISTING)
- 3ø SECONDARY (NEW)
- 120/240V SECONDARY (EXISTING)
- 120/240V SECONDARY (NEW)
- 120V STREET LIGHT FEED (NEW)
- STREET LIGHT CONTROL (EXISTING)
- 100W HPS STREET LIGHT (EXISTING)
- 100W HPS STREET LIGHT W/PHOTOCELL (NEW)
- 150W HPS STREET LIGHT W/PHOTOCELL (NEW)
- STREET LIGHT BREAKER
- (8') ARM LENGTH
- TRANSFORMER (NEW)
- TRANSFORMER (EXISTING)
- TRANSFORMER (REMOVE)
- 12345 TRANSFORMER LOC. NO.
- 50 TRANSFORMER KVA SIZE
- (222) ADDRESS NUMBER
- HYDRO POLE (NEW)
- HYDRO POLE (EXISTING)
- HYDRO POLE (REMOVE)
- HP HYDRO POLE
- CP CUSTOMER POLE
- GUY AND ANCHOR (NEW)
- GUY AND ANCHOR (EXISTING)
- GUY AND ANCHOR (REMOVE)
- DOUBLE GUY AND ANCHOR (NEW)
- DOUBLE GUY AND ANCHOR (EXISTING)
- DOUBLE GUY AND ANCHOR (REMOVE)
- TRIPLE GUY AND ANCHOR (NEW)
- SPAN GUY (NEW)
- DOUBLE SPAN GUY (NEW)

SEE DRAWING A1-1535 FOR PROJECT NOTES, STRI
LIGHT AND PRIMARY SCHEMATICS.

No.	REVISION	DATE	IN
2	RISER POLE RELOCATIONS FOR LRT IMPROVEMENTS. W.R. #8666.	15.08.18	
1	CHANGES AS PER ECO 5387-01. AS CONSTRUCTED DRAWING. REGISTERED PLAN #58R-17669 ADDED.	14.01.30	D

REFERENCE DRAWINGS

A1-1497 NORTHFIELD DRIVE WEST, CONESTOGA PARKWAY TO COLBY DRIVE, WATERLOO
A1-1535 NORTHFIELD DRIVE WEST, KING STREET NORTH TO COLBY DRIVE, WATERLOO

WATERLOO NORTH HYDRO INC.

CERTIFICATE OF APPROVAL

THE INSTALLATION WORK COVERED BY THIS DOCUMENT MEETS THE SAFETY REQUIREMENTS OF SECTION 4 OF REGULATION 22/04.

NORTHFIELD DRIVE WEST

CONESTOGO RD/ COLBY DR TO KING STREET

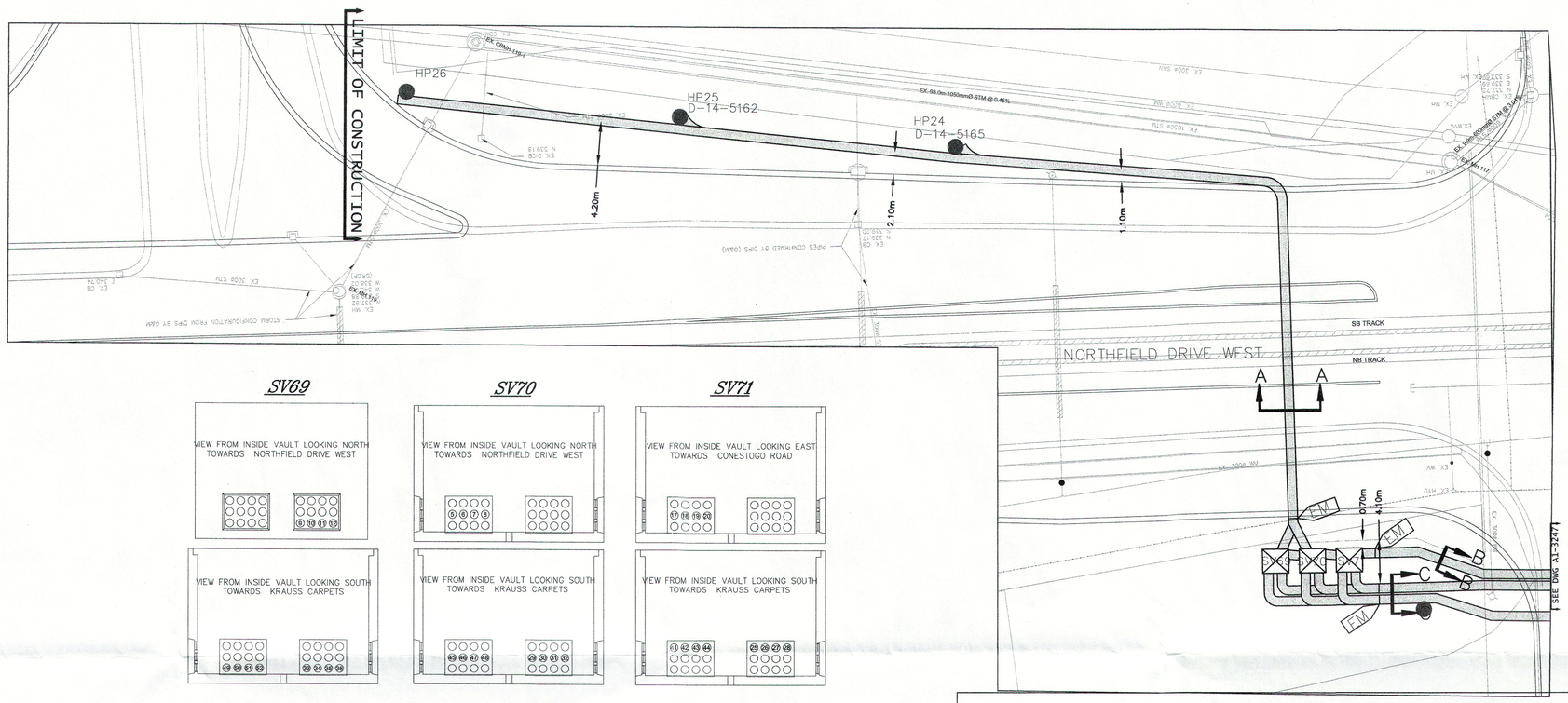
WATERLOO

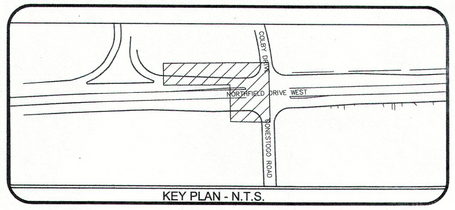
SCALE: 1 : 500

DRAWING NO. A1-1534

DESIGNED	DAVID WINKLER	12.02.22
DRAWN	CHRIS MAZEREEUW	12.06.13
CHECKED	DOROTHY MORYC	
FILE #	WA-014-OH-N14	

MUNICIPAL CONSENT





KEY PLAN - N.T.S.

LEGEND

- WNH CONCRETE-ENCASED DUCTBANK (NEW)
- HP WOOD HYDRO POLE(EXISTING)
- HP HYDRO POLE (REMOVE)
- HP WOOD HYDRO POLE(NEW)
- DRIVEWAY
- 222 MUNICIPAL ADDRESS
- OVERHEAD TRANSFORMER (EXISTING)
- 30 PADMOUNTED TRANSFORMER (EXISTING)
- 11273 / 50 TRANSFORMER LOCATION NUMBER / TRANSFORMER KVA SIZE
- SM SUBMERSIBLE VISTA SWITCHGEAR (NEW)
- DRAIN VAULT (NEW)
- EM ELECTRONIC MARKER BALL

REGIONAL WATERLOO
Transportation Division
APPROVED
For Location Only
PER
DATE Sept 2/15

WORK PERMIT TO BE OBTAINED FROM
Transportation Division
Regional Municipality
of Waterloo

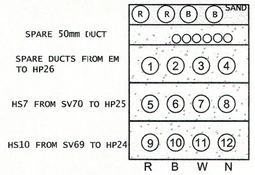
The Roadway Design and Municipal Service infrastructure shown on this drawing was provided by a third party on 2014.08.15. Waterloo North Hydro Inc. is responsible for the underground electrical distribution system design only.

SV69

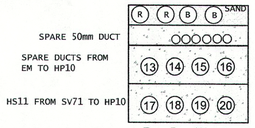
SV70

SV71

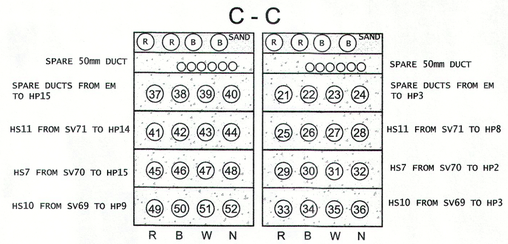
A - A



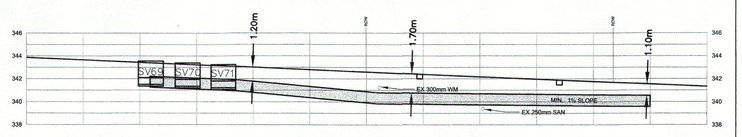
B - B



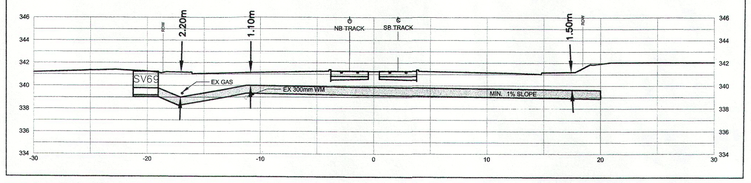
C - C



NORTHFIELD CROSSING CONESTOGO



Northfield Drive Crossing (A - A)



FOR OVERHEAD CONSTRUCTION DRAWING SEE DWG.# A1-3171
FOR CONSTRUCTION NOTES SEE DWG.# A1-3247

REV.NO.	DESCRIPTION	DATE	INITIALS

THIS DRAWING NOT TO BE REPRODUCED WITHOUT THE EXPRESS WRITTEN CONSENT OF WATERLOO NORTH HYDRO INC.

Waterloo North Hydro Inc.
Engineering Department

ISSUED
for

☒ approval ☐ review
☐ construction ☐ as built

signed: [signature]
date: 04/21/2016.

☐ Return to Eng ☐ Site Copy

MUNICIPAL CONSENT
FOR OFFSET LOCATION ONLY

SIGNATURE
PER
DATE

WATERLOO NORTH HYDRO INC.

CERTIFICATE OF APPROVAL

THE INSTALLATION WORK COVERED BY THIS DOCUMENT MEETS THE SAFETY REQUIREMENTS OF SECTION 4 OF REGULATION 22/04.

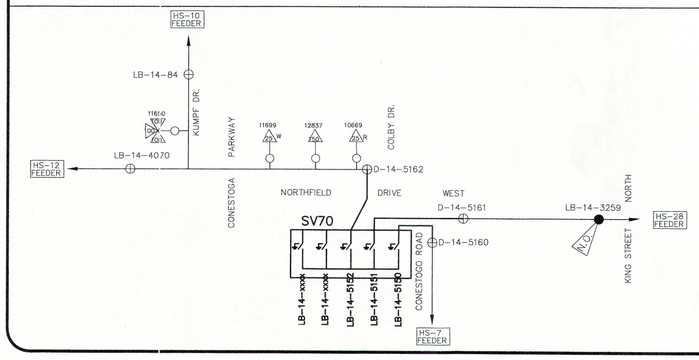
DUCT BANK CONSTRUCTION
NORTHFIELD DRIVE
CONESTOGO DRIVE CROSSING
WATERLOO

SCALE: HORIZONTAL: 1:250
VERTICAL: 1:250

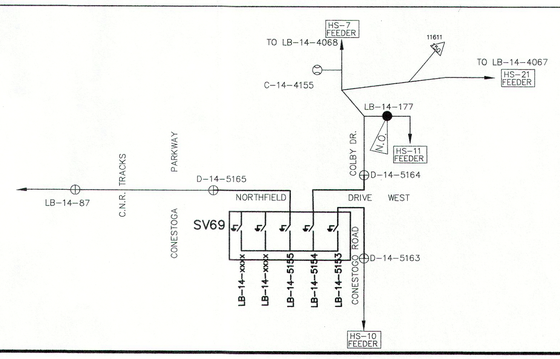
DRAWN	BRANDON COLVIN	2015.08.19
DESIGNED	BRANDON COLVIN	2015.08.19
CHECKED	DL, DS, RK	
FILE #	014-DB-N001	

Dwg no. A1-3248
DWG: A1-3247

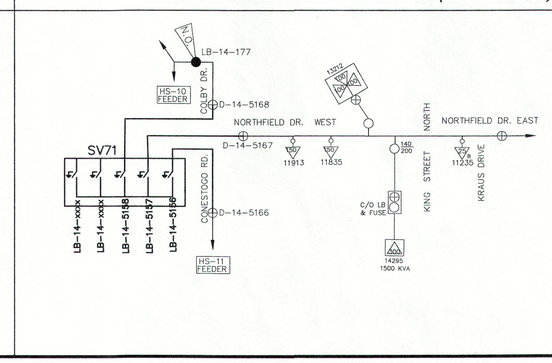
PROPOSED 13.8kV PRIMARY SCHEMATIC (HS-7 FEEDER) N.T.S

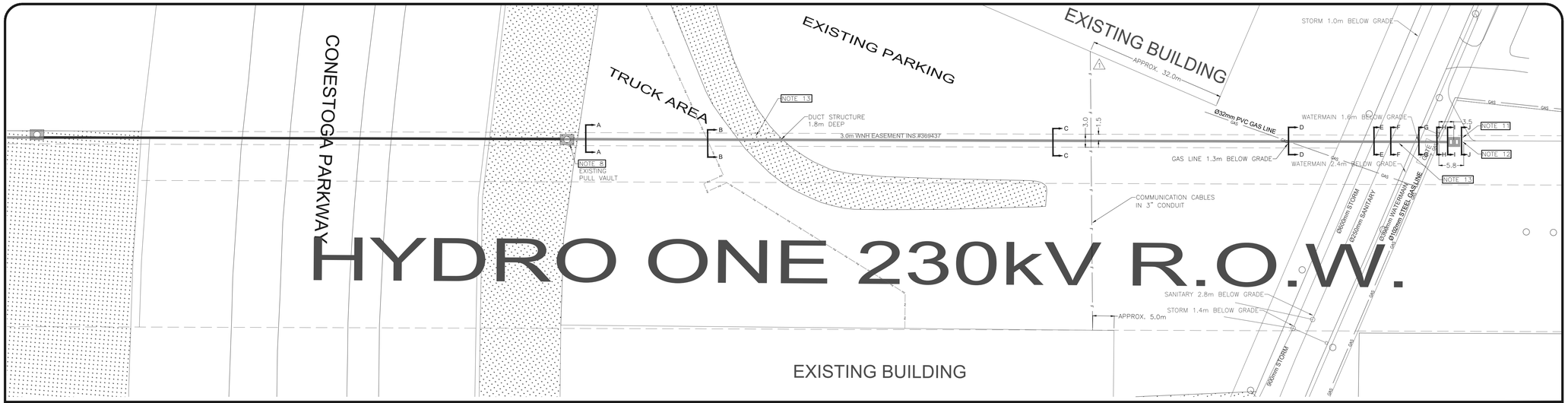


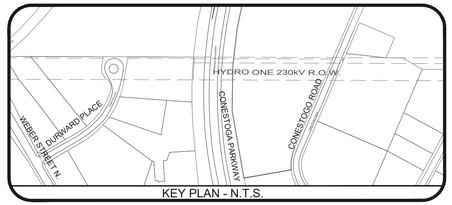
PROPOSED 13.8kV PRIMARY SCHEMATIC (HS-10 FEEDER) N.T.S



PROPOSED 13.8kV PRIMARY SCHEMATIC (HS-11 FEEDER) N.T.S







KEY PLAN - N.T.S.

LEGEND

- DUCT (NEW)
- DUCT (EXISTING)
- ROAD CROSSING
- NUMBER OF ROAD CROSSING DUCTS
- UTILITY HOLE
- CATCH BASIN
- DOUBLE CATCH BASIN
- FIRE HYDRANT
- HYDRO POLE (EXISTING)
- 4" 120 PSI INSULATED STEAM PIPE
- COMMUNICATION WIRES
- GAS PIPE

STANDARD CONSTRUCTION NOTES:

1. CONTACT THE ENGINEERING DEPARTMENT BEFORE MAKING ANY CHANGES TO THIS DESIGN. ON COMPLETION OF THE PROJECT, RETURN DRAWING TO THE ENGINEERING DEPARTMENT INDICATING FIELD CHANGES.
2. ALL REFERENCES TO ELEVATIONS AND DIMENSIONS ARE IN METRES UNLESS SPECIFIED OTHERWISE.
3. CONTRACTOR IS RESPONSIBLE FOR ALL LOCATES INCLUDING HYDRO.
4. CONTRACTOR TO HAND DIG WITHIN 1.0m OF EXISTING UNDERGROUND SERVICES.
5. MAINTAIN A MINIMUM 1.0m CLEARANCE FROM ALL CATCH BASINS, FIRE HYDRANTS AND OTHER EXISTING SERVICES.

SITE SPECIFIC CONSTRUCTION NOTES:

6. ALL CHARGES ARE TO BE DISTRIBUTED AS FOLLOWS:

   ALL LABOUR, TRUCKING, MATERIALS PLUS OUTSIDE CHARGES RELATED TO LOCATING THE EXISTING PART OF THE STRUCTURE AND DESIGNING THE EXTENSION TO SCHEIFELE T.S.TO WORK ORDER #1375 AND THE FOLLOWING JOB ORDERS:
   1 - OH CAPITAL ENGINEERING (DESIGN)
   4 - OH CAPITAL LINES (WNH LABOUR AND LABOUR SAVING DEVICES)
   5 - OH CAPITAL ACQUISITION (CONTRACTOR'S LABOUR AND MATERIAL)

   ALL LABOUR, TRUCKING, MATERIALS PLUS OUTSIDE CHARGES RELATED TO CONSTRUCTION OF THE STRUCTURE FROM CONESTOGA EXPRESSWAY TO SCHEIFELE T.S.TO WORK ORDER #1545 JOB ORDER 1 - EG UNDERGROUND CAPITAL - ENGINEERING.

7. DUCT BANK TO BE INSTALLED AS PER WNH STANDARD U2-4.
8. CONTRACTOR TO EXCAVATE AROUND THE EXISTING PULL VAULT AT CONESTOGA PARKWAY. INSTALL 4-10FT GROUND RODS AND RUN 2/0 BARE COPPER CONDUCTOR BETWEEN EACH GROUND ROD FOR CONNECTION BY WNH CREWS.
9. CONTRACTOR TO SAW CUT 2.75m (9') WIDE AND DISPOSE OF ASPHALT ALONG THE TRENCH ROUTE.
10. ALL TRENCHING WITHIN THE PARKING AREA AND CONESTOGO ROAD TO BE CONSTRUCTED AS PER WNH STANDARD U2-3 AND THE CITY OF WATERLOO REQUIREMENTS.
11. INSTALL ICS192A PULL VAULT AS PER THE DESIGN.INSTALL 4-10FT GROUND RODS AND RUN 2/0 BARE COPPER CONDUCTOR BETWEEN EACH GROUND ROD FOR CONNECTION BY WNH CREWS.
12. LOCATE THE END OF THE EXISTING HS17 DUCTS 5.8m EAST OF CONESTOGO ROAD. EXTEND THE DUCTS INTO THE ICS192A. REFER TO A1-1694 FOR THE EXISTING INSTALLATION OF HS17 DUCTS.
13. USE 5° BENDS AND 0.5m SECTIONS OF PIPE WHEN MAKING ELEVATION CHANGES.
14. NOTE: NONMETALLIC ROPE OR BANDING SHALL BE USED TO TIE DUCTS AND SPACERS EVERY 3.0m.
15. ANY OPEN SECTION OF THE TRENCH TO BE FENCED OFF AND BARRICADED AT ALL TIMES.

DUCT BANK CROSS SECTION - REFER TO U2-4 FOR INSTALLATION DETAILS.

A - A

B - B

DUCT BANK AT STEAM PIPE CROSSING TO BE PROTECTED AS PER STANTEC CONSULTING DRAWING 1610-00893, CERTIFIED JULY 17, 2006 BY R.E. BROOKE, P.ENG.

C - C ⚠

D - D ⚠

E - E ⚠

F - F ⚠

H - H ⚠

G - G ⚠

I - I
ICS -192A

⚠ J - J
ICS -192A

REV.NO.	DESCRIPTION	DATE	INITIALS
⚠	REVISED DUCT BANK CROSS SECTION C-C, D-D, E-E, F-F, G-G, AND H-H. ADDED DUCK BANK CROSS SECTION J-J.	MAR. 2, 2007	G.T

THIS DRAWING NOT TO BE REPRODUCED WITHOUT THE EXPRESS WRITTEN CONSENT OF WATERLOO NORTH HYDRO INC.

WATERLOO NORTH HYDRO INC.

CERTIFICATE OF APPROVAL

THE INSTALLATION WORK COVERED BY THIS DOCUMENT MEETS THE SAFETY REQUIREMENTS OF SECTION 4 OF REGULATION 22/04.

HOWARD SCHEIFELE T.S. HS17 FEEDER EGRESS
CONESTOGA PARKWAY TO CONESTOGO ROAD
WATERLOO

SCALE: 1 : 500

dwg no. A1-2588

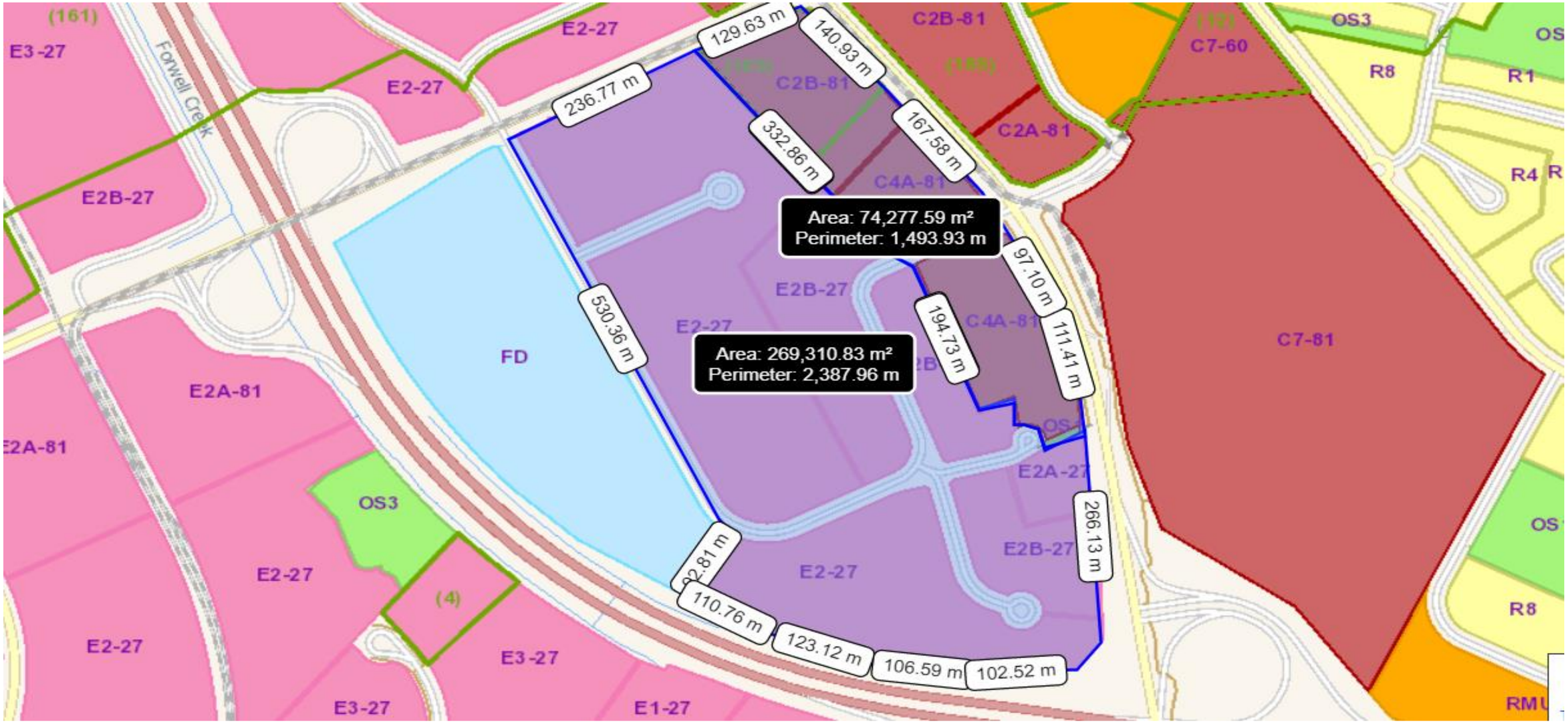
DRAWN	Chirs Sosnowski	2006.06.29
DESIGNED	Chris Sosnowski	2006.06.29
CHECKED	DM	2006.06.29
FILE #	O14-DB-C005	

APPENDIX B

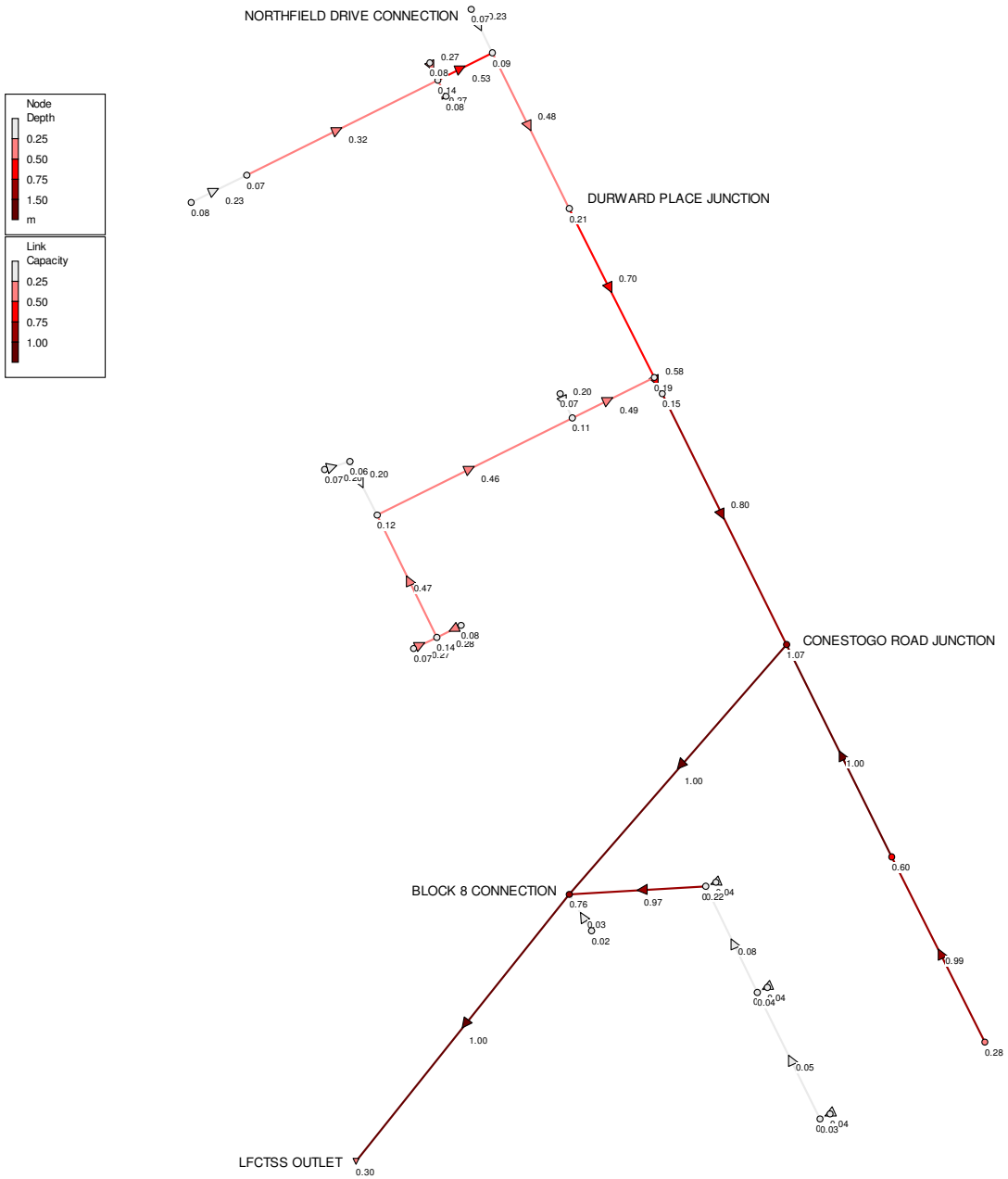
Sanitary Demand Calculations

- Sanitary Sewer Design Sheet
- Sanitary Flow Network
- HGL - Conestogo North to LFCTSS
- HGL - Conestogo South to LFCTSS
- Excerpts from Sanitary Master Plan:
    - Evaluation of Lower Forwell Trunk Constraints
    - Figures illustrating downstream constraints

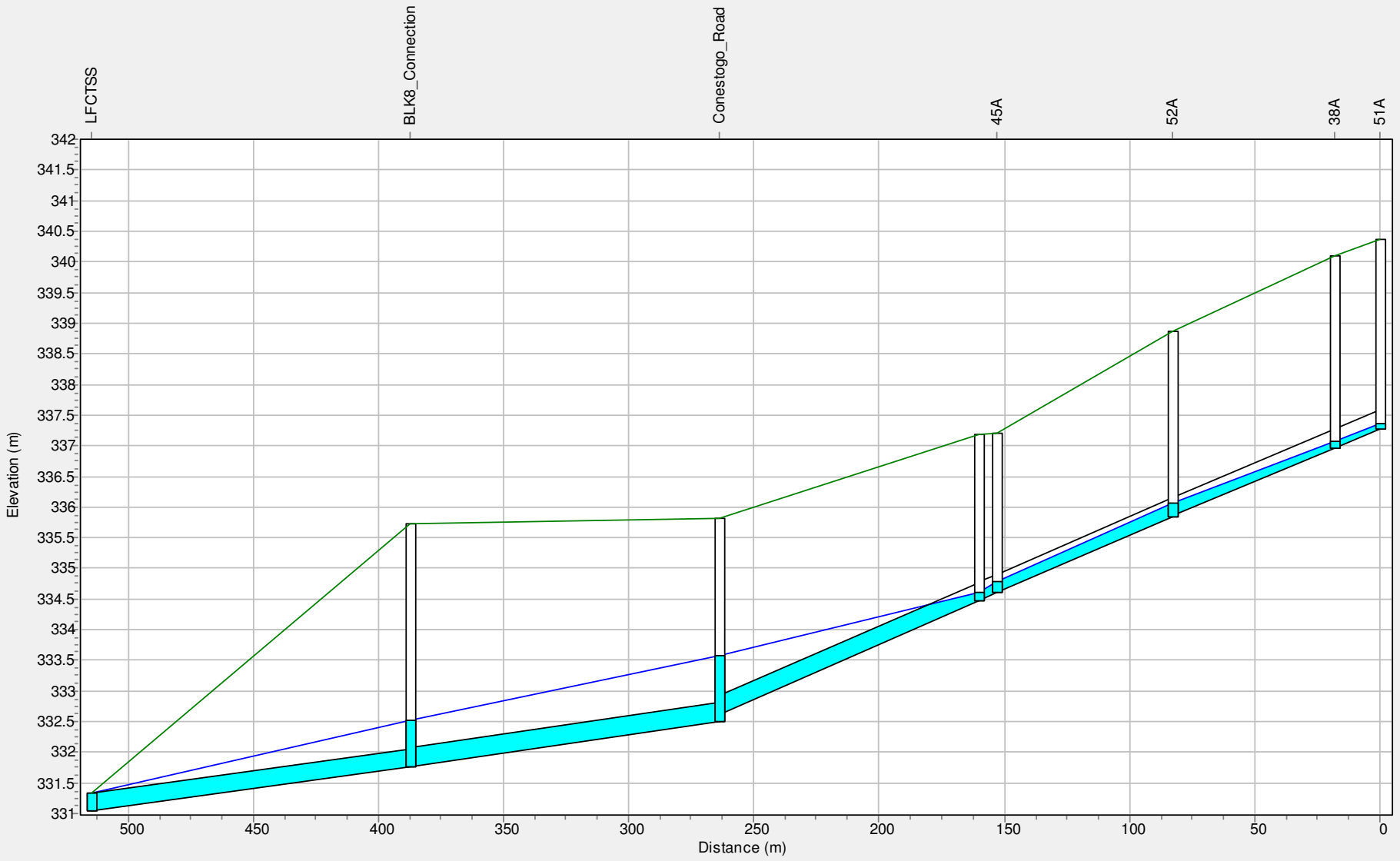
Project:	Kraus Flooring - Redevelopment			Design Data			**SANITARY SEWER DESIGN CALCULATIONS**																										
Project No:	2019-0654-10			Min. Velocity	0.8	m/s																											
Date:	5/31/2021			Max. Velocity	3.0	m/s		Residential			Commercial			Industrial			Institutional														
Designed By:	LC	Checked By:	RK	Manning's 'n'	0.013		Peaking Factor	Harmon			Peaking Factor	2.5		Peaking Factor	2		Peaking Factor	1														
				Infiltration	0.25	l/s/ha	Avg. Daily Flow	275	L/c/d		Avg. Daily Flow	0.5	L/s/ha	Avg. Daily Flow	0.4	L/s/ha	Avg. Daily Flow	0	L/s/ha													
Pipe Data				**Residential**				**Cumulative**			**Commercial**			**Industrial**			**Institutional**			**Infiltration**		**Total**	**Design Data**									
From	To	Length	Area	Units	Density	Population	Area	Population	Peak Factor	Area	Total Area		Area	Total Area		Area	Total Area		Area	Total Area	**Flow**	Diameter	Slope	Q_{FULL}	V_{FULL}						
		(m)	*(ha)*		*(ppu)*	*(people)*	*(ha)*	*(people)*		*(ha)*	*(ha)*		*(ha)*	*(ha)*		*(ha)*	*(ha)*		*(ha)*	*(ha)*	*(L/s)*	*(mm)*	*(%)*	*(L/s)*	*(m/s)*						
Redeveloped Kraus Flooring Site			7.93	2534	1.76	**4460**	7.93	4460	**3.29**	2.79	2.79		0.00	0.00		0.00	0.00		10.72	10.72	**52.880**	250	1.00	**59.47**	**1.21**						
External Drainage Area			0	0	1.76	**0**	0.00	0	**4.50**	7.43	7.43		26.93	26.93		0.00	0.00		34.36	34.36	**39.422**	300	0.61	**75.53**	**1.07**						
Total Sanitary Drainage Upstream of ON-85			7.93	2177	1.76	**3832**	7.93	3832	**3.35**	10.22	10.22		26.93	26.93		0.00	0.00		45.08	45.08	**86.448**	300	0.61	**75.53**	**1.07**						



