EMPIRE (GRAND NIAGARA) PROJECT GP INC.
WSP FILE 211-08936

8547 GRASSY BROOK ROAD
NIAGARA FALLS, ONTARIO

GRAND NIAGARA
MIXED-USE DEVELOPMENT
FUNCTIONAL SERVICING REPORT

FEBRUARY 03, 2023

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EXECUTIVE SUMMARY

WSP Canada Inc. (WSP) has been retained by Empire (Grand Niagara) Project GP Inc. (the Owner) to prepare a Functional Servicing Report in support of a proposed Draft Plan of Subdivision for the Grand Niagara Mixed-Use Development located in Niagara Falls, Ontario. This report provides the conceptual framework for road networks and grading, water distribution, sanitary sewage, and storm drainage for the site in support of Draft Plan approval and prior to detailed design being undertaken.

The subject property is located at 8547 Grassy Brook, in the city of Niagara Falls, Ontario, and occupies an area of approximately 184.46 hectares (455.80 acres), which is proposed to be developed with this Draft Plan of Subdivision. The site is bounded by Biggar Road to the south, the Welland River to the north, Crowland Road to the West, and the Montrose Road to the east.

The proposed development plan includes detached/semi-detached units (707 units), small lot detached units (184 units), detached units with coach house (128 units), townhouse units (455 units), back-to-back townhouse units (74 units), residential apartment development (1,266 units), medium density development (605 units), mixed-use development (1,968 units), hospital employment development (1.35 ha), stormwater management facility blocks (8.78 ha), bioswale block (0.09 ha), school blocks (5.78 ha), park space (5.23 ha), environmentally protected areas (79.38 ha), road widening blocks (0.49 ha), and rights-of-ways (23.00 ha).

ROADS AND GRADING

The proposed development will be serviced by local residential roads and collector roads. Access to the site will be provided by several connections off the existing Grassy Brook Road, Montrose Road, and Biggar Road. In areas where proposed lots front unto the existing Grassy Brook Road, the existing road shall be urbanized to provide adequate pedestrian and driveway access to the proposed lots. Three new creek crossings for roads are proposed within the development. Please refer to the Floodplain Mapping Study report, dated February 03, 2023, by WSP for further details regarding the proposed creek crossings.

All existing grades will be maintained along the perimeter of the property. Where subdivision roads connect to the wider existing network, proposed road grades will match into the elevations of the existing roadways. The proposed preliminary elevations are designed to comply with the criteria set out in City of Niagara Falls Engineering Design Guidelines Manual, minimize earth moving (cutting and filling) for road and lot construction, while providing adequate cover for underground services. It is expected that the existing groundwater table will have no major impact on the proposed development. Initial groundwater findings were based on borehole data and are subject to seasonal variations. Refer to the Preliminary Geotechnical Investigation Report Proposed Grand Niagara Subdivision (March 22, 2021, GeoTerre) for further details.

Road elevations will be set to direct the major storm to outlet into the appropriate watercourse. Roads will be designed with a minimum grade of 0.5% and a maximum grade of 6.0%. The minimum net grade over the length of the proposed roads is 0.3% with high points overtopping at a depth of a maximum ponding elevation of 0.15m while maintaining the overland flow towards the SWM facilities as designed.

STORM SERVICING

The proposed Grand Niagara Property Mixed-Use Development is within the Niagara Peninsula Conservation Authority (NPCA) jurisdiction and the Welland River watershed. Welland River runs adjacent to the site along its north boundary, and Grassy Brook Creek and Lyons Creek run through the site. All three watercourses drain from west to east. Grassy Brook Creek and Lyons Creek eventually converge with Welland River further downstream, beyond the subject property limits. Existing surface runoff from the site drains to one of the three nearby watercourses, ultimately outletting to the Niagara River via Welland River. Additionally, the site has several non-regulated ponds which were created as landscaping features for the existing golf course.

Storm sewers will be designed to convey the runoff resulting from a 5-year return period storm event. A small portion of the site, adjacent to the future South Niagara Hospital, shall drain to the already designed storm sewer system, by Parsons Corporation, and outlet to Lyon's Creek. The Stormwater Management Plan for the Grand Niagara Secondary Plan (WSP, 2016) concludes that quantity control under the major storm event is not recommended for the proposed development. The major storms above the 5-year return period event will be directed via site grading to public rights-of-way, which in turn will be conveyed overland and outlet to the appropriate nearby watercourses. Refer to the Stormwater Management Report under separate cover (WSP, February 2023) for more details.

Following recommendations of the 2023 hydrogeological report by Terra-Dynamics, it is proposed to direct clean water drainage to various wetland locations within the site. Where possible, this requirement shall be satisfied through lot-level grading. Where lot-level grading alone cannot satisfy the water balance requirements, a third pipe system is proposed to convey clean roof-top drainage to the aforementioned wetland areas. Refer to the Functional Servicing Plan SS1 found in Appendix F for the location of the clean water pipe system.

WATER SERVICING

The water distribution system for the development will be supplied from the existing 300 mm diameter watermain on Grassy Brook Road within the site, and the existing 300 mm watermain on Montrose Road. The existing watermain connection to Chippawa Creek Road, passing under the Welland River shall be maintained. Proposed subdivision watermains on Street HH and Biggar Road shall be logical extension of the infrastructure already designed by Parsons, as part of a wider Regional project. Internal to the site, a network of watermains will follow the road layout to provide a looped system to all areas of the proposed development.

A network of watermains will generally follow the road layout to provide a looped system to all areas of the proposed development. Pipe sizing proposed for the site varies, however the minimum pipe size used throughout the site will be 150 mm per City standard.

A new Niagara Falls South elevated tank has been proposed within the vicinity of the subject lands as part of Niagara Region's Water & Wastewater Master Servicing Plan Update in 2016. The timeline of this future planned system upgrade is unknown; thus, its benefits have not been considered in the servicing strategy of the proposed development.

The Niagara Region W&WWMSP provides details regarding the projected 2041 water demands and the associated model information. Based on modelling results, which accounted for the proposed Grand Niagara development, the existing Niagara Falls WTP and reservoir have sufficient capacities to service the future anticipated demand in the NF1 pressure zone.

Additionally, WSP has concluded, based on independent water modelling, that there is adequate minimum pressure and fire protection under the full build out condition to support the proposed development.

SANITARY SERVICING

Wastewater from the Grand Niagara property are currently conveyed towards the Grassy Brook Sewage Pumping Station (SPS) on the east end of Grassy Brook, ultimately outletting to the Niagara Falls Wastewater Treatment Plant (WWTP) via a series of additional pumping stations, forcemains, and gravity sewers. Existing sanitary sewers, 200 mm to 375 mm in diameter, convey flows eastwards along Grassy Brook Road. Additionally, existing sanitary sewers adjacent to the site, ranging from 300 mm to 450 mm in diameter, convey flows northwards along Montrose Road. There currently exists no sanitary sewers along Biggar Road.

The Grand Niagara Mixed-Use Development site is proposed to have multiple connections to the municipal sanitary system, as required based on the site grading and layout. Multiple connections to the existing sanitary sewer on Grassy Brook Road, including the replacement of existing shallow sewers will be constructed where required. Extensions of the planned sanitary sewers on Street HH/Reixinger Road and Biggar Road, designed by Parsons, are proposed to connect the subdivision to the existing sanitary sewer on Montrose Road.

The Region W&WWMSP outlines a future South Niagara Falls Wastewater Treatment Plant located at east of the subject site, and a new accompanying South Niagara Falls trunk sewer along Montrose Road. Upon completion of the South Niagara Falls WWTP and Montrose Road sanitary trunk sewer, the Grassy Brook SPS will be eliminated and the flows will be redirected to the new treatment plant by gravity.

Ahead of the completion of the Region planned projects, various interim sanitary solutions are proposed to service the initial phases of the Grand Niagara development. Proposed design alternatives include the implementation of I/I improvements to the local sanitary system. Complete details of the proposed interim sanitary solutions and system I/I improvements are outlined in the Grand Niagara Development: Sanitary Servicing Analysis technical memo (WSP, February 2023), provided in Appendix I.

UTILITIES

An existing local distribution gas main, owned and operated by Enbridge Gas, runs within the subject lands, generally following the existing Grassy Brooks Road. It is proposed to realign the gas main to avoid conflicts with the planned development of the subject lands. Specifics regarding the realignment shall be determined in the detailed design stage, and all required approvals shall be obtained prior to construction.

1 INTRODUCTION

WSP Canada Inc. (WSP) has been retained by Empire (Grand Niagara) Project GP Inc. (the Owner) to prepare this Functional Servicing Report in support of a proposed subdivision located in the city of Niagara Falls, Ontario. This report provides the conceptual framework for water distribution, sanitary sewage, and storm drainage for the site, prior to detailed design being undertaken. Stormwater management strategies are included with this submission under a separate cover. The proposed plan involves the development of a greenfield mixed-use subdivision.

This report has been prepared to accompany the submission for Draft Plan approval of a plan of subdivision, known as Grand Niagara Property Mixed-Use Development (refer to Appendix A for Draft Plan). In preparing this report, we have consulted with the requirements and available information from the City of Niagara Falls (City), the Niagara Peninsula Conservation Authority (NPCA), and the Ministry of Environment, Conservation and Parks (MECP). Specific documentation in which our report is based on includes, but is not limited to:

- The City of Niagara Falls Engineering Design Guidelines Manual, dated April 2016;
- Region of Niagara 2016 Water and Wastewater Master Servicing Plan (W&WWMSP) Update, dated June 2017, by GM BluePlan;
- South Niagara Falls Wastewater Solutions Environmental Study Report for Public Review, dated July 2022, by GM BluePlan;
- Official Plan for the City of Niagara Falls, amended April 2019, by the City of Niagara Falls;
- Preliminary Municipal Servicing Report Grand Niagara Secondary Plan, dated November 2016, by WSP;
- Stormwater Management Plan Grand Niagara Secondary Plan, dated November 2016, by WSP
- Stormwater Management Report for Grand Niagara Subdivision, dated February 03, 2023, by WSP;
- Grand Niagara Residential Development Floodplain Mapping Study, dated February 03, 2023, by WSP;
- Technical Memo titled “Grand Niagara Development: Sanitary Servicing Analysis”, dated February 03, 2023, by WSP;
- Preliminary Geotechnical Investigation Report Proposed Grand Niagara Subdivision, dated March 22, 2021, by GeoTerre;
- Preliminary Hydrogeologic Assessment and Water Balance Study, dated January 11, 2023, by Terra-Dynamics Consulting Inc.;
- Engineering Drawings for Niagara Region Contract #2021-T-269 Road Reconstruction and Widening, dated March 2022, by Parsons Corporation

- Record drawings:
    - Grassy Brook Road As-Constructed Plan/Profiles
    - Montrose Road As- Constructed Plan/Profiles
    - Grassy Brook Sewage Pumping Station As-Constructed Site Plan/SCADA Drawings
- Niagara Peninsula Conservation Authority standards and regulations;
- Erosion and Sediment Control Guidelines for Urban Construction, dated December 2006, prepared by the Greater Golden Horseshoe Area Conservation Authorities
- MECP Stormwater Management Planning and Design Manual (2003, Updated 2019);
- MECP Design Guidelines for Sewage Works (2008, Updated 2019); and
- MECP Design Guidelines for Drinking-Water Systems (2008, Updated 2019).

This report is intended to provide the functional design framework for the proposed development. All required approvals from the City of Niagara Falls, Niagara Region, the MECP, the NPCA, and all other governing bodies shall be obtained as part of the registration of the subdivision.

1.1 SITE DESCRIPTION

The subject property is located at 8547 Grassy Brook Road in the city of Niagara Falls, Ontario, and occupies an area of approximately 184.47 hectares (455.8 acres). The site is bounded by Biggar Road to the south, the Welland River to the north, Crowland Road to the West, and the Montrose Road to the east. Refer to Figure 1 for the site location plan. The site has the following characteristics:

- Most of the subject lands is currently occupied by a golf course, with some residential and farmed areas along the Grassy Brook Road and Montrose Road frontages;
- A Canadian Pacific (CP) rail corridor runs diagonally through the site;
- Welland River runs along the north border of the site, draining from west to east;
- Grassy Brook Creek and Lyons Creek cut through the site, draining from west to east;
- The site topography is generally flat, sloping from south to north, spanning elevations of approximately 170.0 to 180.0 masl;
- Silty clay materials exist below the surface topsoil/organics/fill, and exhibit a pronounced stronger upper crust layer overlaying weaker material at depth; and
- Measured groundwater elevations range from approximately 2.0 to 3.0 mbgs;

The subject lands are designated for low/medium density residential and mixed-use, as outlined in the City's Official Plan under the Grand Niagara Secondary Plan. The watercourses that run adjacent to and within the subject lands pose critical design factors from a stormwater

management, water balance, and site grading perspective. Complete details on the stormwater management and water balance of the site are provided under a separate cover. Site grading design is reflective of the development limits, set by a combination of wetland, woodland, and floodplain constraints. Encroachment into these environmental zones is avoided where possible, however there exists areas of the site where minor encroachments are necessary. Additionally, preliminary design has aimed to keep housing foundations at least 2.0m above the underside of the upper crust layer, as recommended in GeoTerre's 2021 geotechnical report.

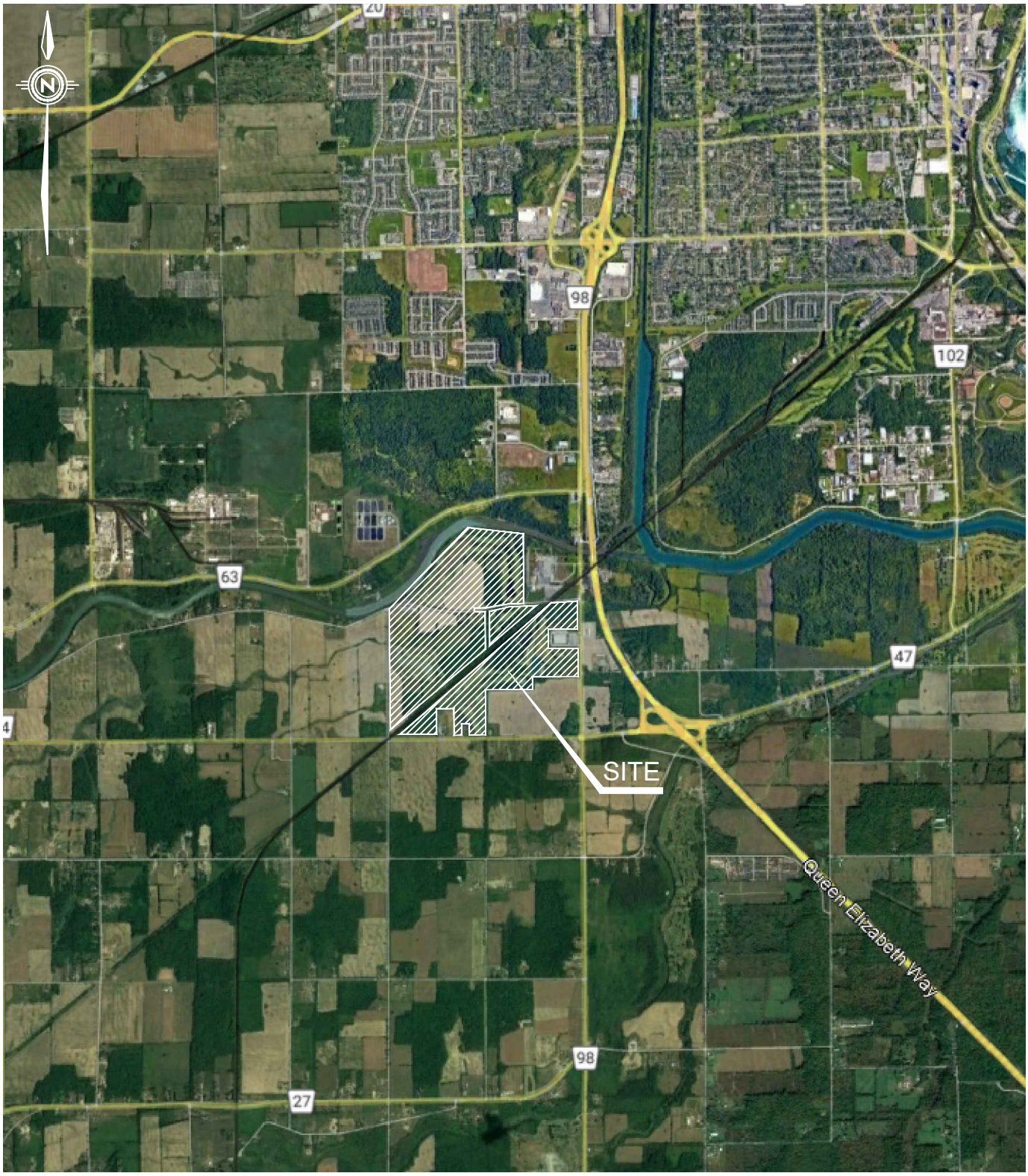
Site elevations in this report and attached engineering drawings are derived from aerial photography compilation. Coordinates are grid and are referenced to UTM17, NAD83.

1.2 DEVELOPMENT PROPOSAL

The Draft Plan of Subdivision is comprised of Part of Lots 1 and 2 Broken Front Concession. The complete Draft Plan is presented in Appendix A. A preliminary phasing plan for the proposed development can be found in Appendix C.

The development has a total area of 184.46 ha which is comprised of mixed-density residential and natural areas, including:

- Detached/Semi-Detached Units - 707 units max.;
- Small Lot Detached Units – 184 units max.;
- Detached Units with Coach House – 128 units max.;
- Townhouse Units - 455 units max.;
- Back-to-back Townhouse Units - 74 units max.;
- Residential Apartment development – 1,266 units max. (8.44 ha.);
- Medium Density development – 605 units max. (8.07 ha);
- Mixed-Use development – 1,968 units max. (9.84 ha);
- Hospital Employment development (1.35 ha);
- Stormwater Management Facility Blocks (8.78 ha);
- Bioswale Block (0.09 ha);
- School Blocks (5.78 ha);
- Park Space (5.23 ha);
- Environmentally Protected Areas (79.38 ha);
- Road Widening Blocks (0.49 ha); and
- Rights-of-ways (23.00 ha).



CLIENT EMPIRE (GRAND NIAGARA) PROJECT GP INC.

TITLE GRAND NIAGARA MIXED-USE SUBDIVISION

LOCATION PLAN

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Checked ADR	Drawn 10/12 Cad
Date FEB 2023	Proj. No. 211-08936
Scale NTS	Figure No. 1

2 ROADS AND GRADING

2.1 EXISTING CONDITIONS

The site is generally flat, sloping from south to north at elevations ranging from 170m to 180m. Per the 2021 preliminary geotechnical report, prepared by GeoTerre, silty clay materials were encountered below the surface topsoil/organics/fill, and exhibited a pronounced stronger upper crust layer overlying weaker material at depth. The geotechnical report recommends that the foundations for all low-rise buildings should be found at least 2m above the underside of the upper crust layer. It is anticipated that a majority of the footing elevations will be 2.0m above the underside of the upper crust layer. For the small portion of the site where this cannot be achieved, soil remediation, specified house grades, or further detailed investigation confirming bearing capacity should be considered at the detailed design stage.

Per the 2023 Preliminary Hydrogeological Assessment and Water Balance Study, prepared by Terra-dynamics, groundwater within the main areas of the proposed development ranges from 1.0 mbgs to 3.0 mbgs. Further details are provided in the 2023 Terra-Dynamics study.

An active CP rail corridor runs diagonally through the site. Based on safety requirements imposed by Canadian Pacific Railway, a 2.5 m high berm is proposed within the buffer blocks adjacent to the existing rail corridor. The berm shall extend along the entire length of the CP rail corridor which borders the subject lands.

2.2 ROAD LAYOUT

As shown in the Draft Plan of Subdivision (Appendix A), the proposed development is serviced by local residential roads and collector roads. Site access will be provided by the following connections:

- Street A at existing Grassy Brook Road;
- Street X at existing Grassy Brook Road;
- Street I at existing Grassy Brook Road;
- Grassy Brook Road extension (Street Q);
- Street A at Biggar Road; and
- Street HH (Reixinger Road Extension) at Montrose Road (Regional Road 98);

Parsons Corporation is responsible for the design of a portion of Street HH (Reixinger Road Extension) as an entrance into the new hospital development property – this is part of Parson's wider Montrose Road project with the Niagara Region. Their design also includes Street KK (future hospital access). A temporary turning circle is provided west of Street KK as part of Parsons' design. The full build out of the proposed development will see the removal of the temporary turning circle provided by Parsons and the complete connection of Street HH to Montrose Road.

A portion of the existing Grassy Brook Road adjacent to the proposed development shall be fully urbanized to provide adequate access and servicing to proposed lots fronting the road. Urbanization shall be per the proposed cross section found in Appendix E.

Road and traffic design will be completed based on the transportation recommendations outlined in the 2017 Niagara Region Transportation Master Plan. Additionally, a Traffic Impact Study has been prepared by WSP under separate cover and submitted concurrently. The conclusions and recommendations of this study shall be incorporated into the detailed design of the proposed development.

2.3 PAVEMENT STRUCTURE

The pavement structure for the proposed subdivision will be in accordance with the geotechnical consultant's recommendations and minimum pavement thickness requirements per the City of Niagara Falls Engineering Design Guidelines Manual - Section 2: Roadways and City Standard Drawings. In some cases, the road compositions outlined in GeoTerre's 2021 report differ from those included in the City guidelines. Generally, roadways shall be constructed to meet City standards, and where geotechnical recommendations are conflicting, the more stringent requirement shall be used. The minimum preliminary pavement structures are as follows:

Road Type	Course	Thickness (mm)
Laneways	Asphalt Surface (HL3)	25
	Asphalt Binder (HL8)	50
	Granular Base (Granular 'A')	100
	Granular Sub-Base (Granular 'B')	200
Local Roads	Asphalt Surface (HL3)	40
	Asphalt Binder (HL8)	80
	Granular Base (Granular 'A')	150
	Granular Sub-Base (Granular 'B')	300
Collector Roads (Geotechnical recommendation is more stringent)	Asphalt Surface (HL3)	40
	Asphalt Binder (HL8)	80
	Granular Base (Granular 'A')	150
	Granular Sub-Base (Granular 'B')	400

2.4 ROADS AND LOT GRADING

Along the perimeter of the property and the natural areas identified within the subject property, the existing grades will be maintained. The proposed preliminary elevations, provided in Appendix D, are designed to minimize the fill import management for road and lot construction, provide adequate cover for underground services, and comply with the City of Niagara Falls Engineering Design Guidelines Manual. Road and lot grading will be designed to convey positive drainage throughout the proposed development.

Road grades will match into the existing elevations on Grassy Brook Road, Biggar Road, and Montrose Road at the limits of the site, with consideration given to potential future roadway urbanization. At development boundaries, finished grades will match existing ground, with the use of 3:1 sloping where required. Proposed sloping is generally contained within the development limits; however, some minor encroaches into environmental buffers or floodplain

limits are proposed due to grading requirements. Furthermore, retaining walls will be avoided and minimized where possible.

Road elevations will be set to direct the major storm to the various proposed stormwater management facilities within the subject lands. Roads will be designed with a minimum longitudinal grade of 0.5% and a maximum grade of 6.0%. In general, the maximum grade proposed is limited to 5.0%. Local low points, with catchbasins as required, will be utilized to achieve positive drainage along the proposed Street A while respecting grading constraints at the site limits. The minimum net grade over the length of the proposed roads is 0.3% with high points overtopping at a depth of a maximum ponding elevation of 0.15m while maintaining the overland flow towards the SWM facilities as designed. Refer to the Functional Site Grading Plan SG1 in Appendix D for details.

2.5 CREEK CROSSINGS

The proposed development plan includes three new creek crossings for roads at the following locations.

- 9.755m x 3.05m open-bottom culvert crossing at Street A over Grassy Brook Creek;
- 8.535m x 3.05m open-bottom culvert crossing at Street A over Lyons Creek; and
- 9.755m x 3.05m open-bottom culvert crossing at Street HH over Lyons Creek

In general, 3:1 sloping shall be used at creek crossings to match into the surrounding existing ground. Where crossings are adjacent to environmentally sensitive areas, wingwalls are proposed to limit the disruptions to the nearby natural areas. Specific regarding the creek crossings shall be determined at the detailed design stages.

Please refer to the Floodplain Mapping Study report, dated February 03, 2023, by WSP for further details regarding the proposed creek crossings.

2.6 RIGHTS-OF-WAY

As shown on the Draft Plan, the proposed development includes laneways with 10.0m right-of-way, local roads with 18.0m and 20.0m right-of-ways, and collector roads with 20.0m, 23.0m, and 26.0m rights-of-ways. The proposed cross-sections for all right-of-way widths, found in Appendix E, generally conform with the details shown in the City of Niagara Falls Standard Drawings.

3 STORM SERVICING

3.1 BACKGROUND & EXISTING DRAINAGE

The proposed development is within the Niagara Peninsula Conservation Authority (NPCA) jurisdiction and the Welland River watershed. Welland River runs adjacent to the site along its north boundary, and Grassy Brook Creek and Lyons Creek run through the site. All three watercourses drain from west to east. Grassy Brook Creek and Lyons Creek eventually converge with Welland River further downstream. Existing surface runoff from the site drains to one of the three watercourses, ultimately outletting to the Niagara River via Welland River. Additionally, the site has several non-regulated ponds that were created as landscaping features for the existing golf course. It is proposed to fill these ponds as they were constructed for aesthetics and golf course irrigation only.

3.2 SWM CRITERIA

Stormwater management (SWM) criteria for the subject lands are required to be consistent with the Ministry of the Environment, Conservation, and Parks (MECP) document Stormwater Management Planning and Design Manual (2003) and the City of Niagara Falls Engineering Design Guidelines Manual.

Effective SWM control is required within the subject lands such that impacts to downstream receiving systems are minimized. As outlined in the 2016 Stormwater Management Plan for the Grand Niagara Secondary Plan area, quantity controls are not recommended for the proposed development. The following summarizes the proposed SWM criteria for the subject lands:

- Erosion Control: Extended detention storage for the 25 mm rainfall event as outlined in the MECP (2003) guidelines; and
- Quality Control: Level I - Enhanced Protection – 80% total suspended solids removed on an annual basis as outlined in the MECP (2003) guidelines.

In addition, the following techniques will be considered when detailing the complete stormwater management approach for the site:

- Lot level techniques and source controls and alternative development standards;
- Transport or conveyance controls; and
- End-of-pipe management techniques.

Furthermore, a wetland recharge program is recommended in the 2022 hydrogeological report by Terra-Dynamics. Where possible, wetland recharge and water balance requirements shall be satisfied through lot-level grading. Specific to the Northwest Welland River Wetland area noted in Section 4.3.1, a third pipe clean water system is proposed on local Street I to convey roof-top drainage to the wetland and satisfy water balance requirements. Refer to the Functional Servicing Plan SS1 found in Appendix F for the location of the clean water pipe system.

3.3 MINOR SYSTEM

Storm sewers will be designed to convey the runoff resulting from a 5-year return period storm event at maximum 80% capacity and will also utilize other design criteria, some of which are outlined in the table below.

	Standards	
a)	Minimum Pipe Diameter	300 mm
b)	Manning's n – concrete, PCV, and HDPE pipes	0.013
c)	Minimum full flow velocity	0.8 m/s
d)	Maximum full flow velocity	6.0 m/s
e)	Minimum cover	1.2 m

The sewers will be located within the municipal rights-of-way and will generally follow the proposed grade of the roads. It is understood that the minimum servicing depth outlined in the City guidelines is 1.80 m, however, due to grading constraints throughout the site, storm sewers are proposed at the minimum cover depth of 1.20 m, resulting in the need of sump pump at all units.

It is proposed to install catchbasins and local storm sewers to capture the minor storm flows along the portion of existing Grassy Brook Road which is being urbanized. Storm sewers for part of Street HH, adjacent to the future South Niagara Hospital, have already been design by Parsons, as part of the Region's Montrose Road project. WSP has confirmed that the Parsons design adequately accounts for the additional segment of Street HH to be constructed with the proposed subdivision. As such, a small portion of the site shall drain to the future planned storm sewers, which ultimately outlets to Lyon's Creek.

To calculate flow, the rational method will be used with a minimum time of concentration of 10 minutes. The sizes of the storm sewer will be confirmed at the detailed design stage. A preliminary design and location of storm sewers are included in the Functional Servicing Plan SS1 found in Appendix F.

3.4 LOT LEVEL STORMWATER CONTROL

Lot level stormwater controls will be designed in accordance with the City of Niagara Falls Engineering Design Guidelines Manual - Section 5: Storm Drainage System, Section 6: Lot Grading & Surface Drainage, and City Standard Drawing NFS-C01. Residential roof water leaders will be discharged to splash pads with flows directed away from the building foundations, and where possible shall discharge to pervious ground surfaces. Along Street I, where the third pipe clean water system is proposed, roof water leaders shall connect to the clean water system directly via a residential service connection. The Functional Servicing Plan SS1 found in Appendix F outlines the applicable lots.

City design criteria indicates that sump pumps may be proposed within the development. Sump pumps are proposed where gravity storm service connections cannot be achieved due to grading constraints.

Refer to the Stormwater Management Report by WSP under separate cover for additional details on the surface water drainage.

3.5 MAJOR SYSTEM

The major storm system is a conveyance system for flows in excess of the minor system flows. As mentioned in the 2016 Stormwater Management Plan Grand Niagara Secondary Plan, quantity control under the major storm event is not recommended for the proposed development. Please refer to the 2016 report for further details.

The major storm will be directed via site grading of lots and roads to the public right-of-way, which in turn will be conveyed to the appropriate watercourse outlet. The major system flow routes consist of roadways, easements, rear yards, and swales. As quantity control is not proposed for any portion of the planned development, the major storm flows shall bypass the proposed SWM facilities and drain directly into the nearby watercourses.

Refer to the Stormwater Management Report (WSP, February 2023) under separate cover for additional details on the major storm system.

3.6 SWM FACILITY

Four SWM facilities (Blocks 135-138) and one bioswale block (Block 150) are proposed within the Draft Plan. The SWM facilities will be designed as a wet pond providing erosion control and quality treatment. Facilities will have a forebay providing quality treatment at the pond inlet and extension detention is provided based on erosion control requirements. SWM Pond 1 & 2 shall outlet to the Welland River, and SWM Ponds 3 & 4 shall outlet to the Grassy Brook Creek. The proposed bioswale shall provide quality treatment and outlet to the Grassy Brook Creek.

SWM facility elevations have been set based on a combination of nearby floodplain water levels and site grading constraints. Refer to the Stormwater Management Report (WSP, February 2023) under separate cover for further information.

3.7 EROSION AND SEDIMENT CONTROL

The erosion and sediment control (ESC) plan for the development will comply with the best management practices outlined in the Erosion and Sediment Control Guidelines for Urban Construction document. Prior to topsoil stripping and rough grading activities, a multi-barrier approach to sediment control including perimeter control, settling control, and filtration control should be implemented, inspected, and maintained for the duration of site construction activity until the site is stabilized. ESC measures include, but are not limited to the following:

- Silt fences along buffer zones, around topsoil and fill stockpiles, and at downhill limits of construction;
- Rock check dams in swales and ditches downstream of the work that direct flow to approved outlets;
- Temporary sediment ponds;
- Catchbasin filters in all catchbasins; and
- Mud mats at construction entrances.

4 WATER SERVICING

The water supply and distribution infrastructure surrounding the subject property is under the jurisdiction of Niagara Region. Water servicing in the region is based on a two-tiered approach. Niagara Region is responsible for the treatment, storage, pumping, and watermains over 300 mm diameter. The City of Niagara Falls is responsible for watermains 300 mm in diameter or less.

4.1 EXISTING WATER SUPPLY

There is only one pressure zone for the city of Niagara Falls, NF1, and the Grand Niagara property falls within this zone. The water supplied to the NF1 area comes from the Niagara Falls Water Treatment Plant (WTP), which is located east of the site and owned by the Region. The treatment plant draws water from the nearby Niagara River and, in addition to the City of Niagara Falls, serves the City of St. Catharines, Niagara-on-the-Lake, and parts of Thorold. The 2016 Water and Wastewater Master Servicing Plan Update, prepared by GM BluePlan, mentions that the treatment plant has a rated capacity of 1,684 L/s (145.5 MLD) and a reservoir with 37.4 MLD of available storage.

Currently, a local 300 mm diameter watermain runs east-west within the subject lands, along Grassy Brook Road. The existing watermain connects to a 300 mm diameter line on Montrose Road to the east and a 300mm diameter line on Chippawa Creek Road to the west. These watermain lines are part of a well-looped distribution network that connects to the 500mm diameter regional watermain on McLeod Road, north of the site. There are no watermains existing on Biggar Road. The Functional Servicing Plan SS1 in Appendix F illustrates the existing water distribution network within, and around, the subject property.

4.1.1 PLANNED REGIONAL WATER DISTRIBUTION IMPROVEMENTS

Various planned water distribution system improvements across Niagara Region are outlined in the 2016 W&WWMSP document. The following improvements were proposed within the vicinity of the subject lands:

- New Niagara Falls South elevated tank (Master Plan ID# W-S-004); and

As the design of the proposed elevated tank is only conceptual at this point, and the timing of the projects is unknown, its potential benefits have not been considered as part of the servicing strategy for the proposed development.

Although not outlined in the 2016 W&WWMSP document, the twinning of the existing watermain line on Montrose Road is planned to occur in anticipation of the planned South Niagara Hospital, to provide redundancy to the water distribution system in the future hospital area. Additionally, City staff have confirmed future plans to install a new 300 mm diameter watermain along Reixinger Road, from Montrose Road to Stanley Avenue. These system improvement will further benefit the proposed development and provide more reliable water supply.

The Niagara Region W&WWMSP provides details regarding the projected 2041 water demands and the associated model information. Based on modelling results, which accounted for the proposed Grand Niagara development, the existing Niagara Falls WTP and reservoir have sufficient capacities to service the future anticipated demand in the NF1 pressure zone.

4.2 PROPOSED WATER DISTRIBUTION

The water distribution system for the development will be supplied from the existing 300 mm diameter watermain on Grassy Brook Road within the site, and the existing 300 mm watermain on Montrose Road. The existing watermain connection to Chippawa Creek Road, passing under the Welland River shall be maintained. A portion of the watermain along Street HH and Biggar Road are to be constructed as part of the Region's wider Montrose Road project, designed by Parsons. The proposed subdivision watermains shall be logical extensions of the already planned infrastructure, designed by Parsons Corporation, on Street HH and Biggar Road.

Internal to the subdivision, a network of watermains will follow the road layout to provide a looped system to all areas of the proposed development. The location of the proposed internal watermains is shown on the Functional Servicing Plan SS1 included in Appendix F and in the Proposed Water Model plan WM1 in Appendix G.

All watermains will be designed per the City of Niagara Falls Engineering Design Guidelines Manual - Section 4: Water Distribution Systems. The minimum pipe size used within the proposed development will be 150mm. Where cul-de-sacs exist, watermain looping will be provided using 50 mm copper loops. All Watermains will be installed at a minimum depth of 1.50 m as per City guidelines and meet AWWA disinfection regulations. Hydrant and valves shall be placed in accordance with the City standards. Exact locations of proposed hydrants and valves will be provided during the detailed design stage.

The City of Niagara Falls Engineering Design Guidelines Manual indicate under normal operating conditions, the maximum operating pressure should not exceed 700 kPa (101.5 psi). Additionally, pressures should not drop below 250 kPa (36.3 psi) under normal operation conditions and should not drop below 149 kPa (21.6 psi) under maximum day plus fire conditions.

4.3 ESTIMATED DEMAND

In accordance with the City of Niagara Falls design criteria, all watermain shall be sized to meet the greater of the following:

- Maximum hourly demand; or
- Maximum daily demand plus fire flow

City of Niagara design guidelines indicate a fire flow rate of 80 L/s is adequate for new systems. The estimated water demands for the development have been calculated based on the City of Niagara Falls Storm and Sanitary Sewer Design Criteria in conjunction with the MECP Design for Drinking Water Systems criteria. The calculations are summarized in the following table.

Equivalent Residential Population	7,295 persons
Equivalent Non-Residential Population	2,880 persons
Total Equivalent Residential Population	**10,150 persons**
Demand Flow Rate	450 L/c/d
Maximum Hourly Demand Factor (Residential)	2.85
Maximum Hourly Demand Factor (Non-Residential)	2.00
Maximum Hourly Demand	**138.05 L/s**
Maximum Daily Demand Factor (Residential)	1.90
Maximum Daily Demand Factor (Non-Residential)	2.00
Maximum Daily Demand	**101.93 L/s**

Note: Refer to Appendix G for complete water demand calculations.

4.4 WATER DISTRIBUTION ANALYSIS

The computer model used to analyze the proposed water distribution system was H2ONET, which is an iterative node balancing type program designed to simulate distribution networks. The model contains the existing and proposed watermains in the vicinity of the Grand Niagara Mixed-Use Development.

The model is based on the HGL of the Lundy's Lane Elevated Reservoir of 249.6m and a skeletonized water supply system using the major transmission watermains between the elevated reservoir and the site. To represent the existing demands within the distribution system, a portion of the peak historic water demand of 53.1 MLD noted in Table 3.C.4 of the Region's 2016 Water and Wastewater Master Servicing Plan was used. It was assumed that one third of the existing demand would occur south of the Lundy's Lane Elevated Tank which meant that one third of the 53.1 MLD demand was applied to 4 Nodes (J12, J14, J26 and J34). The model used the maximum day peaking factor of 1.61 based on the 2016 Water Master Servicing Plan (Table 3.C.4) and a peaking factor of 2.40 for Peak Hour which is a 50% increase on the Maximum Day Demands.

The intent of the water model is to size the watermains to ensure that the proposed distribution system can meet future demands while maintaining adequate residual pressures throughout the entire development.

Maximum Day

As shown in the results in Appendix G under the maximum day flow scenario, the pressures within the Grand Niagara Mixed-Use Development range from 386 kPa to 637 kPa. These pressures are above the City minimum criteria of 275 kPa and below the City's maximum pressure limit of 700 kPa.

Maximum Day plus Fire

For the maximum day plus fire flow scenario, the residual pressures at the required fire flow rates range from 33 kPa to 459 kPa, all above the City's minimum requirement of 140 kPa. The available fire flows within the development range from 130 L/s to 197 L/s, at a residual pressure of 140 kPa.

Peak Hour

As shown in the results, in Appendix G, under the peak hour flow scenario, the pressures within the Grand Niagara Mixed-Use Development range from 349 kPa to 567 kPa. These pressures are above the City criteria of 275 kPa and below the City's maximum of 700 kPa.

It has been concluded that the proposed water distribution system within subject development is adequate to meet the City's design criteria for the peak hour and maximum day plus fire demand scenarios.

5 SANITARY SERVICING

The sanitary servicing infrastructure in the City of Niagara Falls is based on a two-tiered approach. Niagara Region is responsible for the wastewater treatment, trunk sewers, pumping stations, and forcemains. The City of Niagara Falls is responsible for local gravity sewer systems.

5.1 EXISTING SANITARY SEWAGE SYSTEM

Wastewater from the Grand Niagara property is conveyed towards the Grassy Brook Sewage Pumping Station (SPS) on the east end of Grassy Brook, ultimately outletting to the Niagara Falls Wastewater Treatment Plant (WWTP) via a series of additional pumping stations, forcemains, and gravity sewers. The Grassy Brook SPS is equipped with 2 pumps (1 duty and 1 stand-by), with capacity for up to a total of four pumps. The pumping station outlets to a 750 mm gravity sewer on Montrose Road via a 150 mm forcemain under the Welland River. As per the 2016 Niagara Region W&WWMSP Update document, the operational capacity of the Grassy Brook SPS is 20.9 L/s.

Existing sanitary sewers, 200 mm to 375 mm in diameter, convey flows eastwards along Grassy Brook Road. Additionally, existing sanitary sewers adjacent to the site, ranging from 300 mm to 450 mm in diameter, convey flows northwards along Montrose Road. There currently exists no sanitary sewers along Biggar Road. The Functional Servicing Plan SS1 in Appendix F illustrates the existing sanitary infrastructure within, and around, the subject property.

5.1.1 PLANNED REGIONAL SANITARY SYSTEM IMPROVEMENTS

The Niagara Region Water and Wastewater Master Servicing Plan Update outlines several future planned sanitary system improvements for the wider region area, in anticipation of the future growth up to the year 2041, which includes the proposed Grand Niagara development. Below are key planned improvements outlined in the 2016 document that have direct impact on the South Niagara Falls area and the proposed development:

- New South Niagara Falls Wastewater Treatment Plant (Master Plan ID# WW-TP-002); and
- South Side High Lift sewer conveyance to new South Niagara Falls Wastewater Treatment Plant (Master Plan ID# WW-FM-008)

The Region initiated the Schedule C Class Environmental Assessment process for the projects above in April 2019. The South Niagara Falls Wastewater Solutions Environmental Study Report, prepared by GM BluePlan, was released in July 2022 for public review. The report outlines the preliminary details of the proposed South Niagara Falls WWTP and accompanying sanitary trunk sewer:

- New South Niagara Falls Wastewater Treatment Plant located at 6811 Reixinger Road; and
- New South Niagara Falls trunk sewer along Montrose Road

As per Volume 3.11 of the 2022 ESR, the new South Niagara Falls WWTP have a capacity of 60 MLD (694.4 L/s) at full build-out and will be commissioned in two stages:

- Stage 1: Provide 30 MLD of capacity to offload approximately 15 MLD from the existing Niagara Falls WWTP, which services existing South Niagara Falls developments, and to service approximately 15 MLD from new developments areas.
- Stage 2: Provide 60 MLD of capacity to service the full future build-out of the South Niagara Falls area.

Outlined in Volume 2.4 of the ESR, the proposed tunneled sanitary trunk sewer along Montrose Road will range from 1200 mm to 2500 mm in diameter and be at depths of 10 m to 18 m below ground.

Upon completion of the South Niagara Falls WWTP and Montrose Road sanitary trunk sewer, flows from the Grassy Brook SPS will be redirected from the existing Niagara Falls WWTP to the new nearby treatment plant.

5.2 PROPOSED DEVELOPMENT FLOWS

An estimate of the post-development sanitary sewage flows from the site has been calculated. The approximate peak sanitary flows were calculated based the City of Niagara Falls Engineering Design Guidelines Manual - Section 4: Sanitary Drainage Systems and the City of Niagara Falls Storm and Sanitary Sewer Design Criteria. Key design guidelines are mentioned below:

- Equivalent Population Density for R1 & R2 Zoning – 45.5 persons/ha;
- Equivalent Population Density for R3 & R4 Zoning – 96.4 persons/ha;
- Equivalent Population Density for R5F Zoning (Equivalent to R4F) – 355.8 persons/ha;
- Equivalent Population Density for Institutional Zoning – 96.4 persons/ha;
- Equivalent Population Density for General Commercial Zoning – 180.4 persons/ha;
- Proposed Wastewater Generation Rate - 380 L/cap/day;
- Infiltration Allowance for New Installations - 0.18 L/s/ha; and
- Peaking Factor - Harmon Formula.

A sanitary drainage plan has been developed based on the current version of the Draft Plan and breakdown of unit types. The total estimated flow from the Grand Niagara Subdivision development is 147.70 L/s. Refer to Appendix H for the detailed sanitary flow generation

calculations. The sanitary design sheet, and downstream analysis, can be found in Appendix H. As evident in the design sheet, the existing sanitary conveyance infrastructure around the site can adequately accommodate the proposed development flow with no surcharging.

5.3 PROPOSED LOCAL SANITARY SEWER SYSTEM

The Grand Niagara Mixed-Use Development site is proposed to have multiple connections to the municipal sanitary system, as required based on the site grading and layout. Much of the site shall convey flows to the existing sanitary sewer on Grassy Brook Road. A portion of the existing sanitary on Grassy Brook Road is currently installed at shallow depths. It is proposed to excavate the existing sanitary sewers and install new sanitary sewers along this segment of Grassy Brook Road to deepen the overall sanitary system and achieve adequate cover at the extremities of the site.

Sanitary sewers along a portion of Street HH and Biggar Road have already been designed by Parsons Corporation as part of the Niagara Region's Montrose Road project. Subdivision sanitary sewers are proposed to connect to the already planned infrastructure at those roads.

Internal to the site, sanitary servicing is proposed within the municipal right-of-way. All local sanitary sewers will be designed per the MECP Design Guidelines and the City of Niagara Falls Engineering Design Guidelines Manual - Section 4: Sanitary Drainage Systems. The minimum pipe size used in residential areas will be 200 mm. All sanitary sewers shall be installed at a minimum depth of 2.80m below the centreline of the road, as per County standards, ensuring adequate frost cover and servicing depth to the houses.

A preliminary design of the proposed sanitary sewers is included in the Functional Servicing Plan SS1 found in Appendix F.

5.3.1 PROPOSED INTERIM SANITARY SEWER SYSTEM

Based on SCADA data provided to WSP by the Region, a design wet weather flow rate, including extraneous flows, into the existing Grassy Brook SPS was determined to be 11.4 L/s. As discussed in Section 5.1, the pumping station has a capacity of 20.9 L/s, resulting in 9.5 L/s of available capacity.

While it is understood that all remaining capacity in the Grassy Brook SPS is reserved for the future South Niagara Hospital, WSP proposes that the available capacity be allocated to a phased portion of the proposed Grand Niagara development, in the interim condition, prior to the construction of the future hospital.

The following interim alternatives are proposed:

Alternative 1: Limit development such that a maximum peak discharge flowrate of the proposed Grand Niagara Phase 1 development is 9.5 L/s. This alternative would allow flows to directly drain to the Grassy Brook SPS and considers that the hospital is not yet discharging sanitary flows to the Grassy Brook SPS. This design alternative includes implementing I/I improvements and proposes no upgrades to the existing Grassy Brook SPS.

Alternative 2a: Limit development such that a maximum peak discharge flowrate of the proposed Grand Niagara Phase 1 development is 11.1 L/s. This alternative would allow flows to directly drain to the Grassy Brook SPS and considers that the hospital is not yet discharging sanitary flows to the Grassy Brook SPS. This design alternative includes implementing I/I improvements and proposes the addition of an identical pump to the existing Grassy Brook SPS.

Alternative 2b: Limit development such that a maximum peak discharge flowrate of the proposed Grand Niagara Phase 1 development is 32.8 L/s. This alternative would allow flows to directly drain to the Grassy Brook SPS and considers that the hospital is not yet discharging sanitary flows to the Grassy Brook SPS. This design alternative includes implementing I/I improvements and proposes an upgrade to the existing pumps at the Grassy Brook SPS with larger specifications models.

Alternative 3: Limit development such that a maximum peak discharge flowrate of the proposed Grand Niagara Phase 1 development is 32.2 L/s. Installation of a new SPS rated at 19.3 L/s, complete with a primary storage for 4 hours, within the Grand Niagara Area to allow the wastewater flows from Phase 1 to discharge to the Grassy Brook SPS at off-peak times. There is also the suboption of incorporating an additional secondary storage in an earthen basin, pending Region preference. This design alternative includes implementing I/I improvements.

Alternative 4: Limit development such that a maximum peak discharge flowrate of the proposed Grand Niagara Phase 1 development is 31.7 L/s. This alternative would allow flows to directly drain to the Grassy Brook SPS and considers that the hospital is not yet discharging sanitary flows to the Grassy Brook SPS. This design alternative proposes upgrades to the Grassy Brook SPS forcemain to include a new 300 mm diameter forcemain, therefore expanding the capacity to 50.5 L/s with 1 duty pump, or 84.5 L/s with 2 duty pumps.

Alternative 5: Limit development such that a maximum peak discharge flowrate of the proposed Grand Niagara Phase 1 development is 31.7 L/s. This design alternatives proposes the installation of an on-site packaged wastewater treatment plant to treat the sanitary flows and discharging the effluent to the Welland River.

Refer to the technical memo titled “Grand Niagara Development: Sanitary Servicing Analysis”, dated February 03, 2023, by WSP, for further details.

With the completion of the planned South Niagara Falls WWTP and trunk sewer, it is proposed to decommission the temporary Grand Niagara SPS and existing Grassy Brook SPS and connect directly into the new trunk sewer by gravity. Further discussions with the Region are recommended to discuss the timing of planned external system upgrades and the feasibility of the proposed interim sanitary servicing strategy.

6 UTILITIES

Currently, an existing gas distribution main runs through the site, within an easement, generally along the alignment of the existing Grassy Brook Road. The gas main and associated easement are owned by Enbridge Gas.

It is proposed to relocate the existing gas main, to avoid conflicts with the planned elements of the subject development. Through previous correspondences, the Owner has confirmed that Enbridge Gas is open to the proposal of the gas main relocation. The existing gas main, and proposed realignment, are shown in the Functional Servicing Plan SS1 found in Appendix F. Specifics regarding the relocation shall be determined at the detailed design stage, and all necessary approvals shall be obtained prior to construction.

7 STANDARD LIMITATIONS

This report was prepared by WSP Canada Inc. (WSP) for the client in accordance with the agreement between WSP and the client. This report is based on information provided to WSP which has not been independently verified. The disclosure of any information contained in this report is the sole responsibility of the client. The material in this report, accompanying spreadsheets and all information relating to this activity reflect WSP's judgment in light of the information available to us at the time of preparation of this report. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. WSP accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions based on this report.

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

This Standard Limitations statement is considered part of this report.

PREPARED BY

FEB 03 2023

Alessandro D. Raimondo, P.Eng., PMP
Project Manager

Date

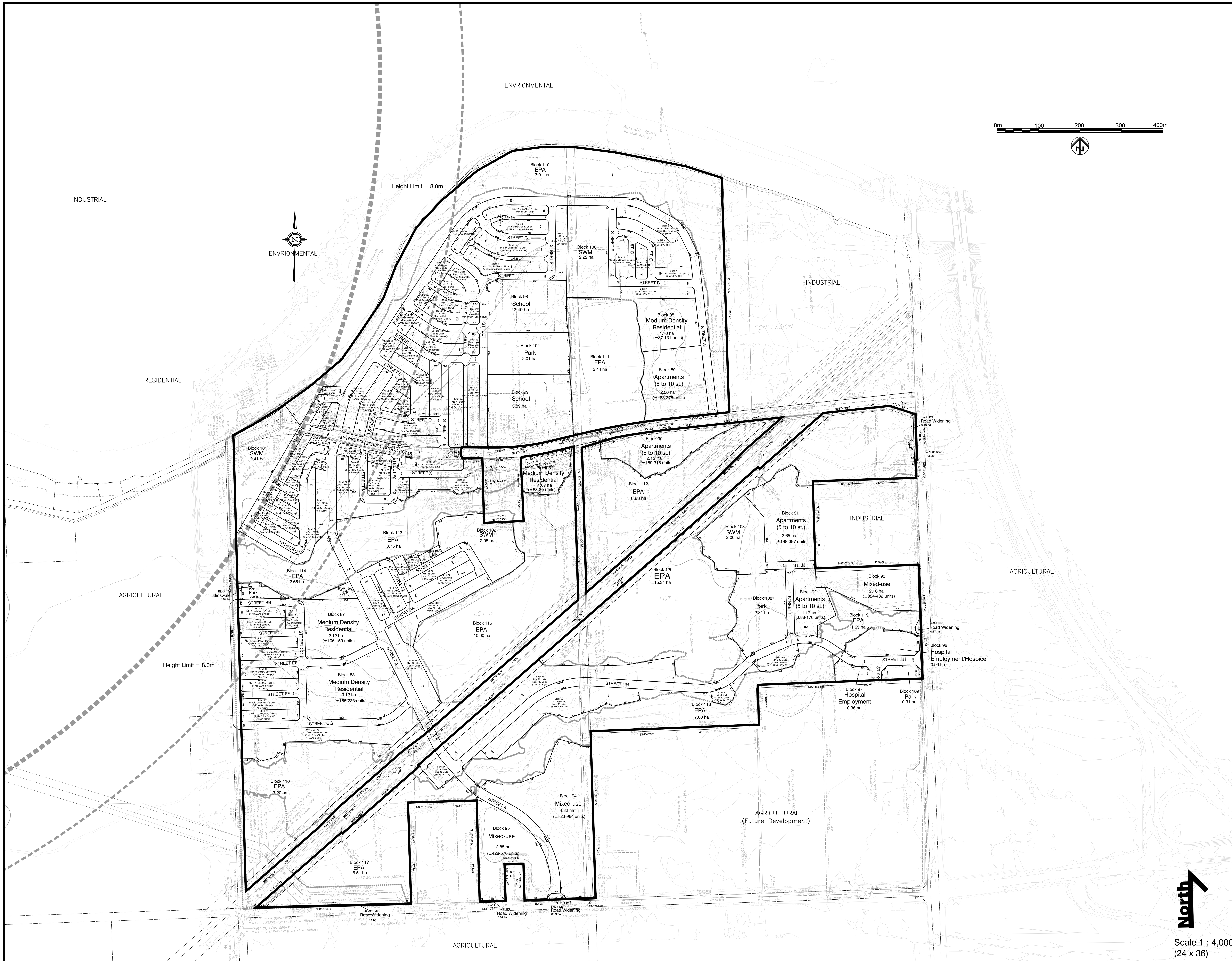
FEB 03 2023

Victor Li, E.I.T.
Designer

Date

APPENDIX

A DRAFT PLAN OF SUBDIVISION

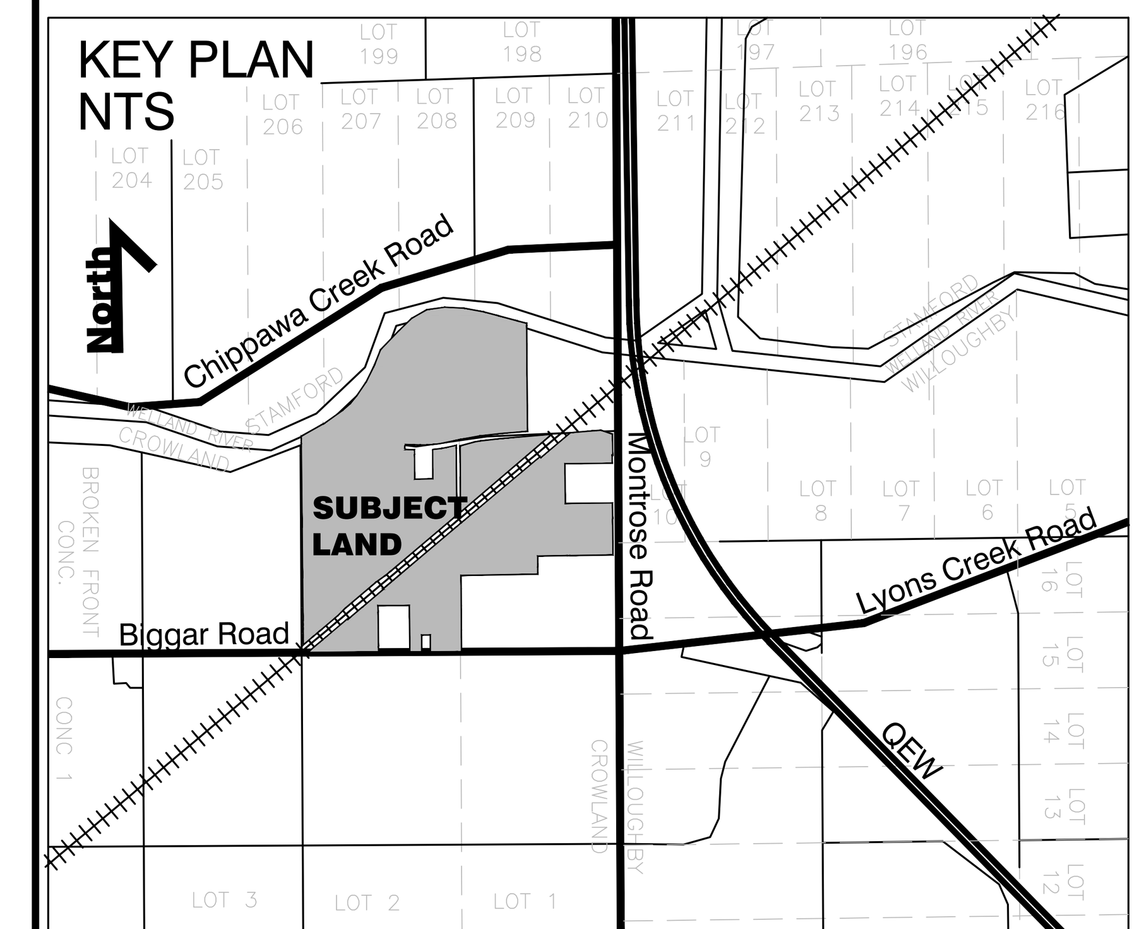


DRAFT PLAN OF SUBDIVISION

FOR PART OF LOTS 1 & 2
BROKEN FRONT CONCESSION
(GEOGRAPHIC TOWNSHIP OF CROWLAND)
REGIONAL MUNICIPALITY OF NIAGARA

January 26, 2023

KEY PLAN
NTS



LAND USE	Block Number	Units	Area (ha)	Area (ac)
Residential Back-to-back, 6.5m x 14.75m	2, 3, 61	57 to 74	0.99	2.5
Residential Townhouse, 4.7m x 28.0m	1, 4, 5, 58, 66, 67 68, 69, 80-84	374 to 455	10.13	25.0
Residential, Detached with coach house, 9.5m x 28.0m	11, 19, 20, 29, 65	50 to 66	1.87	4.6
Residential, Detached with coach house, 9.5m x 36.0m	9, 10, 28, 64	48 to 62	2.21	5.5
Residential Detached, Semi-det. 28.0m	3, 6, 7,13-18, 21-27 30-36, 52-57, 59, 60, 62, 63, 70-79	348 to 678	15.39	38.0
Residential Detached, 28.0m	8, 12	27 to 29	0.62	1.5
Residential Small-lot Detached, 7.0m x 20.0m	37-51	142 to 184	2.81	6.9
Residential Medium Density	85-88	403 to 605*	8.07	19.9
Residential Apartments	89-92	633 to 1,266*	8.44	20.9
Residential Mixed Use	93-95	1476 to 1,968*	9.84	24.3
Subtotal		3,558 to 5,387	60.36	149.2