Sanitary Flow Network

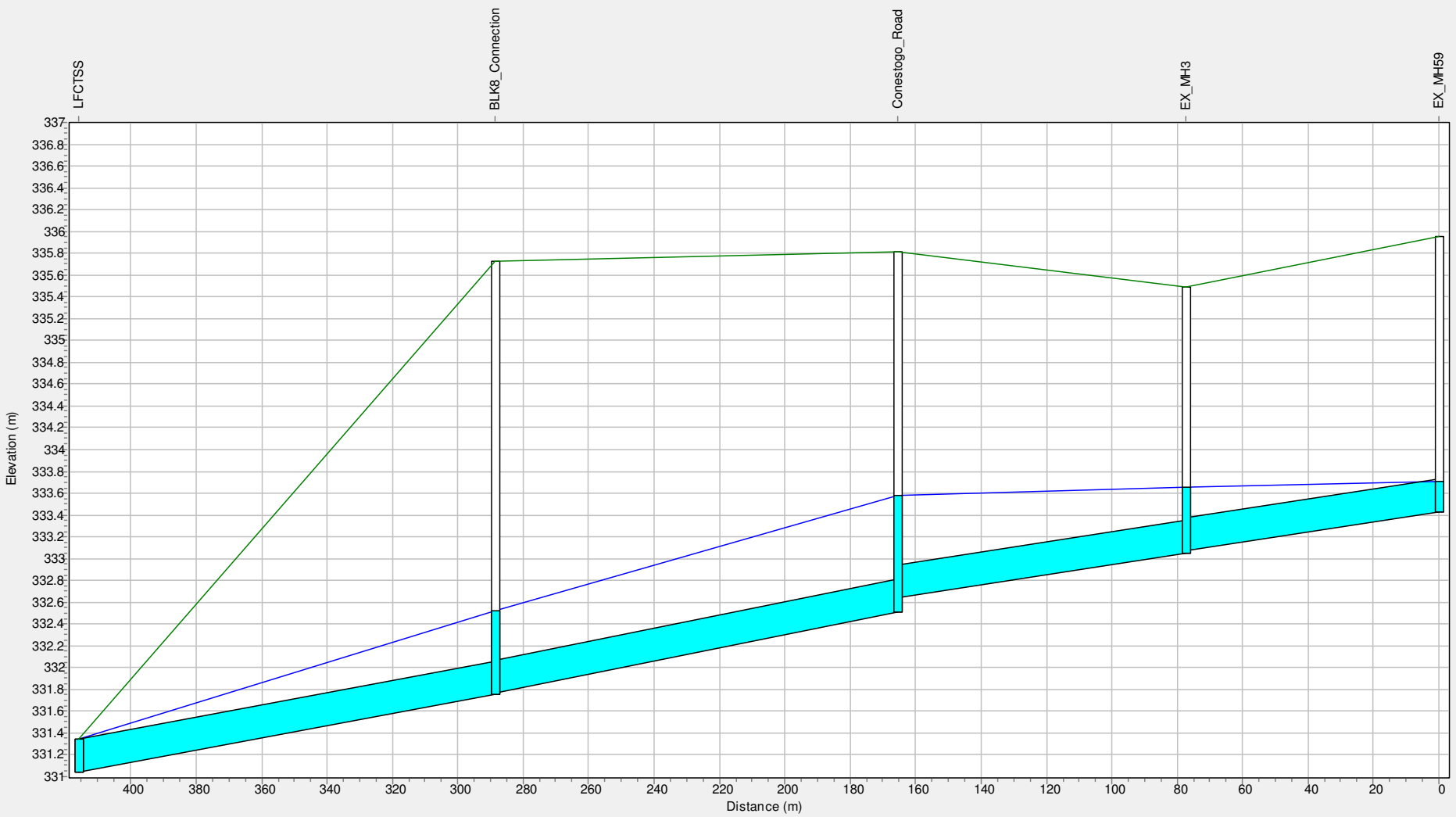


Water Elevation Profile: North of Conestogo Road to Lower Forwell Trunk



05/31/2021 01:25:00

Water Elevation Profile: South of Conestogo Road to Lower Forwell Trunk



05/31/2021 01:25:00

6.2.3.3 Improving Downstream Frobisher SPS Capacity Constraint

The results of the evaluation of alternatives identified in Section 6.1.3.2 are presented in detail in Appendix B. Table 6-11 presents the results of the evaluation.

From Table 6-11 it can be seen that the top ranked alternative is Alternative 5C. This is because it reduces operations and maintenance due to the removal of old infrastructure, and reduced risk of utility conflicts due to unchanged alignment.

6.2.3.4 Improving Lower Forwell Capacity Constraint

The results of the evaluation of alternatives identified in Section 6.1.3.3 are presented in detail in Appendix B. Table 6-12 presents the results of the evaluation.

From Table 6-12 it can be seen that the top ranked alternative is Alternative 6A which is the 'do nothing' alternative. This constraint is located through the Hillside Trail, adjacent to the WWTP. It is unlikely that surcharging in this area would cause basement flooding because there are no direct connections. The Hillside Trail is an environmentally sensitive area, and the 'do nothing' alternative avoids construction through this area.

Table 6-12: Detailed Evaluation of Lower Forwell Trunk Alternatives

Ranking

Good Neutral Poor

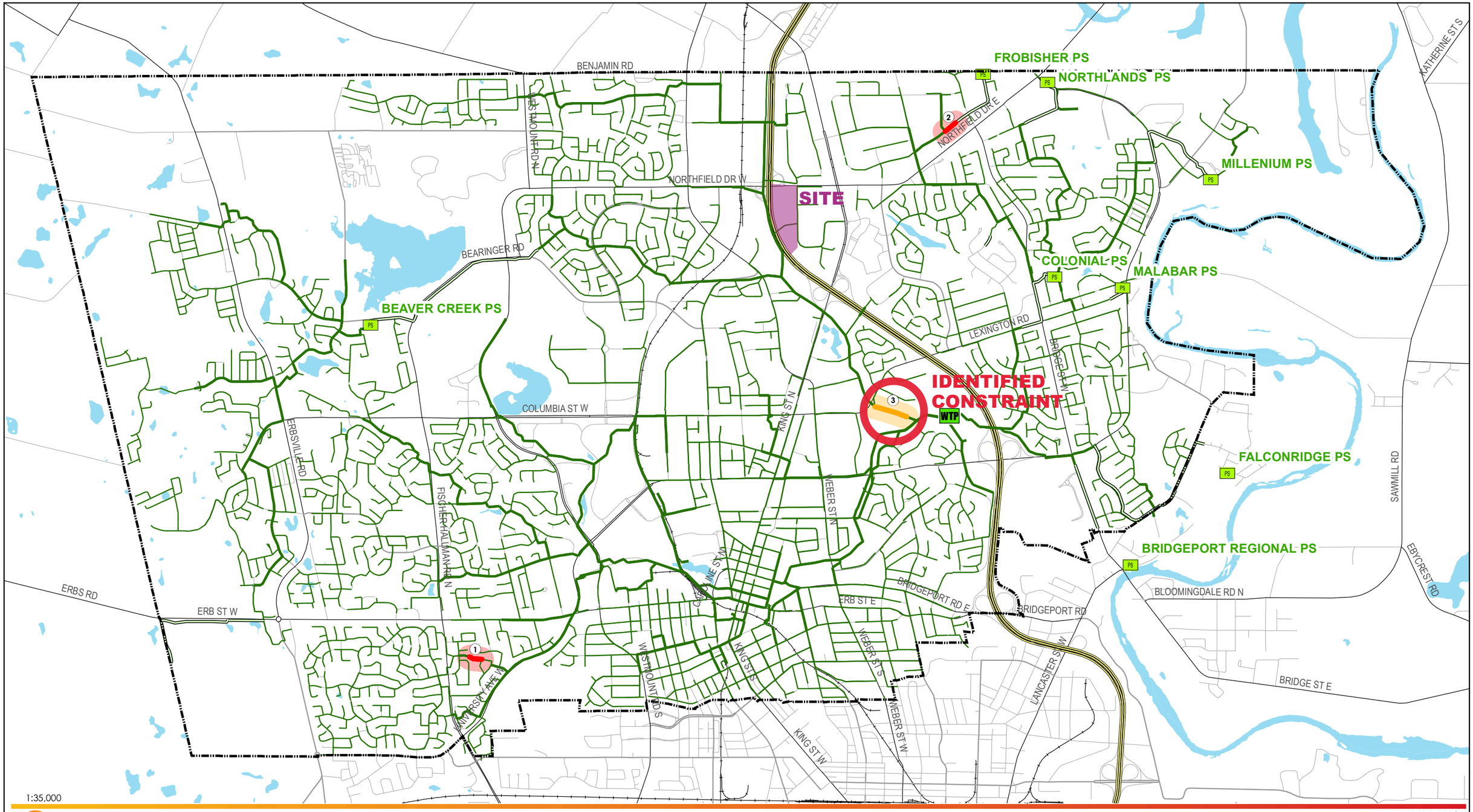
Ranking		Alternative		
		Lower Forwell Trunk		
		6A	6B	6C
Category	**Criteria**	Do Nothing	Twin Sewer	Replace Sewer Section
Technical	Hydraulic Improvements			
	Operations and Maintenance			
	System Resiliency			
Ease of Implementation	Constructability			
	Regulatory Considerations			
Social	Impact for Surrounding Residents			
System Suitability	Consistency with Planned Upgrades			
	Consistency with Operating Strategies			
Environment/ Sustainability	Carbon Footprint			
	Impact on Terrestrial/ Aquatic Systems			
Financial	Capital Cost			
	Operating and Maintenance Cost			
Total Score		7 1/4	5 1/4	6

Table B4: Detailed Evaluation of Lower Forwell Alternatives

Ranking

Ranking		Alternative		
		Lower Forwell Trunk		
		6A	6B	6C
Category	**Criteria**	Do Nothing	Twin Sewer	Replace Sewer Section
Technical	Hydraulic Improvements			
	Operations and Maintenance			
	System Resiliency			
Ease of Implementation	Constructability			
	Regulatory Considerations			
Social	Impact for Surrounding Residents			
System Suitability	Consistency with Planned Upgrades			
	Consistency with Operating Strategies			
Environment/ Sustainability	Carbon Footprint			
	Impact on Terrestrial/ Aquatic Systems			
Financial	Capital Cost			
	Operating and Maintenance Cost			
Total Score		7 1/4	5 1/4	6

Comment		Alternative		
		Downstream of Beaver Creek SPS		
		6A	6B	6C
Category	**Criteria**	Do Nothing	Twin Sewer	Replace Sewer Section
Technical	Hydraulic Improvements	poor - continued capacity constraint; necessary for growth	good - address hydraulic constraint	good - Opportunity to increase slope
	Operations and Maintenance	poor - risk of surcharge	neutral - no change	good - removed old pipe from system
	System Resiliency	poor - capacity constraint identified under wet weather	good - address hydraulic constraint	good - address hydraulic constraint
Ease of Implementation	Constructability	good - no construction required	neutral - no change	neutral - less disruptive, less risk of utility conflicts
	Regulatory Considerations	Neutral	poor - environmentally sensitive area	poor - environmentally sensitive area
Social	Impact for Surrounding Residents	good - low risk of basement flooding	poorer - may impact use of trails	poorer - may impact use of trails
System Suitability	Consistency with Planned Upgrades	poor - capacity constraint identified	good - addresses capacity constraint	good - addresses capacity constraint
	Consistency with Operating Strategies	poor - capacity constraint identified	good - no changes to operations	good - no changes to operations
Environment/ Sustainability	Carbon Footprint	neutral - use of existing infrastructure	poorer - adding additional pipe	poorer - replace pipe section
	Impact on Terrestrial/ Aquatic Systems	good - low risk of spills to environment, no construction required	poor - environmentally sensitive area	poor - environmentally sensitive area
Financial	Capital Cost	good - no capital cost	poor - capital cost of twinned sewer	poor - capital cost of replacement
	Operating and Maintenance Cost	neutral - no change	poor - additional pipe to maintain	neutral - no change



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Legend

- PS — Sewage Pump Station
- Forcemain
- WTP — Wastewater Treatment Plant

Sanitary Sewers

- Local Sewers
- Trunk Sewers

Capacity Constraints

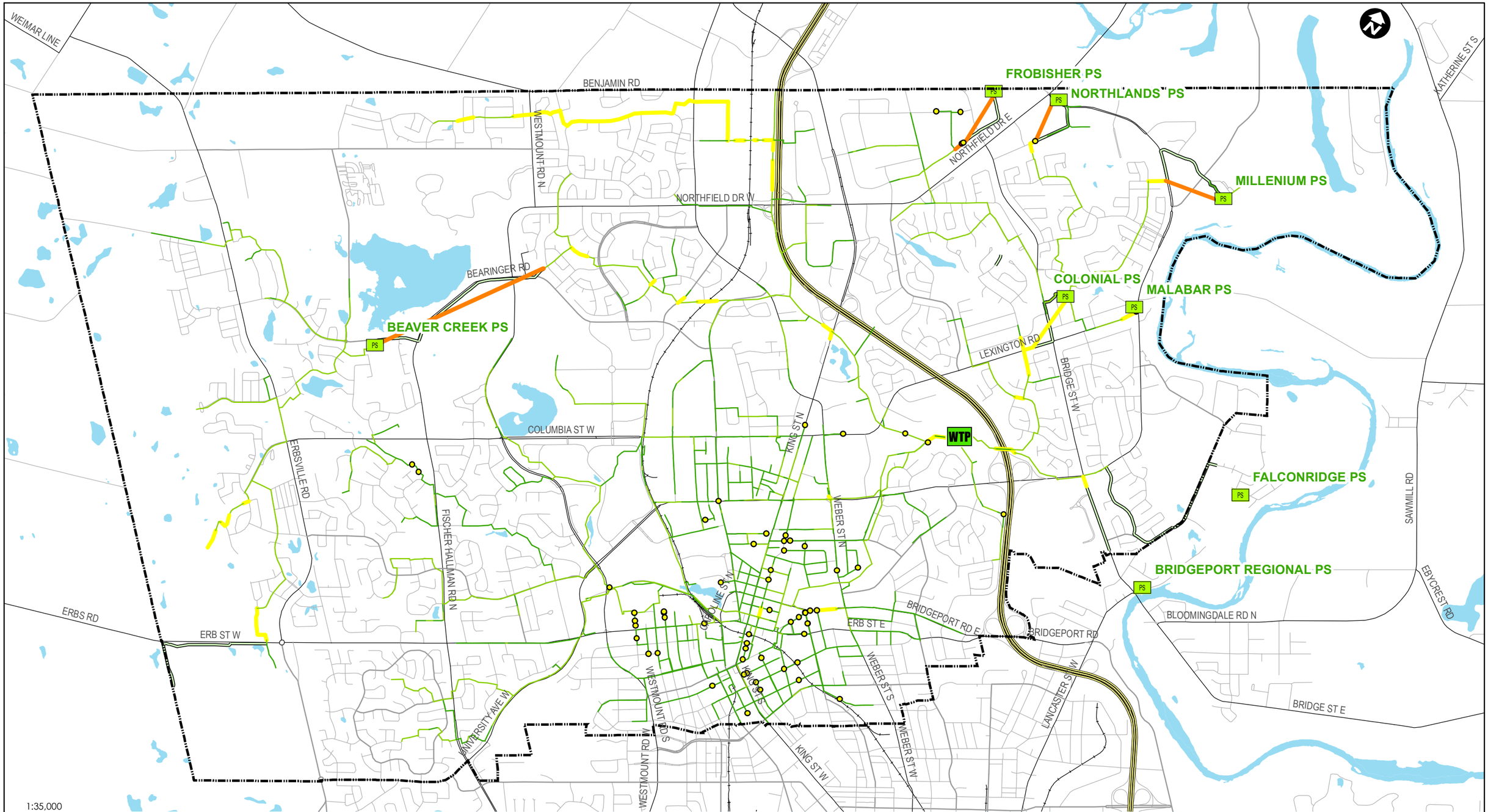
- Existing Conditions Constraint
- 2029 WWF Constraint

Constraint		Details
1	Maple Hill Trunk	Existing conditions wet weather flow constraint
2	Downstream of Frobisher SPS	Existing conditions dry weather flow and wet weather flow constraint
3	Lower Forwell Trunk	2029 wet weather flow constraint

Figure No. FIGURE 6-5

Title **CAPACITY CONSTRAINTS EXISTING & FUTURE CONDITIONS**

Client/Project CITY OF WATERLOO SANITARY SERVICING MASTER PLAN UPDATE



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Legend

Transportation Network
- Arterial
- Collector
- Highway
- Local
- CityBoundary

- Water Body
- PS Existing Pump Station
- Forcemain
- WTP Wastewater Treatment Plant

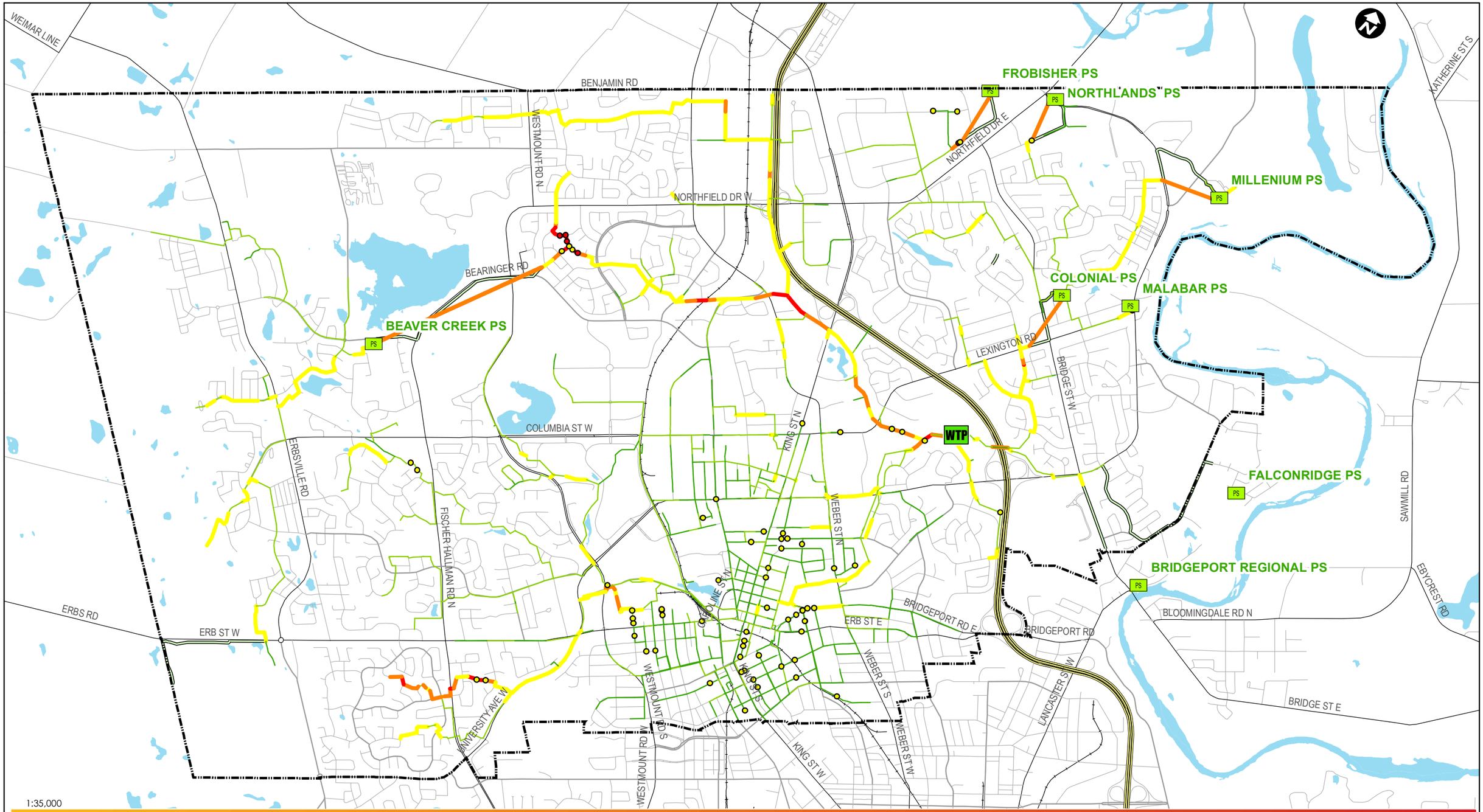
HGL Freeboard
- Above Ground
- Basement Depth (<1.8m)

d/D Ratio
- 0% - 20%
- 21% - 50%
- 51% - 80%
- 81% - 99%
- 100%

Figure No. FIGURE 4-1

Title **DWF MODELING RESULTS FOR FUTURE 2029 CONDITIONS**

Client/Project CITY OF WATERLOO SANITARY SERVICING MASTER PLAN UPDATE



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Legend

Transportation Network
- Arterial
- Collector
- Highway
- Local
- CityBoundary

- Water Body
- PS Existing Pump Station
- Forcemain
- WTP Wastewater Treatment Plant

HGL Freeboard
- Above Ground
- Basement Depth (<1.8m)

d/D Ratio
- 0% - 20%
- 21% - 50%
- 51% - 80%
- 81% - 99%
- 100%

Figure No. FIGURE 4-2

Title **WWF MODELING RESULTS FOR FUTURE 2029 CONDITIONS (10 YR, 3 HR, CHICAGO STORM)**

Client/Project CITY OF WATERLOO SANITARY SERVICING MASTER PLAN UPDATE

APPENDIX C

Water Demand Calculations

- Domestic Water Demand
- Network Configuration
- Fire Water Demand
- Region Modelling Information
- Average Day Results
- Maximum Day Results
- Maximum Flow at Node
- EPANET Water Model

TABLE C-1 - DOMESTIC WATER DEMAND

DGSSMS 2020, Water Supply and Distribution Optimization Master Plan and ONTARIO BUILDING CODE

WALTERFEDY

Project	525-565 Conestogo Road W., Plan of Subdivision
Project #	2019-0654-10
Designer	Rushin Khakharia
Address	Kitchener, Ontario
Description	Overall Domestic Flows

Building Description	Area (ha) / Units	Density (ppu)	Population	Operating Hours	Demand	Max Daily Peak Factor	Max Hourly Peak Factor	Max Daily Demand (L/s)	Peak Hour Demand (L/s)	Average Day Demand (L/s)	Node
Block 1											
Residential	567	1.76	998	-	225 L/cap/day	1.42	3.0	3.691	7.797	2.599	
Commercial	0.00			16	42000 L/ha/day	1.50	2.0	0.000	0.000	0.000	
Total Block 1				-				3.691	7.797	2.599	Block1
Block 2											
Residential	350	1.76	616	-	225 L/cap/day	1.42	3.0	2.278	4.813	1.604	
Commercial	0.00			16	42000 L/ha/day	1.50	2.0	0.000	0.000	0.000	
Total Block 2				-				2.278	4.813	1.604	Block2
Block 3											
Residential	355	1.76	625	-	225 L/cap/day	1.42	3.0	2.311	4.883	1.628	
Commercial	0.00		0	16	42000 L/ha/day	1.50	2.0	0.000	0.000	0.000	
Total Block 3				-				2.311	4.883	1.628	Block3
Block 4											
Residential	292	1.76	514	-	225 L/cap/day	1.42	3.0	1.901	4.016	1.339	
Commercial	0.10		0	16	42000 L/ha/day	1.50	2.0	0.072	0.097	0.048	
Total Block 4				-				1.973	4.112	1.387	Block4
Block 5											
Residential	270	1.76	476	-	225 L/cap/day	1.42	3.0	1.760	3.719	1.240	
Commercial	0.10		0	16	42000 L/ha/day	1.50	2.0	0.072	0.097	0.048	
Total Block 5				-				1.833	3.815	1.288	Block5
Block 6											
Residential	384	1.76	676	-	225 L/cap/day	1.42	3.0	2.500	5.281	1.760	
Commercial	0.09		0	16	42000 L/ha/day	1.50	2.0	0.064	0.086	0.043	
Total Block 6				-				2.564	5.367	1.803	Block6
Block 7											
Residential	316	1.76	557	-	225 L/cap/day	1.42	3.0	2.060	4.352	1.451	
Commercial	1.63		0	16	42000 L/ha/day	1.50	2.0	1.186	1.581	0.790	
Total Block 7				-				3.245	5.932	2.241	Block7
Block 8											
Residential	0	1.76	0	-	225 L/cap/day	1.42	3.0	0.000	0.000	0.000	
Commercial	1.82		0	16	42000 L/ha/day	1.50	2.0	1.328	1.771	0.886	
Total Block 8				-				1.328	1.771	0.886	Block8

Appendix C2 - Network Configuration

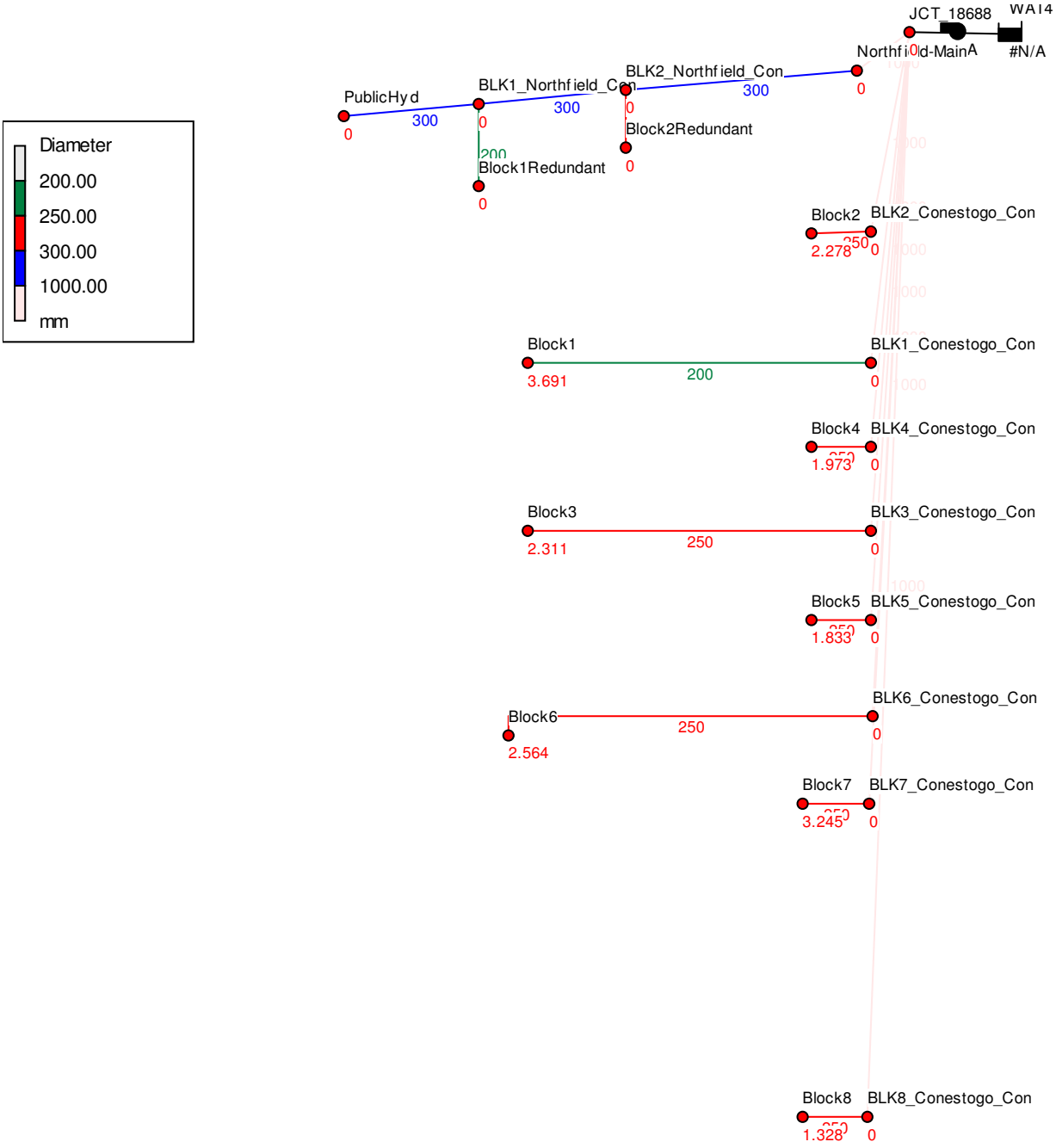

TABLE C-3 - FIRE WATER DEMAND

WALTERFEDY

DGSSMS 2020, Water Supply and Distribution Optimization Master Plan and ONTARIO BUILDING CODE

Project	525-565 Conestogo Road W., Plan of Subdivision
Project #	2019-0654-10
Designer	Rushin Khakharia
Address	Kitchener, Ontario
Description	Overall Domestic Flows

Building Description	Required Fire Flow (L/s)	Maximum Day Domestic Demand (L/s)	Total Demand (L/s)	Pipe Size (mm)	Velocity (m/s)
Block 1	133.33	3.69	137.02	200	4.36
Block 2	183.33	2.28	185.61	250	3.78
Block 3	200.00	2.31	202.31	250	4.12
Block 4	216.67	1.97	218.64	250	4.45
Block 5	200.00	1.83	201.83	250	4.11
Block 6	183.33	2.56	185.90	250	3.79
Block 7	183.33	3.25	186.58	250	3.80
Block 8	166.67	1.33	167.99	250	3.42

REQUIRED FIRE FLOW

Water Supply for Public Fire Protection (FUS 1999)

WALTERFEDY

Project	Northfield Development
Project #	2019-0654-10
Designer	RK
Address	525-565 Conestogo Road, Waterloo
Description	Fire Demand - Block 1

$$F = 220 \times C \times \sqrt{A}$$

F = Required fire flow (LPM)
C = Coefficient related to type of construction
A = Total floor area (including all storeys but excluding any basement levels at least 50% below grade)