LAND USE	Block Number	Units	Area (ha)	Area (ac)
Hospital Employment/Hospice	96, 97	-	1.35	3.34
Schools	98, 99	-	5.78	14.3
SWM	100-103	-	8.78	21.7
Parks	104-109	-	5.23	12.9
EPA (Envrionmental Protection Area)	110-120	-	79.38	196.1
Road Widenings	121-125	-	0.49	1.2
Bioswale	126	-	0.09	0.2
Roads	Streets A-NN	-	23.00	56.8
Subtotal		-	124.10	306.7
Subtotal		3,558 to 5,387	60.36	149.2
Total		3,558 to 5,387	184.46	455.8

- - - - Development Limit
▪▪▪▪ 2.0km to Cytec property
- - - - 200m buffer to Cytec 2.0km line
— — 15.0m setback from rail line

* DENSITY RANGE BASED ON 50/75 UPHA FOR MEDIUM, 75/150 UPHA FOR APARTMENT AND 150/200 UPHA FOR MIXED

ADDITIONAL INFORMATION REQUIRED UNDER SECTION 51 (17) OF THE PLANNING ACT, R.S.O., 1990

(a) AS SHOWN ON DRAFT AND KEY PLANS
(b) AS SHOWN ON DRAFT PLAN AS SHOWN ON DRAFT AND KEY PLANS
(c) AS SHOWN ON DRAFT PLAN AS SHOWN ON DRAFT AND KEY PLANS
(d) THE LAND IS TO BE USED ACCORDING TO THE SCHEDULE OF LAND USE
(e) AS SHOWN ON DRAFT AND KEY PLANS
(f) AS SHOWN ON DRAFT PLAN
(g) AS SHOWN ON DRAFT AND KEY PLANS
(h) MUNICIPAL WATER SUPPLY TO BE MADE AVAILABLE
(i) SOIL IS SILTY CLAY
(j) AS SHOWN ON DRAFT PLAN
(k) FULL MUNICIPAL SERVICES TO BE MADE AVAILABLE
(l) SUBJECT TO EASEMENTS AS SHOWN ON THE DRAFT PLAN

Note:
All dimensions on curves are chord lengths unless otherwise indicated.

OWNER'S AUTHORIZATION

I AUTHORIZE WSP CANADA GROUP LTD. TO PREPARE AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION TO THE CITY OF NIAGARA FALLS FOR APPROVAL.

Daniel Guizzetti, President
Empire (Grand Niagara) Project GP Inc.
DATE

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE SUBDIVIDED AS SHOWN ON THIS PLAN AND THEIR RELATIONSHIP TO THE ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN.

Yuriy Bogdanov, Ontario Land Surveyor, OLIP
Geoverra
JAN. 26, 2023
DATE

PLAN PREPARED BY

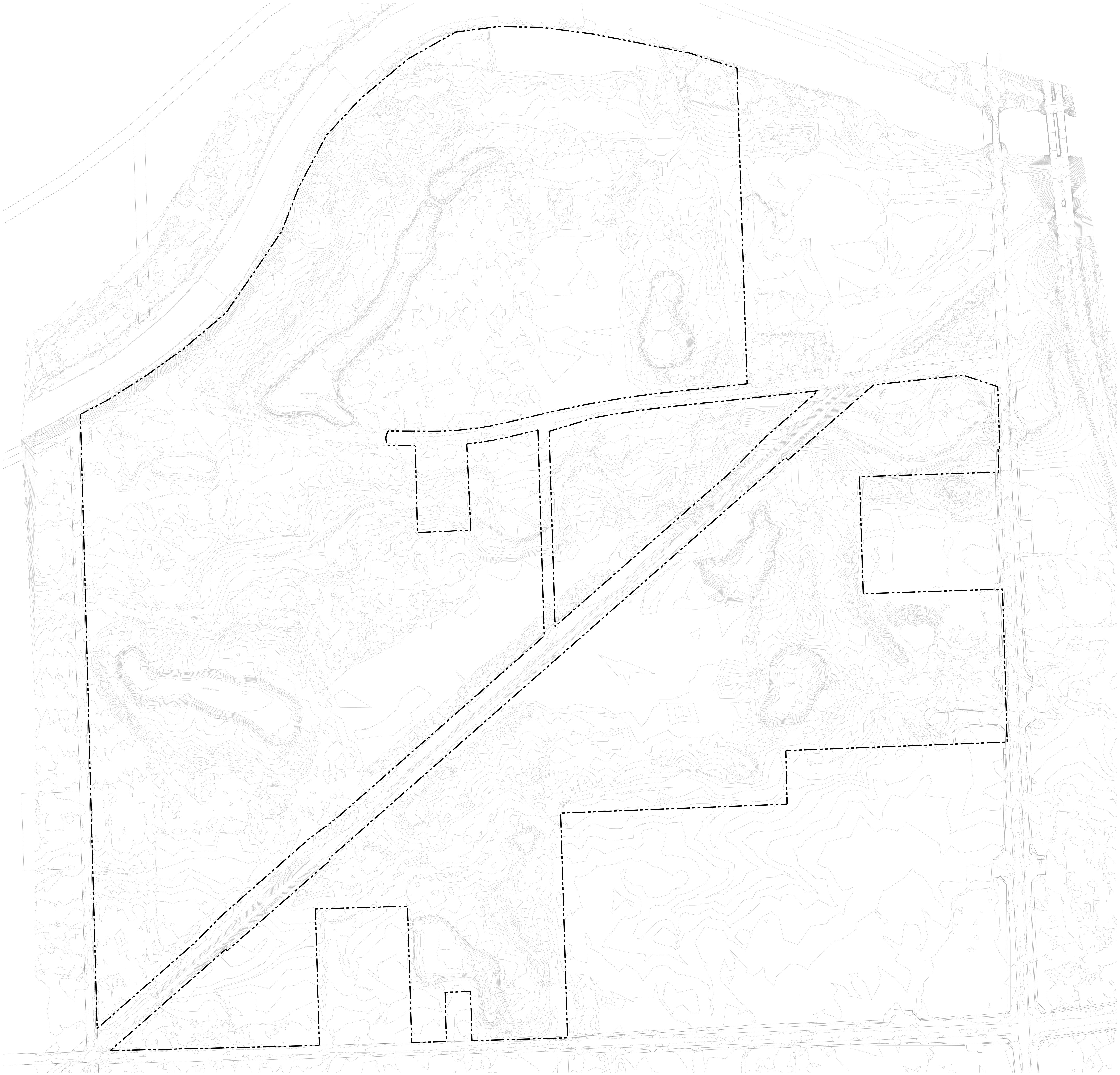
WSP

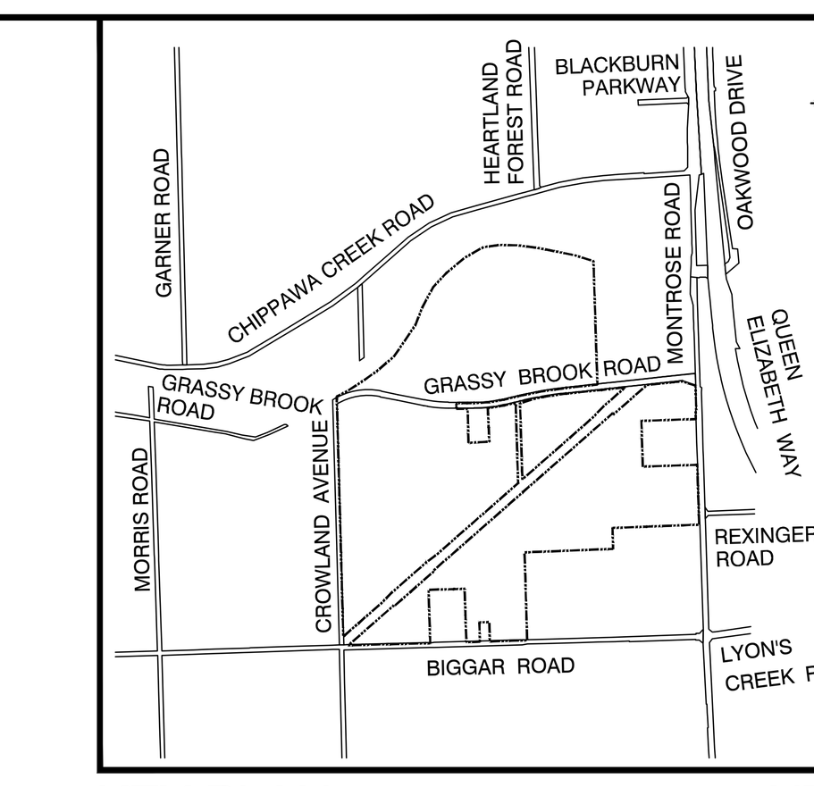
Nathan Hanas, CPT
WSP CANADA GROUP LTD.
JAN. 26, 2023
DATE

211-08936-00-PL2

APPENDIX

B TOPOGRAPHIC SURVEY





KEY PLAN NTS

LEGEND

– – – LIMIT OF PROPERTY

No.	REVISIONS TO DRAWING	BY	DATE	APPR.
1	FIRST DPA SUBMISSION	ZB/VL	2023/02/03	ADR

ALL PREVIOUS ISSUES OF THIS DRAWING ARE SUPERSEDED

CLIENT
EMPIRE (GRAND NIAGARA) PROJECT GP INC.

MUNICIPALITY
CITY OF NIAGARA FALLS

PROJECT TITLE
GRAND NIAGARA MIXED-USE SUBDIVISION

SHEET TITLE
TOPO SURVEY PLAN

CONSULTANT
wsp
100 Commerce Valley Dr. West, Thornhill, ON Canada L3T 0A1
t: 905.882.1100 f: 905.882.0055 www.wsp.com

STAMP

APPROVAL

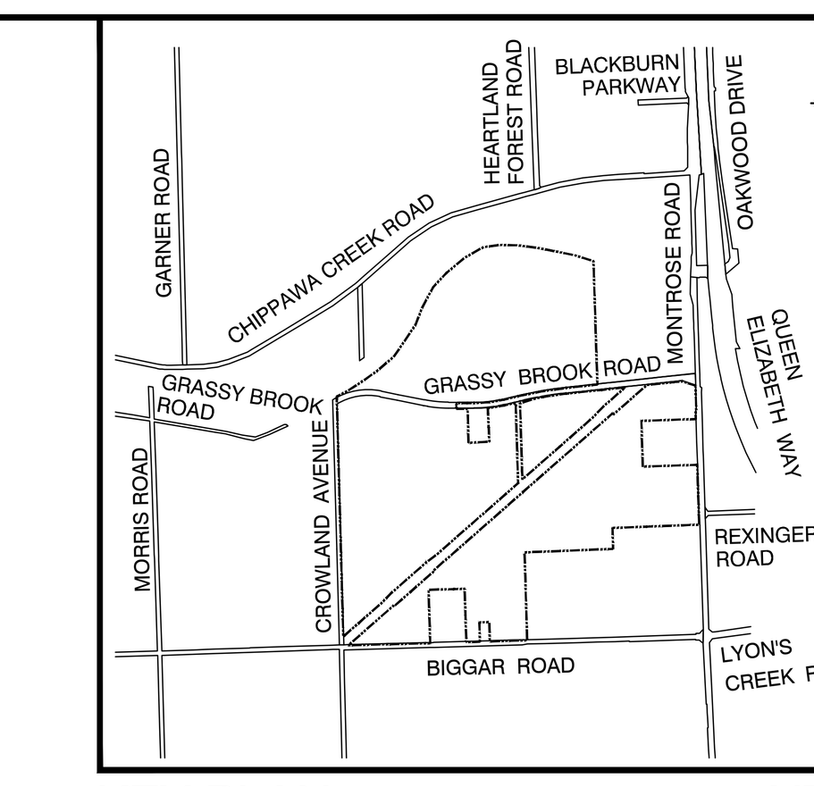
DESIGNED	DRAWN	CHECKED
ZB/VL	ZB/VL	ADR

SCALE	DATE
1:2500	JANUARY 2023

PROJECT NUMBER	DWG. NUMBER
211-08936	TS1

APPENDIX

C PRELIMINARY PHASING PLAN



KEY PLAN NTS

LEGEND

LIMIT OF PROPERTY
LIMIT OF SUBDIVISION
EXISTING FLOODPLAIN
PROPOSED FLOODPLAIN (WHERE APPLICABLE)
PHASE 1 LIMITS
PHASE 2 LIMITS
PHASE 3 LIMITS
PHASE 4 LIMITS

1	FIRST DPA SUBMISSION	ZB/VL	2023/02/03	ADR
No.	REVISIONS TO DRAWING	BY	DATE	APPR.

ALL PREVIOUS ISSUES OF THIS DRAWING ARE SUPERSEDED

CLIENT
EMPIRE (GRAND NIAGARA) PROJECT GP INC.

MUNICIPALITY
CITY OF NIAGARA FALLS

PROJECT TITLE
GRAND NIAGARA MIXED-USE SUBDIVISION

SHEET TITLE
PRELIMINARY PHASING PLAN

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STAMP

APPROVAL

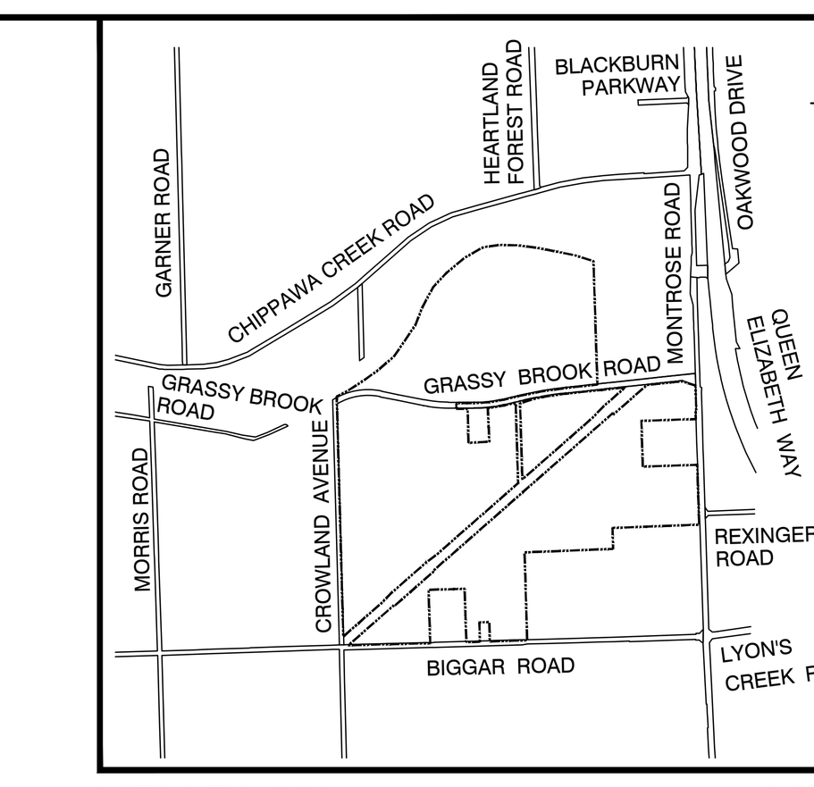
DESIGNED	DRAWN	CHECKED
ZB/VL	ZB/VL	ADR

SCALE	DATE
1:2500	JANUARY 2023

PROJECT NUMBER	DWG. NUMBER
211-08936	SP1

APPENDIX

D FUNCTIONAL GRADING PLAN (SG1)



KEY PLAN NTS

LEGEND

- LIMIT OF PROPERTY
- LIMIT OF SUBDIVISION
- EXISTING FLOODPLAIN
- PROPOSED FLOODPLAIN (WHERE APPLICABLE)
- × EX. 176.34 — EXISTING GRADE
- + 245.50 — PROPOSED GRADE
- 1.0% — PROPOSED SLOPE
- PROPOSED RETAINING WALL
- DIRECTION OF OVERLAND FLOW
- EXISTING GROUND CONTOUR
- PROPOSED 1.0m HIGH BERM
- PROPOSED 2.5m HIGH BERM
- PROPOSED SWALE

NOTE: PLEASE REFER TO THE DESIGN BY PARSONS CORPORATION FOR PORTION OF STREET FF AND STREET NN LABELED AS 'BY OTHERS'.

NOTE: PROPOSED GRADES AND SLOPES ARE CONCEPTUAL ONLY AND ARE SUBJECT TO DETAILED DESIGN

NOTE: 0.3% ROAD SLOPE REPRESENTS SAW-TOOTHING TO BE DETAILED FURTHER AT DETAILED DESIGN

No.	REVISIONS TO DRAWING	BY	DATE	APPR.
1	FIRST DPA SUBMISSION	ZB/VL	2023/02/03	ADR

ALL PREVIOUS ISSUES OF THIS DRAWING ARE SUPERSEDED

CLIENT
EMPIRE (GRAND NIAGARA) PROJECT GP INC.

MUNICIPALITY
CITY OF NIAGARA FALLS

PROJECT TITLE
GRAND NIAGARA MIXED-USE SUBDIVISION

SHEET TITLE
PRELIMINARY GRADING PLAN

CONSULTANT
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t: 905.882.1100 f: 905.882.0055 www.wsp.com

STAMP | APPROVAL

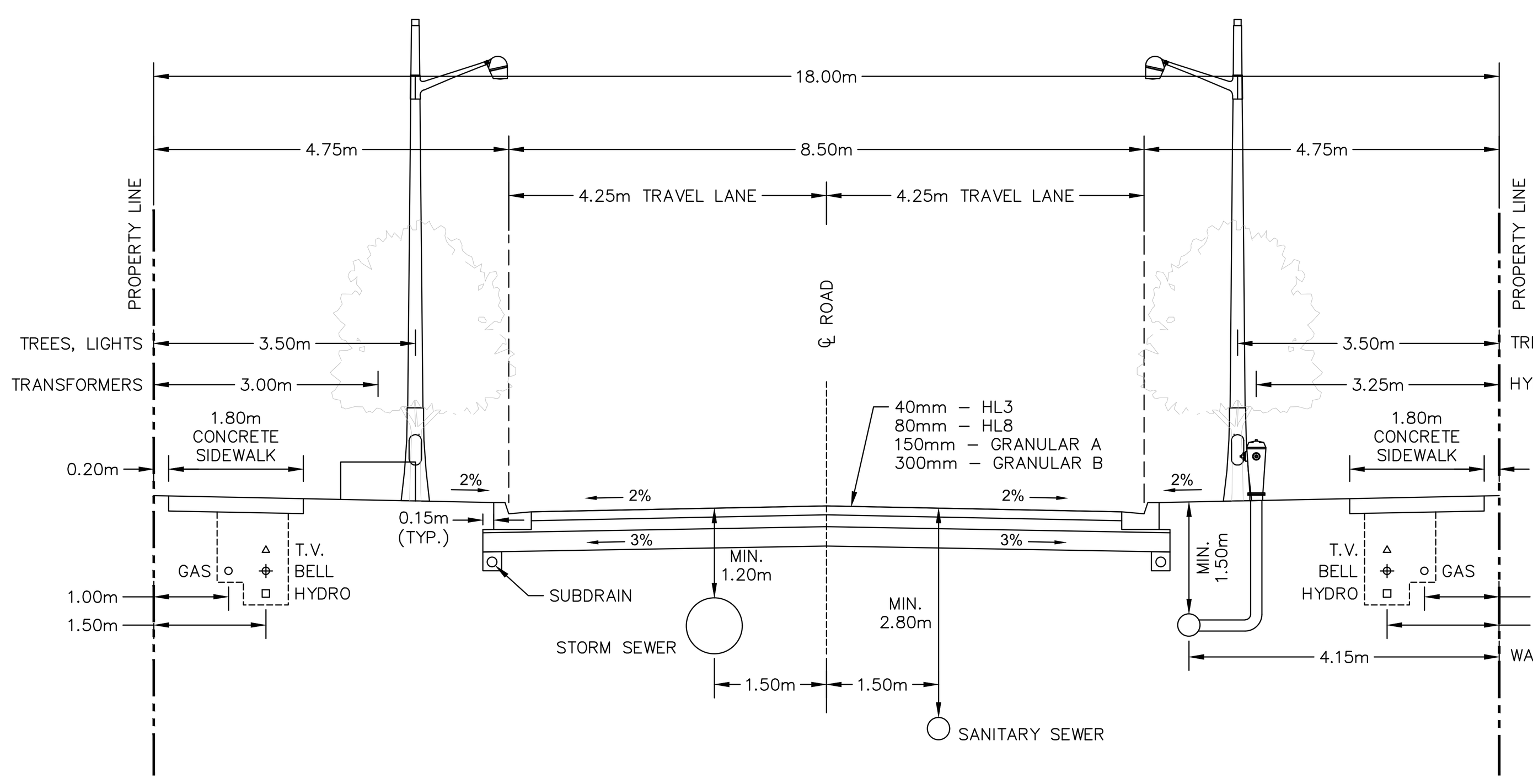
DESIGNED	DRAWN	CHECKED
ZB/VL	ZB/VL	ADR

SCALE	DATE
1:2500	JANUARY 2023

PROJECT NUMBER	DWG. NUMBER
211-08936	SG1

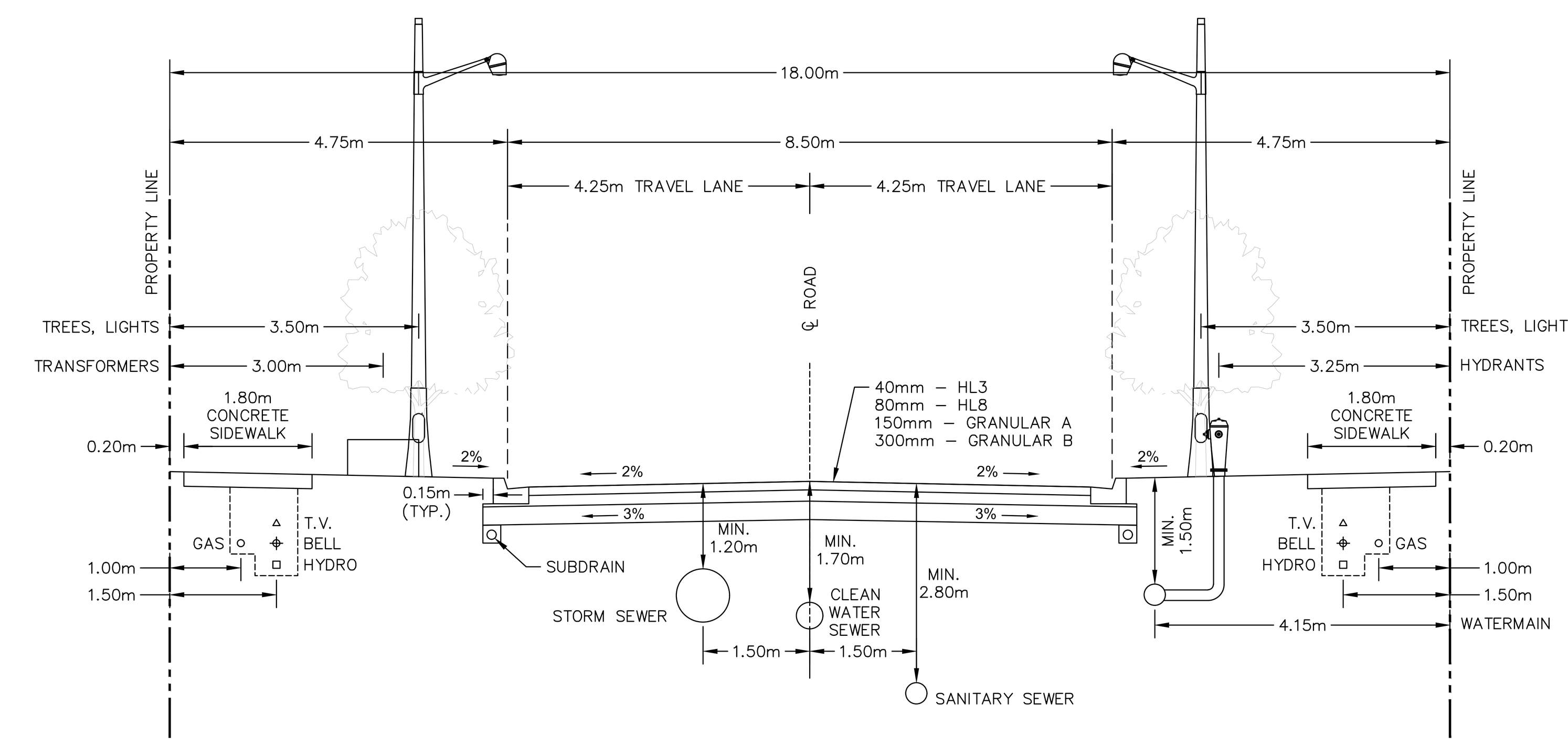
APPENDIX

E CROSS SECTION DETAILS



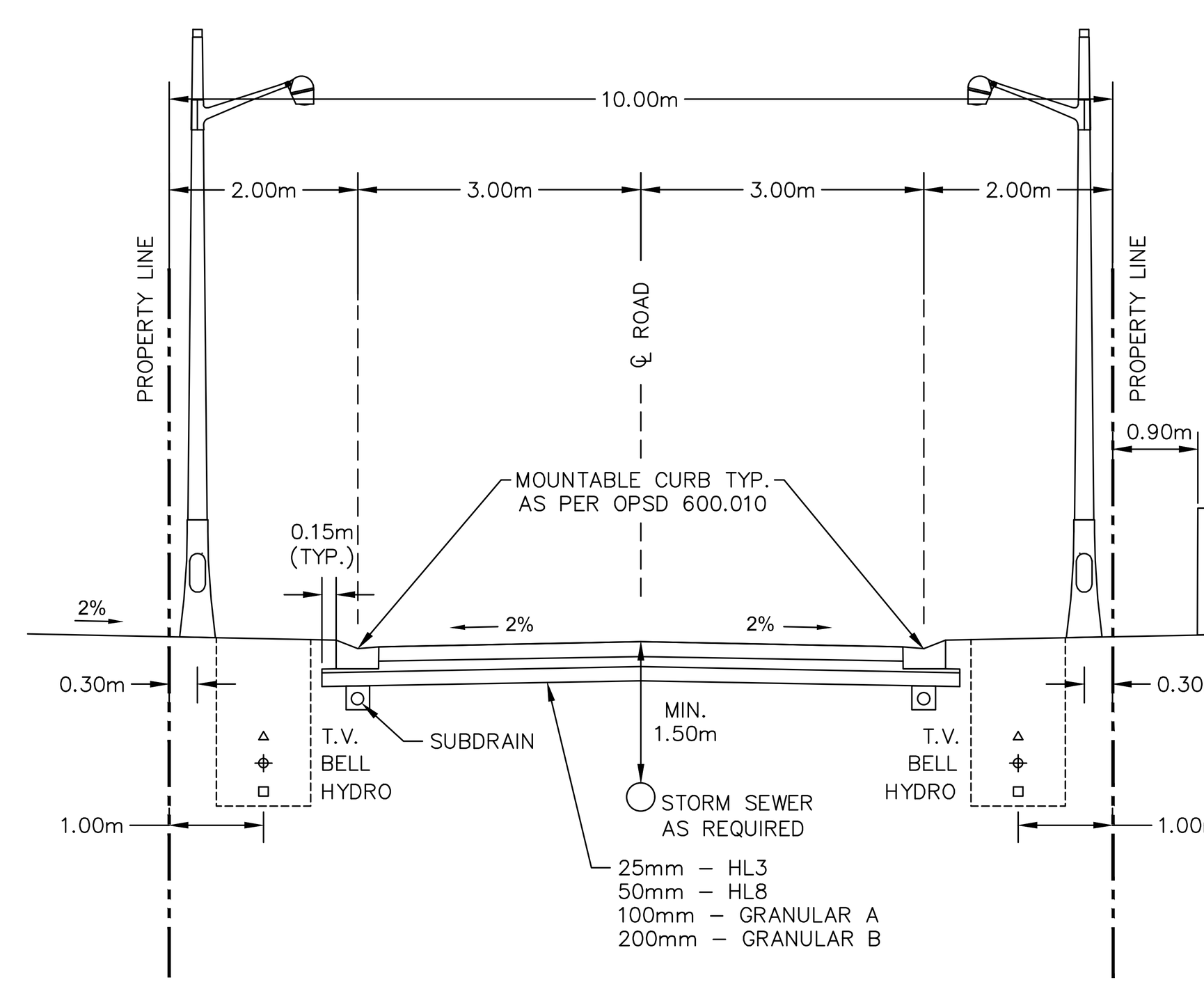
18.0m WIDTH LOCAL ROAD CROSS SECTION

N.T.S.



18.0m WIDTH LOCAL ROAD (STREET I) CROSS SECTION

N.T.S.

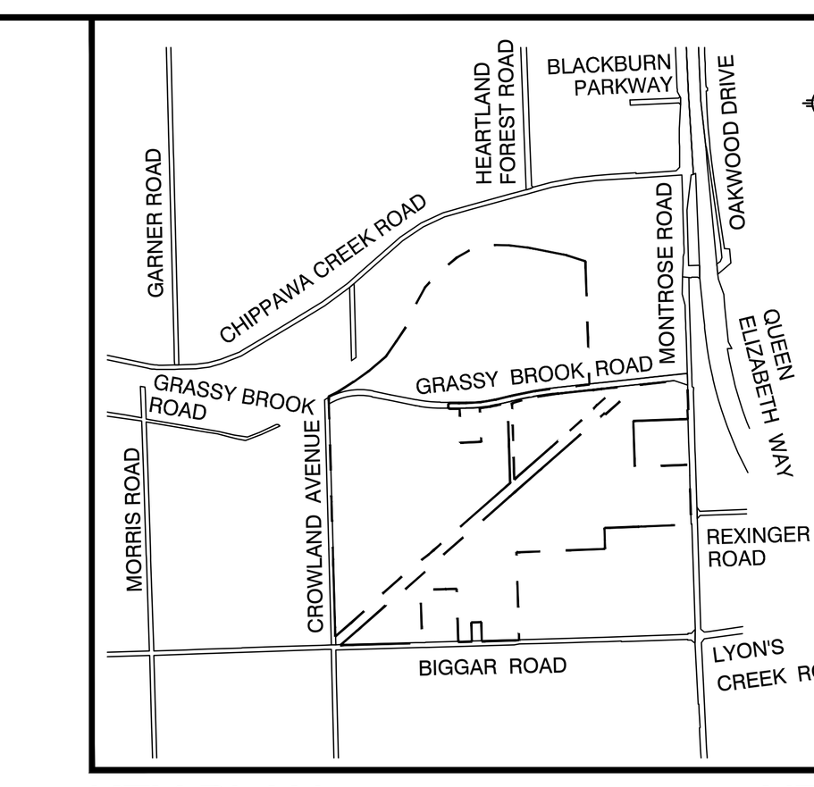


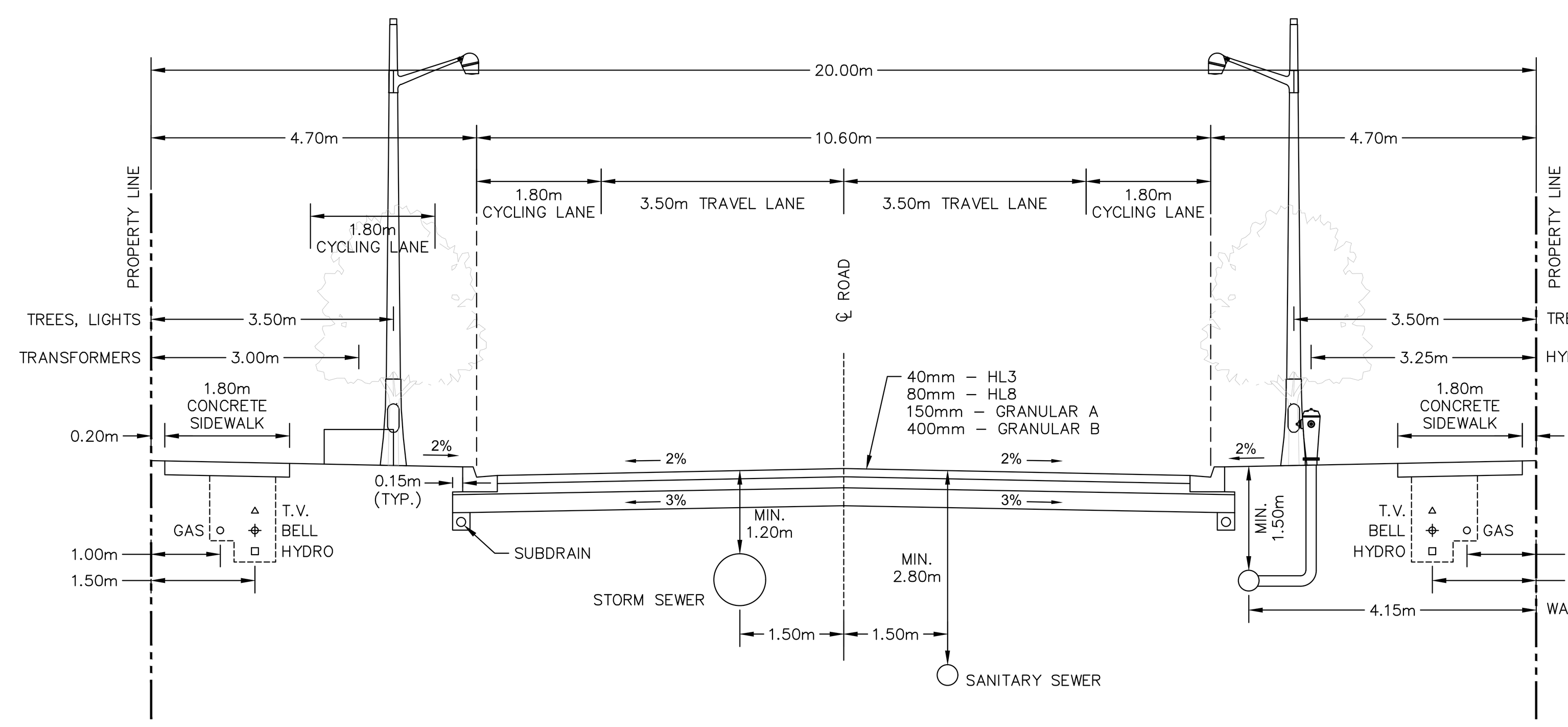
10.0m WIDTH LOCAL LANEWAY CROSS SECTION

N.T.S.

NOTES:

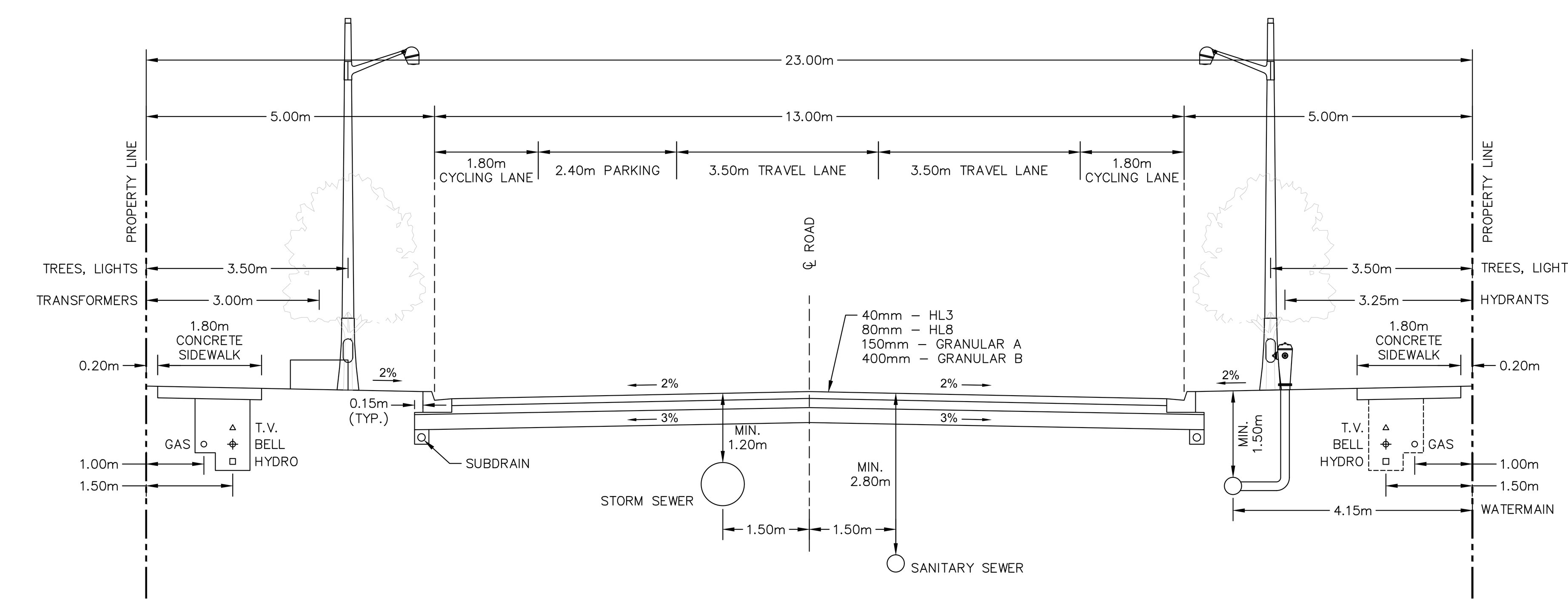
1. LANEWAY R.O.W. TO BE WIDENED PERIODICALLY TO ACCOMMODATE TRANSFORMERS, SWITCH GEARS, UTILITY PEDESTALS AND HYDRANTS WHEN NECESSARY.
2. BELL AND CABLE TV PEDESTALS TO BE INSTALLED WITHIN TRANSFORMER NOTCHES.
3. PUBLIC LANE LIGHTING TO BE PROVIDED.
4. PRIMARY HYRDO TO BE LOCATED OPPOSITE FROM LANE LIGHTS.
5. TYP. MINIMUM DEPTH FOR UTILITY CROSSING SHALL BE 1.0m (TO CLEAR SUB-DRAINS)





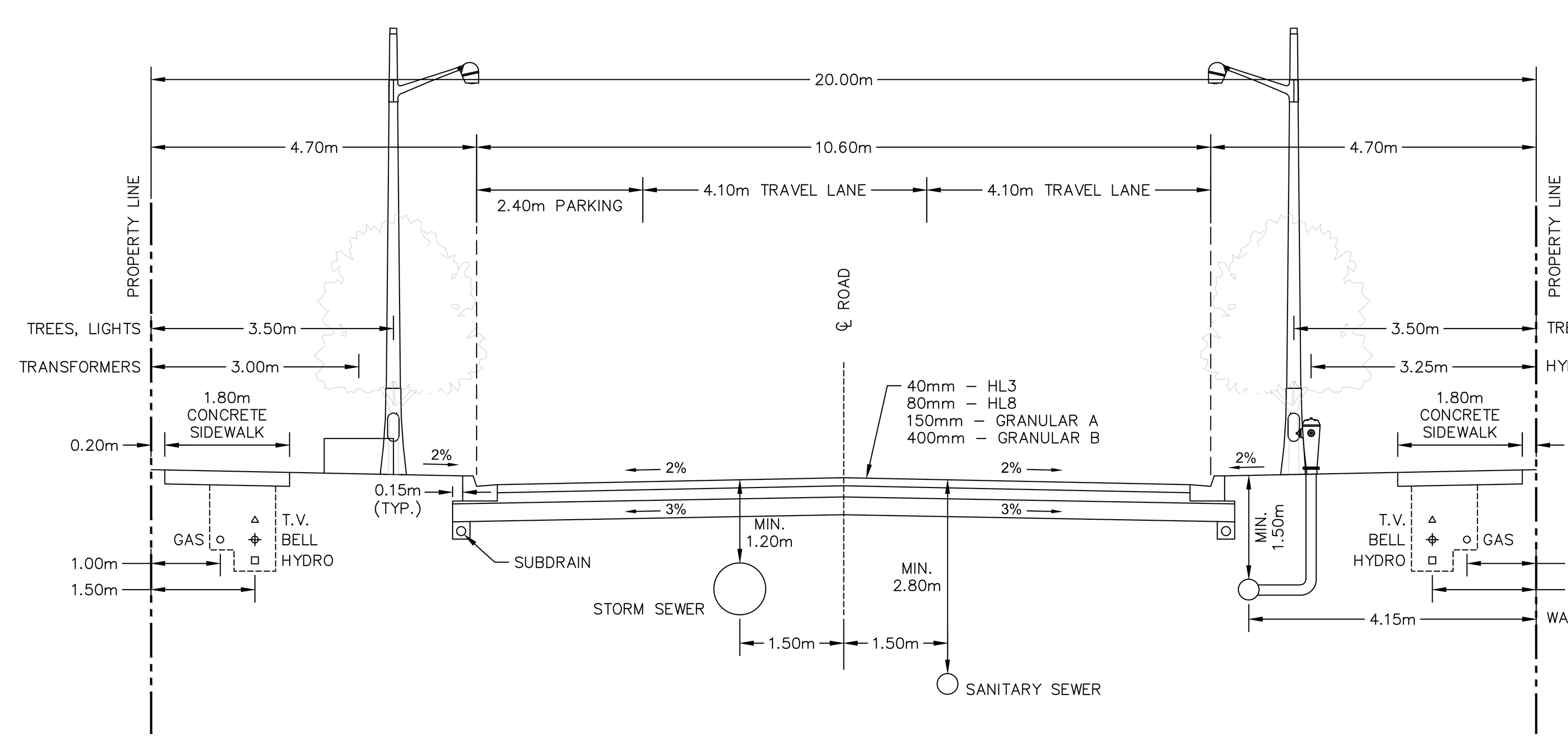
20.0m WIDTH COLLECTOR ROAD CROSS SECTION

N.T.S.



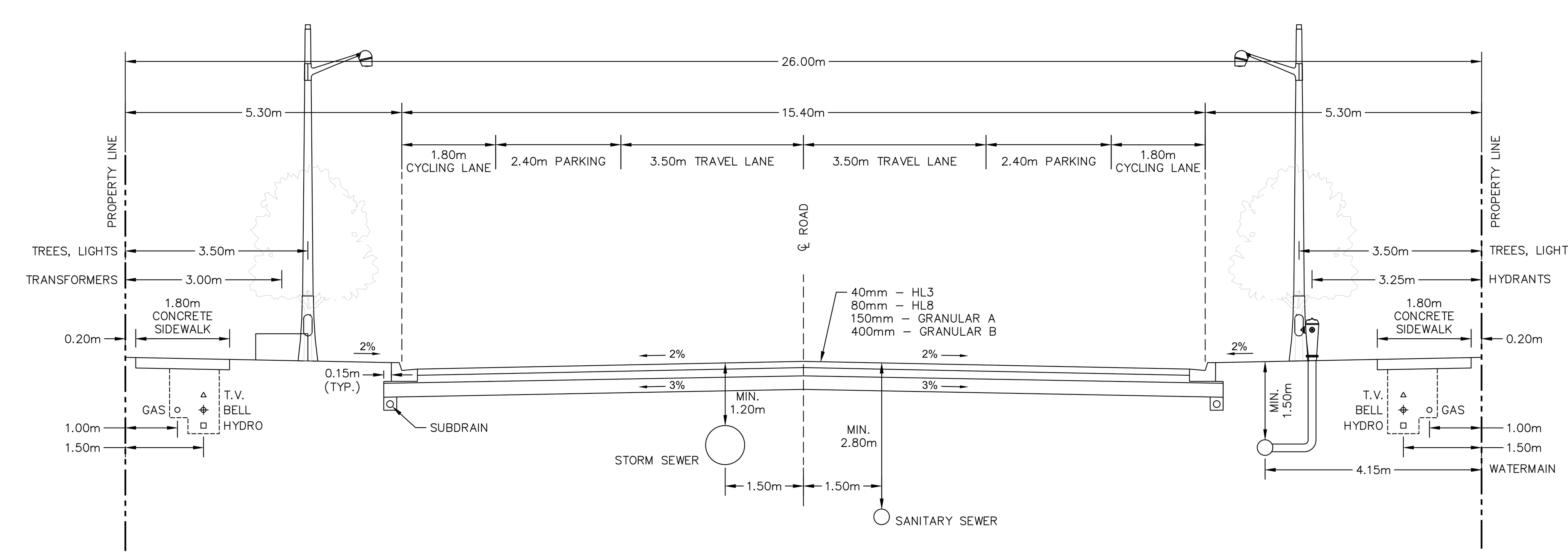
23.0m WIDTH COLLECTOR ROAD CROSS SECTION

N.T.S.



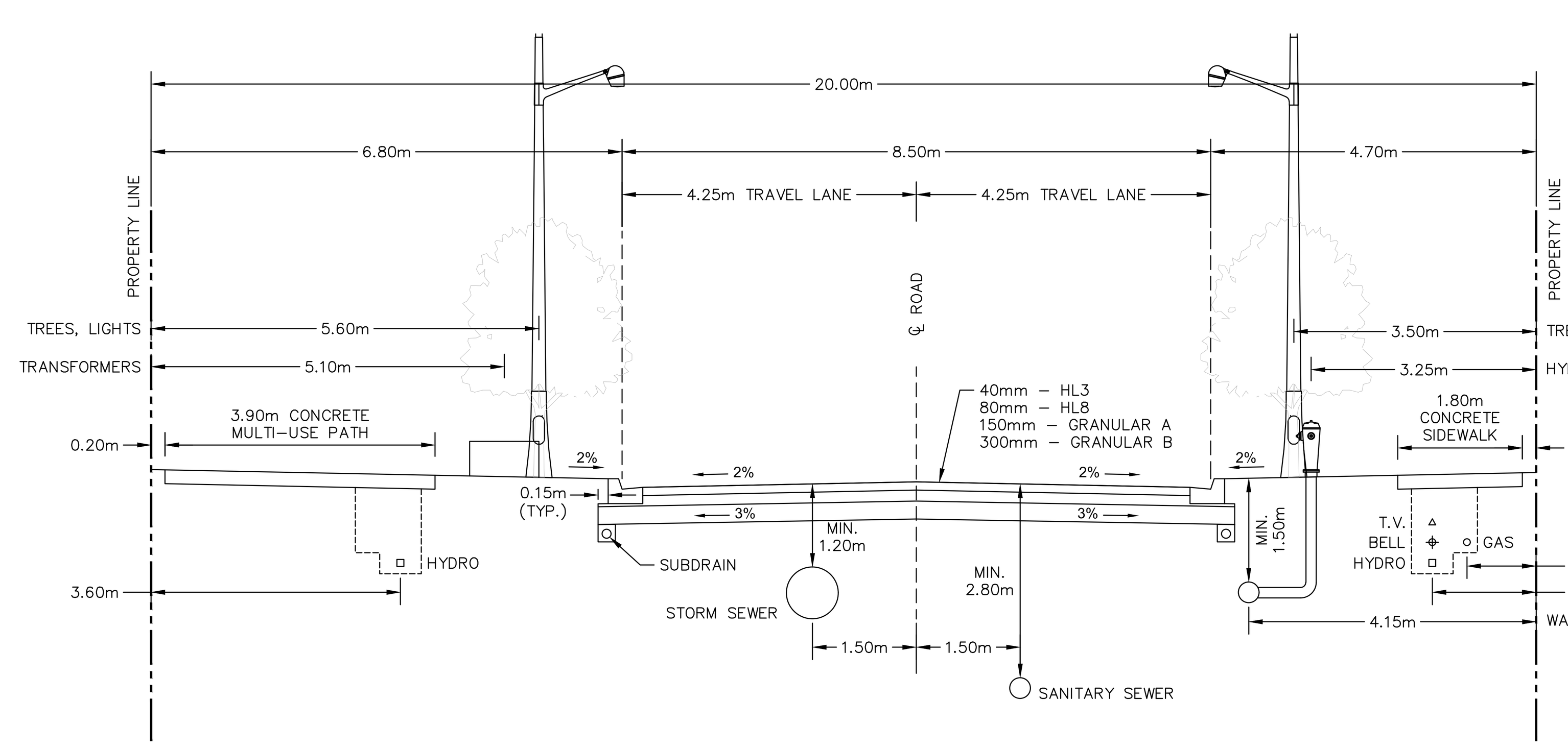
20.0m WIDTH COLLECTOR ROAD (STREET HH) CROSS SECTION

N.T.S.



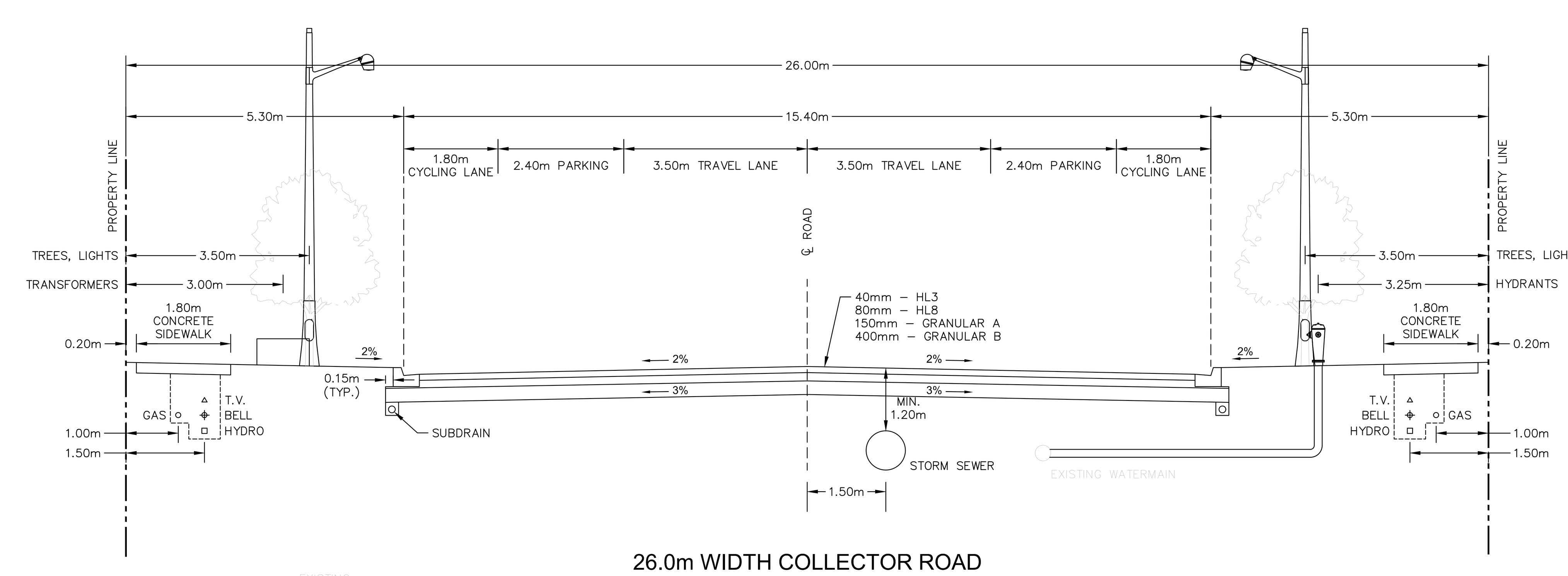
26.0m WIDTH COLLECTOR ROAD CROSS SECTION

N.T.S.



20.0m WIDTH COLLECTOR ROAD (STREET A) CROSS SECTION

N.T.S.



26.0m WIDTH COLLECTOR ROAD (EXISTING GRASSY BROOK URBANIZATION) CROSS SECTION

N.T.S.

No.	REVISIONS TO DRAWING	BY	DATE	APPR.
1	FIRST DPA SUBMISSION	ZB/VL	2023/02/03	ADR

ALL PREVIOUS ISSUES OF THIS DRAWING ARE SUPERSEDED

CLIENT: EMPIRE (GRAND NIAGARA) PROJECT GP INC.