Type of Construction	Fire-Resistive Construction	**C =**	0.6
Description	**Fully Protected Frame, Roof, Floors. Minimum 3 Hour Rated Structural Members and Floors with Reinforced Concrete or Protected Steel**		

Floor Area	3183	m^2	(L2 and L3)
Floor Area	927		(L4 to L13)
# Storeys	35		
Fire Resistant Building?	YES		

Vertical Openings and Exterior Vertical Communications protected with minimum one (1) hr rating? NO

Area	13782	m^2
Description	Area of two largest floors + 50% of each of the floors above it (max 8)	
Required Fire Flow	15000	L/min

Occupancy Charge	Limited-Combustible Contents			
Fire Flow Reduction	-15%	**OR**	-2250	L/min
Required Fire Flow	12750	L/min		

Automated Sprinker Protection	YES		
Designed to NFPA 13 Standard	YES	-30%	
Standard Water Supply to Sprinklers and Standpipes	YES	-10%	
Fully Supervised System	YES	-10%	
Fire Flow Adjustment		-6375	L/min

Exposure 1 (North)	**Distance**	50	m	**Charge**	0%
Description					
Exposure 2 (East)	**Distance**	20.5	m	**Charge**	10%
Description	Block 1 - Mixed Use Building				
Exposure 3 (West)	**Distance**	50	m	**Charge**	0%
Description					
Exposure 4 (South)	**Distance**	30.2	m	**Charge**	5%
Description	Block 3				
Total Exposure Charge					15%
Fire Flow Adjustment					1912.5 L/min

Total Required Fire Flow	8000	L/min
Total Required Fire Flow	2113	U.S. GPM
Total Required Fire Flow	133	L/s

REQUIRED FIRE FLOW

Water Supply for Public Fire Protection (FUS 1999)

WALTERFEDY

Project	Northfield Development
Project #	2019-0654-10
Designer	RK
Address	525-565 Conestogo Road, Waterloo
Description	Fire Demand - Block 2

$$F = 220 \times C \times \sqrt{A}$$

F = Required fire flow (LPM)
C = Coefficient related to type of construction
A = Total floor area (including all storeys but excluding any basement levels at least 50% below grade)

Type of Construction	Fire-Resistive Construction	**C =**	0.6
Description	**Fully Protected Frame, Roof, Floors. Minimum 3 Hour Rated Structural Members and Floors with Reinforced Concrete or Protected Steel**		

Floor Area	2337	m^2	(L2 and L3)
Floor Area	927		(L4 to L13)
# Storeys	24		
Fire Resistant Building?	YES		

Vertical Openings and Exterior Vertical Communications protected with minimum one (1) hr rating? NO

Area	12090	m^2
Description	Area of two largest floors + 50% of each of the floors above it (max 8)	
Required Fire Flow	15000	L/min

Occupancy Charge	Limited-Combustible Contents			
Fire Flow Reduction	-15%	**OR**	-2250	L/min
Required Fire Flow	12750	L/min		

Automated Sprinker Protection	YES	
Designed to NFPA 13 Standard	YES	-30%
Standard Water Supply to Sprinklers and Standpipes	YES	-10%
Fully Supervised System	YES	-10%
Fire Flow Adjustment		-6375 L/min

Exposure 1 (North)	**Distance**	50	m	**Charge**	0%
Description					
Exposure 2 (East)	**Distance**	20	m	**Charge**	15%
Description	Block 2 Mixed Use Building				
Exposure 3 (West)	**Distance**	25.5	m	**Charge**	10%
Description	Block 1				
Exposure 4 (South)	**Distance**	15	m	**Charge**	15%
Description	Block 4				

Total Exposure Charge	40%
Fire Flow Adjustment	5100 L/min

Total Required Fire Flow	11000	L/min
Total Required Fire Flow	2906	U.S. GPM
Total Required Fire Flow	183	L/s

REQUIRED FIRE FLOW

Water Supply for Public Fire Protection (FUS 1999)

WALTERFEDY

Project	Northfield Development
Project #	2019-0654-10
Designer	RK
Address	525-565 Conestogo Road, Waterloo
Description	Fire Demand - Block 3

$$F = 220 \times C \times \sqrt{A}$$

F = Required fire flow (LPM)
C = Coefficient related to type of construction
A = Total floor area (including all storeys but excluding any basement levels at least 50% below grade)

Type of Construction	Fire-Resistive Construction	**C =**	0.6
Description	**Fully Protected Frame, Roof, Floors. Minimum 3 Hour Rated Structural Members and Floors with Reinforced Concrete or Protected Steel**		

Floor Area	2337	m^2	(L2 and L3)
Floor Area	927		(L4 to L13)
# Storeys	22		
Fire Resistant Building?	YES		

Vertical Openings and Exterior Vertical Communications protected with minimum one (1) hr rating? NO

Area	12090	m^2
Description	Area of two largest floors + 50% of each of the floors above it (max 8)	
Required Fire Flow	15000	L/min

Occupancy Charge	Limited-Combustible Contents			
Fire Flow Reduction	-15%	**OR**	-2250	L/min
Required Fire Flow	12750	L/min		

Automated Sprinker Protection	YES		
Designed to NFPA 13 Standard	YES	-30%	
Standard Water Supply to Sprinklers and Standpipes	YES	-10%	
Fully Supervised System	YES	-10%	
Fire Flow Adjustment		-6375	L/min

Exposure 1 (North)	**Distance**	30.2	m	**Charge**	5%	
Description	Block 1					
Exposure 2 (East)	**Distance**	20	m	**Charge**	15%	
Description	Block 5					
Exposure 3 (West)	**Distance**	26.6	m	**Charge**	10%	
Description	Block 6					
Exposure 4 (South)	**Distance**	14	m	**Charge**	15%	
Description	Block 3 Mixed Use Building					
Total Exposure Charge					45%	
Fire Flow Adjustment					5737.5	L/min

Total Required Fire Flow	12000	L/min
Total Required Fire Flow	3170	U.S. GPM
Total Required Fire Flow	200	L/s

REQUIRED FIRE FLOW

Water Supply for Public Fire Protection (FUS 1999)

WALTERFEDY

Project	Northfield Development
Project #	2019-0654-10
Designer	RK
Address	525-565 Conestogo Road, Waterloo
Description	Fire Demand - Block 4

$$F = 220 \times C \times \sqrt{A}$$

F = Required fire flow (LPM)
C = Coefficient related to type of construction
A = Total floor area (including all storeys but excluding any basement levels at least 50% below grade)

Type of Construction	Fire-Resistive Construction	**C =**	0.6
Description	**Fully Protected Frame, Roof, Floors. Minimum 3 Hour Rated Structural Members and Floors with Reinforced Concrete or Protected Steel**		

Floor Area	2385	m^2	(L1 and L2)
Floor Area	1856		(L3 to L7)
Floor Area	926		(L8 to L20)
# Storeys	22		
Fire Resistant Building?	YES		

Vertical Openings and Exterior Vertical Communications protected with minimum one (1) hr rating? NO

Area	16828	m^2	
Description	Area of two largest floors + 50% of each of the floors above it (max 8)		
Required Fire Flow	17000	L/min	

Occupancy Charge	Limited-Combustible Contents			
Fire Flow Reduction	-15%	**OR**	-2550	L/min
Required Fire Flow	14450	L/min		

Automated Sprinker Protection	YES		
Designed to NFPA 13 Standard	YES	-30%	
Standard Water Supply to Sprinklers and Standpipes	YES	-10%	
Fully Supervised System	YES	-10%	
Fire Flow Adjustment		-7225	L/min

Exposure 1 (North)	**Distance**	14	m	**Charge**	15%	
Description	Block 2					
Exposure 2 (East)	**Distance**	50	m	**Charge**	0%	
Description						
Exposure 3 (West)	**Distance**	20	m	**Charge**	15%	
Description	Block 3					
Exposure 4 (South)	**Distance**	24	m	**Charge**	10%	
Description	Block 5					
Total Exposure Charge					40%	
Fire Flow Adjustment					5780	L/min

Total Required Fire Flow	13000	L/min
Total Required Fire Flow	3434	U.S. GPM
Total Required Fire Flow	217	L/s

REQUIRED FIRE FLOW

Water Supply for Public Fire Protection (FUS 1999)

WALTERFEDY

Project	Northfield Development
Project #	2019-0654-10
Designer	RK
Address	525-565 Conestogo Road, Waterloo
Description	Fire Demand - Block 5

$$F = 220 \times C \times \sqrt{A}$$

F = Required fire flow (LPM)
C = Coefficient related to type of construction
A = Total floor area (including all storeys but excluding any basement levels at least 50% below grade)

Type of Construction	Fire-Resistive Construction	**C =**	0.6
Description	**Fully Protected Frame, Roof, Floors. Minimum 3 Hour Rated Structural Members and Floors with Reinforced Concrete or Protected Steel**		

Floor Area	2385	m^2	(L1 and L2)
Floor Area	1856		(L3 to L7)
Floor Area	926		(L8 to L20)
# Storeys	20		
Fire Resistant Building?	YES		

Vertical Openings and Exterior Vertical Communications protected with minimum one (1) hr rating? NO

Area	16828	m^2	
Description	Area of two largest floors + 50% of each of the floors above it (max 8)		
Required Fire Flow	17000	L/min	

Occupancy Charge	Limited-Combustible Contents			
Fire Flow Reduction	-15%	**OR**	-2550	L/min
Required Fire Flow	14450	L/min		

Automated Sprinker Protection	YES		
Designed to NFPA 13 Standard	YES	-30%	
Standard Water Supply to Sprinklers and Standpipes	YES	-10%	
Fully Supervised System	YES	-10%	
Fire Flow Adjustment		-7225	L/min

Exposure 1 (North)	**Distance**	24	m	**Charge**	10%	
Description	Block 5					
Exposure 2 (East)	**Distance**	50	m	**Charge**	0%	
Description						
Exposure 3 (West)	**Distance**	20	m	**Charge**	15%	
Description	Block 3					
Exposure 4 (South)	**Distance**	25	m	**Charge**	10%	
Description	Block 7					
Total Exposure Charge					35%	
Fire Flow Adjustment					5057.5	L/min

Total Required Fire Flow	12000	L/min
Total Required Fire Flow	3170	U.S. GPM
Total Required Fire Flow	200	L/s

REQUIRED FIRE FLOW

Water Supply for Public Fire Protection (FUS 1999)

WALTERFEDY

Project	Northfield Development
Project #	2019-0654-10
Designer	RK
Address	525-565 Conestogo Road, Waterloo
Description	Fire Demand - Block 6

$$F = 220 \times C \times \sqrt{A}$$

F = Required fire flow (LPM)
C = Coefficient related to type of construction
A = Total floor area (including all storeys but excluding any basement levels at least 50% below grade)

Type of Construction	Fire-Resistive Construction	**C =**	0.6
Description	**Fully Protected Frame, Roof, Floors. Minimum 3 Hour Rated Structural Members and Floors with Reinforced Concrete or Protected Steel**		

Floor Area	3039	m^2	(L1 and L2)
Floor Area	3039		(L3 to L4)
Floor Area	1212		(L5 to L15)
# Storeys	15		
Fire Resistant Building?	YES		

Vertical Openings and Exterior Vertical Communications protected with minimum one (1) hr rating? NO

Area	19428	m^2	
Description	Area of two largest floors + 50% of each of the floors above it (max 8)		
Required Fire Flow	18000	L/min	

Occupancy Charge	Limited-Combustible Contents			
Fire Flow Reduction	-15%	**OR**	-2700	L/min
Required Fire Flow	15300	L/min		

Automated Sprinker Protection	YES		
Designed to NFPA 13 Standard	YES	-30%	
Standard Water Supply to Sprinklers and Standpipes	YES	-10%	
Fully Supervised System	YES	-10%	
Fire Flow Adjustment		-7650	L/min

Exposure 1 (North)	**Distance**	26	m	**Charge**	10%	
Description	Block 3					
Exposure 2 (East)	**Distance**	20	m	**Charge**	15%	
Description	Block 7					
Exposure 3 (West)	**Distance**	50	m	**Charge**	0%	
Description						
Exposure 4 (South)	**Distance**	50	m	**Charge**	0%	
Description						
Total Exposure Charge					25%	
Fire Flow Adjustment					3825	L/min

Total Required Fire Flow	11000	L/min
Total Required Fire Flow	2906	U.S. GPM
Total Required Fire Flow	183	L/s

REQUIRED FIRE FLOW

Water Supply for Public Fire Protection (FUS 1999)

WALTERFEDY

Project	Northfield Development
Project #	2019-0654-10
Designer	RK
Address	525-565 Conestogo Road, Waterloo
Description	Fire Demand - Block 7

$$F = 220 \times C \times \sqrt{A}$$

F = Required fire flow (LPM)
C = Coefficient related to type of construction
A = Total floor area (including all storeys but excluding any basement levels at least 50% below grade)

Type of Construction	Fire-Resistive Construction	**C =**	0.6
Description	**Fully Protected Frame, Roof, Floors. Minimum 3 Hour Rated Structural Members and Floors with Reinforced Concrete or Protected Steel**		

Floor Area	2337	m^2	(L2 and L3)
Floor Area	927		(L4 to L13)
# Storeys	19		
Fire Resistant Building?	YES		

Vertical Openings and Exterior Vertical Communications protected with minimum one (1) hr rating? NO

Area	12090	m^2
Description	Area of two largest floors + 50% of each of the floors above it (max 8)	
Required Fire Flow	15000	L/min

Occupancy Charge	Limited-Combustible Contents			
Fire Flow Reduction	-15%	**OR**	-2250	L/min
Required Fire Flow	12750	L/min		

Automated Sprinker Protection	YES	
Designed to NFPA 13 Standard	YES	-30%
Standard Water Supply to Sprinklers and Standpipes	YES	-10%
Fully Supervised System	YES	-10%
Fire Flow Adjustment		-6375 L/min

Exposure 1 (North)	**Distance**	25	m	**Charge**	10%
Description	Block 5				
Exposure 2 (East)	**Distance**	20	m	**Charge**	15%
Description	Block 7 Mixed Use				
Exposure 3 (West)	**Distance**	20	m	**Charge**	15%
Description	Block 6				
Exposure 4 (South)	**Distance**	50	m	**Charge**	0%
Description	Block 3				

Total Exposure Charge	40%	
Fire Flow Adjustment	5100	L/min

Total Required Fire Flow	11000	L/min
Total Required Fire Flow	2906	U.S. GPM
Total Required Fire Flow	183	L/s

REQUIRED FIRE FLOW

Water Supply for Public Fire Protection (FUS 1999)

WALTERFEDY

Project	Northfield Development
Project #	2019-0654-10
Designer	RK
Address	525-565 Conestogo Road, Waterloo
Description	Fire Demand - Block 8

$$F = 220 \times C \times \sqrt{A}$$

F = Required fire flow (LPM)
C = Coefficient related to type of construction
A = Total floor area (including all storeys but excluding any basement levels at least 50% below grade)

Type of Construction	Non-Combustible Construction	**C =**	0.8
Description	**Unprotected Metal Structural Components, Masonry or Metal Walls. All Structural Members are Non-Combustible but does not qualify as Fire-Resisitive**		

Floor Area	3559	m^2	L1
Floor Area	3559		(L2 to L3)
# Storeys	3312		(L4 to L5)
Fire Resistant Building?	NO		

Vertical Openings and Exterior Vertical Communications protected with minimum one (1) hr rating? NO

Area	17301	m^2	
Description	Total Building Floor Area		
Required Fire Flow	23000	L/min	

Occupancy Charge	Limited-Combustible Contents			
Fire Flow Reduction	-15%	**OR**	-3450	L/min
Required Fire Flow	19550	L/min		

Automated Sprinker Protection	YES	
Designed to NFPA 13 Standard	YES	-30%
Standard Water Supply to Sprinklers and Standpipes	YES	-10%
Fully Supervised System	YES	-10%
Fire Flow Adjustment		-9775 L/min

Exposure 1 (North)	**Distance**	50	m	**Charge**	0%
Description					
Exposure 2 (East)	**Distance**	50	m	**Charge**	0%
Description					
Exposure 3 (West)	**Distance**	50	m	**Charge**	0%
Description					
Exposure 4 (South)	**Distance**	50	m	**Charge**	0%
Description					

Total Exposure Charge	0%
Fire Flow Adjustment	0 L/min

Total Required Fire Flow	10000	L/min
Total Required Fire Flow	2642	U.S. GPM
Total Required Fire Flow	167	L/s

Region of Waterloo

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150 Frederick Street
Kitchener ON Canada N2G 4J3
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Fax: (519) 575-4452
www.region.waterloo.on.ca

Date: June 25, 2020
File #: E18-10/WA

Rushin Khakharia, P. Eng.
WalterFedy
675 Queen St S., Suite 111
Kitchener, ON N2M 1A1
t. 519.576.2150 ext 469
e.rkhakharia@walterfedy.com

Dear: Rushin

Re: Kraus Flooring
525-565 Conestogo Rd W., Waterloo

Please find the results of the modeling simulations for boundary conditions requested on May 14, 2020. The results included a figure showing the locations of the nodes from the Region's model. Attached are a series of spreadsheets containing results for Average Day, Maximum Day demands and available fire flows at Northfield Dr and Conestogo Rd.

The diurnal 24 hour demand distribution accounts for the minimum hour and peak hour peaking factors. The minimum hourly demand on the average day represents the minimum hour, and the maximum hourly demand on the maximum day represents the peak hour.

Demands applied to the request as noted:

Node	Elevation (mASL)	Res Dmd		Emp Dmd		Fire Flow Results	
		ADD (L/s)	MDD (L/s)	ADD (L/s)	MDD (L/s)	Design Flow (L/s)	Design Pressure (m)
JCT_18688	341.00	9.98	14.17	1.68	2.38	798.9	15.9

A fire flow analysis shows the maximum flow available at a node with an associated design pressure during the maximum day scenario while maintaining the minimum design pressure of 14 m (140 kPa) at all nodes within the pressure zone.

If you have any questions, please contact me.

Kevin Dolishny P.Eng.
Senior Project Engineer, Servicing and Development Planning
t. 519.575.4757 x 3862
e-mail: kdolishny@regionofwaterloo.ca

cc John Holowackyj. Region of Waterloo

Wat 4 Infowater Intersection of Northfield at Conestogo Rd

JCT_18688 Average Day 24 Hour Simulation

Time	Demand (L/s)	Head (m)	Pressure (m)
00:00 hrs	7.35	379.48	38.48
01:00 hrs	5.77	379.91	38.91
02:00 hrs	6.17	382.24	41.24
03:00 hrs	6.43	382.42	41.42
04:00 hrs	5.80	382.94	41.94
05:00 hrs	5.02	383.21	42.21
06:00 hrs	7.43	382.41	41.41
07:00 hrs	14.28	380.41	39.41
08:00 hrs	17.44	379.31	38.31
09:00 hrs	15.39	378.23	37.23
10:00 hrs	15.17	378.01	37.01
11:00 hrs	14.83	377.75	36.75
12:00 hrs	14.20	377.60	36.60
13:00 hrs	13.53	377.53	36.53
14:00 hrs	12.72	377.50	36.50
15:00 hrs	11.92	377.56	36.56
16:00 hrs	12.38	377.54	36.54
17:00 hrs	12.86	378.34	37.34
18:00 hrs	14.29	378.50	37.50
19:00 hrs	15.15	378.60	37.60
20:00 hrs	15.02	378.75	37.75
21:00 hrs	14.03	378.97	37.97
22:00 hrs	12.59	379.22	38.22
23:00 hrs	10.33	379.55	38.55

Average Day HGL:	379.42
Minimum Hour:	383.21

JCT_18688 Maximum Day 24 Hour Simulation

Time	Demand (L/s)	Head (m)	Pressure (m)
00:00 hrs	8.94	379.96	38.96
01:00 hrs	6.30	382.23	41.23
02:00 hrs	6.79	382.30	41.30
03:00 hrs	7.73	379.30	38.30
04:00 hrs	7.62	379.48	38.48
05:00 hrs	6.74	379.69	38.69
06:00 hrs	12.02	378.93	37.93
07:00 hrs	22.01	377.46	36.46
08:00 hrs	25.24	377.90	36.90
09:00 hrs	20.18	379.12	38.12
10:00 hrs	16.78	379.47	38.47
11:00 hrs	15.97	379.54	38.54
12:00 hrs	14.82	378.66	37.66
13:00 hrs	16.49	377.53	36.53
14:00 hrs	18.81	377.43	36.43
15:00 hrs	16.83	377.39	36.39
16:00 hrs	20.56	378.17	37.17
17:00 hrs	21.22	376.86	35.86
18:00 hrs	24.47	377.33	36.33
19:00 hrs	26.39	375.73	34.73
20:00 hrs	26.34	376.46	35.46
21:00 hrs	23.96	377.45	36.45
22:00 hrs	17.52	377.71	36.71
23:00 hrs	13.17	378.32	37.32

Maximum Day HGL:	378.52
Peak Hour:	375.73

Wat 4 Infowater

Intersection of Northfield at Conestogo Rd

Available Flow (L/s)	Residual Pressure (m)
0.0	37.8
25.0	37.6
50.0	37.3
75.0	37.0
100.0	36.6
125.0	36.3
150.0	35.9
175.0	35.5
200.0	35.0
225.0	34.5
250.0	34.0
275.0	33.4
300.0	32.8
325.0	32.2
350.0	31.6
375.0	30.9
400.0	30.2
425.0	29.5
450.0	28.8
475.0	28.0
500.0	27.2
525.0	26.4
550.0	25.6
575.0	24.7
600.0	23.8
625.0	22.9
650.0	22.0
675.0	21.0
700.0	20.0
725.0	19.0
750.0	18.0
775.0	16.9
798.9	15.9

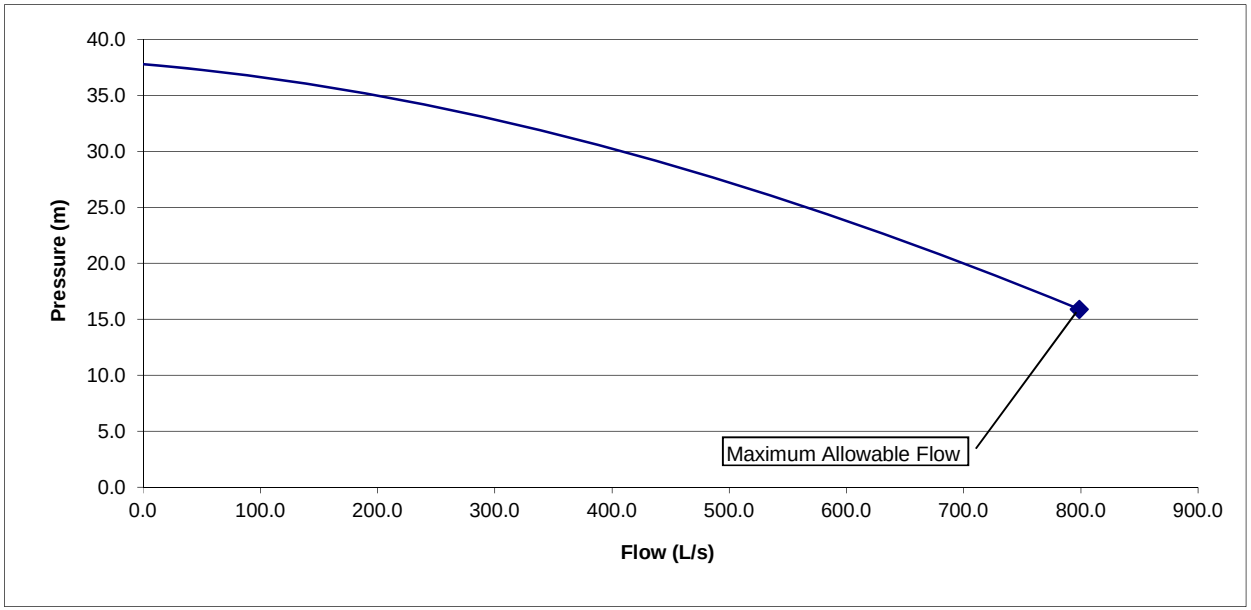
Fire Flow Analysis

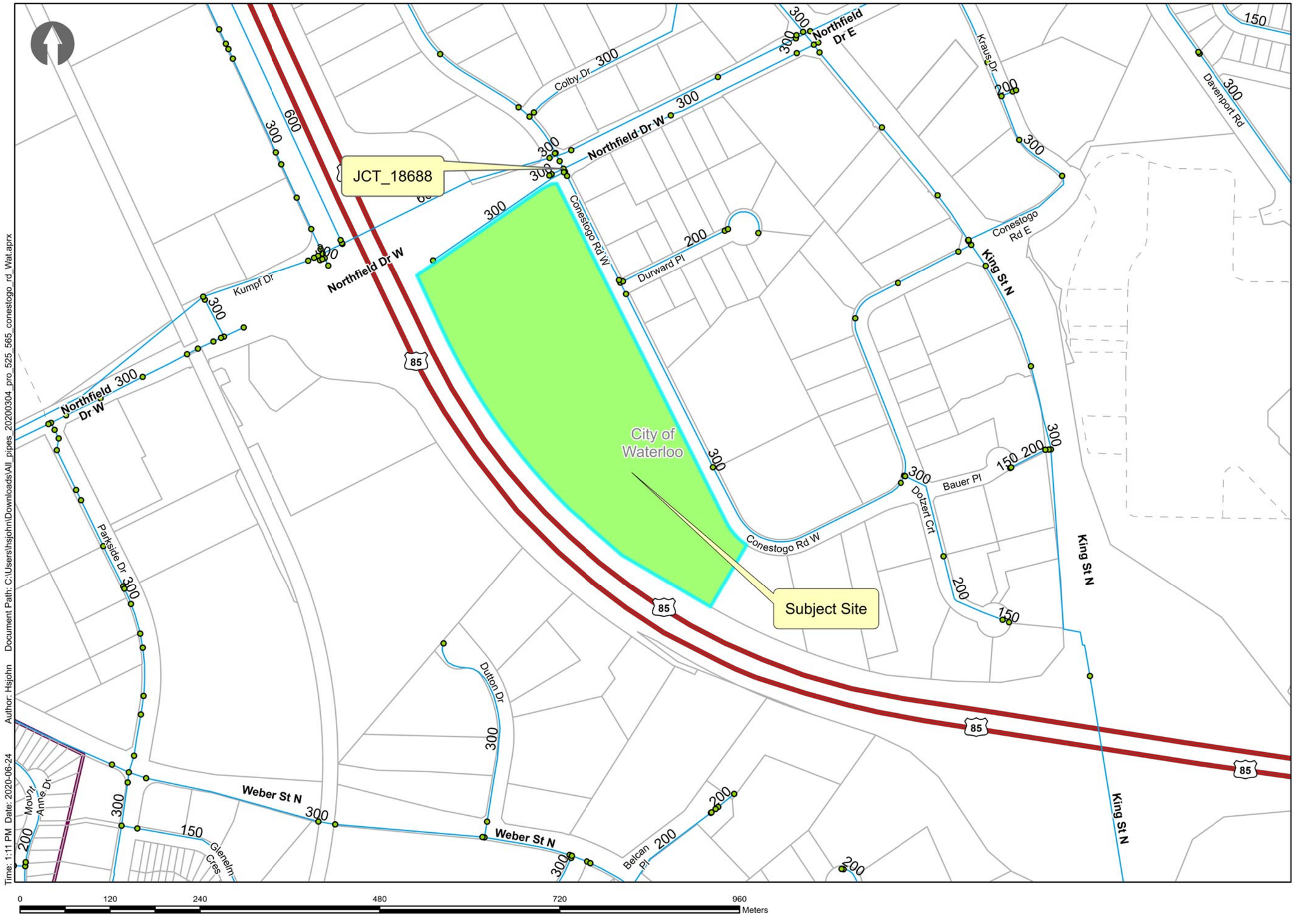
Fire Flow Node:	JCT_18688
Design Flow (L/s):	798.9
	15.9

The final adjusted flow at the node to maintain the minimum design pressure (14m (140 kPa)) at ALL locations within the pressure zone.

The lowest allowable pressure at the node to maintain the minimum design pressure (14m (140 kPa)) at ALL locations within the pressure zone.

The constraining node within the pressure zone that drops to the minimum design pressure of (14m (140 kPa)) during the design flow.