MUNICIPALITY: CITY OF NIAGARA FALLS

PROJECT TITLE: GRAND NIAGARA MIXED-USE SUBDIVISION

SHEET TITLE: CROSS SECTIONS

CONSULTANT: WSP

100 Commerce Valley Dr. West, Thornhill, ON Canada L3T 0A1

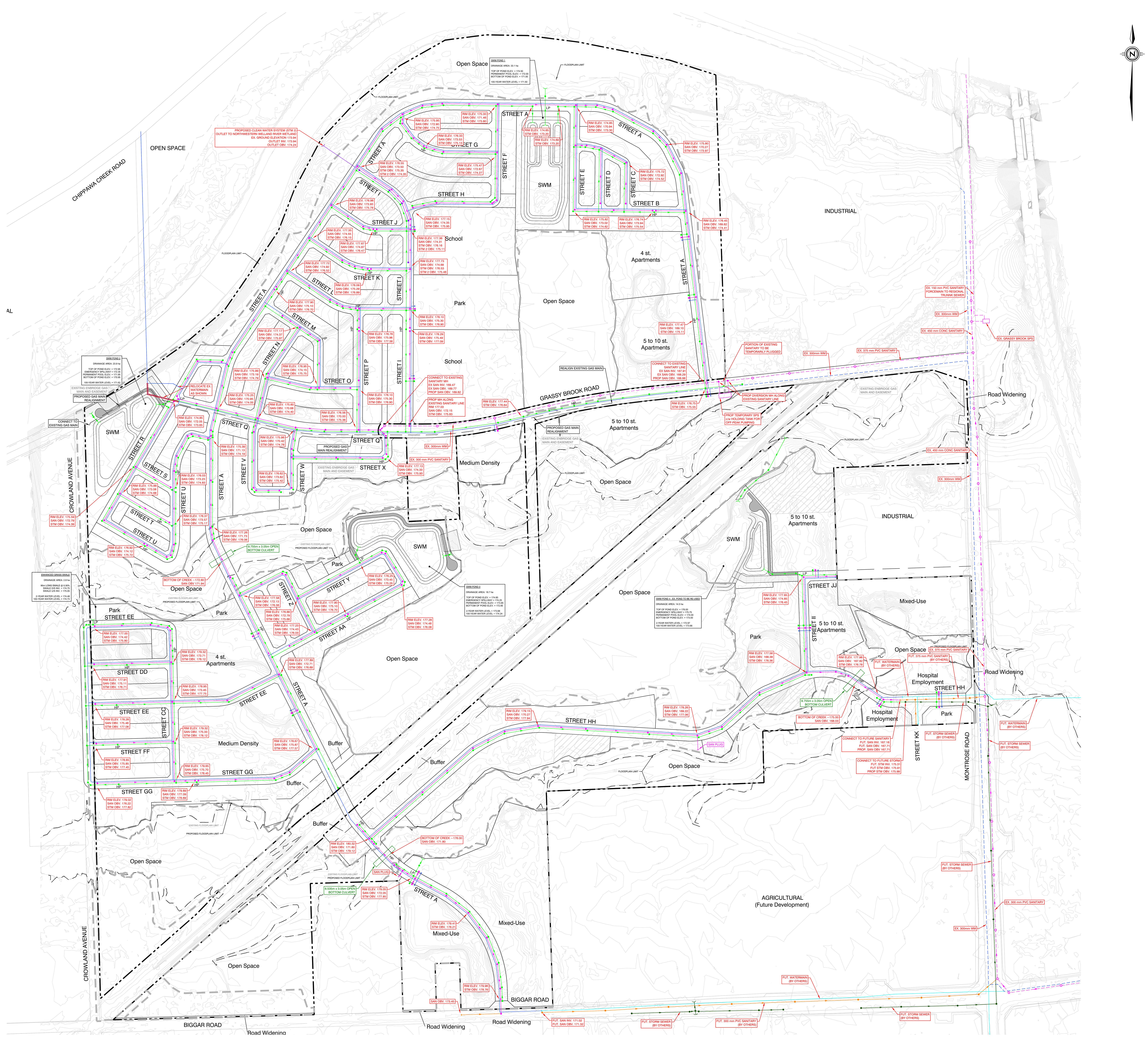
STAMP

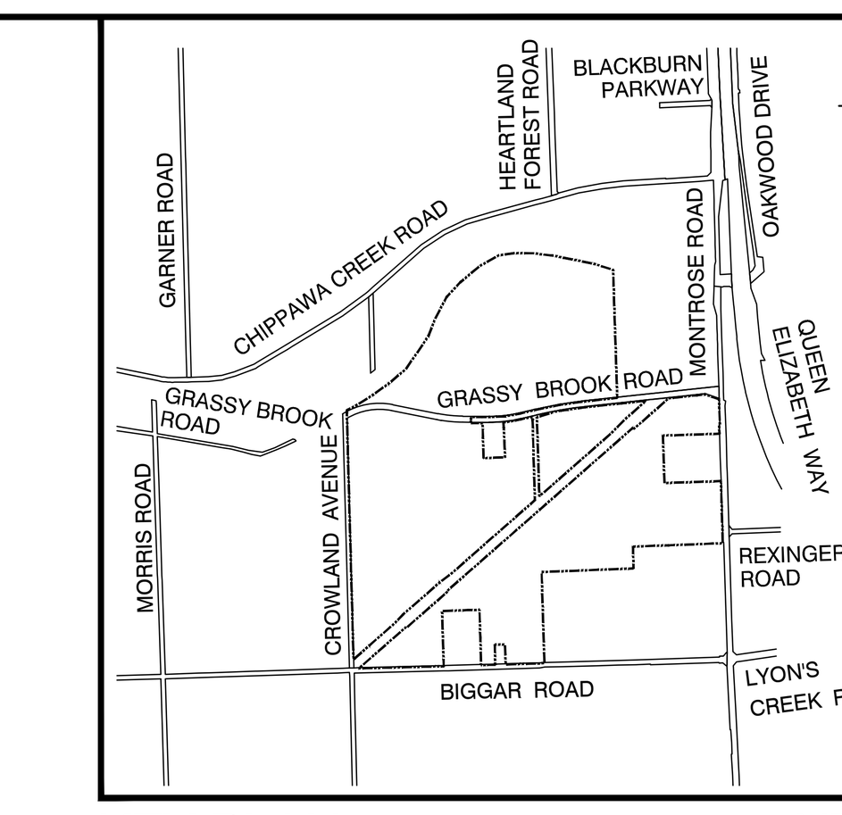
APPROVAL

DESIGNED	DRAWN	CHECKED
ZB/VL	ZB/VL	ADR
SCALE 1:2500	DATE JANUARY 2023	
PROJECT NUMBER 211-08936	DWG. NUMBER D1	

APPENDIX

F FUNCTIONAL SERVICING PLAN (SS1)





KEY PLAN NTS

LEGEND

- LIMIT OF SUBDIVISION
- LIMIT OF SUBDIVISION
- PROPOSED STORM SEWER
- PROPOSED CULVERTS
- PROPOSED SANITARY SEWER
- PROPOSED WATERMAIN
- EXISTING SANITARY SEWER
- LOCAL SANITARY REQUIRED
- EXISTING WATERMAIN
- FUTURE STORM SEWER (B.O.)
- FUTURE SANITARY SEWER (B.O.)
- FUTURE WATERMAIN (B.O.)
- PROPOSED CLEAN WATER SYSTEM (STM 2)
- PROPOSED GAS MAIN REALIGNMENT
- CLEAN WATER DRAINAGE AREAS INTENDED FOR WETLAND RECHARGE

NOTE: RESIDENTIAL MEDIUM DENSITY, MIXED-USE, AND EMPLOYMENT BLOCKS SHALL HAVE ON-SITE STORM CONTROLS AND OUTLET DIRECTLY INTO ADJACENT WATERCOURSES.

NOTE: FINISHED GRADES AT MANHOLES ARE APPROXIMATE ONLY. THEY ARE BASED ON CENTRELINE GRADES AND DO NOT ACCOUNT FOR CROSSFALL

NOTE: REFER TO DESIGN BY PARSONS CORPORATION FOR FURTHER DETAILS REGARDING FUTURE INFRASTRUCTURE ALONG MONTROSE ROAD, BIGGAR ROAD , STREET FF, AND STREET NN.

No.	REVISIONS TO DRAWING	BY	DATE	APPR.
1	FIRST DPA SUBMISSION	ZB/VL	2023/02/03	ADR

ALL PREVIOUS ISSUES OF THIS DRAWING ARE SUPERSEDED

CLIENT
EMPIRE (GRAND NIAGARA) PROJECT GP INC.

MUNICIPALITY
CITY OF NIAGARA FALLS

PROJECT TITLE
GRAND NIAGARA MIXED-USE SUBDIVISION

SHEET TITLE
PRELIMINARY SERVICING PLAN

CONSULTANT
wsp
100 Commerce Valley Dr. West, Thornhill, ON Canada L3T 0A1
t: 905.882.1100 f: 905.882.0055 www.wsp.com

STAMP

APPROVAL

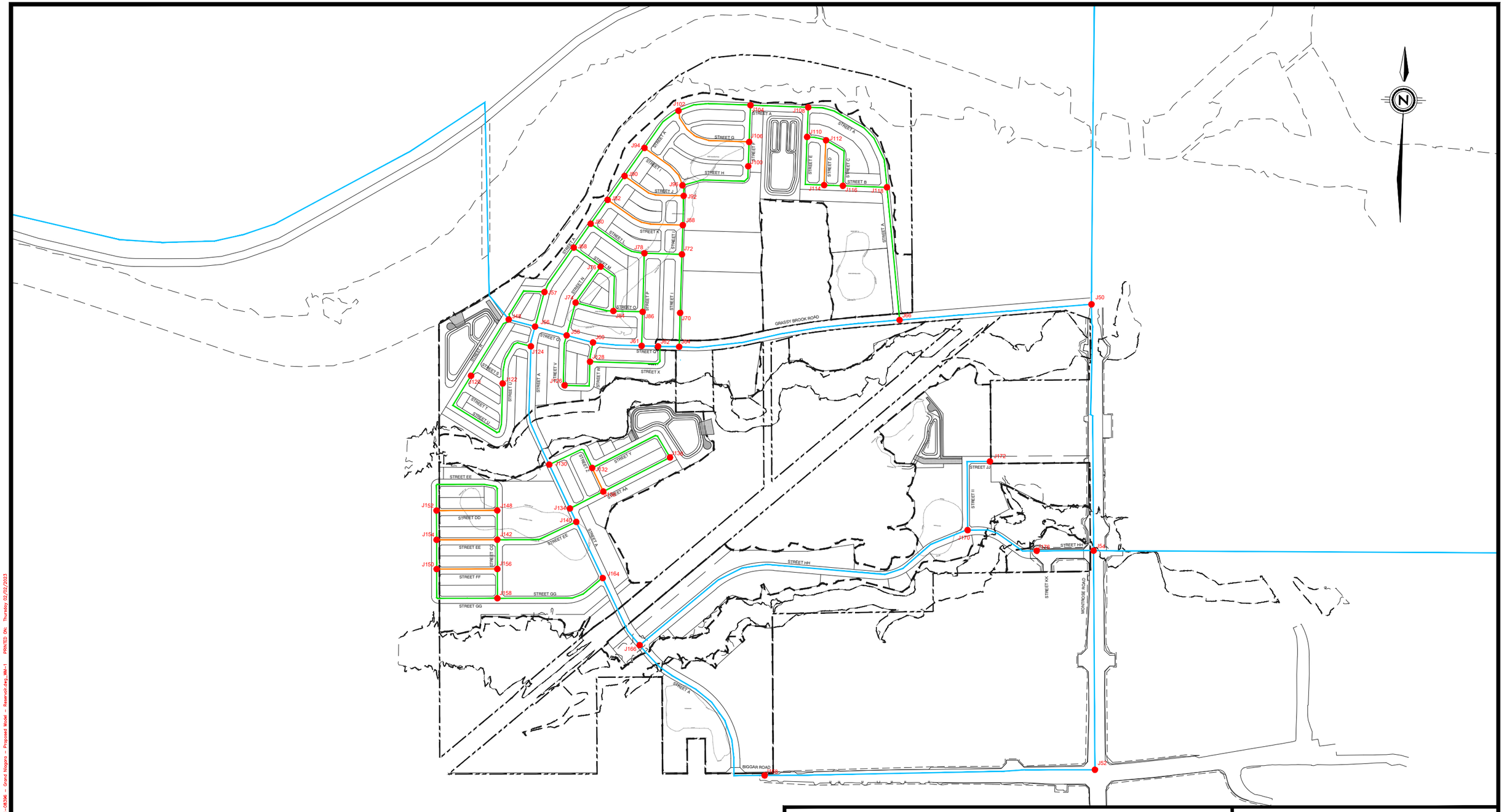
DESIGNED	DRAWN	CHECKED
ZB/VL	ZB/VL	ADR

SCALE	DATE
1:2500	JANUARY 2023

PROJECT NUMBER	DWG. NUMBER
211-08936	SS1

APPENDIX

G PROPOSED WATER MODEL PLAN (WM1) AND MODEL RESULTS



LEGEND

Pipe Input View
PIPEHYD–>DIAMETER

- 150mm
- 200mm
- 300mm
- 500mm
- 900mm
- 1050mm

CLIENT
EMPIRE (GRAND NIAGARA) GP INC.

TITLE
GRAND NIAGARA RESIDENTIAL SUBDIVISION

PROPOSED WATER MODEL

wsp
100 Commerce Valley Dr. West, Thornhill, ON Canada L3T 0A1
t: 905.882.1100 f: 905.882.0055 www.wsp.com

Checked R.K.	Drawn I.B.
Date JAN 2023	Proj. No. 211-08936
Scale N.T.S.	Figure No. WM-1

APPENDIX E

PROPOSED WATER DEMAND

Project: **Grand Niagara Mixed-Use Subdivision**
Job No.: **211-08936**

Proposed Development

Catchment ID	Land Use Category	Area [1] (ha)	Population Density [2] (persons/ha)	Population
101	R1/R2	12.1	45.5	550
102	Institutional	2.4	96.4	230
103	R3/R4	3.2	96.4	310
104	R3/R4	2.0	96.4	195
105	R5F	2.8	355.8	995
106	R1/R2	15.8	45.5	720
107	R3/R4	1.2	96.4	115
108	Institutional	3.6	96.4	345
109	R3/R4	1.1	96.4	105
110	R5F	2.1	355.8	745
111	R1/R2	7.3	45.5	330
112	R3/R4	2.6	96.4	250
113	R3/R4	3.8	96.4	365
114	R1/R2	1.7	45.5	75
115	R3/R4	3.8	96.4	365
116	R3/R4	7.1	96.4	685
117	GC	8.5	180.4	1535
118	R5F	4.2	355.8	1495
119	GC	2.2	180.4	395
120	GC	1.9	180.4	345
	TOTAL	**89.40**		**10,150**

Proposed Water Demands

				Peak Hour		Max Day	
Building	Population (see above)	Per Capita Flow [3] (L/cap/day)	Average Daily Demand (L/s)	Peaking Factor [4]	Demand (L/s)	Peaking Factor [5]	Demand (L/s)
Residential	7,300	450	38.02	2.85	108.36	1.90	72.24
Non-Residential	2,850	450	14.84	2.00	29.69	2.00	29.69
TOTAL	**10,150**	**450**	**52.86**		**138.05**		**101.93**

Note 1: Drainage areas per Preliminary Sanitary Drainage Plan (Dwg. No. SA1)
Note 2: Design flow rates per the City of Niagara Falls Storm and Sanitary Sewers Design Criteria. City criteria does not define a population density for R5F land use - it has been assumed to be equivalent to R4F.
Note 3: Design flow rates per the City of Niagara Falls Storm and Sanitary Sewers Design Criteria.
Note 4: Peaking factors per the MECP Design Guidelines for Drinking Water Systems (2008, Updated 2019).

211-08936 - Grand Niagara
Water Distribution Modelling

Date: 2023-02-02

Maximum Day

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (kPa)
J10	0.00	209	248.38	386
J100	0.43	175.78	234.77	578
J102	0.49	175.95	234.77	576
J104	0.35	175	234.77	586
J106	0.51	175.47	234.77	581
J108	0.68	174.85	234.76	587
J110	0.67	175.22	234.76	583
J112	0.67	175.46	234.76	581
J114	0.67	176.06	234.76	575
J116	0.67	176.3	234.76	573
J118	2.68	176.45	234.77	571
J12	82.00	200	243.08	422
J120	0.64	175.6	234.87	581
J122	1.24	176.03	234.82	576
J124	0.28	175.39	234.81	582
J126	0.78	176.27	234.82	574
J128	0.60	176.28	234.82	574
J130	0.27	177.58	234.61	559
J132	0.64	176.9	234.59	565
J134	2.61	177.7	234.58	557
J136	1.33	177.28	234.58	561
J138	1.24	177.28	234.58	561
J14	82.00	192	244.59	515
J140	4.39	177.89	234.56	555
J142	0.36	178.95	234.55	545
J148	0.46	179.32	234.55	541
J150	0.69	178.17	234.54	552
J152	0.42	177.5	234.54	559
J154	0.33	177.87	234.54	555
J156	0.32	179.32	234.55	541
J158	0.61	179.69	234.54	538
J16	0.00	201	243.45	416
J164	0.85	178.65	234.55	548
J166	35.39	180.32	234.53	531
J168	0.00	179.43	234.69	542
J170	2.10	177.56	234.68	560
J172	23.73	176.97	234.56	564
J176	2.66	177.6	234.93	562
J18	0.00	191	243.41	514
J20	0.00	193	243.39	494
J22	0.00	183	243.28	591
J24	0.00	181	243.11	609
J26	0.00	178	243.04	637
J28	82.00	179	242.97	627
J30	0.00	185	242.29	561
J32	0.00	176	241.01	637
J34	82.00	180	242.95	617
J48	0.25	174.85	234.9	588
J50	0.00	176	235.37	582
J52	0.00	181	234.96	529
J54	0.00	173	235.13	609
J56	0.35	175.25	234.83	584
J57	0.43	176.2	234.84	575
J58	0.45	175.6	234.82	580
J60	0.26	176	234.82	576
J61	0.13	176.56	234.82	571
J62	1.06	176.85	234.82	568
J64	1.31	177.05	234.82	566
J66	18.53	176.75	234.85	569
J68	0.21	177.55	234.81	561
J70	3.93	177.63	234.79	560
J72	0.22	178.1	234.79	556
J74	0.38	175.99	234.82	576
J76	0.38	177.17	234.81	565
J78	0.49	178.57	234.8	551
J80	0.34	177.72	234.8	559
J82	0.39	177.35	234.79	563
J84	0.44	176.95	234.81	567
J86	0.63	178.1	234.81	556
J88	0.50	177.73	234.78	559
J90	0.28	176.98	234.78	566
J92	2.72	177.36	234.77	563
J94	0.43	176.55	234.77	571
J96	0.53	177.19	234.77	564

Maximum Day - Pipe Data

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)
P101	J56	J57	90.42	200	110	-2.17	0.07	0	0.05
P103	J68	J80	74	200	110	4.55	0.14	0.02	0.21
P105	J80	J82	74	200	110	4.17	0.13	0.01	0.18
P107	J82	J90	74	200	110	3.28	0.1	0.01	0.11
P109	J90	J94	87	200	110	2.31	0.07	0.01	0.06
P111	J94	J102	129.12	200	110	1.63	0.05	0	0.03
P113	J104	J108	146	200	110	1.14	0.04	0	0.02
P115	J108	J110	75	200	110	1.15	0.04	0	0.02
P117	J110	J112	48.96	200	110	0.35	0.01	0	0
P119	J112	J116	141.2	200	110	-0.33	0.01	0	0
P121	J110	J114	167.5	200	110	0.13	0	0	0
P123	J118	J66	337.08	200	110	-4.9	0.16	0.08	0.24
P127	J64	J70	85.82	200	110	5.22	0.17	0.02	0.27
P129	J70	J72	148	200	110	1.29	0.04	0	0.02
P131	J58	J74	85.93	200	110	2.85	0.09	0.01	0.09
P133	J76	J74	111.13	200	110	-1.16	0.04	0	0.02
P135	J68	J76	83.14	200	110	-0.44	0.01	0	0
P137	J72	J88	74	200	110	3.6	0.11	0.01	0.13
P139	J74	J84	98.36	200	110	1.31	0.04	0	0.02
P141	J78	J72	95	200	110	2.53	0.08	0.01	0.07
P143	J76	J84	130.16	200	110	0.34	0.01	0	0
P145	J80	J78	157.54	200	110	0.04	0	0	0
P147	J82	J88	207.68	150	100	0.5	0.03	0	0.02
P149	J84	J86	74	200	110	1.21	0.04	0	0.02
P151	J86	J78	148.21	200	110	2.98	0.09	0.01	0.09
P153	J88	J92	74	200	110	3.59	0.11	0.01	0.13
P155	J90	J92	163.86	150	100	0.69	0.04	0.01	0.03
P157	J96	J100	200.33	200	110	1.29	0.04	0	0.02
P159	J94	J96	138.67	150	100	0.25	0.01	0	0
P165	J100	J106	61.4	200	110	0.86	0.03	0	0.01
P169	J102	J106	217.64	150	100	0.28	0.02	0	0.01
P171	J102	J104	185.13	200	110	0.86	0.03	0	0.01
P173	J106	J104	93	200	110	0.63	0.02	0	0.01
P179	J114	J116	47.5	200	110	-0.53	0.02	0	0
P181	J112	J114	113.55	150	100	0.01	0	0	0
P183	J116	J118	111.51	200	110	-1.53	0.05	0	0.03
P185	J48	J120	173.63	200	110	4.35	0.14	0.03	0.19
P187	J120	J122	347.93	200	110	3.71	0.12	0.05	0.14
P191	J122	J124	150.78	200	110	2.47	0.08	0.01	0.07
P195	J126	J128	124.08	200	110	0.55	0.02	0	0
P197	J58	J126	128.46	200	110	1.33	0.04	0	0.02
P199	J128	J60	49.34	200	110	-0.96	0.03	0	0.01
P201	J128	J62	219.28	200	110	0.91	0.03	0	0.01
P203	J130	J132	146.25	200	110	4.12	0.13	0.03	0.17
P205	J132	J136	66.03	150	100	1.66	0.09	0.01	0.15
P207	J132	J138	247.79	200	110	1.82	0.06	0.01	0.04
P209	J138	J136	189.42	200	110	0.58	0.02	0	0
P211	J136	J134	94.54	200	110	0.91	0.03	0	0.01
P213	J140	J142	209.81	200	110	2.77	0.09	0.02	0.08
P217	J142	J148	74.00	200	110	1.06	0.03	0	0.01
P219	J142	J156	74	200	110	1	0.03	0	0.01
P221	J152	J148	153.42	150	100	-0.24	0.01	0	0
P223	J148	J152	277.01	200	110	0.36	0.01	0	0
P225	J152	J154	74	200	110	0.18	0.01	0	0
P227	J154	J142	153.44	150	100	-0.35	0.02	0	0.01
P229	J150	J156	153.46	150	100	-0.21	0.01	0	0
P231	J150	J158	226.43	200	110	-0.27	0.01	0	0
P233	J156	J158	74	200	110	0.47	0.01	0	0
P249	J166	J170	929.63	300	120	-12.79	0.18	0.15	0.17
P251	J170	J172	230.84	300	120	23.73	0.34	0.12	0.52
P257	J176	J54	143.82	300	120	-41.28	0.58	0.21	1.45
P275	J57	J68	134.92	200	110	4.32	0.14	0.03	0.19
P277	J48	J57	135.55	200	110	6.91	0.22	0.06	0.45
P279	J61	J62	41.63	300	100	1.09	0.02	0	0
P281	J170	J176	190.17	300	120	-38.62	0.55	0.24	1.28
P283	J164	J158	282.7	200	110	0.42	0.01	0	0
P285	J154	J150	74	200	110	0.21	0.01	0	0
P287	J108	J118	319.98	200	110	-0.69	0.02	0	0.01
P289	J92	J96	27.14	200	110	1.57	0.05	0	0.03
P291	J61	J86	86	200	110	2.4	0.08	0.01	0.06
P293	RES9002	J10	86.01	500	100	452.4	2.3	1.22	14.2
P295	J10	J12	1,661.76	500	100	202	1.03	5.3	3.19
P297	J12	J34	2,112.20	900	110	120	0.19	0.12	0.06
P299	J34	J30	4,399.86	500	100	38.9	0.2	0.66	0.15
P301	J30	J32	2,851.28	400	100	38.9	0.31	1.28	0.45
P303	J32	J48	3,361.93	300	100	38.9	0.55	6.11	1.82
P305	J34	J50	3,111.60	300	100	45.58	0.64	7.59	2.44
P307	J10	J14	797.16	500	100	250.4	1.28	3.79	4.75

P309	J14	J16	1,221.54	600	100	168.4	0.6	1.14	0.94
P311	J16	J18	470.28	750	110	90.49	0.2	0.04	0.08
P313	J18	J22	1,548.93	750	110	90.49	0.2	0.13	0.08
P315	J22	J20	1,072.22	675	110	-77.91	0.22	0.11	0.11
P317	J20	J16	522.61	675	110	-77.91	0.22	0.06	0.11
P319	J22	J24	646.92	750	110	168.4	0.38	0.17	0.26
P321	J24	J26	1,243.18	1050	110	168.4	0.19	0.06	0.05
P323	J26	J28	2,311.48	1050	110	128.48	0.15	0.07	0.03
P325	J28	J34	1,713.46	900	110	46.48	0.07	0.02	0.01
P327	J26	J54	5,813.55	300	120	39.92	0.56	7.91	1.36
P67	J50	J54	625.87	300	100	16.55	0.23	0.23	0.37
P69	J54	J52	553.99	300	100	15.19	0.21	0.18	0.32
P71	J48	J56	68.85	300	100	27.4	0.39	0.07	0.95
P73	J56	J58	82.96	300	100	9.47	0.13	0.01	0.13
P75	J58	J60	68.96	300	100	4.84	0.07	0	0.04
P77	J60	J61	123.38	300	100	3.62	0.05	0	0.02
P79	J62	J64	53.37	300	100	0.93	0.01	0	0
P81	J64	J66	562.58	300	100	-5.6	0.08	0.03	0.05
P83	J66	J50	494.21	300	100	-29.03	0.41	0.52	1.06
P85	J52	J168	835.35	300	100	15.19	0.21	0.27	0.32
P87	J168	J166	511.41	300	100	15.19	0.21	0.16	0.32
P89	J166	J164	194.82	300	100	-7.41	0.1	0.02	0.08
P91	J164	J140	156.88	300	100	-8.68	0.12	0.02	0.11
P93	J140	J134	37.52	300	100	-15.84	0.22	0.01	0.34
P95	J134	J130	122.63	300	120	-17.54	0.25	0.04	0.3
P97	J130	J124	309.64	300	100	-21.93	0.31	0.19	0.63
P99	J124	J56	51.42	300	100	-19.75	0.28	0.03	0.52