Time: 1:11 PM Date: 2020-06-24 Author: Hsjohn Document Path: C:\Users\hsjohn\Downloads\All_pipes_20200304_pro_525_565_conestogo_rd_Wat.aprx

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Legend

- Junction
  - TYPE
    - Active
    - Domain
- Tank
  - TYPE
    - Active
    - Domain
- Reservoir
  - TYPE
    - Active
    - Domain
- Pump
  - TYPE
    - Active
    - Domain
- Valve
  - TYPE
    - Active
    - Domain
- Pipe
  - TYPE
    - Active
    - Domain
    - Subject Site
    - Assessment Parcels (MPAC)
- Roads
  - Roads
    - Highway
    - Arterial/Collector
    - Local
    - Private
    - Proposed Roads
- Pressure Zones
  - Pressure Zone
- Non modelling data Layer
  - Regional Municipal Boundaries
  - Assessment Parcels (MPAC)

525-565 Conestogo Rd W, Waterloo

Appendix C5 - Average Day Results

Network Table - Nodes

Node ID	Elevation m	Demand LPS	Head m	Pressure m
Junc PublicHyd	340.18	0.00	378.69	38.51
Junc Northfield-Main	341.76	0.00	378.69	36.93
Junc Block1Redundant	341.50	0.00	378.69	37.19
Junc BLK1_Northfield_Con	339.86	0.00	378.69	38.83
Junc Block2Redundant	341.50	0.00	378.69	37.19
Junc BLK2_Northfield_Con	341.33	0.00	378.69	37.36
Junc Block2	341.50	1.60	378.69	37.19
Junc BLK2_Conestogo_Con	340.86	0.00	378.69	37.83
Junc BLK1_Conestogo_Con	339.95	0.00	378.69	38.74
Junc Block1	341.50	2.60	378.69	37.19
Junc Block4	340.35	1.39	378.69	38.34
Junc BLK4_Conestogo_Con	339.43	0.00	378.69	39.26
Junc Block5	338	1.29	378.69	40.69
Junc BLK5_Conestogo_Con	338.12	0.00	378.69	40.57
Junc Block7	338	2.24	378.69	40.69
Junc BLK7_Conestogo_Con	336.62	0.00	378.69	42.07
Junc BLK6_Conestogo_Con	337.30	0.00	378.69	41.39
Junc Block6	339.30	1.80	378.69	39.39
Junc BLK3_Conestogo_Con	338.84	0.00	378.69	39.85
Junc Block3	339.15	1.63	378.69	39.54
Junc Block8	336	0.89	378.69	42.69
Junc BLK8_Conestogo_Con	335.43	0.00	378.69	43.26
Junc JCT_18688	341.00	0.00	378.69	37.69
Resvr WAT4	341.00	-13.44	341.00	0.00

Appendix C6 - Maximum Day Results

Network Table - Nodes

Node ID	Elevation m	Demand LPS	Head m	Pressure m
Junc PublicHyd	340.18	0.00	378.65	38.47
Junc Northfield-Main	341.76	0.00	378.65	36.89
Junc Block1Redundant	341.50	0.00	378.65	37.15
Junc BLK1_Northfield_Con	339.86	0.00	378.65	38.79
Junc Block2Redundant	341.50	0.00	378.65	37.15
Junc BLK2_Northfield_Con	341.33	0.00	378.65	37.32
Junc Block2	341.50	2.28	378.65	37.15
Junc BLK2_Conestogo_Con	340.86	0.00	378.65	37.79
Junc BLK1_Conestogo_Con	339.95	0.00	378.65	38.70
Junc Block1	341.50	3.69	378.64	37.14
Junc Block4	340.35	1.97	378.65	38.30
Junc BLK4_Conestogo_Con	339.43	0.00	378.65	39.22
Junc Block5	338	1.83	378.65	40.65
Junc BLK5_Conestogo_Con	338.12	0.00	378.65	40.53
Junc Block7	338	3.24	378.65	40.65
Junc BLK7_Conestogo_Con	336.62	0.00	378.65	42.03
Junc BLK6_Conestogo_Con	337.30	0.00	378.65	41.35
Junc Block6	339.30	2.56	378.64	39.34
Junc BLK3_Conestogo_Con	338.84	0.00	378.65	39.81
Junc Block3	339.15	2.31	378.64	39.49
Junc Block8	336	1.33	378.65	42.65
Junc BLK8_Conestogo_Con	335.43	0.00	378.65	43.22
Junc JCT_18688	341.00	0.00	378.65	37.65
Resvr WAT4	341.00	-19.22	341.00	0.00

TABLE C-7 - MAXIMUM AVAILABLE FLOWS

WALTERFEDY

DGSSMS 2020, Water Supply and Distribution Optimization Master Plan and ONTARIO BUILDING CODE

Project	525-565 Conestogo Road W., Plan of Subdivision
Project #	2019-0654-10
Designer	Rushin Khakharia
Address	Kitchener, Ontario
Description	Overall Domestic Flows

Analysis Node	Domestic Flow	Available Fire Flow	Maximum Total Flow	Elevation	Total Head	Min Pressure	Node with Min Pressure
	(L/s)	*(L/s)*	*(L/s)*	*(m)*	*(m)*	*(m)*	
BLK1_Conestogo_Con	0	779.677	779.677	339.95	354.050	15.140	Northfield-Main
BLK1_Northfield_Con	0	400.481	387.700	339.86	353.960	14.100	Block1Redundant
BLK2_Conestogo_Con	0	779.677	779.677	340.86	354.960	15.140	Northfield-Main
BLK2_Northfield_Con	0	461.030	459.000	341.33	355.430	14.100	Block1Redundant
BLK3_Conestogo_Con	0	779.677	779.677	338.84	352.940	15.140	Northfield-Main
BLK4_Conestogo_Con	0	779.677	779.677	339.43	353.530	15.140	Northfield-Main
BLK5_Conestogo_Con	0	779.677	779.677	338.12	352.220	15.140	Northfield-Main
BLK6_Conestogo_Con	0	779.677	779.677	337.30	351.400	15.140	Northfield-Main
BLK7_Conestogo_Con	0	779.677	779.677	336.62	350.720	15.140	Northfield-Main
BLK8_Conestogo_Con	0	779.677	779.677	335.43	349.530	15.140	Northfield-Main
Block1	3.691	213.297	216.988	341.50	355.600	14.100	Block1
Block1Redundant	0	295.010	295.010	341.50	355.600	14.100	Block1Redundant
Block2	2.278	612.084	614.362	341.50	355.600	14.100	Block2
Block2Redundant	0	415.174	415.174	341.50	355.600	14.100	Block2Redundant
Block3	2.311	371.491	373.802	339.15	353.250	14.100	Block3
Block4	1.973	631.944	633.917	340.35	354.450	14.100	Block4
Block5	1.833	670.080	671.913	338.00	352.100	14.100	Block5
Block6	2.564	353.183	355.747	339.30	353.400	14.100	Block6
Block7	3.245	654.311	657.556	338.00	352.100	14.100	Block7
Block8	1.328	687.848	689.176	336.00	350.100	14.100	Block8
JCT_18688	0	779.677	779.677	341.00	355.100	15.140	Northfield-Main
Northfield-Main	0	779.677	779.677	341.76	355.860	15.140	Northfield-Main
PublicHyd	0	350.686	350.686	340.18	354.280	14.100	PublicHyd
WAT4	0	-19.224	-19.224	341.00	355.100	36.886	Northfield-Main

```
[TITLE]
Kraus Carpet - Water Distribution Model

[JUNCTIONS]
;ID                   Elev            Demand          Pattern
 PublicHyd            340.18          0                                     ;
 Northfield-Main      341.76          0                                     ;
 Block1Redundant      341.50          0                                     ;
 BLK1_Northfield_Con  339.86          0                                     ;
 Block2Redundant      341.50          0                                     ;
 BLK2_Northfield_Con  341.33          0                                     ;
 Block2               341.50          2.278                                 ;
 BLK2_Conestogo_Con   340.86          0                                     ;
 BLK1_Conestogo_Con   339.95          0                                     ;
 Block1               341.50          3.691                                 ;
 Block4               340.35          1.973                                 ;
 BLK4_Conestogo_Con   339.43          0                                     ;
 Block5               338             1.833                                 ;
 BLK5_Conestogo_Con   338.12          0                                     ;
 Block7               338             3.245                                 ;
 BLK7_Conestogo_Con   336.62          0                                     ;
 BLK6_Conestogo_Con   337.30          0                                     ;
 Block6               339.30          2.564                                 ;
 BLK3_Conestogo_Con   338.84          0                                     ;
 Block3               339.15          2.311                                 ;
 Block8               336             1.328                                 ;
 BLK8_Conestogo_Con   335.43          0                                     ;
 JCT_18688            341.00          0                                     ;

[RESERVOIRS]
;ID                   Head            Pattern
 WAT4                 341.00                                  ;

[TANKS]
;ID                   Elevation       InitLevel       MinLevel        MaxLevel
Diameter        MinVol          VolCurve

[PIPES]
;ID                   Node1                   Node2                   Length
Diameter        Roughness       MinorLoss       Status
 p2                   Block1Redundant         BLK1_Northfield_Con     31.82
200             150             0               Open    ;
 p3                   Block2Redundant         BLK2_Northfield_Con     21.9
250             150             0               Open    ;
 p4                   Block2                  BLK2_Conestogo_Con      23.11
250             150             0               Open    ;
 p5                   BLK1_Conestogo_Con      Block1                  132.4
200             150             0               Open    ;
```

```
 p6                 Block4              BLK4_Conestogo_Con      22.85
250             150             0               Open    ;
 p7                 Block5              BLK5_Conestogo_Con      22.66
250             150             0               Open    ;
 p8                 Block7              BLK7_Conestogo_Con      25.14
250             150             0               Open    ;
 p9                 BLK6_Conestogo_Con      Block6              147.78
250             150             0               Open    ;
 p10                BLK3_Conestogo_Con      Block3              132.2
250             150             0               Open    ;
 p11                Block8              BLK8_Conestogo_Con      24.69
250             150             0               Open    ;
 Pipe1              JCT_18688           Northfield-Main         1
1000            1000            0               Open    ;
 Pipe2              JCT_18688           BLK2_Conestogo_Con      1
1000            1000            0               Open    ;
 Pipe3              JCT_18688           BLK1_Conestogo_Con      1
1000            1000            0               Open    ;
 Pipe4              JCT_18688           BLK4_Conestogo_Con      1
1000            1000            0               Open    ;
 Pipe5              JCT_18688           BLK3_Conestogo_Con      1
1000            1000            0               Open    ;
 Pipe6              JCT_18688           BLK5_Conestogo_Con      1
1000            1000            0               Open    ;
 Pipe7              JCT_18688           BLK6_Conestogo_Con      1
1000            1000            0               Open    ;
 Pipe8              JCT_18688           BLK7_Conestogo_Con      1
1000            1000            0               Open    ;
 Pipe9              Northfield-Main     BLK2_Northfield_Con     89.40
300             110             0               Open    ;
 Pipe10             BLK2_Northfield_Con     BLK1_Northfield_Con     56.52
300             110             0               Open    ;
 Pipe11             BLK1_Northfield_Con     PublicHyd           52.69
300             110             0               Open    ;
 Pipe12             JCT_18688           BLK8_Conestogo_Con      1
1000            1000            0               Open    ;

[PUMPS]
;ID                Node1               Node2               Parameters
 Pump1              WAT4                JCT_18688           HEAD Curve1
;

[VALVES]
;ID                Node1               Node2               Diameter
Type    Setting         MinorLoss

[TAGS]
```

```
[DEMANDS]
;Junction                Demand          Pattern                  Category

[STATUS]
;ID                      Status/Setting

[PATTERNS]
;ID                      Multipliers

[CURVES]
;ID                      X-Value         Y-Value
;HEADLOSS: Headloss from JCT_18688
 Curve1                  0               37.8
 Curve1                  25              37.6
 Curve1                  50              37.3
 Curve1                  75              37
 Curve1                  100             36.6
 Curve1                  125             36.3
 Curve1                  150             35.9
 Curve1                  175             35.5
 Curve1                  200             35.0
 Curve1                  225             34.5
 Curve1                  250             34
 Curve1                  275             33.4
 Curve1                  300             32.8
 Curve1                  325             32.2
 Curve1                  350             31.6
 Curve1                  375             30.9
 Curve1                  400             30.2
 Curve1                  425             29.5
 Curve1                  600             23.8
 Curve1                  750             18
 Curve1                  798.9           15.9

[CONTROLS]

[RULES]

[ENERGY]
 Global Efficiency       75
 Global Price            0
 Demand Charge           0

[EMITTERS]
;Junction                Coefficient

[QUALITY]
;Node                    InitQual
```

```
[SOURCES]
;Node                   Type            Quality         Pattern

[REACTIONS]
;Type           Pipe/Tank               Coefficient


[REACTIONS]
 Order Bulk             1
 Order Tank             1
 Order Wall             1
 Global Bulk            0
 Global Wall            0
 Limiting Potential     0
 Roughness Correlation  0

[MIXING]
;Tank                   Model

[TIMES]
 Duration               0
 Hydraulic Timestep     1:00
 Quality Timestep       0:05
 Pattern Timestep       1:00
 Pattern Start          0:00
 Report Timestep        1:00
 Report Start           0:00
 Start ClockTime        12 am
 Statistic              None

[REPORT]
 Status                 No
 Summary                No
 Page                   0

[OPTIONS]
 Units                  LPS
 Headloss               H-W
 Specific Gravity       1
 Viscosity              1
 Trials                 40
 Accuracy               0.001
 CHECKFREQ              2
 MAXCHECK               10
 DAMPLIMIT              0
 Unbalanced             Continue 10
 Pattern                1
```

```
 Demand Multiplier      1.0
 Emitter Exponent       0.5
 Quality                None mg/L
 Diffusivity            1
 Tolerance              0.01

[COORDINATES]
;Node                   X-Coord                 Y-Coord
 PublicHyd              -35.98                  27.14
 Northfield-Main        161.88                  44.29
 Block1Redundant        16.50                   0.00
 BLK1_Northfield_Con    16.50                   31.82
 Block2Redundant        72.79                   14.94
 BLK2_Northfield_Con    72.79                   36.85
 Block2                 144.50                  -18.04
 BLK2_Conestogo_Con     167.61                  -17.97
 BLK1_Conestogo_Con     167.39                  -68.57
 Block1                 34.95                   -68.58
 Block4                 144.50                  -100.48
 BLK4_Conestogo_Con     167.35                  -100.48
 Block5                 144.50                  -167.56
 BLK5_Conestogo_Con     167.16                  -167.56
 Block7                 141.50                  -238.06
 BLK7_Conestogo_Con     166.64                  -238.08
 BLK6_Conestogo_Con     168.27                  -204.43
 Block6                 28.02                   -211.96
 BLK3_Conestogo_Con     167.65                  -133.28
 Block3                 35.50                   -133.28
 Block8                 141.50                  -359.04
 BLK8_Conestogo_Con     166.19                  -359.14
 JCT_18688              182.53                  59.12
 WAT4                   221.02                  58.55

[VERTICES]
;Link                   X-Coord                 Y-Coord
 p9                     28.02                   -204.43

[LABELS]
;X-Coord           Y-Coord          Label & Anchor Node

[BACKDROP]
 DIMENSIONS             -46.19                  -379.31                 178.49
        64.46
 UNITS                  Meters
 FILE
 OFFSET                 0.00                    0.00

[END]
```

APPENDIX D

Storm Servicing

- Storm Sewer Design Sheet (Northfield Drive)

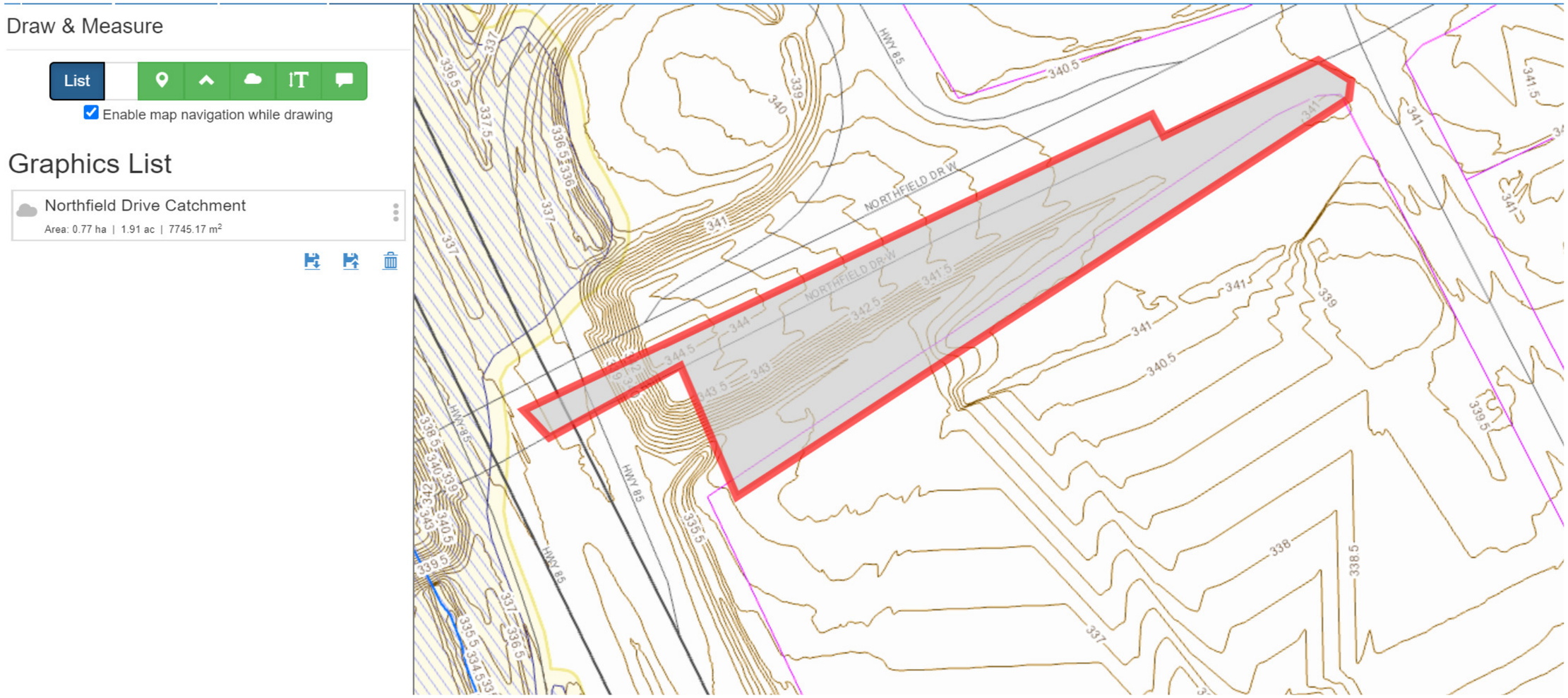
WALTERFEDY

Project:	525-565 Conestogo Road, Waterloo (Northfield Drive Storm Sewer)			Storm Parameters			
Project No:	2019-0654-10			A	1593		
Date:	26-Jul-20			B	11		
Designed By:	RK	Checked By:	RK	C	0.878		

STORM SEWER DESIGN CALCULATIONS

Design Frequency	5-YR	Maximum Permitted Full Flow Velocity (m/s)	6
Manning's 'n'	0.013	Minimum Permitted Full Flow Velocity (m/s)	0.8

	Pipe Data			Drainage Area				Time		Design Flow		Pipe Flow							
	From	To	Length (m)	Area (ha)	C	AC	∑AC	Inlet (min)	System (min)	I (mm/hr)	Q (L/s)	Diameter (mm)	Slope (%)	Q_{FULL} (L/s)	Q/Q_{FULL}	V_{FULL} (m/s)	V (m/s)	Flow Time (min)	Remarks
Conestogo Road		Ditch	110	0.77	0.8	**0.616**	**0.616**	5	**5**	**139.64**	**238.93**	450	1.00%	**285.11**	**0.84**	**1.79**	**2.01**	**0.91**	**No Surcharge**



APPENDIX E

Stormwater Management

- Roof Storage
- Parking Lot Storage
- Stormceptor EFO – Catchment 203
- Stormceptor EFO – Catchment 205
- Stormceptor EFO – Catchment 208

APPENDIX E
STORMWATER MANAGEMENT CALCULATIONS
ROOF STORAGE

FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT REPORT
NORTHFIELD PROPERTIES LP
WATERLOO, ONTARIO

5a

Parameter	Units	
Total Rooftop Area	(m^2)	1518.0
Roof Slope	%	0.3
Rooftop Area Used for Storage	%	100
Rooftop Area Used for Storage	(m^2)	1518.0
Maximum Depth	(m)	0.15
Number of Roof Drains[1]	drains	3
Area per Roof Drain	(m^2/drain)	506.00
Total Storage Volume	(m^3)	227.7
Base of unit[2]	(m)	349.40
Top of unit	(m)	349.55
Roof Drain Diameter	(mm)	50
Number of Roof Drains		3

S5a

Stage-Storage

Elevation (m)	Notes	Depth (m)	Area (m^2)	Storage Volume (m^3)
349.400		0.000	0.00	0.0
349.425		0.025	833	10.4
349.426		0.026	901	11.3
349.450		0.050	1518	40.3
349.475		0.075	1518	78.3
349.500		0.100	1518	116.2
349.525		0.125	1518	154.2
349.550		0.150	1518	192.1

5b

Parameter	Units	
Total Rooftop Area	(m^2)	1518.0
Roof Slope	%	0.3
Rooftop Area Used for Storage	%	100
Rooftop Area Used for Storage	(m^2)	1518.0
Maximum Depth	(m)	0.15
Number of Roof Drains[1]	drains	3
Area per Roof Drain	(m^2/drain)	506.00
Total Storage Volume	(m^3)	227.7
Base of unit[2]	(m)	349.40
Top of unit	(m)	349.55
Roof Drain Diameter	(mm)	50
Number of Roof Drains		3

S5b

Stage-Storage

Elevation (m)	Notes	Depth (m)	Area (m^2)	Storage Volume (m^3)
349.400		0.000	0.00	0.0
349.425		0.025	833	10.4
349.426		0.026	901	11.3
349.450		0.050	1518	40.3
349.475		0.075	1518	78.3
349.500		0.100	1518	116.2
349.525		0.125	1518	154.2
349.550		0.150	1518	192.1

5c

Parameter	Units	
Total Rooftop Area	(m^2)	1518.0
Roof Slope	%	0.3
Rooftop Area Used for Storage	%	100
Rooftop Area Used for Storage	(m^2)	1518.0
Maximum Depth	(m)	0.15
Number of Roof Drains[1]	drains	3
Area per Roof Drain	(m^2/drain)	506.00
Total Storage Volume	(m^3)	227.7
Base of unit[2]	(m)	349.40
Top of unit	(m)	349.55
Roof Drain Diameter	(mm)	50
Number of Roof Drains		3

S5c

Stage-Storage

Elevation (m)	Notes	Depth (m)	Area (m^2)	Storage Volume (m^3)
349.400		0.000	0.00	0.0
349.425		0.025	833	10.4
349.426		0.026	901	11.3
349.450		0.050	1518	40.3
349.475		0.075	1518	78.3
349.500		0.100	1518	116.2
349.525		0.125	1518	154.2
349.550		0.150	1518	192.1

5d

Parameter	Units	
Total Rooftop Area	(m^2)	1518.0
Roof Slope	%	0.3
Rooftop Area Used for Storage	%	100
Rooftop Area Used for Storage	(m^2)	1518.0
Maximum Depth	(m)	0.15
Number of Roof Drains[1]	drains	3
Area per Roof Drain	(m^2/drain)	506.00
Total Storage Volume	(m^3)	227.7
Base of unit[2]	(m)	349.4
Top of unit	(m)	349.6
Roof Drain Diameter	(mm)	50
Number of Roof Drains		3

S5d

Stage-Storage

Elevation (m)	Notes	Depth (m)	Area (m^2)	Storage Volume (m^3)
349.400		0.000	0.00	0.0
349.425		0.025	833	10.4
349.426		0.026	901	11.3
349.450		0.050	1518	40.3
349.475		0.075	1518	78.3
349.500		0.100	1518	116.2
349.525		0.125	1518	154.2
349.550		0.150	1518	192.1

Notes:
1. Number of roofdrains per roof is a preliminary assumption
2. Height of building is a preliminary estimate - 14 feet per storey

APPENDIX E
STORMWATER MANAGEMENT CALCULATIONS
PARKING LOT STORAGE

FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT REPORT
NORTHFIELD PROPERTIES LP
WATERLOO, ONTARIO

CBMH63

Parameter	Units	
Bottom Footprint Area	(m^2)	24.2
Top Footprint Area	(m^2)	1060
Maximum Depth of Ponding	(m)	0.30
Total Storage Volume	(m^3)	137.4
Base of surface storage	(m)	336.0
Top of surface storage	(m)	336.3
Manhole - CBMH63		
Sump Elevation	(m)	334.14
Rim Elevation	(m)	335.95
Diameter	(mm)	1200
Area	(m^2)	1.13
Orifice Diameter (at elev. 333.461 m)	(mm)	140
Weir Width (at elev. 336.25 m)	(m)	7

South Parking Lot

Parameter	Units	
Surface		
Bottom Footprint Area	(m^2)	112.3
Top Footprint Area	(m^2)	5645
Maximum Depth of Ponding	(m)	2.94
Total Storage Volume	(m^3)	483.6
Base of surface storage	(m)	336.0
Top of surface storage	(m)	338.9
Manhole - CBMH54		
Sump Elevation	(m)	333.36
Rim Elevation	(m)	335.95
Diameter	(mm)	1200
Area	(m^2)	1.13
Orifice Diameter (at elev. 333.461 m)	(mm)	140
Weir Width (at elev. 336.25 m)	(m)	6
Weir Width (at elev. 336.20 m)	(m)	7

Notes:
1. Infiltration is not proposed due to contaminated soils
2. Preliminary sizing of sites storage requirements

S4

Stage-Storage

Elevation (m)	Notes	Depth (m)	Area (m^2)	Storage Volume (m^3)
334.14	Sump Elevation	0.00	1.13	0.0
334.64		0.50	1.13	0.6
335.14		1.00	1.13	1.1
335.64		1.50	1.13	2.1
335.95		1.82	1.13	2.5
336.00	Surface Storage Begins	1.87	24.2	3.7
336.05		1.92	96.1	9.7
336.10		1.97	217.7	17.6
336.15		2.01	398.9	33.0
336.20		2.07	570.7	57.2
336.25		2.12	788.5	91.2
336.30		2.17	1060.4	137.4

S5

Stage-Storage

Elevation (m)	Notes	Depth (m)	Area (m^2)	Storage Volume (m^3)
333.36	Sump Elevation	0.00	1.13	0.0
333.95		0.59	1.13	0.7
334.55		1.19	1.13	1.3
335.15		1.79	1.13	2.0
335.75		2.39	1.13	2.7
335.95		2.59	1.13	2.9
336.00	Surface Ponding Begins	2.64	112.3	5.8
336.05		2.69	367.9	17.8
336.10		2.74	575.1	41.3
336.15		2.79	1213.4	86.1
336.20		2.84	1781.3	160.9
336.25		2.89	2740.9	274.0
336.30		2.94	5644.9	483.6

Stormceptor®

FORTERRA

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

05/27/2021

Province:	Ontario
City:	Waterloo
Nearest Rainfall Station:	WATERLOO WELLINGTON AP
NCDC Rainfall Station Id:	9387
Years of Rainfall Data:	34

Site Name:	65 Northfield Drive W - Catchment 203
Drainage Area (ha):	0.57
% Imperviousness:	100.00

Runoff Coefficient 'c': 0.90

Particle Size Distribution:	Fine
Target TSS Removal (%):	80.0

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	20.10
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Former Kraus Carpet
Project Number:	2019-0654-10
Designer Name:	Marlee Sauder
Designer Company:	WalterFedy
Designer Email:	msauder@walterfedy.com
Designer Phone:	519-719-8074
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	75
EFO6	83
EFO8	87
EFO10	89
EFO12	91

Recommended Stormceptor EFO Model: EFO6

Estimated Net Annual Sediment (TSS) Load Reduction (%): 83

Water Quality Runoff Volume Capture (%): > 90

imbrium

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterwavs.

PARTICLE SIZE DISTRIBUTION (PSD)

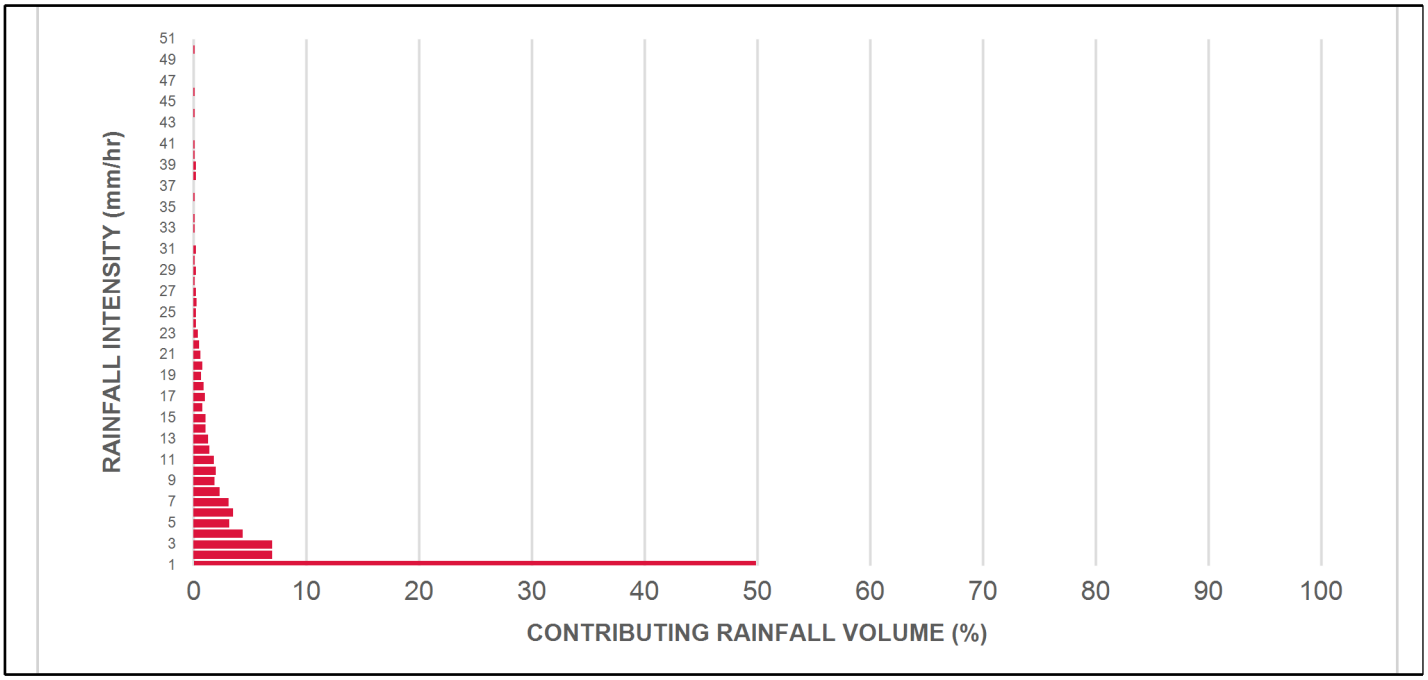
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

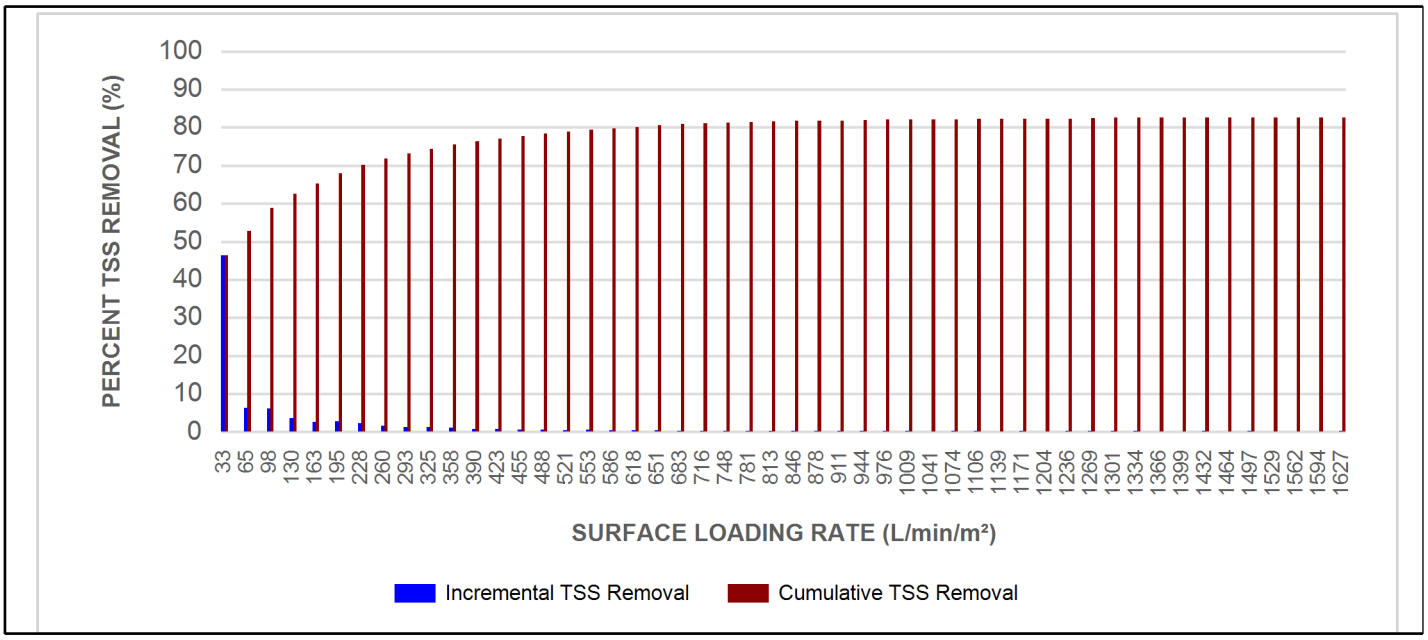
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.9	49.9	1.43	86.0	33.0	93	46.4	46.4
2	7.0	56.9	2.85	171.0	65.0	91	6.4	52.8
3	7.0	63.9	4.28	257.0	98.0	88	6.2	58.9
4	4.4	68.3	5.70	342.0	130.0	84	3.7	62.6
5	3.2	71.5	7.13	428.0	163.0	80	2.6	65.2
6	3.5	75.0	8.56	513.0	195.0	77	2.7	67.9
7	3.1	78.1	9.98	599.0	228.0	74	2.3	70.2
8	2.3	80.4	11.41	685.0	260.0	71	1.6	71.8
9	1.9	82.3	12.84	770.0	293.0	68	1.3	73.1
10	2.0	84.3	14.26	856.0	325.0	65	1.3	74.4
11	1.8	86.1	15.69	941.0	358.0	63	1.1	75.5
12	1.4	87.5	17.11	1027.0	390.0	59	0.8	76.3
13	1.3	88.8	18.54	1112.0	423.0	57	0.7	77.1
14	1.1	89.9	19.97	1198.0	455.0	57	0.6	77.7
15	1.1	91.0	21.39	1284.0	488.0	56	0.6	78.3
16	0.8	91.8	22.82	1369.0	521.0	54	0.4	78.8
17	1.0	92.8	24.24	1455.0	553.0	54	0.5	79.3
18	0.9	93.7	25.67	1540.0	586.0	53	0.5	79.8
19	0.7	94.4	27.10	1626.0	618.0	52	0.4	80.1
20	0.8	95.2	28.52	1711.0	651.0	52	0.4	80.5
21	0.6	95.8	29.95	1797.0	683.0	52	0.3	80.9
22	0.5	96.3	31.38	1883.0	716.0	51	0.3	81.1
23	0.4	96.7	32.80	1968.0	748.0	51	0.2	81.3
24	0.2	96.9	34.23	2054.0	781.0	51	0.1	81.4
25	0.2	97.1	35.65	2139.0	813.0	51	0.1	81.5

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.3	97.4	37.08	2225.0	846.0	51	0.2	81.7
27	0.2	97.6	38.51	2310.0	878.0	51	0.1	81.8
28	0.1	97.7	39.93	2396.0	911.0	50	0.1	81.8
29	0.2	97.9	41.36	2481.0	944.0	50	0.1	81.9
30	0.1	98.0	42.78	2567.0	976.0	50	0.1	82.0
31	0.2	98.2	44.21	2653.0	1009.0	50	0.1	82.1
32	0.0	98.2	45.64	2738.0	1041.0	50	0.0	82.1
33	0.1	98.3	47.06	2824.0	1074.0	49	0.0	82.1
34	0.1	98.4	48.49	2909.0	1106.0	49	0.0	82.2
35	0.0	98.4	49.91	2995.0	1139.0	49	0.0	82.2
36	0.1	98.5	51.34	3080.0	1171.0	48	0.0	82.2
37	0.0	98.5	52.77	3166.0	1204.0	48	0.0	82.2
38	0.2	98.7	54.19	3252.0	1236.0	48	0.1	82.3
39	0.2	98.9	55.62	3337.0	1269.0	47	0.1	82.4
40	0.1	99.0	57.05	3423.0	1301.0	47	0.0	82.5
41	0.1	99.1	58.47	3508.0	1334.0	47	0.0	82.5
42	0.0	99.1	59.90	3594.0	1366.0	46	0.0	82.5
43	0.0	99.1	61.32	3679.0	1399.0	46	0.0	82.5
44	0.1	99.2	62.75	3765.0	1432.0	45	0.0	82.6
45	0.0	99.2	64.18	3851.0	1464.0	44	0.0	82.6
46	0.1	99.3	65.60	3936.0	1497.0	43	0.0	82.6
47	0.0	99.3	67.03	4022.0	1529.0	42	0.0	82.6
48	0.0	99.3	68.45	4107.0	1562.0	41	0.0	82.6
49	0.0	99.3	69.88	4193.0	1594.0	41	0.0	82.6
50	0.1	99.4	71.31	4278.0	1627.0	40	0.0	82.6
							Estimated Net Annual Sediment (TSS) Load Reduction =	**83 %**

RAINFALL DATA FROM WATERLOO WELLINGTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

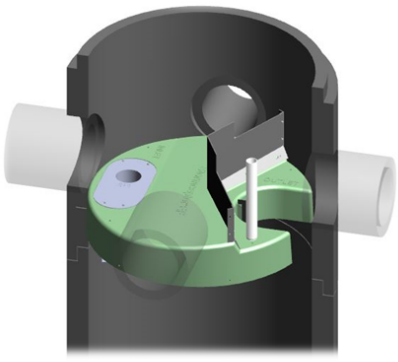
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

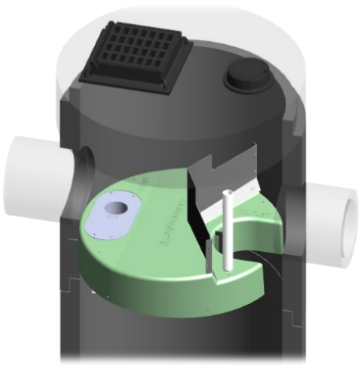
DESIGN FLEXIBILITY

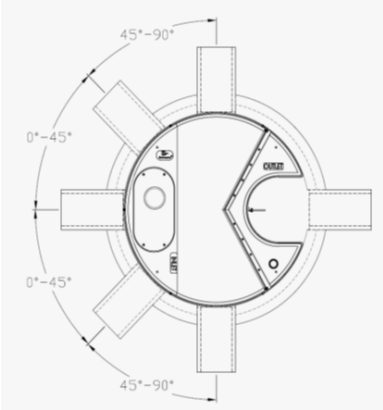
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft^3)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

Stormceptor®

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Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

05/27/2021

Province:	Ontario
City:	Waterloo
Nearest Rainfall Station:	WATERLOO WELLINGTON AP
NCDC Rainfall Station Id:	9387
Years of Rainfall Data:	34

Site Name:	65 Northfield Drive W - Catchment 205
Drainage Area (ha):	2.54
% Imperviousness:	66.00

Runoff Coefficient 'c': 0.69

Particle Size Distribution:	Fine
Target TSS Removal (%):	80.0

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	69.25
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	Yes
Upstream Orifice Control Flow Rate to Stormceptor (L/s):	68.00
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Former Kraus Carpet
Project Number:	2019-0654-10
Designer Name:	Marlee Sauder
Designer Company:	WalterFedy
Designer Email:	msauder@walterfedy.com
Designer Phone:	519-719-8074
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	56
EFO6	70
EFO8	77
EFO10	82
EFO12	87

Recommended Stormceptor EFO Model: EFO10

Estimated Net Annual Sediment (TSS) Load Reduction (%): 82

Water Quality Runoff Volume Capture (%): > 90

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THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterwavs.

PARTICLE SIZE DISTRIBUTION (PSD)

►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

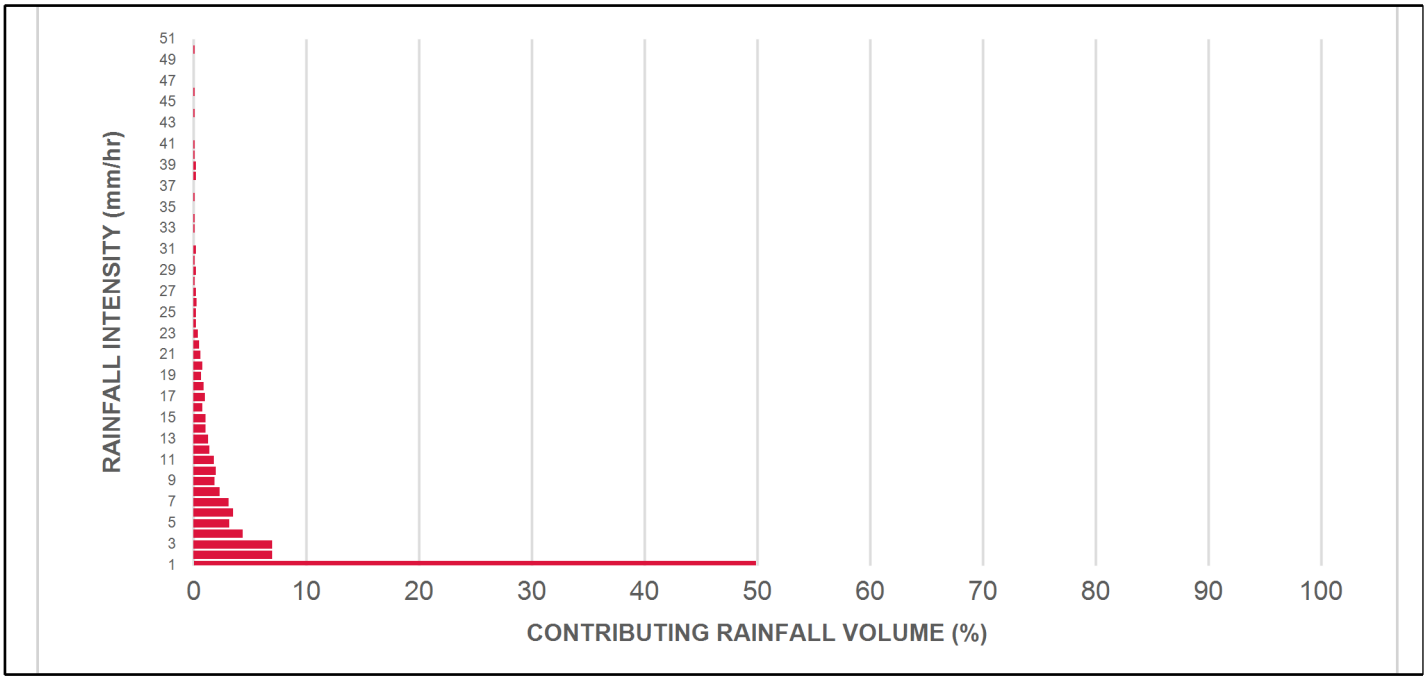
Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Upstream Flow Controlled Results

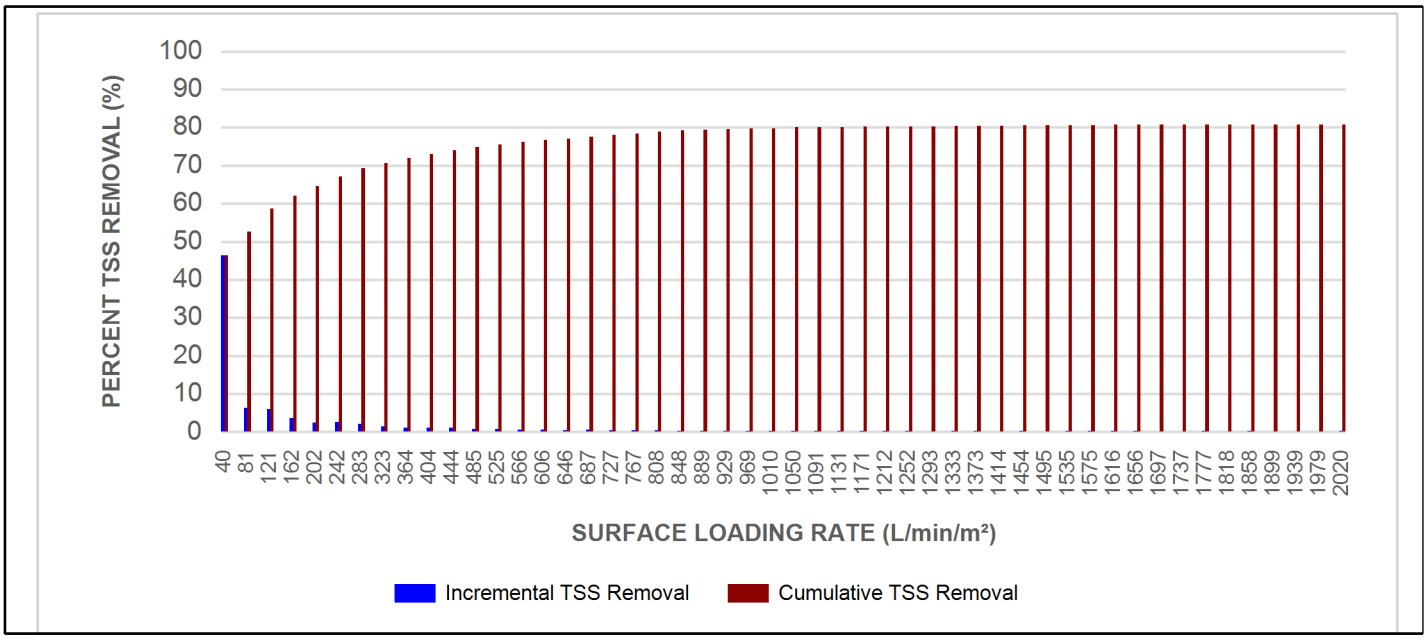
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.9	49.9	4.91	295.0	40.0	93	46.4	46.4
2	7.0	56.9	9.83	590.0	81.0	89	6.2	52.6
3	7.0	63.9	14.74	885.0	121.0	85	5.9	58.6
4	4.4	68.3	19.66	1180.0	162.0	80	3.5	62.1
5	3.2	71.5	24.57	1474.0	202.0	76	2.4	64.5
6	3.5	75.0	29.49	1769.0	242.0	72	2.5	67.1
7	3.1	78.1	34.40	2064.0	283.0	69	2.1	69.2
8	2.3	80.4	39.32	2359.0	323.0	65	1.5	70.7
9	1.9	82.3	44.23	2654.0	364.0	62	1.2	71.9
10	2.0	84.3	49.15	2949.0	404.0	58	1.2	73.0
11	1.8	86.1	54.06	3244.0	444.0	57	1.0	74.0
12	1.4	87.5	58.98	3539.0	485.0	56	0.8	74.8
13	12.5	100.0	63.89	3833.0	525.0	54	6.8	81.6
14	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
15	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
16	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
17	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
18	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
19	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
20	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
21	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
22	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
23	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
24	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
25	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
27	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
28	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
29	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
30	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
31	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
32	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
33	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
34	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
35	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
36	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
37	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
38	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
39	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
40	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
41	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
42	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
43	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
44	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
45	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
46	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
47	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
48	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
49	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
50	0.0	100.0	68.00	4080.0	559.0	54	0.0	81.6
Estimated Net Annual Sediment (TSS) Load Reduction =								**82 %**

RAINFALL DATA FROM WATERLOO WELLINGTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

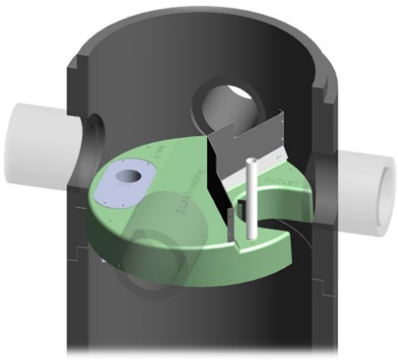
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

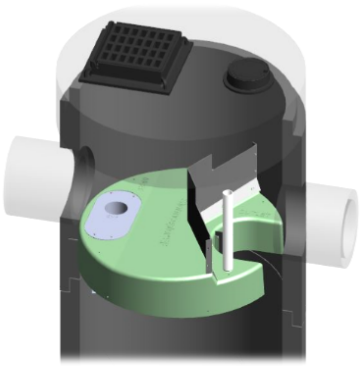
DESIGN FLEXIBILITY

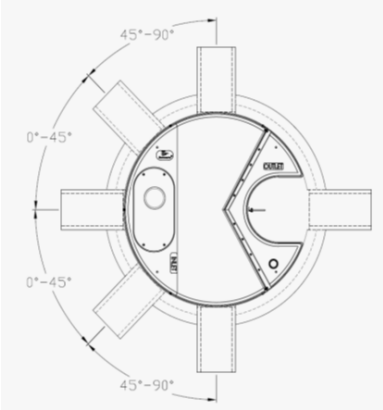
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft^3)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

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1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

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PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

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3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

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Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

05/27/2021

Province:	Ontario
City:	Waterloo
Nearest Rainfall Station:	WATERLOO WELLINGTON AP
NCDC Rainfall Station Id:	9387
Years of Rainfall Data:	34

Site Name:	65 Northfield Drive W - Catchment 208

Drainage Area (ha):	0.65
% Imperviousness:	75.00

Runoff Coefficient 'c': 0.75

Particle Size Distribution:	Fine
Target TSS Removal (%):	80.0

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	19.10
Oil / Fuel Spill Risk Site?	Yes
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Former Kraus Carpet
Project Number:	2019-0654-10
Designer Name:	Marlee Sauder
Designer Company:	WalterFedy
Designer Email:	msauder@walterfedy.com
Designer Phone:	519-719-8074
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EFO4	76
EFO6	83
EFO8	87
EFO10	89
EFO12	91

Recommended Stormceptor EFO Model: EFO6

Estimated Net Annual Sediment (TSS) Load Reduction (%): 83

Water Quality Runoff Volume Capture (%): > 90

imbrium

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterwavs.

PARTICLE SIZE DISTRIBUTION (PSD)

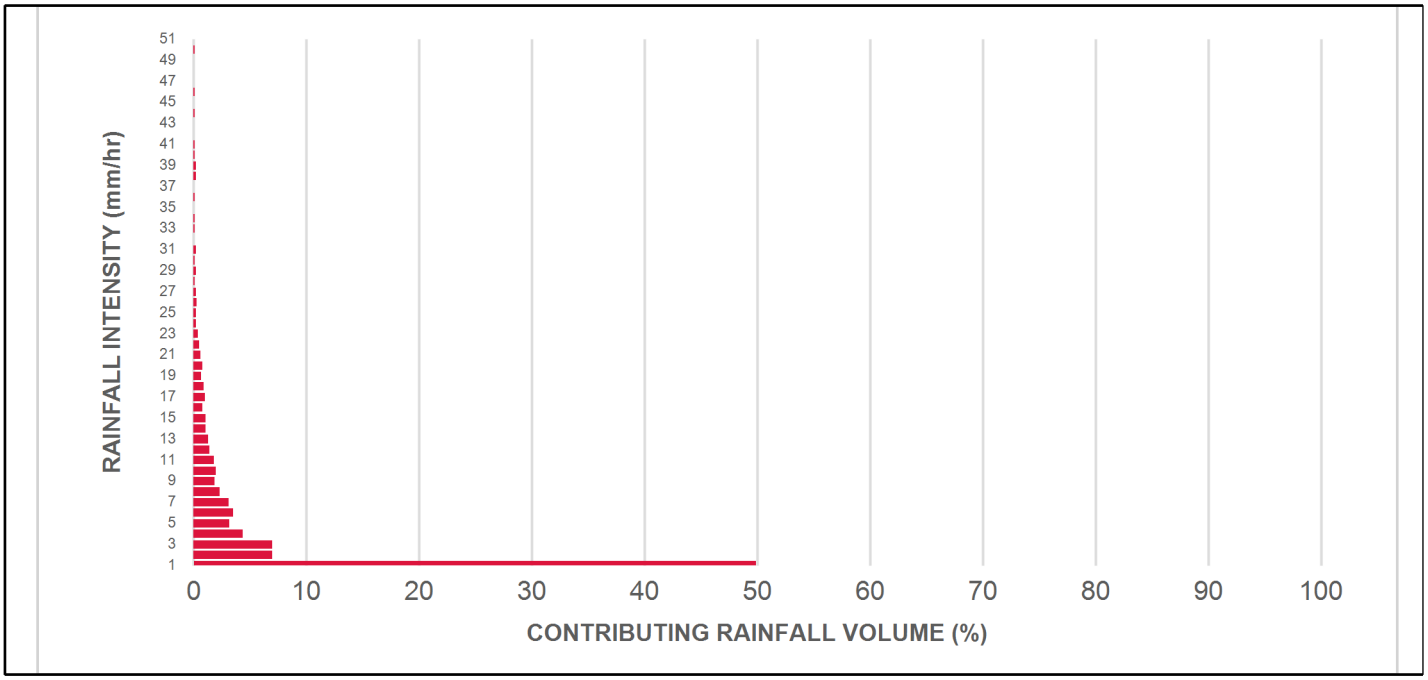
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

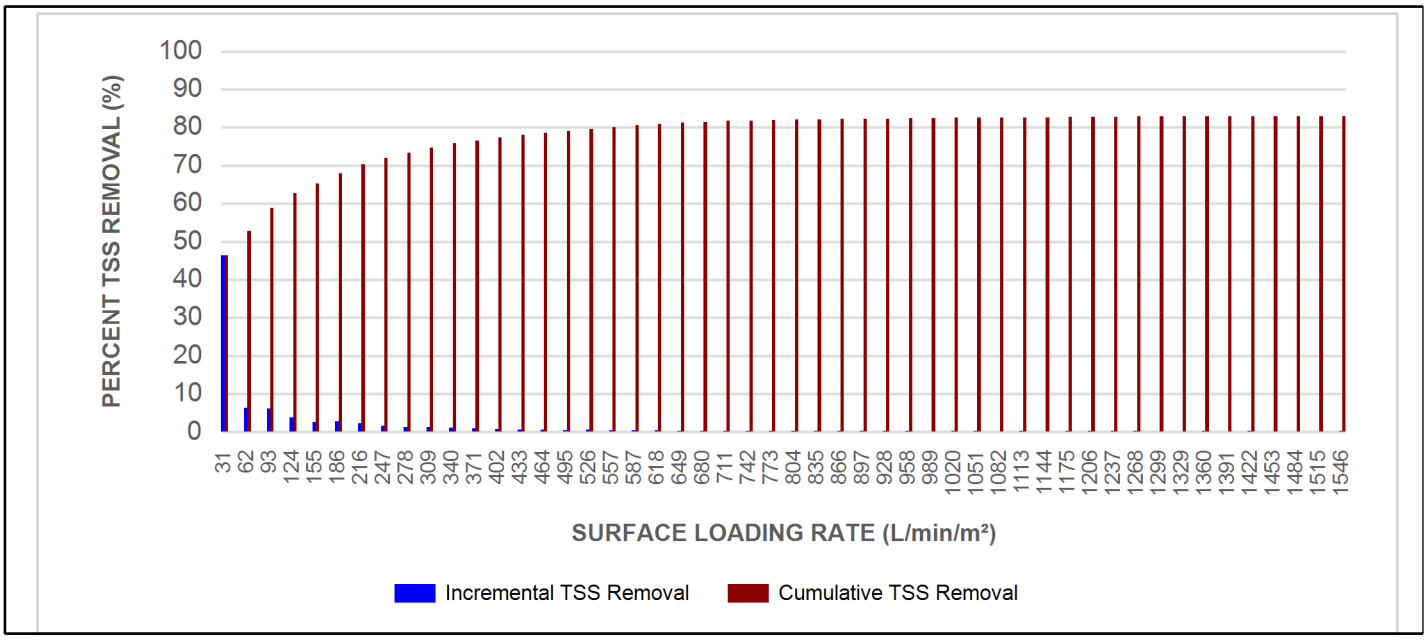
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.9	49.9	1.36	81.0	31.0	93	46.4	46.4
2	7.0	56.9	2.71	163.0	62.0	91	6.4	52.8
3	7.0	63.9	4.07	244.0	93.0	88	6.2	58.9
4	4.4	68.3	5.42	325.0	124.0	85	3.7	62.7
5	3.2	71.5	6.78	407.0	155.0	81	2.6	65.3
6	3.5	75.0	8.13	488.0	186.0	78	2.7	68.0
7	3.1	78.1	9.49	569.0	216.0	75	2.3	70.3
8	2.3	80.4	10.84	651.0	247.0	72	1.7	72.0
9	1.9	82.3	12.20	732.0	278.0	70	1.3	73.3
10	2.0	84.3	13.55	813.0	309.0	66	1.3	74.6
11	1.8	86.1	14.91	894.0	340.0	63	1.1	75.8
12	1.4	87.5	16.26	976.0	371.0	61	0.9	76.6
13	1.3	88.8	17.62	1057.0	402.0	58	0.8	77.4
14	1.1	89.9	18.97	1138.0	433.0	57	0.6	78.0
15	1.1	91.0	20.33	1220.0	464.0	56	0.6	78.6
16	0.8	91.8	21.68	1301.0	495.0	55	0.4	79.1
17	1.0	92.8	23.04	1382.0	526.0	54	0.5	79.6
18	0.9	93.7	24.39	1464.0	557.0	54	0.5	80.1
19	0.7	94.4	25.75	1545.0	587.0	53	0.4	80.5
20	0.8	95.2	27.11	1626.0	618.0	52	0.4	80.9
21	0.6	95.8	28.46	1708.0	649.0	52	0.3	81.2
22	0.5	96.3	29.82	1789.0	680.0	52	0.3	81.4
23	0.4	96.7	31.17	1870.0	711.0	51	0.2	81.7
24	0.2	96.9	32.53	1952.0	742.0	51	0.1	81.8
25	0.2	97.1	33.88	2033.0	773.0	51	0.1	81.9

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.3	97.4	35.24	2114.0	804.0	51	0.2	82.0
27	0.2	97.6	36.59	2196.0	835.0	51	0.1	82.1
28	0.1	97.7	37.95	2277.0	866.0	51	0.1	82.2
29	0.2	97.9	39.30	2358.0	897.0	51	0.1	82.3
30	0.1	98.0	40.66	2439.0	928.0	50	0.1	82.3
31	0.2	98.2	42.01	2521.0	958.0	50	0.1	82.4
32	0.0	98.2	43.37	2602.0	989.0	50	0.0	82.4
33	0.1	98.3	44.72	2683.0	1020.0	50	0.1	82.5
34	0.1	98.4	46.08	2765.0	1051.0	50	0.1	82.5
35	0.0	98.4	47.43	2846.0	1082.0	49	0.0	82.5
36	0.1	98.5	48.79	2927.0	1113.0	49	0.0	82.6
37	0.0	98.5	50.14	3009.0	1144.0	49	0.0	82.6
38	0.2	98.7	51.50	3090.0	1175.0	48	0.1	82.7
39	0.2	98.9	52.85	3171.0	1206.0	48	0.1	82.8
40	0.1	99.0	54.21	3253.0	1237.0	48	0.0	82.8
41	0.1	99.1	55.57	3334.0	1268.0	47	0.0	82.9
42	0.0	99.1	56.92	3415.0	1299.0	47	0.0	82.9
43	0.0	99.1	58.28	3497.0	1329.0	47	0.0	82.9
44	0.1	99.2	59.63	3578.0	1360.0	46	0.0	82.9
45	0.0	99.2	60.99	3659.0	1391.0	46	0.0	82.9
46	0.1	99.3	62.34	3740.0	1422.0	45	0.0	82.9
47	0.0	99.3	63.70	3822.0	1453.0	44	0.0	82.9
48	0.0	99.3	65.05	3903.0	1484.0	44	0.0	82.9
49	0.0	99.3	66.41	3984.0	1515.0	43	0.0	82.9
50	0.1	99.4	67.76	4066.0	1546.0	42	0.0	83.0
							Estimated Net Annual Sediment (TSS) Load Reduction =	**83 %**

RAINFALL DATA FROM WATERLOO WELLINGTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

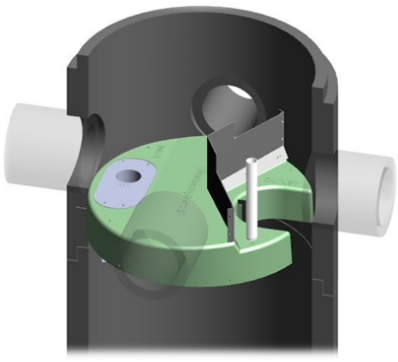
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

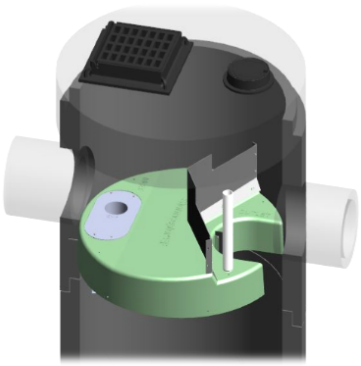
DESIGN FLEXIBILITY

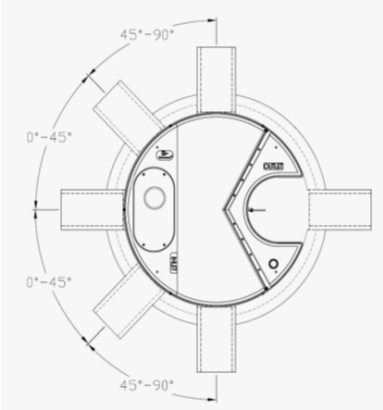
►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.







INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft^3)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The minimum sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall

remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

3.4 LIGHT LIQUID RE-ENTRAINMENT SIMULATION TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of completed third-party Light Liquid Re-entrainment Simulation Testing in accordance with the Canadian ETV **Program's Procedure for Laboratory Testing of Oil-Grit Separators,** with results reported within the Canadian ETV or ISO 14034 ETV verification. This re-entrainment testing is conducted with the device pre-loaded with low density polyethylene (LDPE) plastic beads as a surrogate for light liquids such as oil and fuel. Testing is conducted on the same OGS unit tested for sediment removal to assess whether light liquids captured after a spill are effectively retained at high flow rates.

3.4.1 For an OGS device to be an acceptable stormwater treatment device on a site where vehicular traffic occurs and the potential for an oil or fuel spill exists, the OGS device must have reported verified performance results of greater than 99% cumulative retention of LDPE plastic beads for the five specified surface loading rates (ranging 200 L/min/m2 to 2600 L/min/m2) in accordance with the Light Liquid Re-entrainment Simulation Testing within the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**However, an OGS device shall not be allowed if the Light Liquid Re-entrainment Simulation Testing was performed with screening components within the OGS device that are effective at retaining the LDPE plastic beads, but would not be expected to retain light liquids such as oil and fuel.

APPENDIX F

PCSWMM Model Output

- Existing Conditions – 2 Year
- Existing Conditions – 5 Year
- Existing Conditions – 100 Year
- Proposed Conditions – 2 Year
- Proposed Conditions – 5 Year
- Proposed Conditions – 100 Year

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)
--------------------------------------------------------------

*************
Element Count
*************
Number of rain gages ...... 3
Number of subcatchments ... 6
Number of nodes ........... 6
Number of links ........... 5
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                 Data       Recording
Name                 Data Source                 Type       Interval
-------------------------------------------------------------------
Chi_3hr_100yr        Chi_3hr_100yr               INTENSITY    5 min.
Chi_3hr_2yr          Chi_3hr_2yr                 INTENSITY    5 min.
Chi_3hr_5yr          Chi_3hr_5yr                 INTENSITY    5 min.


*********************
Subcatchment Summary
*********************
Name                 Area     Width   %Imperv   %Slope Rain Gage            Outlet
-----------------------------------------------------------------------------------
101                 11.41   1141.00     70.00    2.0000 Chi_3hr_2yr          Ex_MH6
102                 10.45   1045.00     70.00    2.0000 Chi_3hr_2yr          Ex_MH6
103                  6.15    615.00     75.00    2.0000 Chi_3hr_2yr          Ex_MH6
104                  1.62    324.00     50.00    2.0000 Chi_3hr_2yr          Ex_MH9
105                  1.82    364.00     15.00    2.0000 Chi_3hr_2yr          OF3
106                  0.95    475.00     80.00    2.0000 Chi_3hr_2yr          OF1


************
Node Summary
************
                                    Invert     Max.    Ponded    External
Name                 Type            Elev.    Depth     Area    Inflow
-----------------------------------------------------------------------
Ex_MH6               JUNCTION       332.82     3.18    200.0
Ex_MH9               JUNCTION       332.97     3.03    100.0
J1                   JUNCTION       333.00     3.10    100.0
OF1                  OUTFALL        333.00     0.00      0.0
OF2                  OUTFALL        333.00     3.03      0.0
OF3                  OUTFALL        333.00     0.00      0.0


************
Link Summary
************
Name                 From Node       To Node         Type            Length    %Slope Roughness
---------------------------------------------------------------------------------------------
C1                   Ex_MH9          J1              CONDUIT           85.0    0.0012  0.0130
C2                   Ex_MH9          J1              CONDUIT           85.0    0.7294  0.0150
C3                   J1              OF2             CONDUIT            5.0    0.0200  0.0130
C4                   Ex_MH6          Ex_MH9          CONDUIT           93.4    0.4174  0.0130
C5                   Ex_MH6          Ex_MH9          CONDUIT           94.0    0.1383  0.0150


*********************
Cross Section Summary
*********************
                                    Full     Full     Hyd.     Max.   No. of     Full
Conduit              Shape         Depth     Area     Rad.    Width  Barrels     Flow
-------------------------------------------------------------------------------------
C1                   HORIZ_ELLIPSE  0.97     1.20     0.30     1.52       1     0.14
C2                   TRIANGULAR     0.20     2.50     0.10    25.00       1     3.07
C3                   TRIANGULAR     3.00    37.50     1.46    25.00       1    52.48
C4                   CIRCULAR       1.20     1.13     0.30     1.20       1     2.52
C5                   TRIANGULAR     0.20     2.50     0.10    25.00       1     1.34


***************************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
***************************************************************

****************
Analysis Options
****************
Flow Units ................ CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 04/07/2021 00:00:00
Ending Date .............. 04/07/2021 15:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m

**************************        Volume          Depth
Runoff Quantity Continuity     hectare-m             mm
**************************     ----------      ----------
Total Precipitation ......          1.050          32.400
Evaporation Loss .........          0.000           0.000
Infiltration Loss ........          0.294           9.064
Surface Runoff ...........          0.748          23.073
Final Storage ............          0.014           0.439
Continuity Error (%) .....         -0.542


**************************        Volume          Volume
Flow Routing Continuity        hectare-m       10^6 ltr
**************************     ----------      ----------
Dry Weather Inflow .......          0.000           0.000
Wet Weather Inflow .......          0.748           7.475
Groundwater Inflow .......          0.000           0.000
RDII Inflow ..............          0.000           0.000
External Inflow ..........          0.002           0.025
External Outflow .........          0.748           7.478
Flooding Loss ............          0.000           0.000
Evaporation Loss .........          0.000           0.000
Exfiltration Loss ........          0.000           0.000
Initial Stored Volume ....          0.000           0.000
Final Stored Volume ......          0.002           0.021
Continuity Error (%) .....          0.011


****************************
Time-Step Critical Elements
****************************
Link C3 (53.95%)


*********************************
Highest Flow Instability Indexes
*********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.48 sec
Average Time Step           :     3.42 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.01
Time Step Frequencies       :
     5.000 -  3.155 sec     :    55.94 %
     3.155 -  1.991 sec     :    10.16 %
     1.991 -  1.256 sec     :    26.21 %
     1.256 -  0.792 sec     :     7.69 %
     0.792 -  0.500 sec     :     0.00 %


****************************
Subcatchment Runoff Summary
****************************
-----------------------------------------------------------------------------------------------------------------------------------
                     Total      Total      Total      Total     Imperv      Perv      Total      Total       Peak    Runoff
                    Precip      Runon       Evap      Infil    Runoff    Runoff     Runoff     Runoff    Runoff    Coeff
Subcatchment            mm         mm         mm         mm        mm        mm         mm   10^6 ltr       CMS
-----------------------------------------------------------------------------------------------------------------------------------
101                  32.40       0.00       0.00       8.28     22.84      1.07      23.91       2.73      2.13    0.738
102                  32.40       0.00       0.00       8.28     22.84      1.07      23.91       2.50      1.95    0.738
103                  32.40       0.00       0.00       6.87     24.47      0.92      25.39       1.56      1.22    0.784
104                  32.40       0.00       0.00      13.73     16.26      1.84      18.10       0.29      0.24    0.559
105                  32.40       0.00       0.00      23.68      4.86      2.82       7.68       0.14      0.08    0.237
106                  32.40       0.00       0.00       5.38     25.97      0.87      26.85       0.26      0.22    0.829


******************
Node Depth Summary
******************
-----------------------------------------------------------------------------
                     Average  Maximum  Maximum  Time of Max     Reported
                       Depth    Depth      HGL   Occurrence   Max Depth
Node                 Type       Meters   Meters   Meters  days hr:min       Meters
-----------------------------------------------------------------------------
Ex_MH6               JUNCTION     0.82     3.08   335.90     0  01:17         3.03
Ex_MH9               JUNCTION     0.41     1.97   334.94     0  01:17         1.86
J1                   JUNCTION     0.29     0.80   333.80     0  01:17         0.78
OF1                  OUTFALL      0.00     0.00   333.00     0  00:00         0.00
OF2                  OUTFALL      0.29     0.79   333.79     0  01:17         0.77
OF3                  OUTFALL      0.00     0.00   333.00     0  00:00         0.00


******************
Node Inflow Summary
******************
-------------------------------------------------------------------------------------------------
                     Maximum  Maximum                    Lateral       Total        Flow
                     Lateral    Total  Time of Max        Inflow      Inflow     Balance
                      Inflow   Inflow   Occurrence        Volume      Volume       Error
Node                 Type          CMS      CMS  days hr:min    10^6 ltr    10^6 ltr     Percent
-------------------------------------------------------------------------------------------------
Ex_MH6               JUNCTION    5.298    5.298     0  01:15        6.79        6.79       0.009
Ex_MH9               JUNCTION    0.235    4.605     0  01:16       0.293        7.09       0.147
J1                   JUNCTION    0.000    4.604     0  01:17           0        7.11       0.153
OF1                  OUTFALL     0.222    0.222     0  01:15       0.255       0.255       0.000
OF2                  OUTFALL     0.000    4.605     0  01:17           0        7.11       0.000
OF3                  OUTFALL     0.080    0.080     0  01:15        0.14        0.14       0.000


**********************
Node Surcharge Summary
**********************

No nodes were surcharged.