Maximum Day plus Fire

ID	Static Demand (L/s)	Static Pressure (kPa)	Static Head (m)	Fire-Flow Demand (L/s)	Residual Pressure (kPa)	Available Flow at Hydrant (L/s)	Available Flow Pressure (kPa)
J100	0.43	578	234.77	80	384	146	140
J102	0.49	576	234.77	80	386	148	140
J104	0.35	586	234.77	80	398	152	140
J106	0.51	581	234.77	80	390	148	140
J108	0.68	587	234.76	80	388	145	140
J110	0.67	583	234.76	80	376	139	140
J112	0.67	581	234.76	80	369	135	140
J114	0.67	575	234.76	80	362	134	140
J116	0.67	573	234.76	80	364	136	140
J118	2.68	571	234.77	80	372	143	140
J120	0.64	581	234.87	80	398	153	140
J122	1.24	576	234.82	80	395	154	140
J124	0.28	582	234.81	80	429	185	140
J126	0.78	574	234.82	80	405	163	140
J128	0.6	574	234.82	80	414	173	140
J130	0.27	559	234.61	80	399	170	140
J132	0.64	565	234.59	80	386	153	140
J134	2.61	557	234.58	80	397	171	140
J136	1.33	561	234.58	80	385	155	140
J138	1.24	561	234.58	80	363	139	140
J140	4.39	555	234.56	80	394	172	140
J142	0.36	545	234.55	80	352	139	140
J148	0.46	541	234.55	80	335	130	140
J150	0.69	552	234.54	80	347	133	140
J152	0.42	559	234.54	80	348	131	140
J154	0.33	555	234.54	80	349	133	140
J156	0.32	541	234.55	80	345	135	140
J158	0.61	538	234.54	80	344	136	140
J164	0.85	548	234.55	80	386	166	140
J166	35.39	531	234.53	80	369	196	140
J168	0	542	234.69	80	373	155	140
J170	2.1	560	234.68	80	400	172	140
J172	23.73	564	234.56	80	388	180	140
J176	2.66	562	234.93	80	406	178	140
J48	0.25	588	234.9	80	437	188	140
J50	0	582	235.37	80	438	194	140
J52	0	529	234.96	80	363	154	140
J54	0	609	235.13	80	459	197	140
J56	0.35	584	234.83	80	432	187	140
J57	0.43	575	234.84	80	417	175	140
J58	0.45	580	234.82	80	427	183	140
J60	0.26	576	234.82	80	422	181	140
J61	0.13	571	234.82	80	416	178	140
J62	1.06	568	234.82	80	413	178	140
J64	1.31	566	234.82	80	410	177	140
J66	18.53	569	234.85	80	413	195	140
J68	0.21	561	234.81	80	400	168	140
J70	3.93	560	234.79	80	390	163	140
J72	0.22	556	234.79	80	389	161	140
J74	0.38	576	234.82	80	415	172	140
J76	0.38	565	234.81	80	402	168	140
J78	0.49	551	234.8	80	386	161	140
J80	0.34	559	234.8	80	395	164	140
J82	0.39	563	234.79	80	391	158	140
J84	0.44	567	234.81	80	405	169	140
J86	0.63	556	234.81	80	395	168	140
J88	0.5	559	234.78	80	386	157	140
J90	0.28	566	234.78	80	389	155	140
J92	2.72	563	234.77	80	385	156	140
J94	0.43	571	234.77	80	388	152	140
J96	0.53	564	234.77	80	384	153	140

211-08936 - Grand Niagara
Water Distribution Modelling

Date: 2023-02-02

Peak Hour

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (kPa)
J10	0	209	249.38	396
J100	0.64	175.78	232.17	553
J102	0.73	175.95	232.17	551
J104	0.53	175	232.17	560
J106	0.77	175.47	232.17	556
J108	1.02	174.85	232.16	562
J110	1	175.22	232.16	558
J112	1	175.46	232.16	556
J114	1	176.06	232.16	550
J116	1	176.3	232.16	547
J118	4.02	176.45	232.16	546
J12	0	200	248.3	473
J120	0.95	175.6	232.36	556
J122	1.86	176.03	232.26	551
J124	0.42	175.39	232.24	557
J126	1.17	176.27	232.27	549
J128	0.91	176.28	232.27	549
J130	0.41	177.58	231.86	532
J132	0.95	176.9	231.81	538
J134	2.61	177.7	231.79	530
J136	2	177.28	231.79	534
J138	1.86	177.28	231.79	534
J14	0	192	248.77	556
J140	4.67	177.89	231.76	528
J142	0.55	178.95	231.71	517
J148	0.69	179.32	231.71	513
J150	1.03	178.17	231.71	525
J152	0.63	177.5	231.71	531
J154	0.5	177.87	231.71	528
J156	0.48	179.32	231.71	513
J158	0.92	179.69	231.71	510
J16	0	201	248.39	464
J164	1.28	178.65	231.71	520
J166	53.08	180.32	231.66	503
J168	0	179.43	231.98	515
J170	3.16	177.56	231.95	533
J172	35.59	176.97	231.7	536
J176	2.66	177.6	232.45	537
J18	0	191	248.38	562
J20	0	193	248.37	543
J22	0	183	248.33	640
J24	0	181	248.27	659
J26	0	178	248.25	688
J28	0	179	248.25	679
J30	0	185	246.93	607
J32	0	176	244.43	671
J34	0	180	248.24	669
J48	0.38	174.85	232.43	564
J50	0	176	233.32	562
J52	0	181	232.51	505
J54	0	173	232.86	587
J56	0.53	175.25	232.3	559
J57	0.64	176.2	232.31	550
J58	0.67	175.6	232.28	555
J60	0.39	176	232.27	551
J61	0.19	176.56	232.27	546
J62	1.59	176.85	232.27	543
J64	1.97	177.05	232.27	541
J66	27.8	176.75	232.31	544
J68	0.31	177.55	232.26	536
J70	4.08	177.63	232.23	535
J72	0.33	178.1	232.22	530
J74	0.56	175.99	232.26	551
J76	0.56	177.17	232.26	540
J78	0.73	178.57	232.23	526
J80	0.52	177.72	232.23	534
J82	0.58	177.35	232.21	538
J84	0.66	176.95	232.26	542
J86	0.94	178.1	232.26	531
J88	0.75	177.73	232.21	534
J90	0.42	176.98	232.19	541
J92	2.72	177.36	232.19	537
J94	0.64	176.55	232.18	545
J96	0.8	177.19	232.18	539

Peak Hour - Pipe Data

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)
P101	J56	J57	90.42	200.00	110	-3.22	0.1	0.01	0.11
P103	J68	J80	74.00	200.00	110	6.14	0.2	0.03	0.36
P105	J80	J82	74	200	110	5.75	0.18	0.02	0.32
P107	J82	J90	74.00	200.00	110	4.57	0.15	0.02	0.21
P109	J90	J94	87.00	200.00	110	3.31	0.11	0.01	0.11
P111	J94	J102	129.12	200.00	110	2.69	0.09	0.01	0.08
P113	J104	J108	146.00	200	110	2.27	0.07	0.01	0.06
P115	J108	J110	75	200	110	1.95	0.06	0	0.04
P117	J110	J112	48.96	200	110	0.64	0.02	0	0.01
P119	J112	J116	141.20	200	110	-0.39	0.01	0	0
P121	J110	J114	167.5	200	110	0.31	0.01	0	0
P123	J118	J66	337.08	200	110	-6.77	0.22	0.15	0.43
P127	J64	J70	85.82	200	110	6.4	0.2	0.03	0.39
P129	J70	J72	148.00	200	110	2.32	0.07	0.01	0.06
P131	J58	J74	85.93	200	110	3.89	0.12	0.01	0.15
P133	J76	J74	111.13	200	110	-1.53	0.05	0	0.03
P135	J68	J76	83.14	200.00	110	-0.4	0.01	0	0
P137	J72	J88	74.00	200	110	5.1	0.16	0.02	0.25
P139	J74	J84	98.36	200	110	1.8	0.06	0	0.04
P141	J78	J72	95.00	200	110	3.1	0.1	0.01	0.1
P143	J76	J84	130.16	200	110	0.58	0.02	0	0
P145	J80	J78	157.54	200	110	-0.13	0	0	0
P147	J82	J88	207.68	150	100	0.6	0.03	0	0.02
P149	J84	J86	74	200	110	1.72	0.05	0	0.03
P151	J86	J78	148.21	200	110	3.96	0.13	0.02	0.16
P153	J88	J92	74	200	110	4.94	0.16	0.02	0.24
P155	J90	J92	163.86	150	100	0.85	0.05	0.01	0.04
P157	J96	J100	200.33	200	110	2.25	0.07	0.01	0.06
P159	J94	J96	138.67	150	100	-0.02	0	0	0
P165	J100	J106	61.4	200	110	1.61	0.05	0	0.03
P169	J102	J106	217.64	150	100	0.45	0.03	0	0.01
P171	J102	J104	185.13	200	110	1.5	0.05	0	0.03
P173	J106	J104	93	200	110	1.3	0.04	0	0.02
P179	J114	J116	47.5	200	110	-0.66	0.02	0	0.01
P181	J112	J114	113.55	150	100	0.02	0	0	0
P183	J116	J118	111.51	200	110	-2.05	0.07	0.01	0.05
P185	J48	J120	173.63	200	110	6.3	0.2	0.07	0.38
P187	J120	J122	347.93	200	110	5.35	0.17	0.1	0.28
P191	J122	J124	150.78	200	110	3.49	0.11	0.02	0.13
P195	J126	J128	124.08	200.00	110	0.75	0.02	0	0.01
P197	J58	J126	128.46	200	110	1.92	0.06	0.01	0.04
P199	J128	J60	49.34	200	110	-1.42	0.05	0	0.02
P201	J128	J62	219.28	200	110	1.26	0.04	0	0.02
P203	J130	J132	146.25	200	110	5.99	0.19	0.05	0.34
P205	J132	J136	66.03	150	100	2.4	0.14	0.02	0.31
P207	J132	J138	247.79	200	110	2.64	0.08	0.02	0.08
P209	J138	J136	189.42	200	110	0.78	0.02	0	0.01
P211	J136	J134	94.54	200	110	1.18	0.04	0	0.02
P213	J140	J142	209.81	200	110	4.57	0.15	0.04	0.21
P217	J142	J148	74	200	110	1.64	0.05	0	0.03
P219	J142	J156	74.00	200.00	110	1.78	0.06	0	0.04
P221	J152	J148	153.42	150	100	-0.37	0.02	0	0.01
P223	J148	J152	277.01	200	110	0.58	0.02	0	0
P225	J152	J154	74	200	110	0.32	0.01	0	0
P227	J154	J142	153.44	150	100	-0.61	0.03	0	0.02
P229	J150	J156	153.46	150	100	-0.32	0.02	0	0.01
P231	J150	J158	226.43	200	110	-0.28	0.01	0	0
P233	J156	J158	74	200	110	0.97	0.03	0	0.01
P249	J166	J170	929.63	300	120	-17.98	0.25	0.29	0.31
P251	J170	J172	230.84	300	120	35.59	0.5	0.25	1.1
P257	J176	J54	143.82	300	120	-59.39	0.84	0.41	2.84
P275	J57	J68	134.92	200	110	6.06	0.19	0.05	0.35
P277	J48	J57	135.55	200	110	9.91	0.32	0.12	0.87
P279	J61	J62	41.63	300	100	1.71	0.02	0	0.01
P281	J170	J176	190.17	300	120	-56.73	0.8	0.5	2.61
P283	J164	J158	282.7	200	110	0.23	0.01	0	0
P285	J154	J150	74	200	110	0.43	0.01	0	0
P287	J108	J118	319.98	200	110	-0.7	0.02	0	0.01
P289	J92	J96	27.14	200	110	3.07	0.1	0	0.1
P291	J61	J86	86	200	110	3.19	0.1	0.01	0.11
P293	RES9002	J10	86.01	500	100	178.85	0.91	0.22	2.55
P295	J10	J12	1,661.76	500	100	85.54	0.44	1.08	0.65
P297	J12	J34	2,112.20	900	110	85.54	0.13	0.07	0.03
P299	J34	J30	4,399.86	500	100	56	0.29	1.3	0.3
P301	J30	J32	2,851.28	400	100	56	0.45	2.51	0.88
P303	J32	J48	3,361.93	300	100	56	0.79	12	3.57
P305	J34	J50	3,111.60	300	100	65.65	0.93	14.91	4.79

P307	J10	J14	797.16	500	100	93.31	0.48	0.61	0.76
P309	J14	J16	1,221.54	600	100	93.31	0.33	0.38	0.31
P311	J16	J18	470.28	750	110	50.14	0.11	0.01	0.03
P313	J18	J22	1,548.93	750	110	50.14	0.11	0.04	0.03
P315	J22	J20	1,072.22	675	110	-43.17	0.12	0.04	0.04
P317	J20	J16	522.61	675	110	-43.17	0.12	0.02	0.04
P319	J22	J24	646.92	750	110	93.31	0.21	0.06	0.09
P321	J24	J26	1,243.18	1,050.00	110	93.31	0.11	0.02	0.02
P323	J26	J28	2,311.48	1,050.00	110	36.11	0.04	0.01	0
P325	J28	J34	1,713.46	900	110	36.11	0.06	0.01	0.01
P327	J26	J54	5,813.55	300	120	57.2	0.81	15.4	2.65
P67	J50	J54	625.87	300	100	24.09	0.34	0.47	0.75
P69	J54	J52	553.99	300	100	21.91	0.31	0.35	0.63
P71	J48	J56	68.85	300	100	39.4	0.56	0.13	1.86
P73	J56	J58	82.96	300	100	13.38	0.19	0.02	0.25
P75	J58	J60	68.96	300	100	6.9	0.1	0.01	0.07
P77	J60	J61	123.38	300	100	5.08	0.07	0.01	0.04
P79	J62	J64	53.37	300	100	1.38	0.02	0	0
P81	J64	J66	562.58	300	100	-6.99	0.1	0.04	0.08
P83	J66	J50	494.21	300	100	-41.56	0.59	1.02	2.05
P85	J52	J168	835.35	300	100	21.91	0.31	0.52	0.63
P87	J168	J166	511.41	300	100	21.91	0.31	0.32	0.63
P89	J166	J164	194.82	300	100	-13.2	0.19	0.05	0.25
P91	J164	J140	156.88	300	100	-14.7	0.21	0.05	0.3
P93	J140	J134	37.52	300	100	-23.95	0.34	0.03	0.74
P95	J134	J130	122.63	300	120	-25.37	0.36	0.07	0.59
P97	J130	J124	309.64	300	100	-31.78	0.45	0.39	1.25
P99	J124	J56	51.42	300	100	-28.71	0.41	0.05	1.04

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Water Distribution Modelling

Date: 2023-02-02

Minimum Hour

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (kPa)
J10	0	209	249.58	398
J100	0.15	175.78	248.33	711
J102	0.17	175.95	248.33	709
J104	0.12	175	248.33	719
J106	0.18	175.47	248.33	714
J108	0.24	174.85	248.33	720
J110	0.23	175.22	248.33	716
J112	0.23	175.46	248.33	714
J114	0.23	176.06	248.33	708
J116	0.23	176.3	248.33	706
J118	0.94	176.45	248.33	704
J12	0	200	249.51	485
J120	0.22	175.6	248.34	713
J122	0.43	176.03	248.33	709
J124	0.1	175.39	248.33	715
J126	0.27	176.27	248.33	706
J128	0.21	176.28	248.33	706
J130	0.09	177.58	248.3	693
J132	0.22	176.9	248.3	700
J134	0.92	177.7	248.3	692
J136	0.47	177.28	248.3	696
J138	0.43	177.28	248.3	696
J14	0	192	249.54	564
J140	1.53	177.89	248.3	690
J142	0.13	178.95	248.3	680
J148	0.16	179.32	248.29	676
J150	0.24	178.17	248.29	687
J152	0.15	177.5	248.29	694
J154	0.12	177.87	248.29	690
J156	0.11	179.32	248.3	676
J158	0.22	179.69	248.29	672
J16	0	201	249.51	475
J164	0.3	178.65	248.3	682
J166	12.38	180.32	248.29	666
J168	0	179.43	248.32	675
J170	0.74	177.56	248.31	693
J172	8.31	176.97	248.3	699
J176	0.93	177.6	248.35	693
J18	0	191	249.51	573
J20	0	193	249.51	554
J22	0	183	249.51	652
J24	0	181	249.5	671
J26	0	178	249.5	701
J28	0	179	249.5	691
J30	0	185	249.41	631
J32	0	176	249.22	718
J34	0	180	249.5	681
J48	0.09	174.85	248.35	720
J50	0	176	248.41	710
J52	0	181	248.35	660
J54	0	173	248.38	739
J56	0.12	175.25	248.34	716
J57	0.15	176.2	248.34	707
J58	0.16	175.6	248.34	713
J60	0.09	176	248.33	709
J61	0.04	176.56	248.33	703
J62	0.37	176.85	248.33	700
J64	0.46	177.05	248.33	699
J66	6.49	176.75	248.34	702
J68	0.07	177.55	248.33	694
J70	1.37	177.63	248.33	693
J72	0.08	178.1	248.33	688
J74	0.13	175.99	248.33	709
J76	0.13	177.17	248.33	697
J78	0.17	178.57	248.33	684
J80	0.12	177.72	248.33	692
J82	0.13	177.35	248.33	696
J84	0.15	176.95	248.33	700
J86	0.22	178.1	248.33	688
J88	0.18	177.73	248.33	692
J90	0.1	176.98	248.33	699
J92	0.95	177.36	248.33	695
J94	0.15	176.55	248.33	703
J96	0.19	177.19	248.33	697

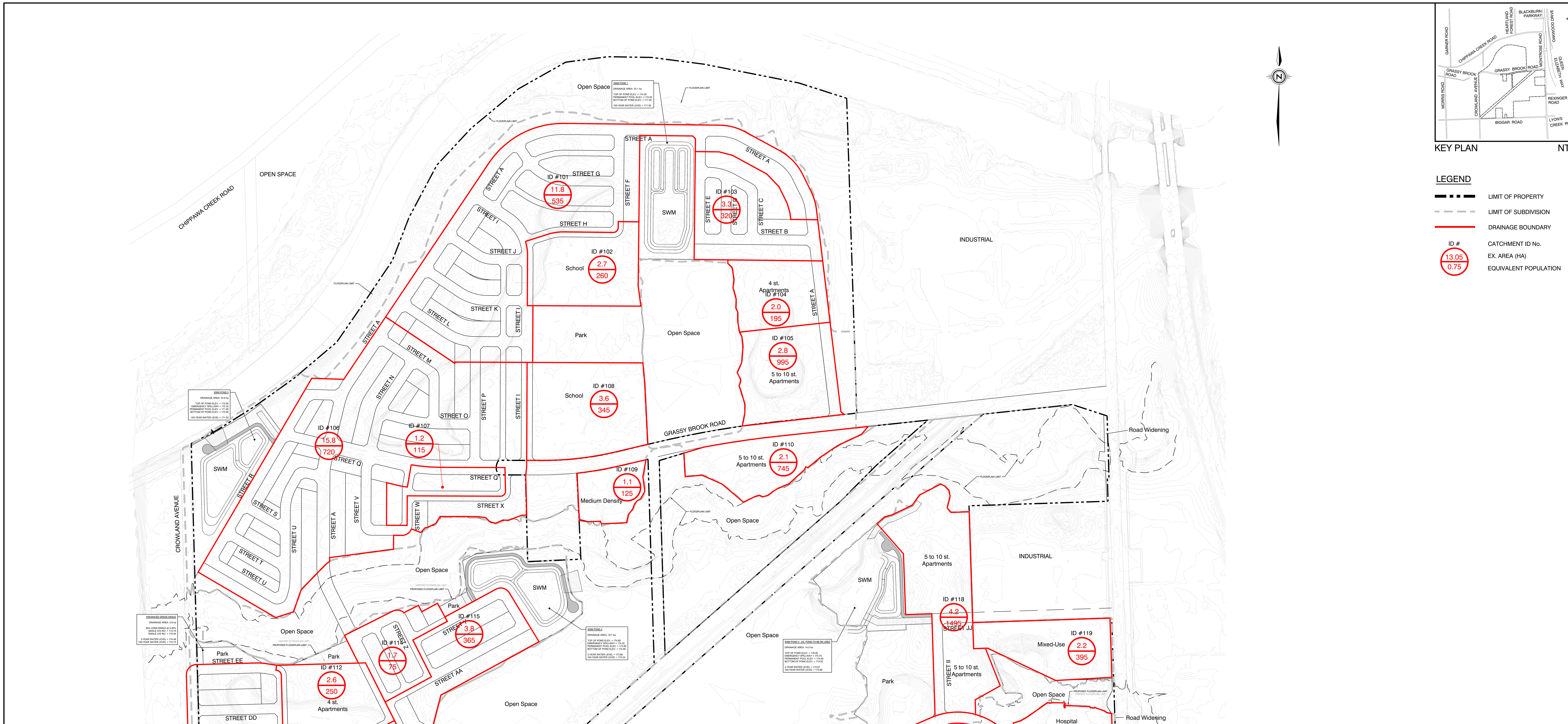
Minimum Hour - Pipe Data

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)
P101	J56	J57	90.42	200.00	110	-0.76	0.02	0	0.01
P103	J68	J80	74.00	200.00	110	1.59	0.05	0	0.03
P105	J80	J82	74	200	110	1.46	0.05	0	0.02
P107	J82	J90	74.00	200.00	110	1.15	0.04	0	0.02
P109	J90	J94	87.00	200.00	110	0.81	0.03	0	0.01
P111	J94	J102	129.12	200.00	110	0.57	0.02	0	0
P113	J104	J108	146.00	200	110	0.39	0.01	0	0
P115	J108	J110	75	200	110	0.39	0.01	0	0
P117	J110	J112	48.96	200	110	0.11	0	0	0
P119	J112	J116	141.20	200	110	-0.11	0	0	0
P121	J110	J114	167.5	200	110	0.05	0	0	0
P123	J118	J66	337.08	200	110	-1.71	0.05	0.01	0.03
P127	J64	J70	85.82	200	110	1.82	0.06	0	0.04
P129	J70	J72	148.00	200	110	0.45	0.01	0	0
P131	J58	J74	85.93	200	110	0.99	0.03	0	0.01
P133	J76	J74	111.13	200	110	-0.4	0.01	0	0
P135	J68	J76	83.14	200.00	110	-0.15	0	0	0
P137	J72	J88	74.00	200	110	1.26	0.04	0	0.02
P139	J74	J84	98.36	200	110	0.46	0.01	0	0
P141	J78	J72	95.00	200	110	0.89	0.03	0	0.01
P143	J76	J84	130.16	200	110	0.12	0	0	0
P145	J80	J78	157.54	200	110	0.01	0	0	0
P147	J82	J88	207.68	150	100	0.18	0.01	0	0
P149	J84	J86	74	200	110	0.43	0.01	0	0
P151	J86	J78	148.21	200	110	1.04	0.03	0	0.01
P153	J88	J92	74	200	110	1.25	0.04	0	0.02
P155	J90	J92	163.86	150	100	0.24	0.01	0	0
P157	J96	J100	200.33	200	110	0.45	0.01	0	0
P159	J94	J96	138.67	150	100	0.09	0.01	0	0
P165	J100	J106	61.4	200	110	0.3	0.01	0	0
P169	J102	J106	217.64	150	100	0.1	0.01	0	0
P171	J102	J104	185.13	200	110	0.3	0.01	0	0
P173	J106	J104	93	200	110	0.21	0.01	0	0
P179	J114	J116	47.5	200	110	-0.19	0.01	0	0
P181	J112	J114	113.55	150	100	-0.01	0	0	0
P183	J116	J118	111.51	200	110	-0.53	0.02	0	0
P185	J48	J120	173.63	200	110	1.52	0.05	0	0.03
P187	J120	J122	347.93	200	110	1.3	0.04	0.01	0.02
P191	J122	J124	150.78	200	110	0.87	0.03	0	0.01
P195	J126	J128	124.08	200.00	110	0.19	0.01	0	0
P197	J58	J126	128.46	200	110	0.46	0.01	0	0
P199	J128	J60	49.34	200	110	-0.34	0.01	0	0
P201	J128	J62	219.28	200	110	0.32	0.01	0	0
P203	J130	J132	146.25	200	110	1.45	0.05	0	0.02
P205	J132	J136	66.03	150	100	0.59	0.03	0	0.02
P207	J132	J138	247.79	200	110	0.64	0.02	0	0.01
P209	J138	J136	189.42	200	110	0.21	0.01	0	0
P211	J136	J134	94.54	200	110	0.33	0.01	0	0
P213	J140	J142	209.81	200	110	0.98	0.03	0	0.01
P217	J142	J148	74	200	110	0.36	0.01	0	0
P219	J142	J156	74.00	200.00	110	0.36	0.01	0	0
P221	J152	J148	153.42	150	100	-0.08	0	0	0
P223	J148	J152	277.01	200	110	0.12	0	0	0
P225	J152	J154	74	200	110	0.05	0	0	0
P227	J154	J142	153.44	150	100	-0.13	0.01	0	0
P229	J150	J156	153.46	150	100	-0.08	0	0	0
P231	J150	J158	226.43	200	110	-0.1	0	0	0
P233	J156	J158	74	200	110	0.17	0.01	0	0
P249	J166	J170	929.63	300	120	-4.46	0.06	0.02	0.02
P251	J170	J172	230.84	300	120	8.31	0.12	0.02	0.07
P257	J176	J54	143.82	300	120	-14.44	0.2	0.03	0.21
P275	J57	J68	134.92	200	110	1.51	0.05	0	0.03
P277	J48	J57	135.55	200	110	2.42	0.08	0.01	0.06
P279	J61	J62	41.63	300	100	0.39	0.01	0	0
P281	J170	J176	190.17	300	120	-13.51	0.19	0.03	0.18
P283	J164	J158	282.7	200	110	0.15	0	0	0
P285	J154	J150	74	200	110	0.06	0	0	0
P287	J108	J118	319.98	200	110	-0.24	0.01	0	0
P289	J92	J96	27.14	200	110	0.55	0.02	0	0
P291	J61	J86	86	200	110	0.83	0.03	0	0.01
P293	RES9002	J10	86.01	500	100	43.51	0.22	0.02	0.19
P295	J10	J12	1,661.76	500	100	20.81	0.11	0.08	0.05
P297	J12	J34	2,112.20	900	110	20.81	0.03	0	0
P299	J34	J30	4,399.86	500	100	13.63	0.07	0.1	0.02
P301	J30	J32	2,851.28	400	100	13.63	0.11	0.18	0.06
P303	J32	J48	3,361.93	300	100	13.63	0.19	0.88	0.26
P305	J34	J50	3,111.60	300	100	15.97	0.23	1.09	0.35

P307	J10	J14	797.16	500	100	22.7	0.12	0.04	0.06
P309	J14	J16	1,221.54	600	100	22.7	0.08	0.03	0.02
P311	J16	J18	470.28	750	110	12.2	0.03	0	0
P313	J18	J22	1,548.93	750	110	12.2	0.03	0	0
P315	J22	J20	1,072.22	675	110	-10.5	0.03	0	0
P317	J20	J16	522.61	675	110	-10.5	0.03	0	0
P319	J22	J24	646.92	750	110	22.7	0.05	0	0.01
P321	J24	J26	1,243.18	1,050.00	110	22.7	0.03	0	0
P323	J26	J28	2,311.48	1,050.00	110	8.79	0.01	0	0
P325	J28	J34	1,713.46	900	110	8.79	0.01	0	0
P327	J26	J54	5,813.55	300	120	13.91	0.2	1.12	0.19
P67	J50	J54	625.87	300	100	5.83	0.08	0.03	0.05
P69	J54	J52	553.99	300	100	5.31	0.08	0.03	0.05
P71	J48	J56	68.85	300	100	9.6	0.14	0.01	0.14
P73	J56	J58	82.96	300	100	3.3	0.05	0	0.02
P75	J58	J60	68.96	300	100	1.69	0.02	0	0.01
P77	J60	J61	123.38	300	100	1.26	0.02	0	0
P79	J62	J64	53.37	300	100	0.34	0	0	0
P81	J64	J66	562.58	300	100	-1.94	0.03	0	0.01
P83	J66	J50	494.21	300	100	-10.14	0.14	0.07	0.15
P85	J52	J168	835.35	300	100	5.31	0.08	0.04	0.05
P87	J168	J166	511.41	300	100	5.31	0.08	0.02	0.05
P89	J166	J164	194.82	300	100	-2.62	0.04	0	0.01
P91	J164	J140	156.88	300	100	-3.07	0.04	0	0.02
P93	J140	J134	37.52	300	100	-5.58	0.08	0	0.05
P95	J134	J130	122.63	300	120	-6.17	0.09	0.01	0.04
P97	J130	J124	309.64	300	100	-7.71	0.11	0.03	0.09
P99	J124	J56	51.42	300	100	-6.94	0.1	0	0.07

APPENDIX

H SANITARY DRAINAGE PLAN (SA1) AND DESIGN SHEET



No.	REVISIONS TO DRAWING	BY	DATE	APPR.
1	FIRST DPA SUBMISSION	ZB/VL	2023/02/03	ADR

ALL PREVIOUS ISSUES OF THIS DRAWING ARE SUPERSEDED

CLIENT
EMPIRE (GRAND NIAGARA) PROJECT GP INC.