**********************
Node Flooding Summary
**********************

No nodes were flooded.


************************
Outfall Loading Summary
************************
-----------------------------------------
                     Flow       Avg       Max       Total
                     Freq      Flow      Flow      Volume
Outfall Node         Pcnt       CMS       CMS   10^6 ltr
-----------------------------------------
OF1                 49.25     0.027     0.222       0.255
OF2                 98.39     0.367     4.605       7.108
OF3                 51.72     0.012     0.080       0.140
-----------------------------------------
System              66.46     0.406     4.839       7.503


********************
Link Flow Summary
********************
-----------------------------------------------------------------
                     Maximum  Time of Max   Maximum     Max/    Max/
                      |Flow|   Occurrence   |Veloc|     Full    Full
Link                 Type          CMS  days hr:min     m/sec    Flow   Depth
-----------------------------------------------------------------
C1                   CONDUIT     4.604     0  01:17      4.06   32.83    0.90
C2                   CONDUIT     0.000     0  00:00      0.00    0.00    0.00
C3                   CONDUIT     4.605     0  01:17      1.90    0.09    0.25
C4                   CONDUIT     4.129     0  01:13      3.65    1.64    1.00
C5                   CONDUIT     0.455     0  01:17      0.47    0.34    0.63


****************************
Flow Classification Summary
****************************
-------------------------------------------------------------------------------------------
                    Adjusted   ---------- Fraction of Time in Flow Class ----------
                     /Actual         Up   Down  Sub   Sup   Up    Down  Norm  Inlet
Conduit               Length    Dry  Dry   Dry   Crit  Crit  Crit  Crit  Ltd   Ctrl
-------------------------------------------------------------------------------------------
C1                      1.00   0.00  0.00  0.00  0.82  0.02  0.00  0.16  0.00  0.00
C2                      1.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
C3                      1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
C4                      1.00   0.00  0.01  0.00  0.99  0.00  0.00  0.00  0.96  0.00
C5                      1.00   0.97  0.00  0.00  0.00  0.00  0.00  0.03  0.00  0.00


************************
Conduit Surcharge Summary
************************
-----------------------------------------------------------------------------
                                                                  Hours       Hours
                     --------- Hours Full --------              Above Full  Capacity
Conduit              Both Ends  Upstream  Dnstream              Normal Flow   Limited
-----------------------------------------------------------------------------
C1                        0.01      0.22      0.01                    2.49      0.01
C4                        0.16      0.17      0.16                    0.19      0.16


Analysis begun on:  Wed May 26 10:10:40 2021
Analysis ended on:  Wed May 26 10:10:40 2021
Total elapsed time: < 1 sec
```

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)

****
Element Count
****
Number of rain gages 3
Number of subcatchments ... 6
Number of nodes 6
Number of links 5
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
Chi_3hr_100yr	Chi_3hr_100yr	INTENSITY	5 min.
Chi_3hr_2yr	Chi_3hr_2yr	INTENSITY	5 min.
Chi_3hr_5yr	Chi_3hr_5yr	INTENSITY	5 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
101	11.41	1141.00	70.00	2.0000	Chi_3hr_5yr	Ex_MH6
102	10.45	1045.00	70.00	2.0000	Chi_3hr_5yr	Ex_MH6
103	6.15	615.00	75.00	2.0000	Chi_3hr_5yr	Ex_MH6
104	1.62	324.00	50.00	2.0000	Chi_3hr_5yr	Ex_MH9
105	1.82	364.00	15.00	2.0000	Chi_3hr_5yr	OF3
106	0.95	475.00	80.00	2.0000	Chi_3hr_5yr	OF1

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
Ex_MH6	JUNCTION	332.82	3.18	200.0	
Ex_MH9	JUNCTION	332.97	3.03	100.0	
J1	JUNCTION	333.00	3.10	100.0	
OF1	OUTFALL	333.00	0.00	0.0	
OF2	OUTFALL	333.00	3.03	0.0	
OF3	OUTFALL	333.00	0.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	Ex_MH9	J1	CONDUIT	85.0	0.0012	0.0130
C2	Ex_MH9	J1	CONDUIT	85.0	0.7294	0.0150
C3	J1	OF2	CONDUIT	5.0	0.0200	0.0130
C4	Ex_MH6	Ex_MH9	CONDUIT	93.4	0.4174	0.0130
C5	Ex_MH6	Ex_MH9	CONDUIT	94.0	0.1383	0.0150

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	HORIZ_ELLIPSE	0.97	1.20	0.30	1.52	1	0.14
C2	TRIANGULAR	0.20	2.50	0.10	25.00	1	3.07
C3	TRIANGULAR	3.00	37.50	1.46	25.00	1	52.48
C4	CIRCULAR	1.20	1.13	0.30	1.20	1	2.52
C5	TRIANGULAR	0.20	2.50	0.10	25.00	1	1.34

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... YES
  Water Quality ..... NO
Infiltration Method ..... CURVE_NUMBER
Flow Routing Method ..... DYNWAVE
Surcharge Method ..... EXTRAN
Starting Date 04/07/2021 00:00:00
Ending Date 04/07/2021 15:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step ..... 5.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001500 m

****

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	1.541	47.549
Evaporation Loss	0.000	0.000
Infiltration Loss	0.358	11.042
Surface Runoff	1.176	36.294
Final Storage	0.014	0.426
Continuity Error (%)	-0.447	

****

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	1.176	11.759
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.009	0.088
External Outflow	1.178	11.783
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.001
Final Stored Volume	0.006	0.063
Continuity Error (%)	0.011	

****
Time-Step Critical Elements
****
Link C3 (50.62%)

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
Ex_MH6	JUNCTION	0.93	3.27	336.09	0 01:18	3.26
Ex_MH9	JUNCTION	0.64	2.42	335.39	0 01:18	2.39
J1	JUNCTION	0.49	0.85	333.85	0 01:18	0.84
OF1	OUTFALL	0.00	0.00	333.00	0 00:00	0.00
OF2	OUTFALL	0.48	0.83	333.83	0 01:18	0.83
OF3	OUTFALL	0.00	0.00	333.00	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
Ex_MH6	JUNCTION	7.099	7.099	0 01:15	10.6	10.6	-0.070
Ex_MH9	JUNCTION	0.307	5.397	0 01:18	0.491	11.1	0.259
J1	JUNCTION	0.000	5.396	0 01:18	0	11.2	0.381
OF1	OUTFALL	0.291	0.291	0 01:15	0.388	0.388	0.000
OF2	OUTFALL	0.000	5.396	0 01:18	0	11.2	0.000
OF3	OUTFALL	0.106	0.106	0 01:15	0.322	0.322	0.000

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
Ex_MH6	JUNCTION	0.15	0.136	0.000

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CMS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
Ex_MH6	0.13	2.143	0 01:15	0.214	0.086

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	51.50	0.040	0.291	0.388
OF2	91.37	0.638	5.396	11.161
OF3	54.24	0.027	0.106	0.322
System	65.70	0.706	5.688	11.872

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	5.396	0 01:18	4.68	38.47	0.92
C2	CONDUIT	0.000	0 00:00	0.00	0.00	0.00
C3	CONDUIT	5.396	0 01:18	1.96	0.10	0.27
C4	CONDUIT	4.143	0 01:11	3.66	1.64	1.00
C5	CONDUIT	1.803	0 01:18	0.82	1.35	0.94

****
Flow Classification Summary
****

****
Highest Flow Instability Indexes
****
Link C3 (3)

****
Routing Time Step Summary
****
Minimum Time Step : 0.93 sec
Average Time Step : 3.36 sec
Maximum Time Step : 5.00 sec
Percent in Steady State : -0.00
Average Iterations per Step : 2.00
Percent Not Converging : 0.03
Time Step Frequencies :
5.000 - 3.155 sec : 49.40 %
3.155 - 1.991 sec : 20.12 %
1.991 - 1.256 sec : 18.21 %
1.256 - 0.792 sec : 12.27 %
0.792 - 0.500 sec : 0.00 %

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
101	47.55	0.00	0.00	10.09	33.46	3.84	37.30	4.26	2.85	0.784
102	47.55	0.00	0.00	10.09	33.46	3.84	37.30	3.90	2.61	0.784
103	47.55	0.00	0.00	8.37	35.85	3.24	39.09	2.40	1.63	0.822
104	47.55	0.00	0.00	16.74	23.84	6.48	30.31	0.49	0.31	0.637
105	47.55	0.00	0.00	28.82	7.13	10.57	17.70	0.32	0.11	0.372
106	47.55	0.00	0.00	6.54	38.09	2.80	40.89	0.39	0.29	0.860

****
Node Depth Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C1	1.00	0.00	0.00	0.00	0.84	0.05	0.00	0.10	0.00	0.00
C2	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C3	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C4	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.23	0.00
C5	1.00	0.94	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Hours Full: Upstream	Hours Full: Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
C1	0.01	0.37	0.01	2.82	0.01
C4	0.29	0.30	0.29	0.31	0.28
C5	0.01	0.15	0.01	0.13	0.01

Analysis begun on: Wed May 26 10:10:16 2021
Analysis ended on: Wed May 26 10:10:16 2021
Total elapsed time: < 1 sec

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)

****
Element Count
****
Number of rain gages 3
Number of subcatchments ... 6
Number of nodes 6
Number of links 5
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
Chi_3hr_100yr	Chi_3hr_100yr	INTENSITY	5 min.
Chi_3hr_2yr	Chi_3hr_2yr	INTENSITY	5 min.
Chi_3hr_5yr	Chi_3hr_5yr	INTENSITY	5 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
101	11.41	1141.00	70.00	2.0000	Chi_3hr_100yr	Ex_MH6
102	10.45	1045.00	70.00	2.0000	Chi_3hr_100yr	Ex_MH6
103	6.15	615.00	75.00	2.0000	Chi_3hr_100yr	Ex_MH6
104	1.62	324.00	50.00	2.0000	Chi_3hr_100yr	Ex_MH9
105	1.82	364.00	15.00	2.0000	Chi_3hr_100yr	OF3
106	0.95	475.00	80.00	2.0000	Chi_3hr_100yr	OF1

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
Ex_MH6	JUNCTION	332.82	3.18	200.0	
Ex_MH9	JUNCTION	332.97	3.03	100.0	
J1	JUNCTION	333.00	3.10	100.0	
OF1	OUTFALL	333.00	0.00	0.0	
OF2	OUTFALL	333.00	3.03	0.0	
OF3	OUTFALL	333.00	0.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	Ex_MH9	J1	CONDUIT	85.0	0.0012	0.0130
C2	Ex_MH9	J1	CONDUIT	85.0	0.7294	0.0150
C3	J1	OF2	CONDUIT	5.0	0.0200	0.0130
C4	Ex_MH6	Ex_MH9	CONDUIT	93.4	0.4174	0.0130
C5	Ex_MH6	Ex_MH9	CONDUIT	94.0	0.1383	0.0150

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	HORIZ_ELLIPSE	0.97	1.20	0.30	1.52	1	0.14
C2	TRIANGULAR	0.20	2.50	0.10	25.00	1	3.07
C3	TRIANGULAR	3.00	37.50	1.46	25.00	1	52.48
C4	CIRCULAR	1.20	1.13	0.30	1.20	1	2.52
C5	TRIANGULAR	0.20	2.50	0.10	25.00	1	1.34

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... YES
  Water Quality ..... NO
Infiltration Method ..... CURVE_NUMBER
Flow Routing Method ..... DYNWAVE
Surcharge Method ..... EXTRAN
Starting Date 04/07/2021 00:00:00
Ending Date 04/07/2021 15:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step ..... 5.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	2.915	89.960
Evaporation Loss	0.000	0.000
Infiltration Loss	0.465	14.342
Surface Runoff	2.449	75.577
Final Storage	0.014	0.437
Continuity Error (%)	-0.440	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	2.448	24.485
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.032	0.319
External Outflow	2.453	24.530
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.001	0.006
Final Stored Volume	0.020	0.203
Continuity Error (%)	0.308	

****
Time-Step Critical Elements
****
Link C3 (49.76%)

****
Highest Flow Instability Indexes
****
Link C3 (56)
Link C1 (11)

****
Routing Time Step Summary
****
Minimum Time Step : 0.84 sec
Average Time Step : 3.21 sec
Maximum Time Step : 5.00 sec
Percent in Steady State : 0.00
Average Iterations per Step : 2.04
Percent Not Converging : 0.04
Time Step Frequencies :
5.000 - 3.155 sec : 50.23 %
3.155 - 1.991 sec : 0.26 %
1.991 - 1.256 sec : 35.44 %
1.256 - 0.792 sec : 14.06 %
0.792 - 0.500 sec : 0.00 %

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
101	89.96	0.00	0.00	13.10	63.22	13.64	76.86	8.77	5.61	0.854
102	89.96	0.00	0.00	13.10	63.22	13.64	76.86	8.03	5.14	0.854
103	89.96	0.00	0.00	10.87	67.75	11.42	79.17	4.87	3.20	0.880
104	89.96	0.00	0.00	21.75	45.05	22.84	67.88	1.10	0.66	0.755
105	89.96	0.00	0.00	37.41	13.50	38.28	51.78	0.94	0.35	0.576
106	89.96	0.00	0.00	8.54	72.02	9.41	81.43	0.77	0.57	0.905

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
Ex_MH6	JUNCTION	1.62	4.23	337.05	0 01:21	4.20
Ex_MH9	JUNCTION	1.33	2.86	335.83	0 01:22	2.85
J1	JUNCTION	1.08	1.38	334.38	0 00:00	1.08
OF1	OUTFALL	0.00	0.00	333.00	0 00:00	0.00
OF2	OUTFALL	1.08	1.08	334.07	0 00:00	1.08
OF3	OUTFALL	0.00	0.00	333.00	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
Ex_MH6	JUNCTION	13.954	13.954	0 01:15	21.7	21.7	0.324
Ex_MH9	JUNCTION	0.656	9.007	0 01:21	1.1	22.9	0.354
J1	JUNCTION	0.000	9.974	0 00:00	0	23.1	0.533
OF1	OUTFALL	0.575	0.575	0 01:15	0.773	0.773	0.000
OF2	OUTFALL	0.000	9.974	0 00:00	0	23.1	0.000
OF3	OUTFALL	0.347	0.347	0 01:20	0.942	0.942	0.000

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
Ex_MH6	JUNCTION	0.54	1.101	0.000
Ex_MH9	JUNCTION	0.06	0.008	0.172

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CMS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
Ex_MH6	0.52	7.285	0 01:15	2.665	1.051

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	53.86	0.077	0.575	0.773
OF2	97.75	1.270	9.974	23.133
OF3	58.71	0.083	0.347	0.942
System	70.11	1.430	9.974	24.849

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	5.856	0 01:22	4.89	41.75	1.00
C2	CONDUIT	3.085	0 01:22	1.23	1.01	1.00
C3	CONDUIT	9.974	0 00:00	2.22	0.19	0.40
C4	CONDUIT	4.465	0 01:21	3.95	1.77	1.00
C5	CONDUIT	4.101	0 01:21	1.64	3.07	1.00

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C2	1.00	0.90	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00
C3	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C4	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C5	1.00	0.86	0.00	0.00	0.00	0.01	0.00	0.12	0.00	0.00

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Upstream	Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
C1	14.98	14.98	14.99	3.10	2.92
C2	0.01	0.06	0.01	0.06	0.01
C4	0.73	0.73	0.90	0.70	0.70
C5	0.06	0.54	0.06	0.53	0.06

Analysis begun on: Wed May 26 10:09:52 2021
Analysis ended on: Wed May 26 10:09:52 2021
Total elapsed time: < 1 sec

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)
--------------------------------------------------------------

WARNING 02: maximum depth increased for Node CBMH65
WARNING 02: maximum depth increased for Node CBMH76
WARNING 02: maximum depth increased for Node EXCBMH13
WARNING 02: maximum depth increased for Node EXMH1
WARNING 02: maximum depth increased for Node EXMH6
WARNING 02: maximum depth increased for Node EXMH61

*************
Element Count
*************
Number of rain gages ..... 4
Number of subcatchments ... 12
Number of nodes ........... 20
Number of links ........... 35
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                  Data       Recording
Name                Data Source                   Type       Interval
----------------------------------------------------------------------
Chi_3h_25mm         Chi_3h_25mm                   INTENSITY  10 min.
Chi_3hr_100yr       Chi_3hr_100yr                 INTENSITY   5 min.
Chi_3hr_2yr         Chi_3hr_2yr                   INTENSITY   5 min.
Chi_3hr_5yr         Chi_3hr_5yr                   INTENSITY   5 min.


*******************
Subcatchment Summary
*******************
Name                 Area     Width   %Imperv    %Slope Rain Gage           Outlet
-----------------------------------------------------------------------------------
201                 11.41   1141.00     70.00    2.0000 Chi_3hr_2yr         EXCBMH13
202                 10.45   1045.00     70.00    2.0000 Chi_3hr_2yr         EXMH61
203                  5.80   1450.00     90.00    2.0000 Chi_3hr_2yr         CBMH76
204                  0.68    170.00     75.00    2.0000 Chi_3hr_2yr         S4
205                  1.25    313.25     45.00    2.0000 Chi_3hr_2yr         S5
205a                 0.15     75.90    100.00    0.3000 Chi_3hr_2yr         S5a
205b                 0.15     75.90    100.00    0.3000 Chi_3hr_2yr         S5b
205c                 0.15     75.90    100.00    0.3000 Chi_3hr_2yr         S5c
205d                 0.15     75.90    100.00    0.3000 Chi_3hr_2yr         S5d
206                  0.58    290.00     15.00    2.0000 Chi_3hr_2yr         OF3
207                  0.97    485.00     50.00    2.0000 Chi_3hr_2yr         OF1
208                  0.65    162.50     75.00    2.0000 Chi_3hr_2yr         CBMH65


************
Node Summary
************
                                    Invert     Max.     Ponded    External
Name                Type             Elev.     Depth      Area    Inflow
----------------------------------------------------------------------
CBMH10              JUNCTION        332.73      3.57     100.0
CBMH65              JUNCTION        333.00      3.30       0.0
CBMH76              JUNCTION        334.30      4.13       0.0
CBMH83              JUNCTION        333.16      3.01     100.0
EXCBMH13            JUNCTION        335.00      2.29     100.0
EXMH1               JUNCTION        333.20      2.68     100.0
EXMH2               JUNCTION        332.85      2.49     100.0
EXMH6               JUNCTION        332.39      3.54     100.0
EXMH61              JUNCTION        333.35      2.67     100.0
J1                  JUNCTION        333.00      3.25     100.0
MH77                JUNCTION        332.70      4.30       0.0
OF1                 OUTFALL         333.00      0.00       0.0
OF2                 OUTFALL         333.00      3.03       0.0
OF3                 OUTFALL         333.00      0.00       0.0
S4                  STORAGE         334.14      2.16       0.0
S5                  STORAGE         333.36      2.94       0.0
S5a                 STORAGE         336.15      0.15       0.0
S5b                 STORAGE         336.15      0.15       0.0
S5c                 STORAGE         336.15      0.15       0.0
S5d                 STORAGE         336.15      0.15       0.0


************
Link Summary
************
Name                From Node       To Node         Type            Length    %Slope Roughness
---------------------------------------------------------------------------------------------
C1                  CBMH10          CBMH65          CONDUIT           52.8    0.0019  0.0130
C10                 CBMH76          MH77            CONDUIT           33.0    1.4971  0.0130
C11                 MH77            CBMH10          CONDUIT           24.4    0.7500  0.0130
C12                 EXMH6           CBMH10          CONDUIT           95.0   -0.2842  0.0100
C13                 EXMH2           EXMH6           CONDUIT           82.0    0.4024  0.0130
C14                 EXMH1           EXMH2           CONDUIT           17.6    1.8185  0.0130
C15                 EXMH61          EXMH1           CONDUIT           64.4    0.3416  0.0130
C16                 EXCBMH13        EXMH6           CONDUIT          111.2    1.7539  0.0130
C17                 EXCBMH13        EXMH6           CONDUIT          112.0    1.2144  0.0100
C18                 EXMH61          EXMH1           CONDUIT           65.0    0.2154  0.0100
C19                 EXMH1           EXMH6           CONDUIT          100.0   -0.0500  0.0100
C2                  J1              OF2             CONDUIT            5.0    0.0200  0.0130
C3                  CBMH10          CBMH65          CONDUIT           85.0    0.7294  0.0100
C4                  CBMH65          J1              CONDUIT           29.0    0.0034  0.0130
C5                  CBMH76          CBMH10          CONDUIT           58.0    3.8097  0.0100
C6                  S4              CBMH83          CONDUIT           29.1    0.4983  0.0130
C7                  EXMH6           CBMH10          CONDUIT           93.4    0.0214  0.0130
C8                  CBMH65          J1              CONDUIT           29.0    0.3448  0.0100
OR3                 S5              CBMH83          CONDUIT           33.3    0.4985  0.0130
OR1                 S5a             S5              ORIFICE
OR10                S5a             S5              ORIFICE
OR11                S5b             S5              ORIFICE
OR12                S5b             S5              ORIFICE
OR13                S5c             S5              ORIFICE
OR14                S5c             S5              ORIFICE
OR2                 S5d             S5              ORIFICE
OR4                 S5b             S5              ORIFICE
OR5                 S5c             S5              ORIFICE
OR6                 S5d             S5              ORIFICE
OR7                 S5d             S5              ORIFICE
OR8                 S5a             S5              ORIFICE
OR9                 CBMH83          CBMH10          ORIFICE
W1                  S4              CBMH10          WEIR
W2                  S5              CBMH10          WEIR
W3                  S5              CBMH10          WEIR


*********************
Cross Section Summary
*********************
                                    Full      Full     Hyd.     Max.   No. of      Full
Conduit             Shape           Depth      Area     Rad.    Width  Barrels      Flow
----------------------------------------------------------------------------------------
C1                  HORIZ_ELLIPSE    0.97      1.20     0.30     1.52        1      0.18
C10                 CIRCULAR         1.05      0.87     0.26     1.05        1      3.34
C11                 CIRCULAR         1.05      0.87     0.26     1.05        1      2.37
C12                 RoadCrossSection 0.20      1.38     0.11    12.00        1      1.71
C13                 CIRCULAR         0.90      0.64     0.23     0.90        1      1.15
C14                 CIRCULAR         0.90      0.64     0.23     0.90        1      2.44
C15                 CIRCULAR         0.90      0.64     0.23     0.90        1      1.06
C16                 CIRCULAR         0.50      0.20     0.12     0.50        1      0.50
C17                 RoadCrossSection 0.20      1.38     0.11    12.00        1      3.53
C18                 RoadCrossSection 0.20      1.38     0.11    12.00        1      1.49
C19                 RoadCrossSection 0.20      1.38     0.11    12.00        1      0.72
C2                  TRIANGULAR       3.00     37.50     1.46    25.00        1     52.48
C3                  RoadCrossSection 0.20      1.38     0.11    12.00        1      2.73
C4                  HORIZ_ELLIPSE    0.97      1.20     0.30     1.52        1      0.24
C5                  RoadCrossSection 0.20      1.38     0.11    12.00        1      6.25
C6                  CIRCULAR         0.30      0.07     0.07     0.30        1      0.07
C7                  CIRCULAR         1.20      1.13     0.30     1.20        1      0.57
C8                  RoadCrossSection 0.20      1.38     0.11    12.00        1      1.88
OR3                 CIRCULAR         0.30      0.07     0.07     0.30        1      0.07


****************
Transect Summary
****************

Transect RoadCrossSection
Area:
                0.0006  0.0023  0.0052  0.0093  0.0145
                0.0209  0.0284  0.0371  0.0469  0.0579
                0.0701  0.0834  0.0979  0.1135  0.1303
                0.1483  0.1674  0.1877  0.2091  0.2317
                0.2549  0.2791  0.3013  0.3244  0.3476
                0.3708  0.3940  0.4172  0.4404  0.4635
                0.4867  0.5099  0.5331  0.5563  0.5795
                0.6027  0.6259  0.6492  0.6733  0.6984
                0.7244  0.7513  0.7791  0.8079  0.8376
                0.8682  0.8998  0.9323  0.9657  1.0000
Hrad:
                0.0175  0.0350  0.0524  0.0699  0.0874
                0.1049  0.1224  0.1398  0.1573  0.1748
                0.1923  0.2098  0.2272  0.2447  0.2622
                0.2797  0.2972  0.3146  0.3321  0.3496
                0.3842  0.4187  0.4532  0.4875  0.5219
                0.5561  0.5903  0.6244  0.6585  0.6925
                0.7264  0.7603  0.7941  0.8279  0.8615
                0.8952  0.9287  0.9446  0.9439  0.9445
                0.9463  0.9492  0.9530  0.9576  0.9631
                0.9693  0.9761  0.9835  0.9915  1.0000
Width:
                0.0333  0.0666  0.0999  0.1332  0.1665
                0.1998  0.2331  0.2664  0.2997  0.3329
                0.3662  0.3995  0.4328  0.4661  0.4994
                0.5327  0.5660  0.5993  0.6326  0.6659
                0.6659  0.6660  0.6660  0.6661  0.6661
                0.6662  0.6662  0.6662  0.6663  0.6663
                0.6664  0.6664  0.6665  0.6665  0.6666
                0.6666  0.6666  0.6800  0.7067  0.7333
                0.7600  0.7867  0.8133  0.8400  0.8667
                0.8933  0.9200  0.9467  0.9733  1.0000


***************************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
***************************************************************


***************
Analysis Options
***************
Flow Units ................ CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ..... CURVE_NUMBER
Flow Routing Method ..... DYNWAVE
Surcharge Method ........ EXTRAN
Starting Date ........... 04/07/2021 00:00:00
Ending Date ............. 04/07/2021 15:00:00
Antecedent Dry Days ..... 0.0
Report Time Step ........ 00:05:00
Wet Time Step ........... 00:05:00
Dry Time Step ........... 00:05:00
Routing Time Step ....... 5.00 sec
Variable Time Step ...... YES
Maximum Trials .......... 8
Number of Threads ....... 4
Head Tolerance .......... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity      hectare-m            mm
**************************  ------------  ------------
Total Precipitation ......         1.050        32.400
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.251         7.748
Surface Runoff ...........         0.792        24.450
Final Storage ............         0.012         0.382
Continuity Error (%) .....        -0.553


**************************        Volume         Volume
Flow Routing Continuity         hectare-m      10^6 ltr
**************************  ------------  ------------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.792         7.921
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.004         0.042
External Outflow .........         0.792         7.925
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.003         0.035
Continuity Error (%) .....         0.050


**************************
Time-Step Critical Elements
**************************
Link C2 (63.66%)


*********************************
Highest Flow Instability Indexes
*********************************
All links are stable.


************************
Routing Time Step Summary
************************
Minimum Time Step           :     0.52 sec
Average Time Step           :     3.26 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.09
Percent Not Converging      :     0.27
Time Step Frequencies       :
    5.000 -  3.155 sec      :    55.20 %
    3.155 -  1.991 sec      :     9.84 %
    1.991 -  1.256 sec      :    26.94 %
    1.256 -  0.792 sec      :     8.01 %
    0.792 -  0.500 sec      :     0.02 %


**************************
Subcatchment Runoff Summary
**************************
```

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
201	32.40	0.00	0.00	8.28	22.84	1.07	23.91	2.73	2.13	0.738
202	32.40	0.00	0.00	8.28	22.84	1.07	23.91	2.50	1.95	0.738
203	32.40	0.00	0.00	2.69	29.32	0.44	29.75	1.73	1.49	0.918
204	32.40	0.00	0.00	6.77	24.41	1.03	25.44	0.17	0.15	0.785
205	32.40	0.00	0.00	15.07	14.62	2.06	16.68	0.21	0.16	0.515
205a	32.40	0.00	0.00	0.00	32.61	0.00	32.61	0.05	0.04	1.007
205b	32.40	0.00	0.00	0.00	32.61	0.00	32.61	0.05	0.04	1.007
205c	32.40	0.00	0.00	0.00	32.61	0.00	32.61	0.05	0.04	1.007
205d	32.40	0.00	0.00	0.00	32.61	0.00	32.61	0.05	0.04	1.007
206	32.40	0.00	0.00	23.18	4.86	3.30	8.16	0.05	0.03	0.252
207	32.40	0.00	0.00	13.54	16.21	2.05	18.27	0.18	0.14	0.564
208	32.40	0.00	0.00	6.77	24.41	1.03	25.44	0.17	0.14	0.785

```
******************
Node Depth Summary
******************
```

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
CBMH10	JUNCTION	0.65	2.09	334.82	0 01:16	2.01
CBMH65	JUNCTION	0.34	1.18	334.18	0 01:16	1.15
CBMH76	JUNCTION	0.75	1.19	335.49	0 01:15	1.19
CBMH83	JUNCTION	1.00	2.98	336.14	0 01:24	2.97
EXCBMH13	JUNCTION	0.78	2.22	337.22	0 01:15	2.22
EXMH1	JUNCTION	0.74	2.62	335.82	0 01:18	2.61
EXMH2	JUNCTION	0.79	2.88	335.73	0 01:17	2.84
EXMH6	JUNCTION	1.02	3.03	335.42	0 01:16	2.88
EXMH61	JUNCTION	0.86	2.61	335.96	0 01:16	2.58
J1	JUNCTION	0.30	0.80	333.80	0 01:16	0.78
MH77	JUNCTION	0.67	2.17	334.87	0 01:15	2.12
OF1	OUTFALL	0.00	0.00	333.00	0 00:00	0.00
OF2	OUTFALL	0.29	0.78	333.78	0 01:16	0.77
OF3	OUTFALL	0.00	0.00	333.00	0 00:00	0.00
S4	STORAGE	0.70	2.05	336.19	0 01:24	2.05
S5	STORAGE	0.94	2.80	336.16	0 01:39	2.80
S5a	STORAGE	0.02	0.04	336.19	0 01:48	0.04
S5b	STORAGE	0.02	0.04	336.19	0 01:48	0.04
S5c	STORAGE	0.02	0.04	336.19	0 01:48	0.04
S5d	STORAGE	0.02	0.04	336.19	0 01:48	0.04

```
******************
Node Inflow Summary
******************
```

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
CBMH10	JUNCTION	0.000	4.478	0 01:16	0	7.56	0.205
CBMH65	JUNCTION	0.140	4.601	0 01:16	0.165	7.74	0.126
CBMH76	JUNCTION	1.490	1.490	0 01:15	1.73	1.73	0.046
CBMH83	JUNCTION	0.000	0.071	0 01:47	0	0.579	0.013
EXCBMH13	JUNCTION	2.130	2.130	0 01:15	2.73	2.73	0.002
EXMH1	JUNCTION	0.000	1.707	0 01:16	0	2.48	-0.738
EXMH2	JUNCTION	0.000	1.699	0 01:23	0	2.48	0.020
EXMH6	JUNCTION	0.000	3.094	0 01:15	0	5.24	0.160
EXMH61	JUNCTION	1.951	1.951	0 01:15	2.5	2.5	0.626
J1	JUNCTION	0.000	4.603	0 01:16	0	7.74	0.063
MH77	JUNCTION	0.000	1.492	0 01:15	0	1.73	0.038
OF1	OUTFALL	0.142	0.142	0 01:15	0.177	0.177	0.000
OF2	OUTFALL	0.000	4.603	0 01:16	0	7.74	0.000
OF3	OUTFALL	0.026	0.026	0 01:15	0.0473	0.0473	0.000
S4	STORAGE	0.147	0.147	0 01:15	0.173	0.173	0.190
S5	STORAGE	0.165	0.176	0 01:15	0.209	0.407	0.009
S5a	STORAGE	0.042	0.042	0 01:15	0.0495	0.0495	0.007
S5b	STORAGE	0.042	0.042	0 01:15	0.0495	0.0495	0.007
S5c	STORAGE	0.042	0.042	0 01:15	0.0495	0.0495	0.007
S5d	STORAGE	0.042	0.042	0 01:15	0.0495	0.0495	0.007

```
**********************
Node Surcharge Summary
**********************

Surcharging occurs when water rises above the top of the highest conduit.
```

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
CBMH83	JUNCTION	1.63	1.548	0.037
EXMH2	JUNCTION	0.22	1.338	0.000

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CMS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
EXMH2	0.17	0.381	0 01:15	0.046	0.388

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
S4	0.005	4	0	0	0.048	37	0 01:24	0.045
S5	0.016	3	0	0	0.101	21	0 01:39	0.062
S5a	0.010	5	0	0	0.033	16	0 01:48	0.003
S5b	0.010	5	0	0	0.033	16	0 01:48	0.003
S5c	0.010	5	0	0	0.033	16	0 01:48	0.003
S5d	0.010	5	0	0	0.033	16	0 01:48	0.003

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	45.54	0.019	0.142	0.177
OF2	96.33	0.387	4.603	7.742
OF3	46.25	0.005	0.026	0.047
System	62.71	0.410	4.745	7.967

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	4.478	0 01:16	3.74	25.15	1.00
C10	CONDUIT	1.492	0 01:15	3.77	0.45	0.47
C11	CONDUIT	1.488	0 01:15	1.72	0.63	1.00
C12	CHANNEL	0.000	0 00:00	0.00	0.00	0.00
C13	CONDUIT	1.686	0 01:22	2.65	1.47	1.00
C14	CONDUIT	1.699	0 01:23	2.67	0.70	1.00
C15	CONDUIT	1.413	0 01:14	2.22	1.34	1.00
C16	CONDUIT	0.620	0 01:11	3.16	1.24	1.00
C17	CHANNEL	1.570	0 01:15	2.17	0.44	0.65
C18	CHANNEL	0.718	0 01:16	0.95	0.48	0.67
C19	CHANNEL	0.102	0 01:18	0.21	0.14	0.50
C2	CONDUIT	4.603	0 01:16	1.90	0.09	0.25
C3	CHANNEL	0.000	0 00:00	0.00	0.00	0.00
C4	CONDUIT	4.603	0 01:16	4.06	19.17	0.90
C5	CHANNEL	0.000	0 00:00	0.00	0.00	0.00
C6	CONDUIT	0.045	0 02:39	0.87	0.66	1.00
C7	CONDUIT	3.113	0 01:18	2.75	5.46	1.00
C8	CHANNEL	0.000	0 00:00	0.00	0.00	0.00
OR3	CONDUIT	0.062	0 02:24	0.88	0.91	1.00
OR1	ORIFICE	0.001	0 01:54			
OR10	ORIFICE	0.001	0 01:54			
OR11	ORIFICE	0.001	0 01:54			
OR12	ORIFICE	0.001	0 01:54			
OR13	ORIFICE	0.001	0 01:54			
OR14	ORIFICE	0.001	0 01:54			
OR2	ORIFICE	0.001	0 01:54			
OR4	ORIFICE	0.001	0 01:54			
OR5	ORIFICE	0.001	0 01:54			
OR6	ORIFICE	0.001	0 01:54			
OR7	ORIFICE	0.001	0 01:54			
OR8	ORIFICE	0.001	0 01:54			
OR9	ORIFICE	0.071	0 01:47			1.00
W1	WEIR	0.000	0 00:00			0.00
W2	WEIR	0.000	0 00:00			0.00
W3	WEIR	0.000	0 00:00			0.00

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C1	1.00	0.00	0.00	0.00	0.99	0.00	0.01	0.00	0.00	0.00
C10	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00
C11	1.00	0.00	0.01	0.00	0.99	0.00	0.00	0.00	0.03	0.00
C12	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13	1.00	0.01	0.01	0.00	0.98	0.00	0.00	0.00	0.96	0.00
C14	1.00	0.01	0.00	0.00	0.06	0.36	0.00	0.57	0.17	0.00
C15	1.00	0.01	0.00	0.00	0.05	0.00	0.00	0.94	0.00	0.00
C16	1.00	0.01	0.00	0.00	0.05	0.00	0.00	0.94	0.00	0.00
C17	1.00	0.93	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00
C18	1.00	0.96	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.00
C19	1.00	0.97	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
C2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C3	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4	1.00	0.00	0.00	0.00	0.81	0.01	0.00	0.18	0.00	0.00
C5	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C6	1.00	0.01	0.00	0.00	0.26	0.00	0.00	0.73	0.00	0.00
C7	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00
C8	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OR3	1.00	0.01	0.00	0.00	0.55	0.00	0.00	0.44	0.19	0.00

****
Conduit Surcharge Summary
****

Conduit	Hours Full Both Ends	Hours Full Upstream	Hours Full Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
C1	0.18	0.23	0.18	2.27	0.18
C11	0.19	0.19	0.21	0.01	0.01
C13	0.23	0.23	0.26	0.13	0.13
C14	0.20	0.20	0.22	0.01	0.01
C15	0.20	0.20	0.20	0.09	0.07
C16	0.33	0.41	0.33	0.37	0.27
C4	0.01	0.18	0.01	1.94	0.01
C6	1.60	1.60	1.63	0.01	0.01
C7	0.20	0.22	0.20	0.58	0.20
OR3	1.83	1.83	2.04	0.01	0.01

Analysis begun on: Wed May 26 10:26:42 2021
Analysis ended on: Wed May 26 10:26:44 2021
Total elapsed time: 00:00:02

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)

```
WARNING 02: maximum depth increased for Node CBMH65
WARNING 02: maximum depth increased for Node CBMH76
WARNING 02: maximum depth increased for Node EXCBMH13
WARNING 02: maximum depth increased for Node EXMH1
WARNING 02: maximum depth increased for Node EXMH6
WARNING 02: maximum depth increased for Node EXMH61
```

****
Element Count
****

```
Number of rain gages ..... 4
Number of subcatchments ... 12
Number of nodes ........... 20
Number of links ........... 35
Number of pollutants ...... 0
Number of land uses ....... 0
```

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
Chi_3h_25mm	Chi_3h_25mm	INTENSITY	10 min.
Chi_3hr_100yr	Chi_3hr_100yr	INTENSITY	5 min.
Chi_3hr_2yr	Chi_3hr_2yr	INTENSITY	5 min.
Chi_3hr_5yr	Chi_3hr_5yr	INTENSITY	5 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
201	11.41	1141.00	70.00	2.0000	Chi_3hr_5yr	EXCBMH13
202	10.45	1045.00	70.00	2.0000	Chi_3hr_5yr	EXMH61
203	5.80	1450.00	90.00	2.0000	Chi_3hr_5yr	CBMH76
204	0.68	170.00	75.00	2.0000	Chi_3hr_5yr	S4
205	1.25	313.25	45.00	2.0000	Chi_3hr_5yr	S5
205a	0.15	75.90	100.00	0.3000	Chi_3hr_5yr	S5a
205b	0.15	75.90	100.00	0.3000	Chi_3hr_5yr	S5b
205c	0.15	75.90	100.00	0.3000	Chi_3hr_5yr	S5c
205d	0.15	75.90	100.00	0.3000	Chi_3hr_5yr	S5d
206	0.58	290.00	15.00	2.0000	Chi_3hr_5yr	OF3
207	0.97	485.00	50.00	2.0000	Chi_3hr_5yr	OF1
208	0.65	162.50	75.00	2.0000	Chi_3hr_5yr	CBMH65

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
CBMH10	JUNCTION	332.73	3.57	100.0	
CBMH65	JUNCTION	333.00	3.30	0.0	
CBMH76	JUNCTION	334.30	4.13	0.0	
CBMH83	JUNCTION	333.16	3.01	100.0	
EXCBMH13	JUNCTION	335.00	2.29	100.0	
EXMH1	JUNCTION	333.20	2.68	100.0	
EXMH2	JUNCTION	332.85	2.49	100.0	
EXMH6	JUNCTION	332.39	3.54	100.0	
EXMH61	JUNCTION	333.35	2.67	100.0	
J1	JUNCTION	333.00	3.25	100.0	
MH77	JUNCTION	332.70	4.30	0.0	
OF1	OUTFALL	333.00	0.00	0.0	
OF2	OUTFALL	333.00	3.03	0.0	
OF3	OUTFALL	333.00	0.00	0.0	
S4	STORAGE	334.14	2.16	0.0	
S5	STORAGE	333.36	2.94	0.0	
S5a	STORAGE	336.15	0.15	0.0	
S5b	STORAGE	336.15	0.15	0.0	
S5c	STORAGE	336.15	0.15	0.0	
S5d	STORAGE	336.15	0.15	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	CBMH10	CBMH65	CONDUIT	52.8	0.0019	0.0130
C10	CBMH76	MH77	CONDUIT	33.0	1.4971	0.0130
C11	MH77	CBMH10	CONDUIT	24.4	0.7500	0.0130
C12	EXMH6	CBMH10	CONDUIT	95.0	-0.2842	0.0100
C13	EXMH2	EXMH6	CONDUIT	82.0	0.4024	0.0130
C14	EXMH1	EXMH2	CONDUIT	17.6	1.8185	0.0130
C15	EXMH61	EXMH1	CONDUIT	64.4	0.3416	0.0130
C16	EXCBMH13	EXMH6	CONDUIT	111.2	1.7539	0.0130
C17	EXCBMH13	EXMH6	CONDUIT	112.0	1.2144	0.0100
C18	EXMH61	EXMH1	CONDUIT	65.0	0.2154	0.0100
C19	EXMH1	EXMH6	CONDUIT	100.0	-0.0500	0.0100
C2	J1	OF2	CONDUIT	5.0	0.0200	0.0130
C3	CBMH10	CBMH65	CONDUIT	85.0	0.7294	0.0100
C4	CBMH65	J1	CONDUIT	29.0	0.0034	0.0130
C5	CBMH76	CBMH10	CONDUIT	58.0	3.8097	0.0100
C6	S4	CBMH83	CONDUIT	29.1	0.4983	0.0130
C7	EXMH6	CBMH10	CONDUIT	93.4	0.0214	0.0130
C8	CBMH65	J1	CONDUIT	29.0	0.3448	0.0100
OR3	S5	CBMH83	CONDUIT	33.3	0.4985	0.0130
OR1	S5a	S5	ORIFICE			
OR10	S5a	S5	ORIFICE			
OR11	S5b	S5	ORIFICE			
OR12	S5b	S5	ORIFICE			
OR13	S5c	S5	ORIFICE			
OR14	S5c	S5	ORIFICE			
OR2	S5d	S5	ORIFICE			
OR4	S5b	S5	ORIFICE			
OR5	S5c	S5	ORIFICE			
OR6	S5d	S5	ORIFICE			
OR7	S5d	S5	ORIFICE			
OR8	S5a	S5	ORIFICE			
OR9	CBMH83	CBMH10	ORIFICE			
W1	S4	CBMH10	WEIR			
W2	S5	CBMH10	WEIR			
W3	S5	CBMH10	WEIR			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	HORIZ_ELLIPSE	0.97	1.20	0.30	1.52	1	0.18
C10	CIRCULAR	1.05	0.87	0.26	1.05	1	3.34
C11	CIRCULAR	1.05	0.87	0.26	1.05	1	2.37
C12	RoadCrossSection	0.20	1.38	0.11	12.00	1	1.71
C13	CIRCULAR	0.90	0.64	0.23	0.90	1	1.15
C14	CIRCULAR	0.90	0.64	0.23	0.90	1	2.44
C15	CIRCULAR	0.90	0.64	0.23	0.90	1	1.06
C16	CIRCULAR	0.50	0.20	0.12	0.50	1	0.50
C17	RoadCrossSection	0.20	1.38	0.11	12.00	1	3.53
C18	RoadCrossSection	0.20	1.38	0.11	12.00	1	1.49
C19	RoadCrossSection	0.20	1.38	0.11	12.00	1	0.72
C2	TRIANGULAR	3.00	37.50	1.46	25.00	1	52.48
C3	RoadCrossSection	0.20	1.38	0.11	12.00	1	2.73
C4	HORIZ_ELLIPSE	0.97	1.20	0.30	1.52	1	0.24
C5	RoadCrossSection	0.20	1.38	0.11	12.00	1	6.25
C6	CIRCULAR	0.30	0.07	0.07	0.30	1	0.07
C7	CIRCULAR	1.20	1.13	0.30	1.20	1	0.57
C8	RoadCrossSection	0.20	1.38	0.11	12.00	1	1.88
OR3	CIRCULAR	0.30	0.07	0.07	0.30	1	0.07

****
Transect Summary
****

```
Transect RoadCrossSection
Area:
               0.0006    0.0023    0.0052    0.0093    0.0145
               0.0209    0.0284    0.0371    0.0469    0.0579
               0.0701    0.0834    0.0979    0.1135    0.1303
               0.1483    0.1674    0.1877    0.2091    0.2317
               0.2549    0.2781    0.3013    0.3244    0.3476
               0.3708    0.3940    0.4172    0.4404    0.4635
               0.4867    0.5099    0.5331    0.5563    0.5795
               0.6027    0.6259    0.6492    0.6733    0.6984
               0.7244    0.7513    0.7791    0.8079    0.8376
               0.8682    0.8998    0.9323    0.9657    1.0000
Hrad:
               0.0175    0.0350    0.0524    0.0699    0.0874
               0.1049    0.1224    0.1398    0.1573    0.1748
               0.1923    0.2098    0.2272    0.2447    0.2622
               0.2797    0.2972    0.3146    0.3321    0.3496
               0.3842    0.4187    0.4532    0.4875    0.5219
               0.5561    0.5903    0.6244    0.6585    0.6925
               0.7264    0.7603    0.7941    0.8279    0.8615
               0.8952    0.9287    0.9446    0.9439    0.9445
               0.9463    0.9492    0.9530    0.9576    0.9631
               0.9693    0.9761    0.9835    0.9915    1.0000
Width:
               0.0333    0.0666    0.0999    0.1332    0.1665
               0.1998    0.2331    0.2664    0.2997    0.3329
               0.3662    0.3995    0.4328    0.4661    0.4994
               0.5327    0.5660    0.5993    0.6326    0.6659
               0.6659    0.6660    0.6660    0.6661    0.6661
               0.6662    0.6662    0.6662    0.6663    0.6663
               0.6664    0.6664    0.6665    0.6665    0.6666
               0.6666    0.6666    0.6800    0.7067    0.7333
               0.7600    0.7867    0.8133    0.8400    0.8667
               0.8933    0.9200    0.9467    0.9733    1.0000
```

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****

```
Flow Units ................ CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 04/07/2021 00:00:00
Ending Date .............. 04/07/2021 15:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 4
Head Tolerance ........... 0.001500 m
```

****

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	1.541	47.549
Evaporation Loss	0.000	0.000
Infiltration Loss	0.306	9.434
Surface Runoff	1.230	37.957
Final Storage	0.012	0.372
Continuity Error (%)	-0.452	

****

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	1.230	12.298
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.012	0.125
External Outflow	1.236	12.362
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume ..	0.000	0.001
Final Stored Volume	0.010	0.098
Continuity Error (%) ...	-0.299	

****
Highest Continuity Errors
****

```
Node EXMH1 (-2.89%)
```

****
Time-Step Critical Elements
****

```
Link C2 (67.11%)
```

****
Highest Flow Instability Indexes
****

```
Link C11 (2)
Link C2 (2)
```

****
Routing Time Step Summary
****

```
Minimum Time Step           :     0.41 sec
Average Time Step           :     2.97 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :    -0.00
Average Iterations per Step :     2.07
Percent Not Converging      :     0.19
Time Step Frequencies       :
    5.000 -  3.155 sec      :    32.82 %
    3.155 -  1.991 sec      :    37.06 %
    1.991 -  1.256 sec      :    18.41 %
    1.256 -  0.792 sec      :    11.67 %
    0.792 -  0.500 sec      :     0.03 %
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
201	47.55	0.00	0.00	10.09	33.46	3.84	37.30	4.26	2.85	0.784
202	47.55	0.00	0.00	10.09	33.46	3.84	37.30	3.90	2.61	0.784
203	47.55	0.00	0.00	3.27	42.95	1.40	44.35	2.57	1.96	0.933
204	47.55	0.00	0.00	8.22	35.77	3.39	39.16	0.27	0.19	0.824
205	47.55	0.00	0.00	18.33	21.43	7.18	28.61	0.36	0.22	0.602
205a	47.55	0.00	0.00	0.00	47.77	0.00	47.77	0.07	0.06	1.005
205b	47.55	0.00	0.00	0.00	47.77	0.00	47.77	0.07	0.06	1.005
205c	47.55	0.00	0.00	0.00	47.77	0.00	47.77	0.07	0.06	1.005
205d	47.55	0.00	0.00	0.00	47.77	0.00	47.77	0.07	0.06	1.005
206	47.55	0.00	0.00	28.21	7.13	11.25	18.39	0.11	0.03	0.387
207	47.55	0.00	0.00	16.45	23.79	6.78	30.56	0.30	0.19	0.643
208	47.55	0.00	0.00	8.22	35.77	3.39	39.16	0.25	0.18	0.824

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
CBMH10	JUNCTION	0.86	2.46	335.19	0 01:15	2.41
CBMH65	JUNCTION	0.53	1.35	334.35	0 01:15	1.33
CBMH76	JUNCTION	0.77	1.33	335.63	0 01:15	1.32
CBMH83	JUNCTION	1.23	3.03	336.19	0 01:31	3.03
EXCBMH13	JUNCTION	0.84	2.25	337.25	0 01:15	2.24
EXMH1	JUNCTION	0.81	2.83	336.03	0 01:20	2.83
EXMH2	JUNCTION	0.87	3.15	336.00	0 01:20	3.15
EXMH6	JUNCTION	1.26	3.49	335.88	0 01:18	3.48
EXMH61	JUNCTION	0.93	2.75	336.10	0 01:19	2.75
J1	JUNCTION	0.48	0.84	333.84	0 01:15	0.83
MH77	JUNCTION	0.89	2.60	335.30	0 01:15	2.57
OF1	OUTFALL	0.00	0.00	333.00	0 00:00	0.00
OF2	OUTFALL	0.48	0.83	333.83	0 01:15	0.82
OF3	OUTFALL	0.00	0.00	333.00	0 00:00	0.00
S4	STORAGE	0.84	2.11	336.25	0 01:28	2.11
S5	STORAGE	1.15	2.85	336.21	0 01:42	2.85
S5a	STORAGE	0.03	0.06	336.21	0 02:24	0.06
S5b	STORAGE	0.03	0.06	336.21	0 02:24	0.06
S5c	STORAGE	0.03	0.06	336.21	0 02:24	0.06
S5d	STORAGE	0.03	0.06	336.21	0 02:24	0.06

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
CBMH10	JUNCTION	0.000	5.151	0 01:15	0	11.8	0.305
CBMH65	JUNCTION	0.184	5.297	0 01:15	0.255	12.1	0.236
CBMH76	JUNCTION	1.957	1.957	0 01:15	2.57	2.57	0.148
CBMH83	JUNCTION	0.000	0.072	0 02:16	0	0.886	0.029
EXCBMH13	JUNCTION	2.852	2.852	0 01:15	4.26	4.26	0.232
EXMH1	JUNCTION	0.000	2.351	0 01:15	0	3.86	-2.809
EXMH2	JUNCTION	0.000	1.700	0 01:30	0	3.4	-0.048
EXMH6	JUNCTION	0.000	3.712	0 01:17	0	8.25	0.465
EXMH61	JUNCTION	2.612	2.612	0 01:15	3.9	3.9	1.078
J1	JUNCTION	0.000	5.309	0 01:15	0	12.1	0.105
MH77	JUNCTION	0.000	1.949	0 01:15	0	2.58	0.062
OF1	OUTFALL	0.187	0.187	0 01:15	0.296	0.296	0.000
OF2	OUTFALL	0.000	5.310	0 01:15	0	12.1	0.000
OF3	OUTFALL	0.035	0.035	0 01:15	0.107	0.107	0.000
S4	STORAGE	0.193	0.193	0 01:15	0.266	0.266	0.135
S5	STORAGE	0.216	0.228	0 01:15	0.358	0.649	0.007
S5a	STORAGE	0.056	0.056	0 01:15	0.0725	0.0726	0.004
S5b	STORAGE	0.056	0.056	0 01:15	0.0725	0.0726	0.004
S5c	STORAGE	0.056	0.056	0 01:15	0.0725	0.0726	0.004
S5d	STORAGE	0.056	0.056	0 01:15	0.0725	0.0726	0.004

****
Node Surcharge Summary
****