MUNICIPALITY
CITY OF NIAGARA FALLS

PROJECT TITLE
GRAND NIAGARA MIXED-USE SUBDIVISION

SHEET TITLE
PRELIMINARY SANITARY DRAINAGE PLAN

CONSULTANT
wsp
100 Commerce Valley Dr. West, Thornhill, ON Canada L3T 0A1
t: 905.882.1100 f: 905.882.0055 www.wsp.com

STAMP

APPROVAL

DESIGNED	DRAWN	CHECKED
ZB/VL	ZB/VL	ADR

SCALE	DATE
1:2500	JANUARY 2023

PROJECT NUMBER	DWG. NUMBER
211-08936	SA1

APPENDIX F

SANITARY FLOW GENERATION

Project: **Grand Niagara Mixed-Use Subdivision**
Job No.: **211-08936**

Proposed Development

Catchment ID	Land Use Category	Area [1] (ha)	Population Density [2] (persons/ha)	Population
101	R1/R2	12.1	45.5	550
102	Institutional	2.4	96.4	230
103	R3/R4	3.2	96.4	310
104	R3/R4	2.0	96.4	195
105	R5F	2.8	355.8	995
106	R1/R2	15.8	45.5	720
107	R3/R4	1.2	96.4	115
108	Institutional	3.6	96.4	345
109	R3/R4	1.1	96.4	105
110	R5F	2.1	355.8	745
111	R1/R2	7.3	45.5	330
112	R3/R4	2.6	96.4	250
113	R3/R4	3.8	96.4	365
114	R1/R2	1.7	45.5	75
115	R3/R4	3.8	96.4	365
116	R3/R4	7.1	96.4	685
117	GC	8.5	180.4	1535
118	R5F	4.2	355.8	1495
119	GC	2.2	180.4	395
120	GC	1.9	180.4	345
	TOTAL	**89.40**		**10,150**

Design Flows

Building	Population (see above)	Per Capita Flow [3] (L/cap/day)	Daily Wastewater Generation (L/s)	Peaking Factor [4]	Peak Flow (L/s)
Residential	7,300	380.00	32.11		
Non-Residential	2,850	380.00	12.53		
TOTAL	**10,150**	**380.00**	**44.64**	**2.95**	**131.61**

Site Area [1] = 89.40 ha
I/I = 16.09 L/s (0.18 L/s/ha for new installations)
Total Design Flow = 147.70 L/s

Note 1: Drainage areas per Preliminary Sanitary Drainage Plan (Dwg. No. SA1)
Note 2: Population densities per the City of Niagara Falls Storm and Sanitary Sewers Design Criteria.
Note 3: Design flow rates per the City of Niagara Falls Storm and Sanitary Sewers Design Criteria. City criteria does not define a population density for R5F land use - it has been assumed to be equivalent to R4F.

Note 4: Peaking factor derived using Harmon Formula, per the City of Niagara Falls Storm and Sanitary Sewers Design Criteria. Minimum peaking factor is 2.00. Maximum peaking factor is 4.00.

M = 1 + 14 / (4+p^0.5) = PEAKING FACTOR

p = POPULATION /1000

q = 380L /PERSON /DAY

Q = Mqp / 86400 = POPULATION FLOW IN m^3/s

INFILTRATION RATE = 0.18L /s /ha

MANNING'S n = 0.013

POPULATION DENSITIES:

R1/R2	45.5	PERSON / HECTARE	0.0000044	FLOW/PERSON	0.0002001 FLOW/AREA (m^3/ha)
R3/R4	96.4	PERSON / HECTARE	0.0000044	FLOW/PERSON	0.0004240 FLOW/AREA (m^3/ha)
R5F*	355.8	PERSON / HECTARE	0.0000044	FLOW/PERSON	0.0015649 FLOW/AREA (m^3/ha)
GENERAL COMMERCIAL	180.4	PERSON / HECTARE	0.0000044	FLOW/PERSON	0.0007934 FLOW/AREA (m^3/ha)
INSTITUTIONAL	96.4	PERSON / HECTARE	0.0000044	FLOW/PERSON	0.0004688 FLOW/AREA (m^3/ha)

*Assumed to be Equivalent to RF4. City of Niagara Falls Storm and Sanitary Sewers Design Criteria does not define a population density for R5F land use.

NIAGARA REGION

SANITARY SEWER DESIGN

CONSULTANT: WSP CANADA INC.
SUBDIVISION: GRAND NIAGARA MIXED-USE SUBDVISION
PROJECT NO.: 211-08936

LOCATION		SECTION					CUMMULATIVE				M	PEAK	DESIGN	LENGTH	PIPE	TYPE	SLOPE	Flow Capacity	FULL FLOW VEL.	ACTUAL VELOCITY	Capacity Used
Block	CATCHMENT ID (REFER TO DWG. No. SA1)	TYPE	POP.	AREA ha	AVERAGE DRY WEATHER FLOW m^3/s	INFIL. m^3/s	POP.	AREA ha	ADW FLOW m^3/s	INFIL. m^3/s		FLOW m^3/s	FLOW m^3/s	OF SEWER m	SIZE mm	OF PIPE	%		m/s	m/s	%
Grassy Brook Sanitary																					
Grand Niagara Property	106	R1/R2	720	15.80	0.0032	0.0028															
	107	R3/R4	115	1.20	0.0005	0.0002															
	108	Institutional	345	3.60	0.0017	0.0006															
	111	R1/R2	330	7.30	0.0015	0.0013															
	112	R3/R4	250	2.60	0.0011	0.0005															
	113	R3/R4	365	3.80	0.0016	0.0007															
	114	R1/R2	75	1.70	0.0003	0.0003															
	115	R3/R4	365	3.80	0.0016	0.0007															
Existing Grassy Brook Road	-	-	*2565*	*39.80*	*0.0115*	*0.0072*	*2565*	*39.80*	*0.0115*	*0.0072*	*3.499*	*0.0402*	*0.0473*		*300*		*0.30*	*0.0530*	*0.75*		*89.40%*
Grand Niagara Property	101	R1/R2	550	12.10	0.0024	0.0022															
	102	Institutional	230	2.40	0.0011	0.0004															
	103	R3/R4	310	3.20	0.0014	0.0006															
	104	R3/R4	195	2.00	0.0008	0.0004															
	105	R5F*	995	2.80	0.0044	0.0005															
	109	R3/R4	105	1.10	0.0005	0.0002															
	110	R5F*	745	2.10	0.0033	0.0004															
Existing Grassy Brook Road	-	-	*3130*	*25.70*	*0.0139*	*0.0046*	*5695*	*65.50*	*0.0254*	*0.0118*	*3.192*	*0.0810*	*0.0928*		*375*		*0.30*	*0.0960*	*0.87*		*96.61%*
Reixinger Road Sanitary																					
Grand Niagara Property	116	R3/R4	685	7.10	0.0030	0.0013															
	117	General Commercial	1535	8.50	0.0067	0.0015															
	118	R5F*	1495	4.20	0.0066	0.0008															
	119	General Commercial	395	2.20	0.0017	0.0004															
	120	General Commercial	345	1.90	0.0015	0.0003															
	Future Development	General Commercial	485	2.70	0.0021	0.0005															
External Properties	Future Development (BO)	General Commercial	720	4.00	0.0032	0.0007															
	Future Development (BO)	-	-	17.00	-	-							0.0323								
	Future Hospital	-	-	-	-	-							0.0365								
Reixinger Road (By Parsons)	-	-	*5660*	*47.60*	*0.0249*	*0.0055*	*5660*	*47.60*	*0.0249*	*0.0055*	*3.195*	*0.0795*	*0.1539*		*450*		*0.50*	*0.2016*	*1.27*		*76.32%*

APPENDIX

I

TECHINICAL MEMORENDUM – GRAND NIAGARA DEVELOPMENT SANITARY SERVICING ANAYLISIS

TECHNICAL MEMORENDUM – GRAND NIAGARA DEVELOPMENT: SANITARY SERVICING ANALYSIS

TO: Empire (Grand Niagara) Project LP

FROM: WSP Canada Inc.

SUBJECT: Grand Niagara Development – Sanitary Servicing Design Alternative Analysis
Grand Niagara Development – Sanitary Servicing Design Alternative Analysis

DATE: February 3rd, 2023

1 INTRODUCTION

WSP Canada Inc. (WSP) has been retained by Empire (Grand Niagara) LP (Empire) for consulting services in support of the Draft Plan Approval of the Grand Niagara Development in Niagara Falls, Ontario. The purpose of this technical memorandum is to present preliminary design alternatives for sanitary servicing of the proposed development prior to the completion of the South Niagara Falls Wastewater Treatment Plant and improvements on Montrose Road.

1.1 SITE DESCRIPTION

The Secondary Plan area occupies land bounded by Biggar Road to the south, the Welland River to the North, Crowland Road to the West, the Queen Elizabeth Way (QEW) to the East, in the City of Niagara Falls. The Subject Lands have a total area of 330 hectares (815 acres) with the majority of the lands currently occupied by a golf course, some residential uses along Grassy Brook Road, and employment uses along the east and west sides of Montrose Road. A Canadian Pacific (CP) rail line runs diagonally through the site.

The majority of the site is owned by Empire. The remaining lands are owned by other property owners who have been notified of the Secondary Plan process.

The Secondary Plan proposes redeveloping the site by replacing the existing golf course and surrounding lands with a complete community containing residential, commercial, institutional (including a hospital), employment, community facilities, park and open space uses. Figure 1illustrates the proposed development plan for the site.

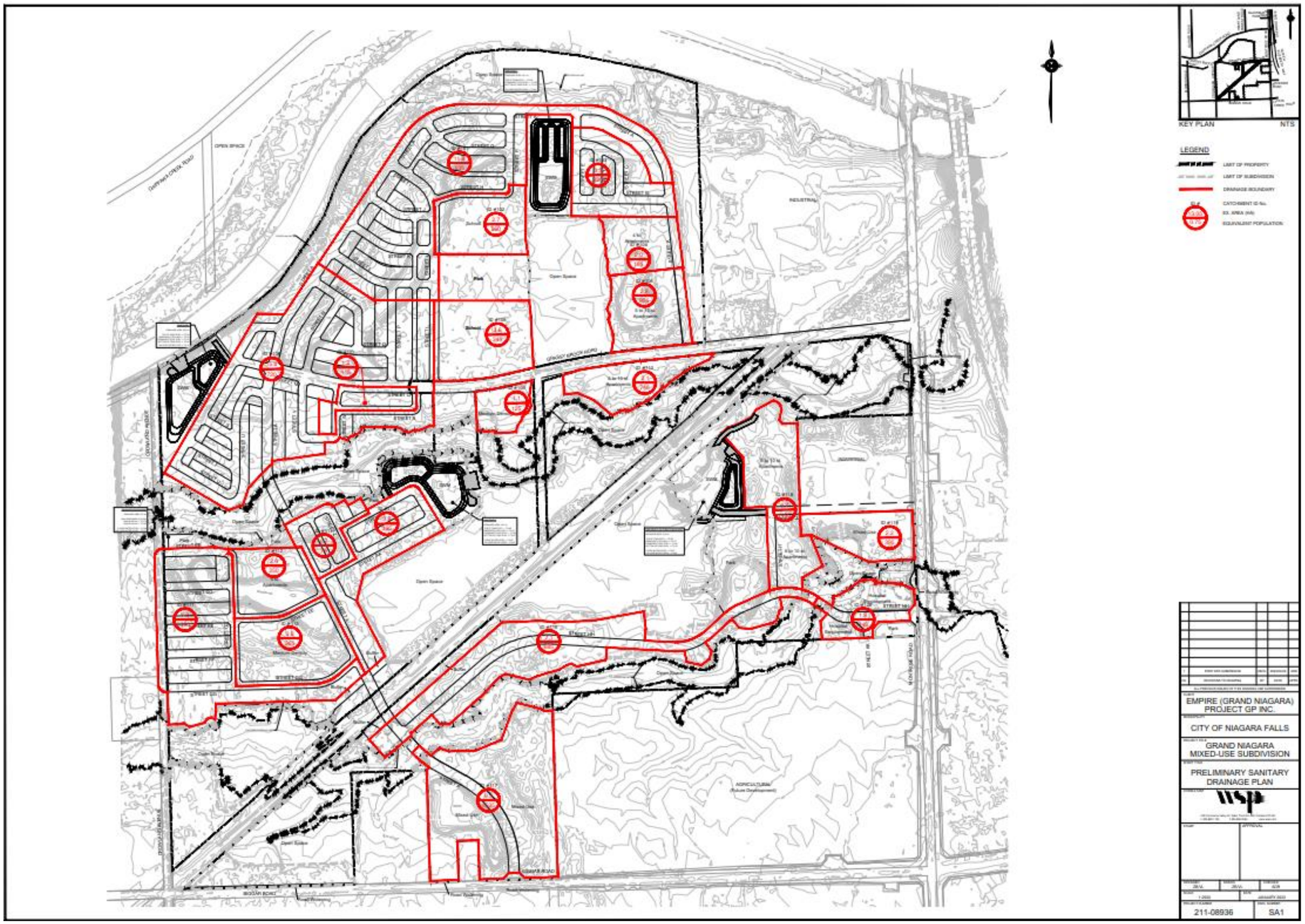


Figure 1. Proposed Development Plan

The development area including residential, institutional, and commercial areas will potentially be separated into multiple phases as part of a Master Plan. Each phase consists of different subdivisions as shown in Figure 2. Table 1 represents the detail of the development plan phasing.

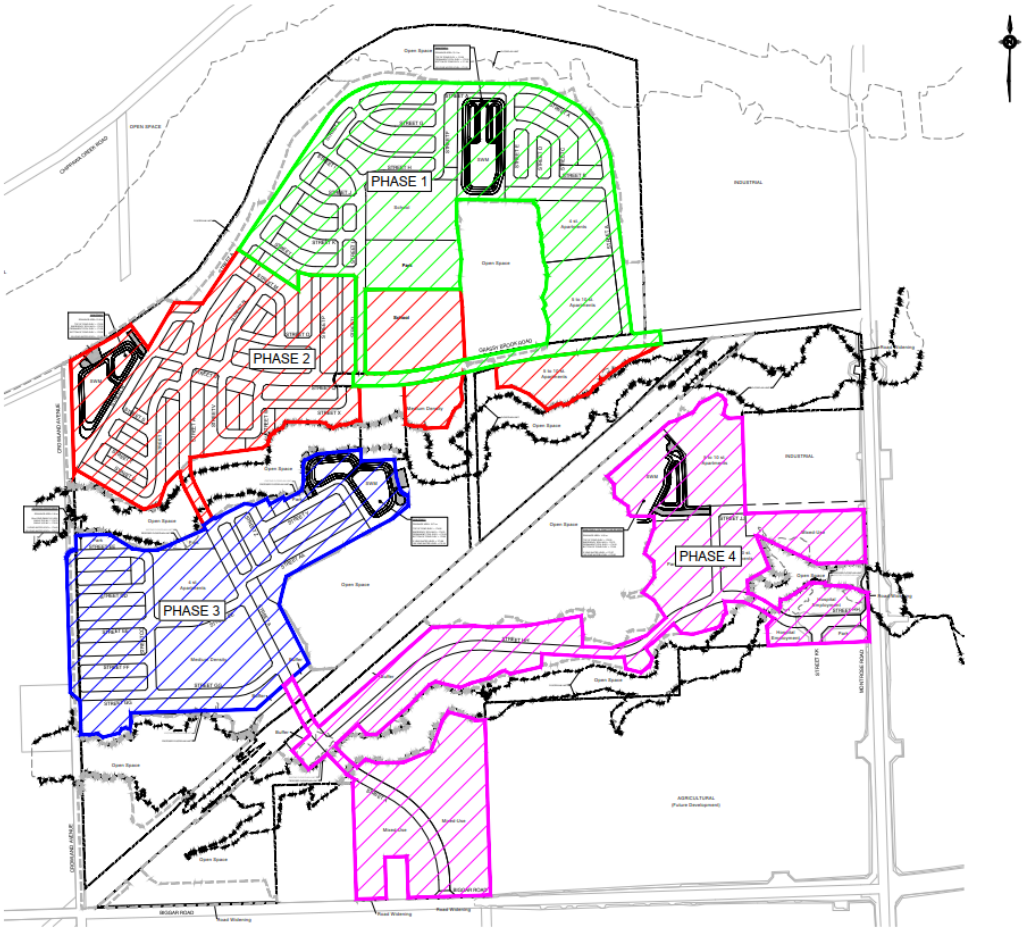


Figure 2 Secondary Plan Land Phasing

Table 1. Detail of the Proposed Development Plan

PHASE	SUBDIVISIONS	DEVELOPABLE AREA (HA)	NUMBER OF UNITS/JOBS
1	101 to 105	22.5	2,280
2	106 to 110	23.8	2,030
3	111 to 115	19.2	1,385
4	116 to 120	23.9	4,455
Total		89.4	10,150

1.2 REFERENCE MATERIALS

To review and assess the existing wastewater infrastructure within the vicinity of the Secondary Plan area, and to determine design criteria requirements to service the site, the following documents were reviewed:

1. Region of Niagara Wastewater Master Servicing Plan (W&WWMSP, by AECOM, 2016)
2. City of Niagara Falls Engineering Design Guidelines Manual (amended January 2012)
3. Record Drawings:
4. Grassy Brook Road As-Constructed Plan/Profiles
5. Montrose Road Drive As-Constructed Plan/Profiles
6. Grassy Brook Sewage Pumping Station As-Constructed Site Plan/SCADA Drawings
7. Ministry of Environment Design Guidelines for Sewage Works (MOE, 2008)
8. Ministry of Environment C of A for the Grassy Brook SPS
9. Preliminary Municipal Servicing Report (14.15039) and Grand Niagara Proposed Secondary Plan
10. Schedule 'C' Municipal Class EA Environmental Assessment - South Niagara Falls Wastewater Solutions Environmental Study Report for public review

2 EXISTING SANITARY COLLECTION SYSTEM

This section discusses existing conditions of the system as a whole and in vicinity of the Secondary Plan area.

2.1 GRASSY BROOK SANITARY PUMPING STATION (SPS)

The Grassy Brook SPS receives sewage from the gravity sewers at invert elevation of 164.67 m and pumps it to a gravity sewer north via approximately 1838m of 150 mm diameter forcemain.

As per the Grassy Brook SPS Environmental Compliance Approval (ECA) – No. 7765-6XGS37, shown in Appendix A, the SPS:

- Has an existing rated capacity of 20.9 L/s.
- Is equipped with a rectangular wet well that has an ultimate rated capacity of 138 L/s.
- Is equipped with two pumps (one duty, one standby), each with a rated capacity of approximately 20.9 L/s at a Total Dynamic Head (TDH) of 33.6 m.

The rated capacity of the existing pump is presented in Figure 3. Pump curve is provided by Xylem as shown in Appendix A.

The existing Grassy Brook SPS has room to readily accommodate a 3rd pump. Should a third pump be added under the existing design conditions, the capacity of the SPS with 2 duty pumps (and a third standby pump), would marginally increase to 22.5 L/s. Refer to Appendix B for hydraulic calculations. It should be indicated, that in accordance with Master Plan, the highest allowable capacity in the forcemain at 2.5 m/s is 44.2 L/s. It requires replacing the existing pumps with larger pumps and upgrading the primary and secondary power as well as the MCC in Grassy Brook SPS.

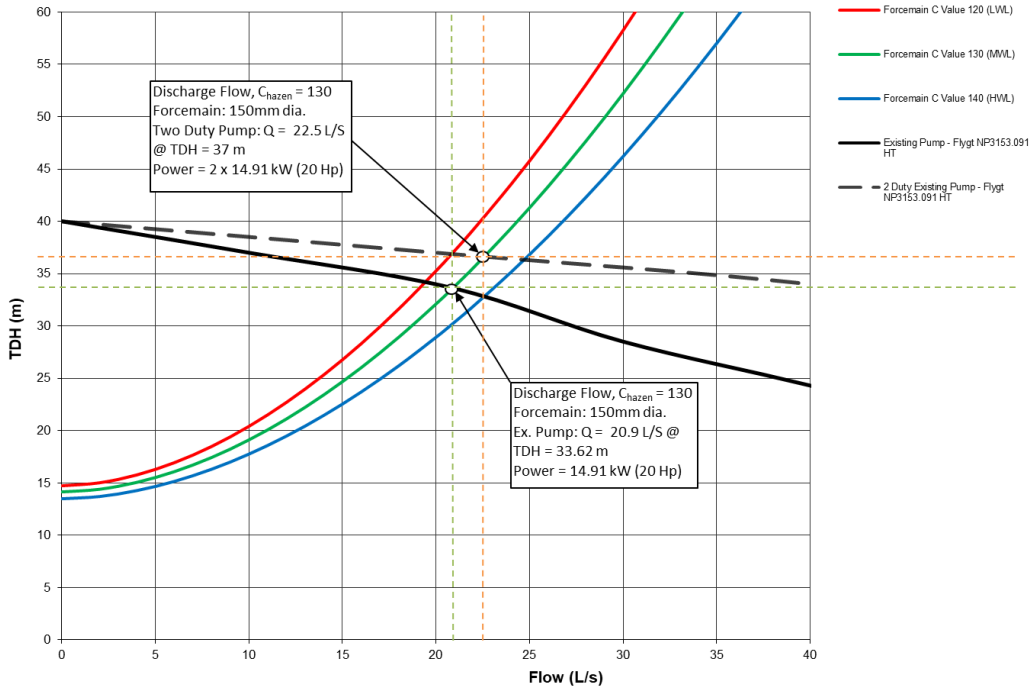


Figure 3. Grassy Brook SPS Pump Curve & Ex. Forcemain System Curve

2.2 GRASSY BROOK SPS CATCHMENT AREA

The existing sanitary sewers within the Grassy Brook SPS catchment area are as follows:

1. 300/375mm diameter sanitary sewer with an approximate length of 1470m which runs east-west along Grassy Brook Road, connecting to Montrose Road to the East and terminating at the Northwest corner of the site
2. 300mm/450mm diameter sanitary sewer with an approximate length of 1550m which runs north-south along Montrose Road, starting at Lyon's Creek Road to the South continuing northward up to the Grassy Brook SPS located on the east side of Montrose Road, approximately 50m north of the intersection.

The existing gravity sewer system was constructed to service parts of the lands within the Grand Niagara golf course and surrounding areas. The existing commercial/industrial properties fronting onto Montrose Road and the existing Grand Niagara golf clubhouse and maintenance building either connect to the existing sewers or have allocation to connect to them. An additional leg of gravity sewer connects from north of the Grassy Brook SPS, providing sanitary service to the E.S. Fox factory north of the SPS. Figure 4 shows the sanitary sewage network.

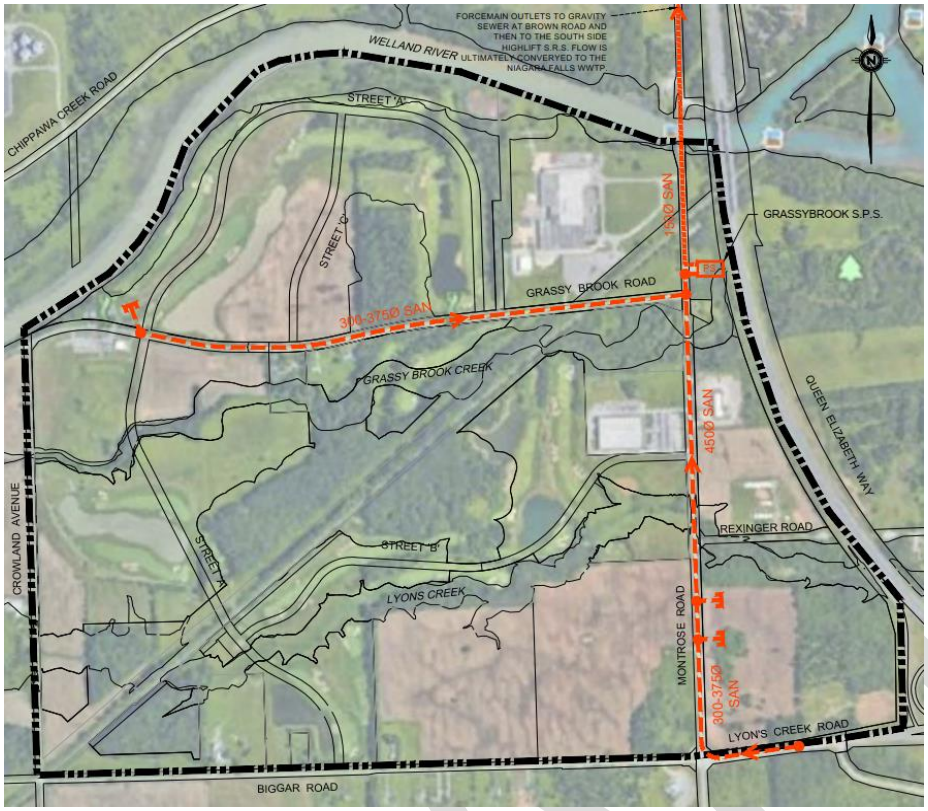


Figure 4. Existing Sanitary Sewage Network

2.3 GRASSY BROOK SPS FORCEMAIN

MECP Recommends maintaining the velocity in a range of 0.6 m/s to 1.1 m/s, with a maximum velocity of 3.0 m/s. It is recommended to maintain a scouring velocity in the range of 0.8 m/s to 1.1 m/s, owing the pump selection, energy management/efficiency, and forcemain design life cycle.

The velocity of the 150mm dia. Grassy Brook SPS forcemain is 1.2 m/s at the rated capacity of 20.9 L/s. Should a third identical pump be added under the existing design conditions, the capacity of the SPS with 2 duty pumps (and a third standby pump), would marginally increase to 22.5 L/s and the velocity would be 1.3 m/s. It determines that the existing forcemain is undersized for projected increases in sanitary flow. However, in accordance with Master Plan, a maximum flowrate of 44.2 L/s (@2.5 m/s) in the existing forcemain is acceptable.

3 GRASSY BROOK SEWAGE PUMPING STATION SCADA DATA AND EXTRANEOUS FLOW ANALYSIS

3.1 MONTHLY DISCHARGE FLOWRATE SCADA DATA ANALYSIS

Region has provided WSP with the Grassy Brook SPS hourly discharge flowrate SCADA data for 2021. The average daily flow of the SPS is always below 4 L/s while peak hourly flow reaches as high as 18.3 L/s. Table 2 below presents the average daily and peak hourly flows for each month in 2021. Figures 4 to 15 present the highest peak flow rate event for each month from January to

December 2021. The green line on each figure represented the actual average daily discharge flowrate for each month.