```
Surcharging occurs when water rises above the top of the highest conduit.
```

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
CBMH83	JUNCTION	2.57	1.602	0.000
EXMH1	JUNCTION	0.20	0.153	0.000
EXMH2	JUNCTION	0.39	1.614	0.000
EXMH61	JUNCTION	0.16	0.084	0.000

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CMS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
CBMH83	0.53	0.006	0 01:24	0.002	0.017
EXMH1	0.18	1.372	0 01:15	0.169	0.153
EXMH2	0.33	0.429	0 01:13	0.078	0.664
EXMH61	0.16	0.274	0 01:17	0.043	0.084

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
S4	0.013	10	0	0	0.089	69	0 01:28	0.054
S5	0.039	8	0	0	0.185	38	0 01:42	0.067
S5a	0.024	12	0	0	0.062	31	0 02:24	0.004
S5b	0.024	12	0	0	0.062	31	0 02:24	0.004
S5c	0.024	12	0	0	0.062	31	0 02:24	0.004
S5d	0.024	12	0	0	0.062	31	0 02:24	0.004

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	43.94	0.031	0.187	0.296
OF2	95.32	0.577	5.310	12.084
OF3	45.27	0.010	0.035	0.107
System	61.51	0.619	5.522	12.487

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	5.121	0 01:15	4.27	28.77	1.00
C10	CONDUIT	1.949	0 01:15	3.83	0.58	0.68
C11	CONDUIT	1.944	0 01:15	2.25	0.82	1.00
C12	CHANNEL	0.000	0 00:00	0.00	0.00	0.37
C13	CONDUIT	1.815	0 01:30	2.85	1.58	1.00
C14	CONDUIT	1.700	0 01:30	2.67	0.70	1.00
C15	CONDUIT	1.434	0 01:11	2.25	1.36	1.00
C16	CONDUIT	0.619	0 01:08	3.15	1.24	1.00
C17	CHANNEL	2.323	0 01:15	2.48	0.66	0.79
C18	CHANNEL	1.448	0 01:15	1.05	0.97	1.00
C19	CHANNEL	0.931	0 01:21	0.84	1.30	0.88
C2	CONDUIT	5.310	0 01:15	1.96	0.10	0.27
C3	CHANNEL	0.000	0 00:00	0.00	0.00	0.00
C4	CONDUIT	5.309	0 01:15	4.61	22.11	0.92
C5	CHANNEL	0.000	0 00:00	0.00	0.00	0.00
C6	CONDUIT	0.048	0 01:23	0.85	0.70	1.00
C7	CONDUIT	3.722	0 01:21	3.29	6.52	1.00
C8	CHANNEL	0.000	0 00:00	0.00	0.00	0.00
OR3	CONDUIT	0.067	0 03:15	0.94	0.97	1.00
OR1	ORIFICE	0.001	0 02:56			
OR10	ORIFICE	0.001	0 02:56			
OR11	ORIFICE	0.001	0 02:56			
OR12	ORIFICE	0.001	0 02:56			
OR13	ORIFICE	0.001	0 02:56			
OR14	ORIFICE	0.001	0 02:56			
OR2	ORIFICE	0.001	0 02:56			
OR4	ORIFICE	0.001	0 02:56			
OR5	ORIFICE	0.001	0 02:56			
OR6	ORIFICE	0.001	0 02:56			
OR7	ORIFICE	0.001	0 02:56			
OR8	ORIFICE	0.001	0 02:56			
OR9	ORIFICE	0.072	0 02:16		1.00	
W1	WEIR	0.008	0 01:28		0.03	
W2	WEIR	0.000	0 00:00		0.00	
W3	WEIR	0.019	0 01:42		0.06	

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C10	1.00	0.01	0.00	0.00	0.00	0.03	0.00	0.96	0.00	0.00
C11	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C12	1.00	0.97	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C13	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.95	0.00
C14	1.00	0.01	0.00	0.00	0.09	0.32	0.00	0.58	0.15	0.00
C15	1.00	0.01	0.00	0.00	0.08	0.00	0.00	0.91	0.00	0.00
C16	1.00	0.01	0.00	0.00	0.08	0.00	0.00	0.91	0.00	0.00
C17	1.00	0.90	0.00	0.00	0.00	0.01	0.00	0.09	0.00	0.00
C18	1.00	0.93	0.00	0.00	0.05	0.00	0.00	0.01	0.00	0.00
C19	1.00	0.94	0.00	0.00	0.01	0.00	0.04	0.00	0.00	0.00
C2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C3	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C4	1.00	0.00	0.00	0.00	0.85	0.04	0.00	0.10	0.00	0.00
C5	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C6	1.00	0.01	0.00	0.00	0.34	0.00	0.00	0.65	0.00	0.00
C7	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C8	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OR3	1.00	0.01	0.00	0.00	0.70	0.00	0.00	0.29	0.31	0.00

****
Conduit Surcharge Summary
****

Conduit	Hours Full Both Ends	Hours Full Upstream	Hours Full Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
C1	0.32	0.40	0.32	2.81	0.32
C11	0.35	0.35	0.38	0.01	0.01
C13	0.39	0.39	0.43	0.16	0.17
C14	0.36	0.36	0.39	0.01	0.01
C15	0.36	0.36	0.36	0.08	0.07
C16	0.52	0.62	0.52	0.43	0.30
C18	0.15	0.16	0.20	0.01	0.01
C19	0.01	0.01	0.20	0.12	0.01
C4	0.01	0.32	0.01	2.66	0.01
C6	2.54	2.54	2.57	0.01	0.01
C7	0.36	0.39	0.36	0.95	0.36
OR3	2.79	2.79	2.92	0.01	0.01

Analysis begun on: Wed May 26 10:27:07 2021
Analysis ended on: Wed May 26 10:27:09 2021
Total elapsed time: 00:00:02

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)
--------------------------------------------------------------

WARNING 02: maximum depth increased for Node CBMH65
WARNING 02: maximum depth increased for Node CBMH76
WARNING 02: maximum depth increased for Node EXCBMH13
WARNING 02: maximum depth increased for Node EXMH1
WARNING 02: maximum depth increased for Node EXMH6
WARNING 02: maximum depth increased for Node EXMH61

*************
Element Count
*************
Number of rain gages ...... 4
Number of subcatchments ... 12
Number of nodes ........... 20
Number of links ........... 35
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                 Data       Recording
Name                Data Source                  Type       Interval
-----------------------------------------------------------------------
Chi_3h_25mm         Chi_3h_25mm                  INTENSITY  10 min.
Chi_3hr_100yr       Chi_3hr_100yr                INTENSITY   5 min.
Chi_3hr_2yr         Chi_3hr_2yr                  INTENSITY   5 min.
Chi_3hr_5yr         Chi_3hr_5yr                  INTENSITY   5 min.


********************
Subcatchment Summary
********************
Name                            Area     Width   %Imperv    %Slope Rain Gage           Outlet
-----------------------------------------------------------------------------------------------
201                            11.41   1141.00     70.00     2.0000 Chi_3hr_100yr       EXCBMH13
202                            10.45   1045.00     70.00     2.0000 Chi_3hr_100yr       EXMH61
203                             5.80   1450.00     90.00     2.0000 Chi_3hr_100yr       CBMH76
204                             0.68    170.00     75.00     2.0000 Chi_3hr_100yr       S4
205                             1.25    313.25     45.00     2.0000 Chi_3hr_100yr       S5
205a                            0.15     75.90    100.00     0.3000 Chi_3hr_100yr       S5a
205b                            0.15     75.90    100.00     0.3000 Chi_3hr_100yr       S5b
205c                            0.15     75.90    100.00     0.3000 Chi_3hr_100yr       S5c
205d                            0.15     75.90    100.00     0.3000 Chi_3hr_100yr       S5d
206                             0.58    290.00     15.00     2.0000 Chi_3hr_100yr       OF3
207                             0.97    485.00     50.00     2.0000 Chi_3hr_100yr       OF1
208                             0.65    162.50     75.00     2.0000 Chi_3hr_100yr       CBMH65


************
Node Summary
************
                                          Invert     Max.     Ponded    External
Name                Type                  Elev.      Depth     Area     Inflow
-----------------------------------------------------------------------------
CBMH10              JUNCTION               332.73     3.57    100.0
CBMH65              JUNCTION               333.00     3.30      0.0
CBMH76              JUNCTION               334.30     4.13      0.0
CBMH83              JUNCTION               333.16     3.01    100.0
EXCBMH13            JUNCTION               335.00     2.29    100.0
EXMH1               JUNCTION               333.20     2.68    100.0
EXMH2               JUNCTION               332.85     2.49    100.0
EXMH6               JUNCTION               332.39     3.54    100.0
EXMH61              JUNCTION               333.35     2.67    100.0
J1                  JUNCTION               333.00     3.25    100.0
MH77                JUNCTION               332.70     4.30      0.0
OF1                 OUTFALL                333.00     0.00      0.0
OF2                 OUTFALL                333.00     3.03      0.0
OF3                 OUTFALL                333.00     0.00      0.0
S4                  STORAGE                334.14     2.16      0.0
S5                  STORAGE                333.36     2.94      0.0
S5a                 STORAGE                336.15     0.15      0.0
S5b                 STORAGE                336.15     0.15      0.0
S5c                 STORAGE                336.15     0.15      0.0
S5d                 STORAGE                336.15     0.15      0.0


************
Link Summary
************
Name                From Node        To Node          Type            Length    %Slope Roughness
---------------------------------------------------------------------------------------------------
C1                  CBMH10           CBMH65           CONDUIT          52.8    0.0019   0.0130
C10                 CBMH76           MH77             CONDUIT          33.0    1.4971   0.0130
C11                 MH77             CBMH10           CONDUIT          24.4    0.7500   0.0130
C12                 EXMH6            CBMH10           CONDUIT          95.0   -0.2842   0.0100
C13                 EXMH2            EXMH6            CONDUIT          82.0    0.4024   0.0130
C14                 EXMH1            EXMH2            CONDUIT          17.6    1.8185   0.0130
C15                 EXMH61           EXMH1            CONDUIT          64.4    0.3416   0.0130
C16                 EXCBMH13         EXMH6            CONDUIT         111.2    1.7539   0.0130
C17                 EXCBMH13         EXMH6            CONDUIT         112.0    1.2144   0.0100
C18                 EXMH61           EXMH1            CONDUIT          65.0    0.2154   0.0100
C19                 EXMH1            EXMH6            CONDUIT         100.0   -0.0500   0.0100
C2                  J1               OF2              CONDUIT           5.0    0.0200   0.0130
C3                  CBMH10           CBMH65           CONDUIT          85.0    0.7294   0.0100
C4                  CBMH65           J1               CONDUIT          29.0    0.0034   0.0130
C5                  CBMH76           CBMH10           CONDUIT          58.0    3.8097   0.0100
C6                  S4               CBMH83           CONDUIT          29.1    0.4983   0.0130
C7                  EXMH6            CBMH10           CONDUIT          93.4    0.0214   0.0130
C8                  CBMH65           J1               CONDUIT          29.0    0.3448   0.0100
OR3                 S5               CBMH83           CONDUIT          33.3    0.4985   0.0130
OR1                 S5a              S5               ORIFICE
OR10                S5a              S5               ORIFICE
OR11                S5b              S5               ORIFICE
OR12                S5b              S5               ORIFICE
OR13                S5c              S5               ORIFICE
OR14                S5c              S5               ORIFICE
OR2                 S5d              S5               ORIFICE
OR4                 S5b              S5               ORIFICE
OR5                 S5c              S5               ORIFICE
OR6                 S5d              S5               ORIFICE
OR7                 S5d              S5               ORIFICE
OR8                 S5a              S5               ORIFICE
OR9                 CBMH83           CBMH10           ORIFICE
W1                  S4               CBMH10           WEIR
W2                  S5               CBMH10           WEIR
W3                  S5               CBMH10           WEIR


********************
Cross Section Summary
********************
                                          Full       Full     Hyd.     Max.   No. of     Full
Conduit             Shape                 Depth      Area     Rad.     Width  Barrels    Flow
-----------------------------------------------------------------------------------------------
C1                  HORIZ_ELLIPSE          0.97      1.20     0.30      1.52        1     0.18
C10                 CIRCULAR               1.05      0.87     0.26      1.05        1     3.34
C11                 CIRCULAR               1.05      0.87     0.26      1.05        1     2.37
C12                 RoadCrossSection       0.20      1.38     0.11     12.00        1     1.71
C13                 CIRCULAR               0.90      0.64     0.23      0.90        1     1.15
C14                 CIRCULAR               0.90      0.64     0.23      0.90        1     2.44
C15                 CIRCULAR               0.90      0.64     0.23      0.90        1     1.06
C16                 CIRCULAR               0.50      0.20     0.12      0.50        1     0.50
C17                 RoadCrossSection       0.20      1.38     0.11     12.00        1     3.53
C18                 RoadCrossSection       0.20      1.38     0.11     12.00        1     1.49
C19                 RoadCrossSection       0.20      1.38     0.11     12.00        1     0.72
C2                  TRIANGULAR             3.00     37.50     1.46     25.00        1    52.48
C3                  RoadCrossSection       0.20      1.38     0.11     12.00        1     2.73
C4                  HORIZ_ELLIPSE          0.97      1.20     0.30      1.52        1     0.24
C5                  RoadCrossSection       0.20      1.38     0.11     12.00        1     6.25
C6                  CIRCULAR               0.30      0.07     0.07      0.30        1     0.07
C7                  CIRCULAR               1.20      1.13     0.30      1.20        1     0.57
C8                  RoadCrossSection       0.20      1.38     0.11     12.00        1     1.88
OR3                 CIRCULAR               0.30      0.07     0.07      0.30        1     0.07


****************
Transect Summary
****************

Transect RoadCrossSection
Area:
                0.0006    0.0023    0.0052    0.0093    0.0145
                0.0209    0.0284    0.0371    0.0469    0.0579
                0.0701    0.0834    0.0979    0.1135    0.1303
                0.1483    0.1674    0.1877    0.2091    0.2317
                0.2549    0.2791    0.3013    0.3244    0.3476
                0.3708    0.3940    0.4172    0.4404    0.4635
                0.4867    0.5099    0.5331    0.5563    0.5795
                0.6027    0.6259    0.6492    0.6733    0.6984
                0.7244    0.7513    0.7791    0.8079    0.8376
                0.8682    0.8998    0.9323    0.9657    1.0000
Hrad:
                0.0175    0.0350    0.0524    0.0699    0.0874
                0.1049    0.1224    0.1398    0.1573    0.1748
                0.1923    0.2098    0.2272    0.2447    0.2622
                0.2797    0.2972    0.3146    0.3321    0.3496
                0.3842    0.4187    0.4532    0.4875    0.5219
                0.5561    0.5903    0.6244    0.6585    0.6925
                0.7264    0.7603    0.7941    0.8279    0.8615
                0.8952    0.9287    0.9446    0.9439    0.9445
                0.9463    0.9492    0.9530    0.9576    0.9631
                0.9693    0.9761    0.9835    0.9915    1.0000
Width:
                0.0333    0.0666    0.0999    0.1332    0.1665
                0.1998    0.2331    0.2664    0.2997    0.3329
                0.3662    0.3995    0.4328    0.4661    0.4994
                0.5327    0.5660    0.5993    0.6326    0.6659
                0.6659    0.6660    0.6660    0.6661    0.6661
                0.6662    0.6662    0.6662    0.6663    0.6663
                0.6664    0.6664    0.6665    0.6665    0.6666
                0.6666    0.6666    0.6800    0.7067    0.7333
                0.7600    0.7867    0.8133    0.8400    0.8667
                0.8933    0.9200    0.9467    0.9733    1.0000


************************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
************************************************************


**************
Analysis Options
**************
Flow Units ................ CMS
Process Models:
  Rainfall/Runoff ......... YES
  RDII .................... NO
  Snowmelt ................ NO
  Groundwater ............. NO
  Flow Routing ............ YES
  Ponding Allowed ......... YES
  Water Quality ........... NO
Infiltration Method ....... CURVE_NUMBER
Flow Routing Method ....... DYNWAVE
Surcharge Method .......... EXTRAN
Starting Date ............. 04/07/2021 00:00:00
Ending Date ............... 04/07/2021 15:00:00
Antecedent Dry Days ....... 0.0
Report Time Step .......... 00:05:00
Wet Time Step ............. 00:05:00
Dry Time Step ............. 00:05:00
Routing Time Step ......... 5.00 sec
Variable Time Step ........ YES
Maximum Trials ............ 8
Number of Threads ......... 4
Head Tolerance ............ 0.001500 m


*************************          Volume          Depth
Runoff Quantity Continuity       hectare-m            mm
*************************     ----------      ----------
Total Precipitation ......          2.915          89.960
Evaporation Loss .........          0.000           0.000
Infiltration Loss ........          0.398          12.270
Surface Runoff ...........          2.517          77.699
Final Storage ............          0.012           0.379
Continuity Error (%) .....         -0.431


*************************          Volume          Volume
Flow Routing Continuity          hectare-m        10^6 ltr
*************************     ----------      ----------
Dry Weather Inflow .......          0.000           0.000
Wet Weather Inflow .......          2.517          25.173
Groundwater Inflow .......          0.000           0.000
RDII Inflow ..............          0.000           0.000
External Inflow ..........          0.044           0.441
External Outflow .........          2.516          25.159
Flooding Loss ............          0.000           0.000
Evaporation Loss .........          0.000           0.000
Exfiltration Loss ........          0.000           0.000
Initial Stored Volume ....          0.001           0.006
Final Stored Volume ......          0.031           0.310
Continuity Error (%) .....          0.589


*************************
Highest Continuity Errors
*************************
Node EXMH1 (-1.03%)


*************************
Time-Step Critical Elements
*************************
Link C2 (54.11%)


*******************************
Highest Flow Instability Indexes
*******************************
Link C2 (35)
Link C4 (29)
Link C11 (16)
Link C1 (9)
Link OR9 (8)


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     3.09 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.89
Percent Not Converging      :     1.00
Time Step Frequencies       :
    5.000 -  3.155 sec      :    46.45 %
    3.155 -  1.991 sec      :     2.03 %
    1.991 -  1.256 sec      :    35.52 %
    1.256 -  0.792 sec      :    15.92 %
    0.792 -  0.500 sec      :     0.07 %


*************************
Subcatchment Runoff Summary
*************************
-----------------------------------------------------------------------------------------------------------------------------------
                      Total      Total      Total      Total     Imperv      Perv     Total     Total      Peak    Runoff
                     Precip      Runon       Evap      Infil    Runoff    Runoff    Runoff    Runoff    Runoff    Coeff
Subcatchment             mm         mm         mm         mm        mm        mm        mm  10^6 ltr       CMS
-----------------------------------------------------------------------------------------------------------------------------------
201                     89.96       0.00       0.00      13.10     63.22     13.64     76.86      8.77      5.61    0.854
202                     89.96       0.00       0.00      13.10     63.22     13.64     76.86      8.03      5.14    0.854
203                     89.96       0.00       0.00       4.27     81.15      4.70     85.86      4.98      3.67    0.954
204                     89.96       0.00       0.00      10.75     67.60     11.63     79.22      0.54      0.38    0.881
205                     89.96       0.00       0.00      23.89     40.52     25.19     65.71      0.82      0.49    0.730
205a                    89.96       0.00       0.00       0.00     90.25      0.00     90.25      0.14      0.10    1.003
205b                    89.96       0.00       0.00       0.00     90.25      0.00     90.25      0.14      0.10    1.003
205c                    89.96       0.00       0.00       0.00     90.25      0.00     90.25      0.14      0.10    1.003
205d                    89.96       0.00       0.00       0.00     90.25      0.00     90.25      0.14      0.10    1.003
206                     89.96       0.00       0.00      36.78     13.50     39.15     52.65      0.31      0.15    0.585
207                     89.96       0.00       0.00      21.49     45.00     23.25     68.25      0.66      0.45    0.759
208                     89.96       0.00       0.00      10.75     67.60     11.63     79.22      0.51      0.37    0.881


*****************
Node Depth Summary
*****************
-----------------------------------------------------------------------------------------------
                                  Average    Maximum    Maximum  Time of Max      Reported
                                    Depth      Depth        HGL   Occurrence     Max Depth
Node                Type           Meters     Meters     Meters  days hr:min        Meters
-----------------------------------------------------------------------------------------------
CBMH10              JUNCTION         1.58       3.08     335.81    0  01:22          3.08
CBMH65              JUNCTION         1.18       2.08     335.08    0  01:22          2.05
CBMH76              JUNCTION         0.85       2.48     336.78    0  01:15          2.47
CBMH83              JUNCTION         1.91       3.09     336.25    0  01:24          3.09
EXCBMH13            JUNCTION         1.01       2.77     337.77    0  01:19          2.77
EXMH1               JUNCTION         1.26       3.59     336.79    0  01:25          3.59
EXMH2               JUNCTION         1.62       3.90     336.75    0  01:26          3.90
EXMH6               JUNCTION         2.04       4.18     336.57    0  01:27          4.17
EXMH61              JUNCTION         1.21       3.63     336.98    0  01:22          3.61
J1                  JUNCTION         1.08       1.44     334.44    0  00:00          1.10
MH77                JUNCTION         1.62       3.47     336.17    0  01:15          3.46
OF1                 OUTFALL          0.00       0.00     333.00    0  00:00          0.00
OF2                 OUTFALL          1.08       1.08     334.07    0  00:00          1.08
OF3                 OUTFALL          0.00       0.00     333.00    0  00:00          0.00
S4                  STORAGE          1.09       2.16     336.30    0  01:18          2.16
S5                  STORAGE          1.74       2.89     336.25    0  01:24          2.89
S5a                 STORAGE          0.05       0.10     336.25    0  02:24          0.10
S5b                 STORAGE          0.05       0.10     336.25    0  02:24          0.10
S5c                 STORAGE          0.05       0.10     336.25    0  02:24          0.10
S5d                 STORAGE          0.05       0.10     336.25    0  02:24          0.10


*****************
Node Inflow Summary
*****************
-----------------------------------------------------------------------------------------------
                                  Maximum    Maximum                    Lateral      Total
                                  Lateral      Total  Time of Max        Inflow     Inflow
                                   Inflow     Inflow   Occurrence        Volume     Volume
Node                Type              CMS        CMS  days hr:min    10^6 ltr   10^6 ltr
-----------------------------------------------------------------------------------------------
CBMH10              JUNCTION        0.000      7.426    0  01:22            0       24.2
CBMH65              JUNCTION        0.366      7.588    0  01:22        0.515       24.7
CBMH76              JUNCTION        3.668      3.668    0  01:15        4.98        4.98
CBMH83              JUNCTION        0.000      0.064    0  02:27            0       1.18
EXCBMH13            JUNCTION        5.612      5.612    0  01:15        8.77        8.77
EXMH1               JUNCTION        0.000      3.927    0  01:16            0       8.32
EXMH2               JUNCTION        0.000      1.652    0  01:56            0        5.2
EXMH6               JUNCTION        0.000      6.328    0  01:19            0       17.2
EXMH61              JUNCTION        5.140      5.140    0  01:15        8.03        8.05
J1                  JUNCTION        0.000      9.238    0  00:00            0       24.7
MH77                JUNCTION        0.000      3.671    0  01:15            0       5.01
OF1                 OUTFALL         0.449      0.449    0  01:15        0.662       0.662
OF2                 OUTFALL         0.000      9.238    0  00:00            0       24.6
OF3                 OUTFALL         0.152      0.152    0  01:20        0.305       0.305
S4                  STORAGE         0.383      0.383    0  01:15        0.539       0.539
S5                  STORAGE         0.485      0.485    0  01:15        0.823        1.39
S5a                 STORAGE         0.100      0.100    0  01:15        0.137       0.139
S5b                 STORAGE         0.100      0.100    0  01:15        0.137       0.139
S5c                 STORAGE         0.100      0.100    0  01:15        0.137       0.139
S5d                 STORAGE         0.100      0.100    0  01:15        0.137       0.139


**********************
Node Surcharge Summary
```

****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
CBMH83	JUNCTION	3.74	1.662	0.000
EXCBMH13	JUNCTION	0.28	0.480	0.000
EXMH1	JUNCTION	0.73	0.913	0.000
EXMH2	JUNCTION	1.00	2.363	0.000
EXMH6	JUNCTION	0.62	0.638	0.000
EXMH61	JUNCTION	0.68	0.956	0.000
MH77	JUNCTION	0.45	0.619	0.831

****
Node Flooding Summary
****

Flooding refers to all water that overflows a node, whether it ponds or not.

Node	Hours Flooded	Maximum Rate CMS	Time of Max Occurrence days hr:min	Total Flood Volume 10^6 ltr	Maximum Ponded Depth Meters
CBMH83	1.25	0.033	0 01:15	0.008	0.077
EXCBMH13	0.28	1.686	0 01:15	0.376	0.480
EXMH1	0.71	1.959	0 01:15	1.008	0.913
EXMH2	0.86	0.345	0 01:07	0.166	1.413
EXMH6	0.62	2.752	0 01:15	1.521	0.638
EXMH61	0.68	1.502	0 01:15	0.479	0.956

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
S4	0.025	20	0	0	0.127	98	0 01:18	0.287
S5	0.075	15	0	0	0.285	58	0 01:24	0.280
S5a	0.057	29	0	0	0.121	60	0 02:24	0.005
S5b	0.057	29	0	0	0.121	60	0 02:24	0.005
S5c	0.057	29	0	0	0.121	60	0 02:24	0.005
S5d	0.057	29	0	0	0.121	60	0 02:24	0.005

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	53.51	0.063	0.449	0.662
OF2	99.99	1.214	9.238	24.633
OF3	55.09	0.028	0.152	0.305
System	69.53	1.306	9.238	25.601

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	5.649	0 01:36	4.71	31.73	1.00
C10	CONDUIT	3.671	0 01:15	4.24	1.10	1.00
C11	CONDUIT	3.672	0 01:15	4.24	1.55	1.00
C12	CHANNEL	1.993	0 01:27	1.45	1.17	1.00
C13	CONDUIT	1.773	0 01:56	2.79	1.54	1.00
C14	CONDUIT	1.652	0 01:56	2.60	0.68	1.00
C15	CONDUIT	1.422	0 01:16	2.23	1.34	1.00
C16	CONDUIT	0.610	0 01:59	3.11	1.22	1.00
C17	CHANNEL	3.596	0 01:17	2.61	1.02	1.00
C18	CHANNEL	2.505	0 01:16	1.82	1.69	1.00
C19	CHANNEL	1.588	0 01:22	1.15	2.22	1.00
C2	CONDUIT	9.238	0 00:00	2.07	0.18	0.41
C3	CHANNEL	2.585	0 01:23	1.97	0.95	0.97
C4	CONDUIT	7.589	0 01:23	6.33	31.60	1.00
C5	CHANNEL	0.000	0 00:00	0.00	0.00	0.00
C6	CONDUIT	0.052	0 01:14	0.74	0.76	1.00
C7	CONDUIT	3.921	0 01:47	3.47	6.87	1.00
C8	CHANNEL	0.000	0 00:00	0.00	0.00	0.00
OR3	CONDUIT	0.061	0 03:46	0.86	0.89	1.00
OR1	ORIFICE	0.002	0 03:39			
OR10	ORIFICE	0.002	0 03:39			
OR11	ORIFICE	0.002	0 03:39			
OR12	ORIFICE	0.002	0 03:39			
OR13	ORIFICE	0.002	0 03:39			
OR14	ORIFICE	0.002	0 03:39			
OR2	ORIFICE	0.002	0 03:39			
OR4	ORIFICE	0.002	0 03:39			
OR5	ORIFICE	0.002	0 03:39			
OR6	ORIFICE	0.002	0 03:39			
OR7	ORIFICE	0.002	0 03:39			
OR8	ORIFICE	0.002	0 03:39			
OR9	ORIFICE	0.064	0 01:59			1.00
W1	WEIR	0.245	0 01:18			0.32
W2	WEIR	0.001	0 01:24			0.01
W3	WEIR	0.269	0 01:24			0.34

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C10	1.00	0.01	0.00	0.00	0.14	0.01	0.00	0.85	0.01	0.00
C11	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C12	1.00	0.86	0.02	0.00	0.00	0.00	0.12	0.00	0.00	0.00
C13	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C14	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.01	0.00
C15	1.00	0.01	0.00	0.00	0.89	0.00	0.00	0.11	0.24	0.00
C16	1.00	0.00	0.00	0.00	0.92	0.07	0.00	0.00	0.92	0.00
C17	1.00	0.81	0.00	0.00	0.04	0.09	0.00	0.06	0.02	0.00
C18	1.00	0.84	0.00	0.00	0.10	0.05	0.00	0.01	0.87	0.00
C19	1.00	0.84	0.00	0.00	0.08	0.05	0.02	0.00	0.00	0.00
C2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C3	1.00	0.92	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00
C4	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C5	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C6	1.00	0.01	0.00	0.00	0.51	0.00	0.00	0.48	0.01	0.00
C7	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
C8	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OR3	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Upstream	Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
C1	14.97	14.98	14.98	3.09	4.99
C10	0.17	0.17	0.45	0.03	0.03
C11	0.97	0.97	4.59	0.13	0.13
C12	0.01	0.01	13.78	0.19	0.01
C13	1.02	1.02	14.90	0.10	0.11
C14	0.92	0.92	1.00	0.01	0.01
C15	0.91	0.91	0.92	0.23	0.23
C16	1.11	1.11	1.35	0.37	0.35
C17	0.28	0.28	0.62	0.07	0.07
C18	0.68	0.68	0.73	0.25	0.26
C19	0.62	0.62	0.73	0.67	0.01
C4	14.98	14.98	14.99	2.96	4.38
C6	3.67	3.67	3.74	0.01	0.01
C7	1.09	1.23	1.09	1.59	1.07
OR3	14.94	14.94	14.96	0.01	0.01

Analysis begun on: Wed May 26 10:27:34 2021
Analysis ended on: Wed May 26 10:27:36 2021
Total elapsed time: 00:00:02

APPENDIX G

Functional Engineering Plans

- Functional Grading Plans
- Functional Servicing Plan

NORTHFIELD DRIVE W.

CONESTOGO PARKWAY

CONESTOGO ROAD

BLOCK 1
PODIUM + TOWER
55 STOREYS

BLOCK 1
PROPOSED 9 STOREY
MIXED USE BUILDING
(OFFICE+RETAIL)

BLOCK 2
PROPOSED 9 STOREY
MIXED USE BUILDING
(OFFICE+RETAIL)

BLOCK 2
PROPOSED 24 STOREY
MIXED USE BUILDING
(RES+RETAIL)

PODIUM
3 STOREYS
(RES)

BLOCK 2
ROOF DECK
COURTYARD

EXISTING GRADE AT THE LIMIT OF 14M SETBACK TO REMAIN UNCHANGED. APPROPRIATE GUARD TO BE PROVIDED AT LIMIT OF DEVELOPMENT

BLOCK 1
PROPOSED 35 STOREY
MIXED USE BUILDING
(RES+RETAIL)

BLOCK 1
PODIUM + TOWER
13 STOREYS

BLOCK 1
ROOF DECK
COURTYARD

BLOCK 4
PODIUM + SLAB
7 STOREYS

BLOCK 4
PROPOSED 22 STOREY
MIXED USE BUILDING
(RES+RETAIL)

BLOCK 4
PODIUM + TOWER
22 STOREYS

BLOCK 3
PROPOSED 9 STOREY
MIXED USE BUILDING
(OFFICE+RETAIL)

BLOCK 3
PROPOSED 22 STOREY
MIXED USE BUILDING
(RES+RETAIL)

GRCA REGIONAL FLOODPLAIN (GIS)

BOREHOLE 201

BLOCK 5
PODIUM + SLAB
7 STOREYS

BLOCK 5
PROPOSED 20 STOREY
MIXED USE BUILDING
(RES+RETAIL)

PODIUM
3 STOREY

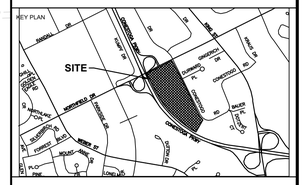
BLOCK 5
PODIUM + TOWER

APPROXIMATE LOCATION OF EXISTING GAS MAIN

331.0

330.5

KEY PLAN



TRUE NORTH PROJECT NORTH

DATE	ISSUANCE	NO.
2021.06.04	ISSUED WITH FSR	

LEGEND

- [123.45] PROPOSED GRADE
- [123.45]EX EXISTING GRADE
- 2.0% 2.0% PROPOSED DRAINAGE ARROW/SLOPE
- PROPOSED SWALE
- PROPOSED SWALE WITH SUBDRAIN
- PROPOSED OVERLAND FLOW ROUTE
- PROPOSED EMBANKMENT (3:1 MAX UNLESS OTHERWISE NOTED)
- PROPOSED CHAINLINK FENCE
- 325.0 EXISTING CONTOUR
- PROPOSED CONCRETE SURFACE
- PROPOSED GRAVEL SURFACE
- PROPOSED RIPRAP
- PROPOSED LIGHT DUTY ASPHALT SURFACE
- PROPOSED HEAVY DUTY ASPHALT SURFACE

CLIENT
NORTHFIELD PROPERTIES LP.
65 NORTHFIELD DR. WATERLOO, ON

PROJECT
FORMER KRAUS
CARPET LANDS
525-565 CONESTOGO RD.

TITLE
GRADING PLAN
SHEET 1 OF 3

WALTERFEDY
KITCHENER HAMILTON 800.685.1378 walterfedy.com

LICENSED PROFESSIONAL ENGINEER
R.J. KHAKHARIA
100225622
June 4, 2021
PROVINCE OF ONTARIO

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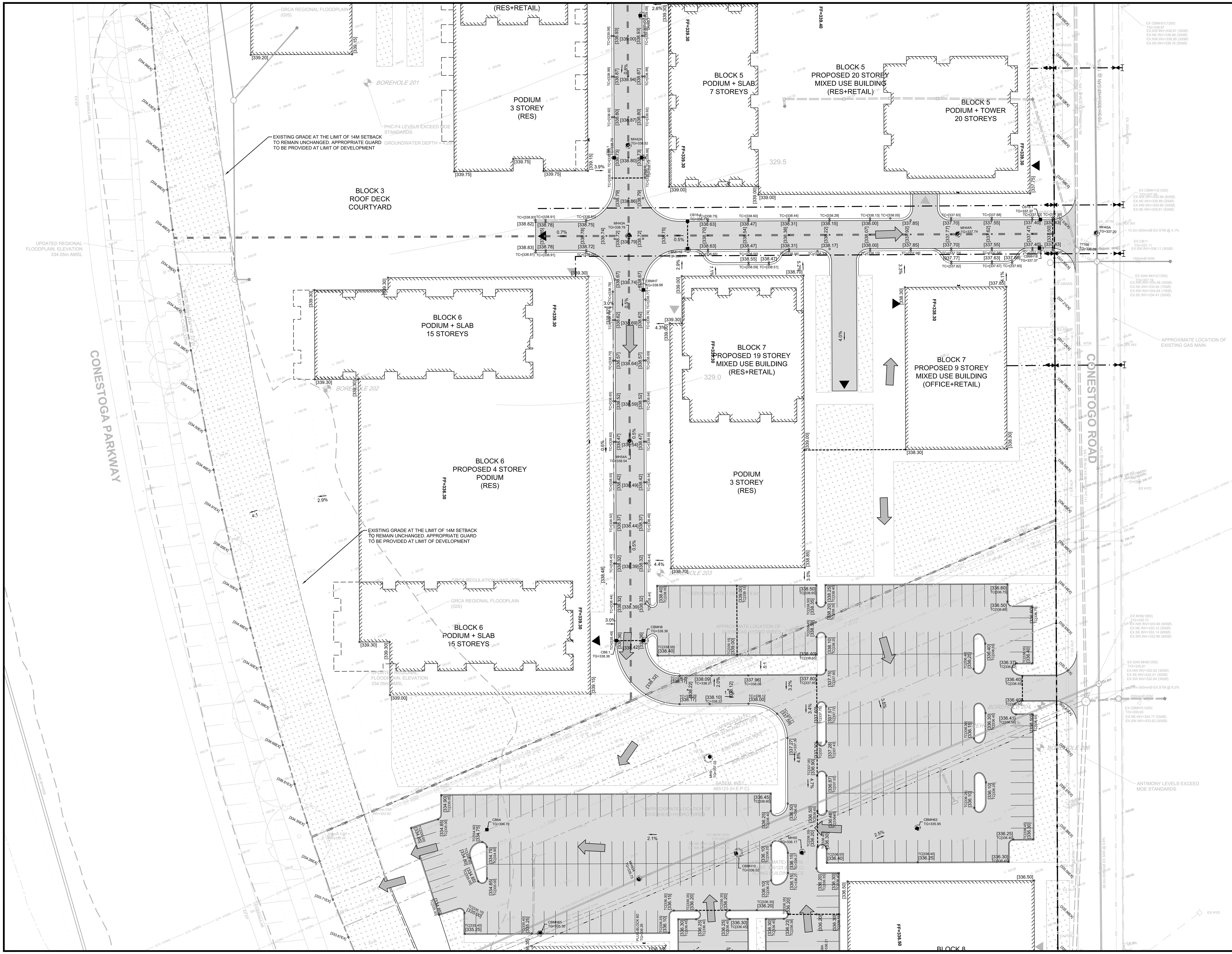

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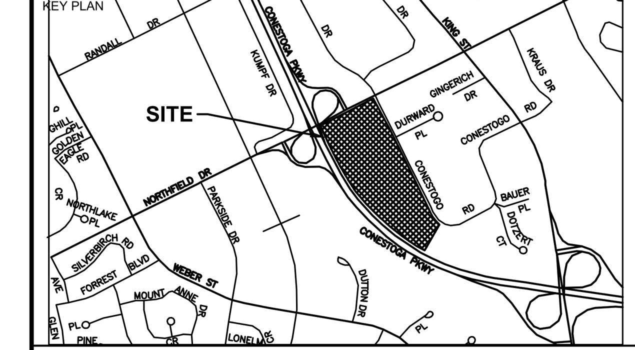

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2021.06.04	ISSUED WITH FSR	

LEGEND

- [123.45] PROPOSED GRADE
- [123.45]EX EXISTING GRADE
- 2.0% 2.0% PROPOSED DRAINAGE ARROW/SLOPE
- PROPOSED SWALE
- PROPOSED SWALE WITH SUBDRAIN
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- PROPOSED EMBANKMENT (3:1 MAX UNLESS OTHERWISE NOTED)
- PROPOSED CHAINLINK FENCE
- 325.0 EXISTING CONTOUR
- PROPOSED CONCRETE SURFACE
- PROPOSED GRAVEL SURFACE
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- PROPOSED LIGHT DUTY ASPHALT SURFACE
- PROPOSED HEAVY DUTY ASPHALT SURFACE

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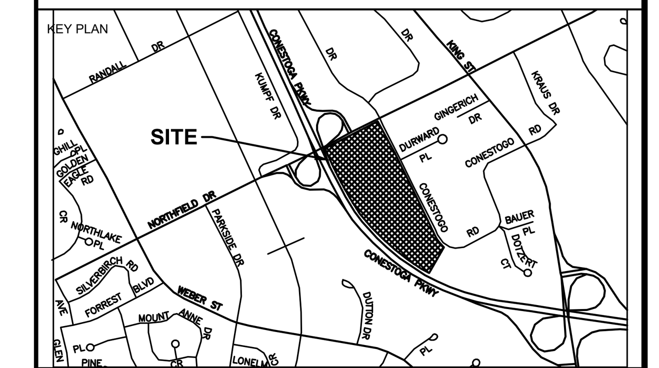

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DATE	ISSUANCE	NO.
2021.06.04	ISSUED WITH FSR	

LEGEND

- [123.45] PROPOSED GRADE
- [123.45]EX EXISTING GRADE
- 2.0% PROPOSED DRAINAGE ARROW/SLOPE
- PROPOSED SWALE
- PROPOSED SWALE WITH SUBDRAIN
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- PROPOSED LIGHT DUTY ASPHALT SURFACE
- PROPOSED HEAVY DUTY ASPHALT SURFACE

CLIENT

NORTHFIELD PROPERTIES LP.

65 NORTHFIELD DR. WATERLOO, ON

PROJECT

FORMER KRAUS CARPET LANDS

525-565 CONESTOGO RD.

TITLE

GRADING PLAN
SHEET 3 OF 3

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June 4, 2021
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DATE	ISSUANCE	NO.

LEGEND

CB	PROPOSED CATCHBASIN
DCB	PROPOSED DOUBLE CATCHBASIN
DICB	PROPOSED DITCH INLET CATCHBASIN
CBMH	PROPOSED CATCHBASIN MANHOLE
DCBMH	PROPOSED DOUBLE CATCHBASIN MANHOLE
MH	PROPOSED STORM MANHOLE
MH	PROPOSED SANITARY MANHOLE
HYD	PROPOSED FIRE HYDRANT
WV	PROPOSED WATERMAIN VALVE
CS	PROPOSED CURB STOP
REDUCER	PROPOSED REDUCER
	PROPOSED FIRE DEPARTMENT CONNECTION
EX CB	EXISTING CATCHBASIN
EX MH	EXISTING STORM MANHOLE
EX CBMH	EXISTING CATCHBASIN MANHOLE
EX DCBMH	EXISTING DOUBLE CATCHBASIN MANHOLE
EX SAN MH	EXISTING SANITARY MANHOLE
EX HYD	EXISTING FIRE HYDRANT
EX WV	EXISTING WATERMAIN VALVE
EX CS	EXISTING CURB STOP
	EXISTING FIRE DEPARTMENT CONNECTION
	PROPOSED SANITARY SEWER/SERVICE
	PROPOSED STORM SEWER/SERVICE
	PROPOSED WATERMAIN/SERVICE
	EXISTING SANITARY SERVICE
	EXISTING STORM SERVICE
	EXISTING WATERMAIN

CLIENT

NORTHFIELD PROPERTIES LP.

65 NORTHFIELD DR. WATERLOO, ON

PROJECT

FORMER KRAUS
CARPET LANDS
525-565 CONESTOGO RD.

TITLE

OVERALL SITE
SERVICING PLAN

WALTERFEDY

KITCHENER HAMILTON 800.685.1378 walterfedy.com

LICENSED PROFESSIONAL ENGINEER
R.J. KHAKHARIA
100225622
June 4, 2021
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CHECKED BY:	RK

SHEET NO.:

C3-0

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