From Figures 5 to 16, the Grassy Brook SPS experienced high discharge flowrates during the months of January, March, July, September, and October. While most of these are reflective of seasonal snowmelt and/or Spring and Fall rain events, the month of July 2021 experienced a significant rainfall event (Link) which lasted for approximately 36 hours. Similarly in January, the high discharge flowrate lasted for approximately 24 hours. Table 3 represents the durations the theoretical discharge flowrate of 10 L/s was exceeded by the Grassy Brook SPS in each month.

Table 2 Grassy Brook SPS Hourly Flow SCADA Data for 2021

	AVERAGE DAILY FLOW L/S	MAX. DAILY FLOW (PEAK DAILY FLOW) L/S	PEAK HOURLY FLOW L/S
January	2.3	10.8	13.3
February	1.4	4.5	7.8
March	2.3	8.7	10.3
April	1.6	2.9	3.4
May	1.4	2.7	3.8
June	1.3	1.9	5.3
July	3.4	13.5	18.3
August	1.2	2.1	5.6
September	3.2	8.8	16.3
October	2.9	9.1	13.6
November	2.4	6.6	8.1
December	2.7	6.4	7.9
Year 2021	**2.2**	**13.5**	**18.3**

Table 3. The durations the theoretical discharge flowrate was exceeded

	PEAK HOURLY FLOW L/S	DURATION (HOURS) (GREATER THAN 10 L/S)
January	13.3	24
February	7.8	0
March	10.3	1
April	3.4	0
May	3.8	0
June	5.3	0
July	18.3	36
August	5.6	0
September	16.3	6
October	13.6	4
November	8.1	0
December	7.9	0
Year 2021	**18.3**	

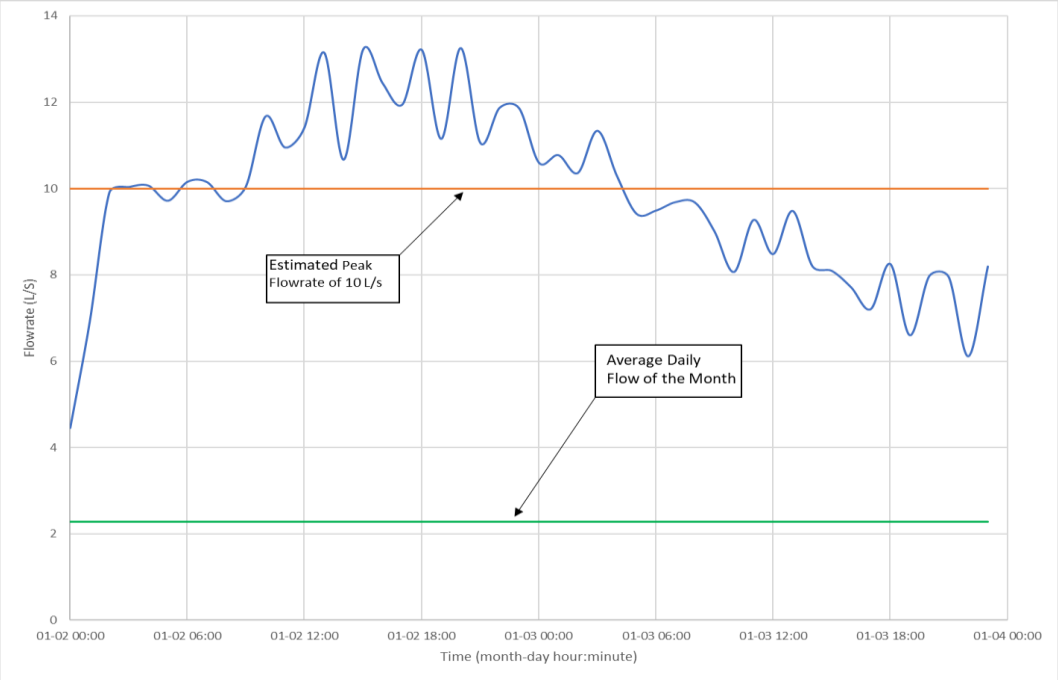


Figure 5. Peak Flow Event: January 2021

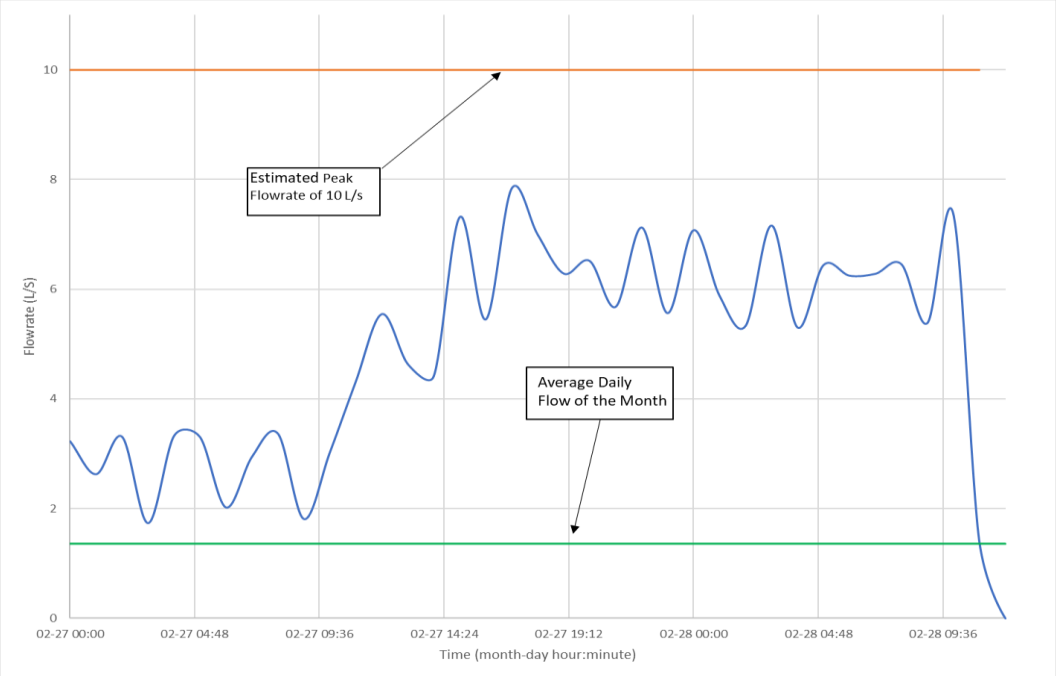


Figure 6. Peak Flow Event: February 2021

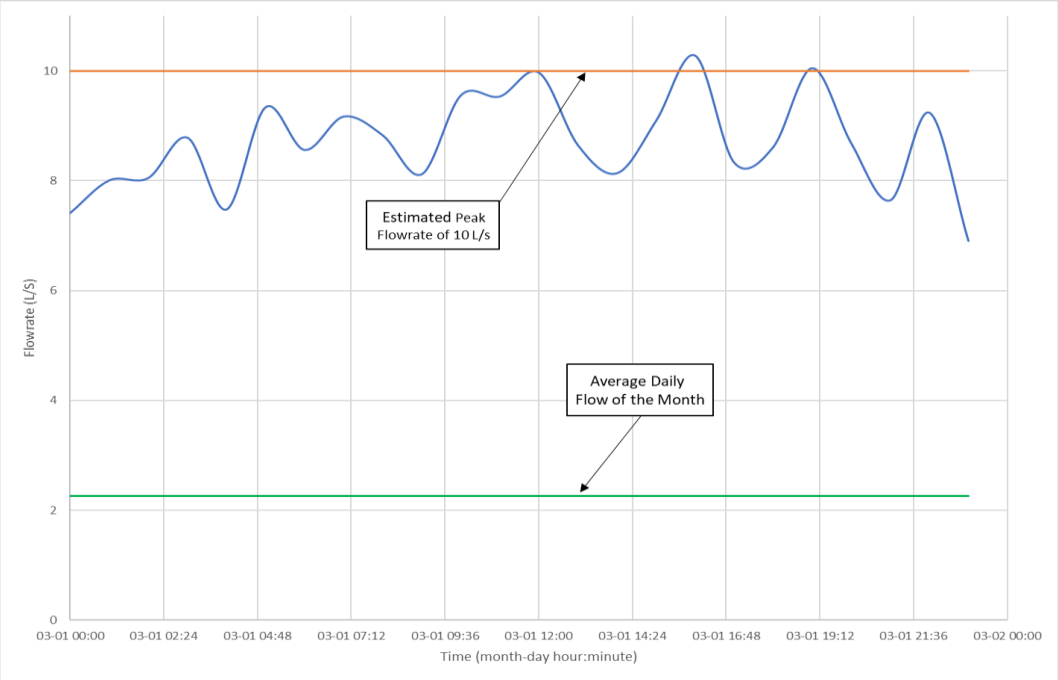


Figure 7. Peak Flow Event: March 2021

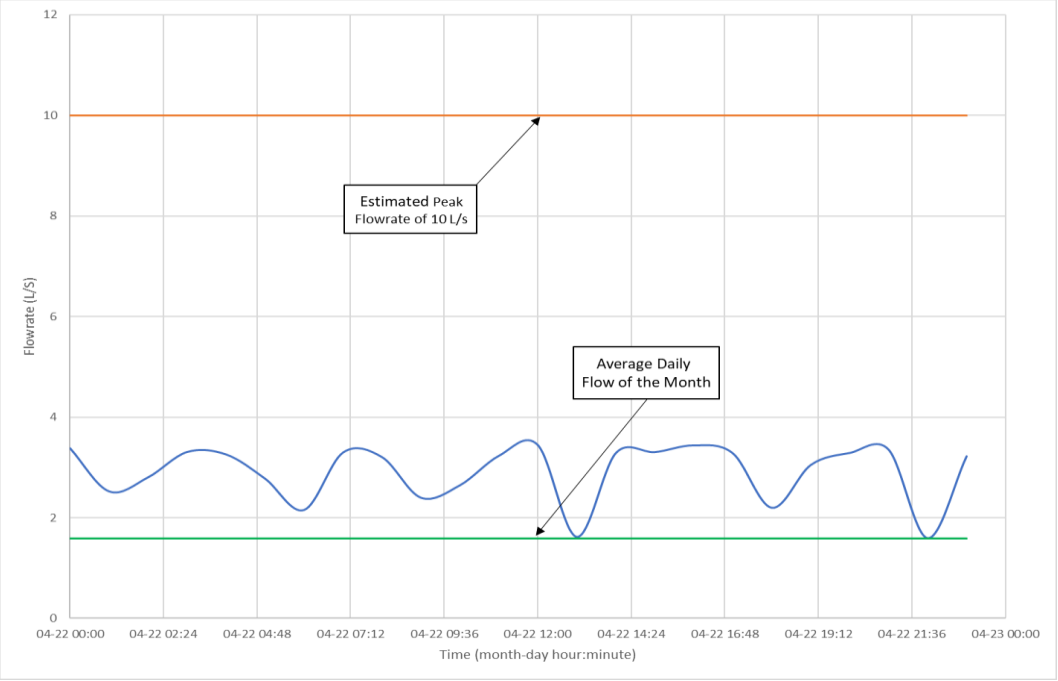


Figure 8. Peak Flow Event: April 2021

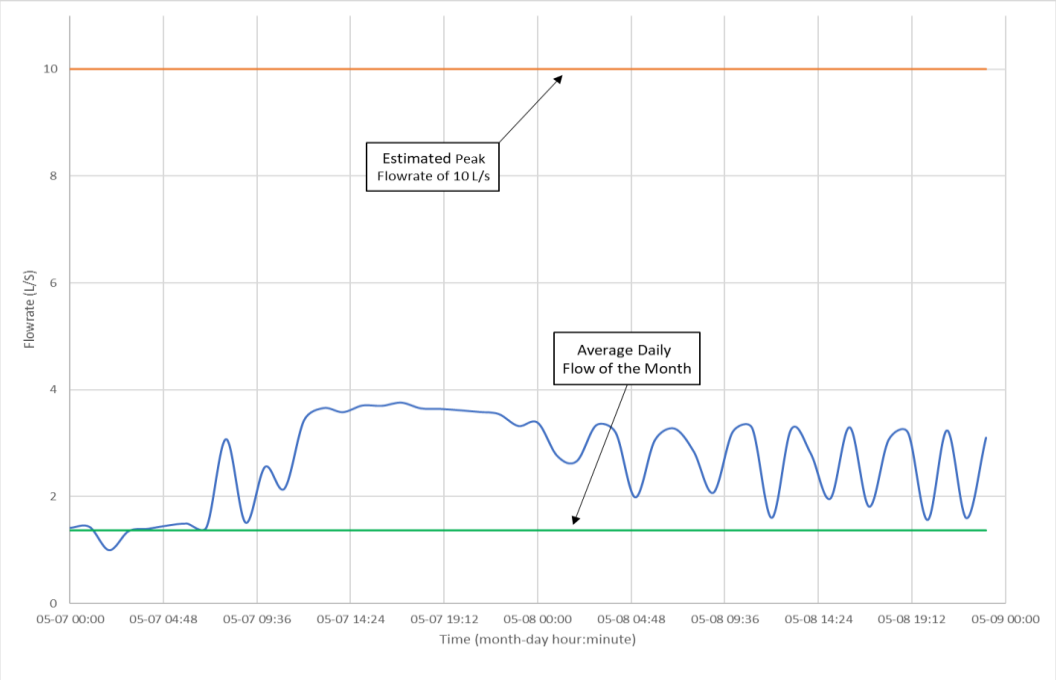


Figure 9. Peak Flow Event: May 2021

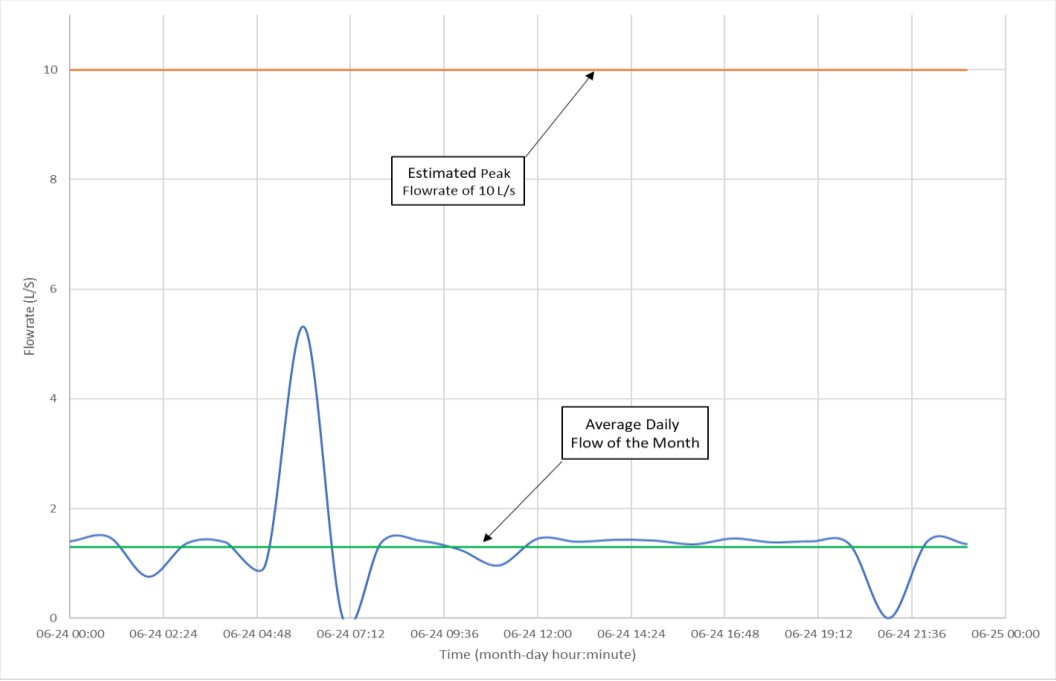


Figure 10. Peak Flow Event: June 2021

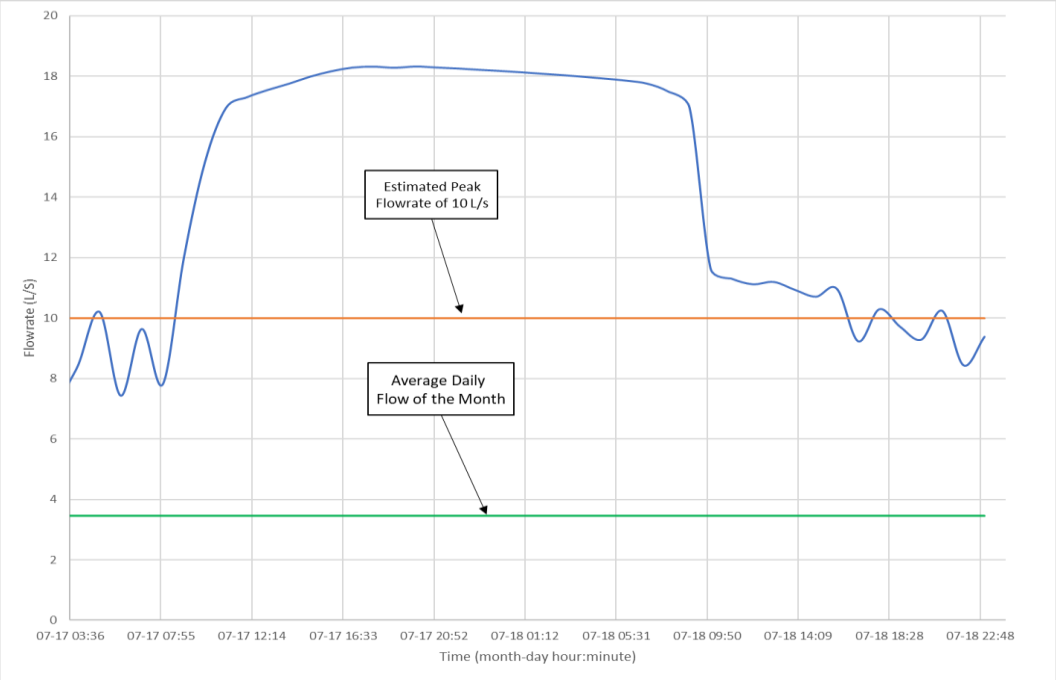


Figure 11. Peak Flow Event: July 2021

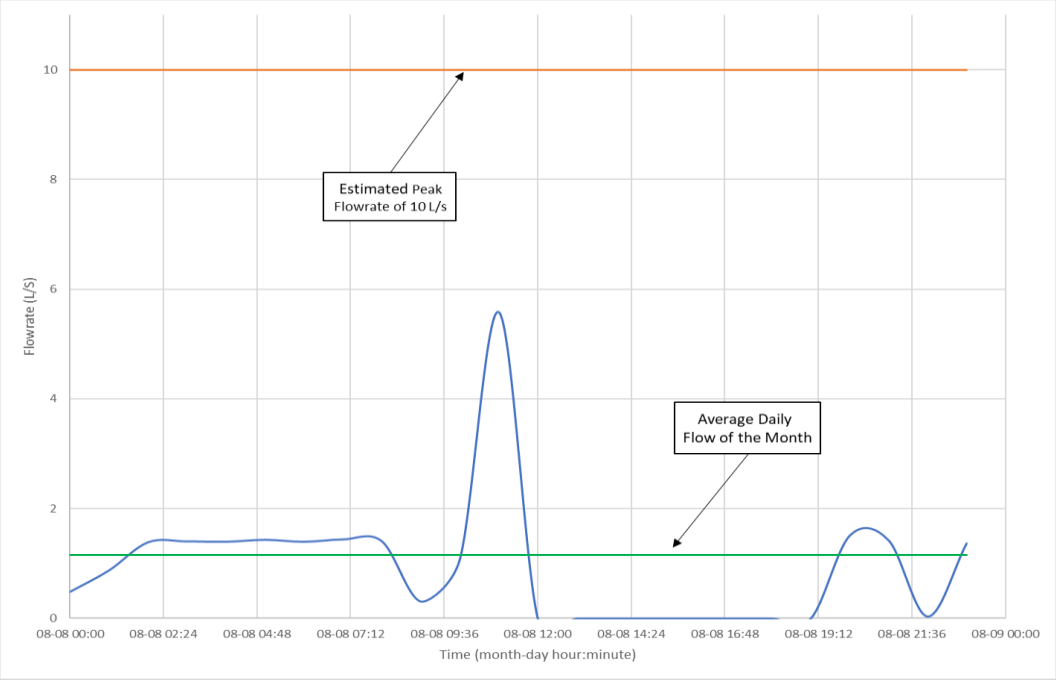


Figure 12. Peak Flow Event: August 2021

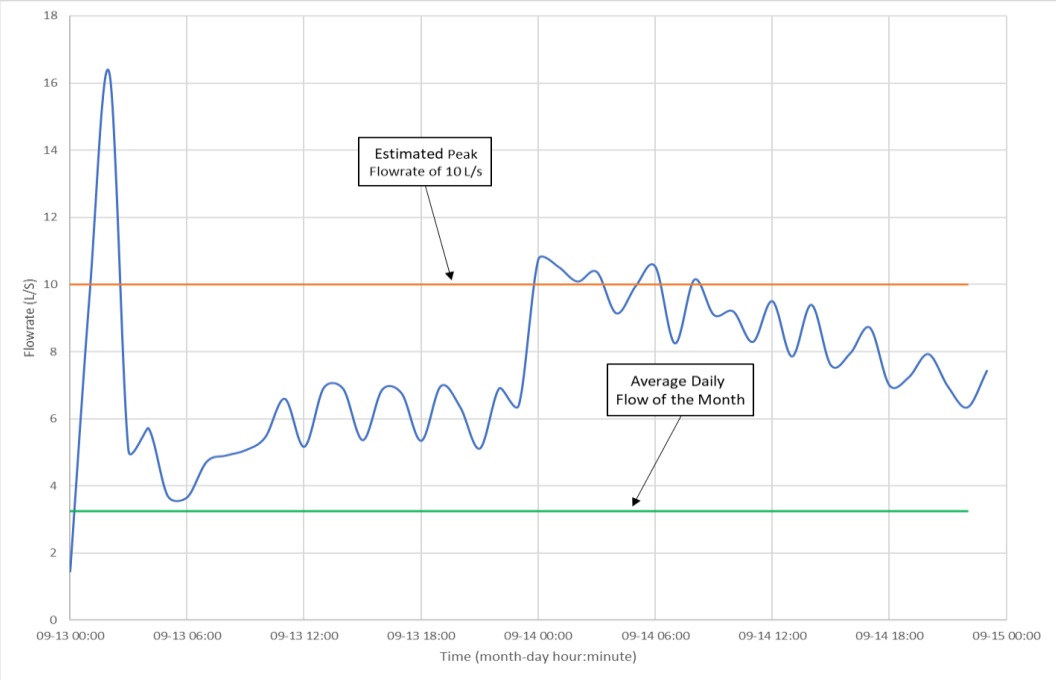


Figure 13. Peak Flow Event: September 2021

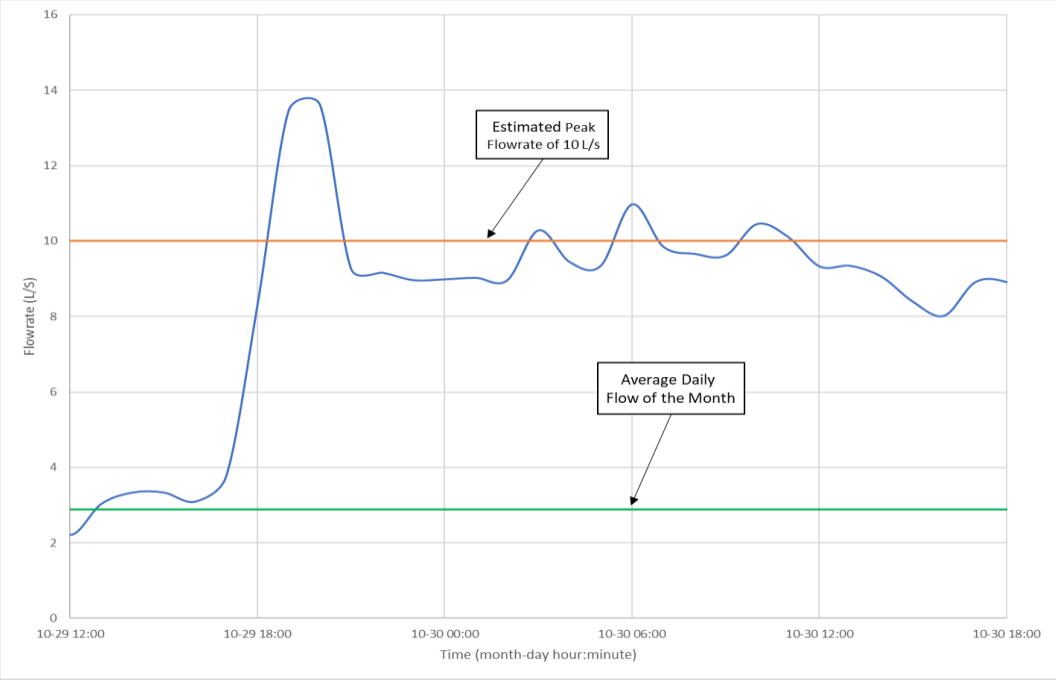


Figure 14. Peak Flow Event: October 2021

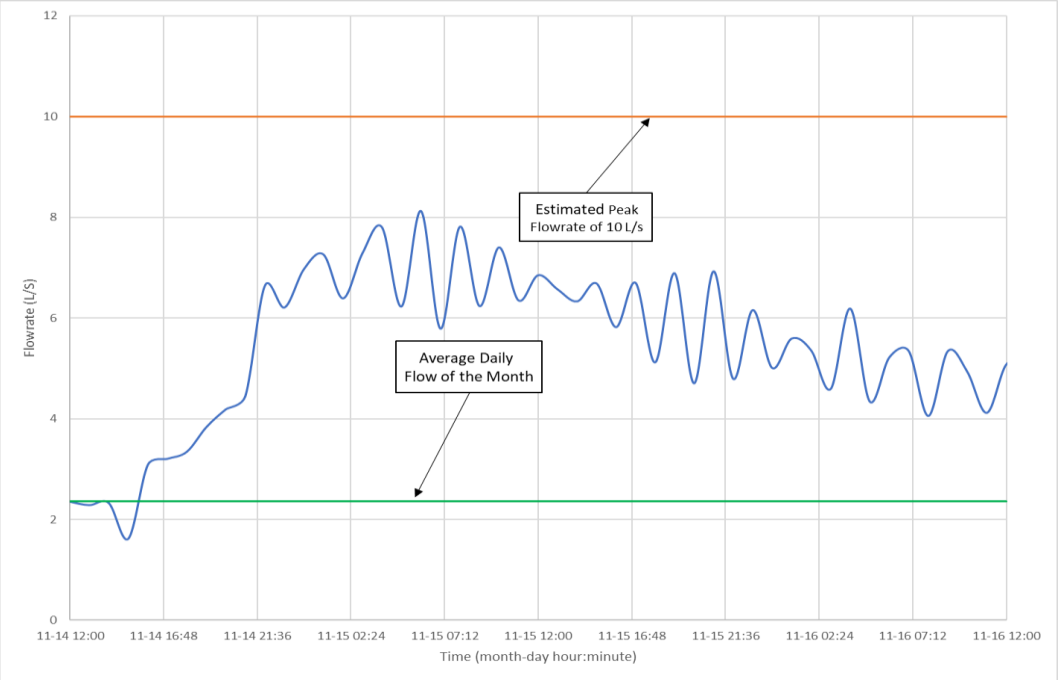


Figure 15. Peak Flow Event: November 2021

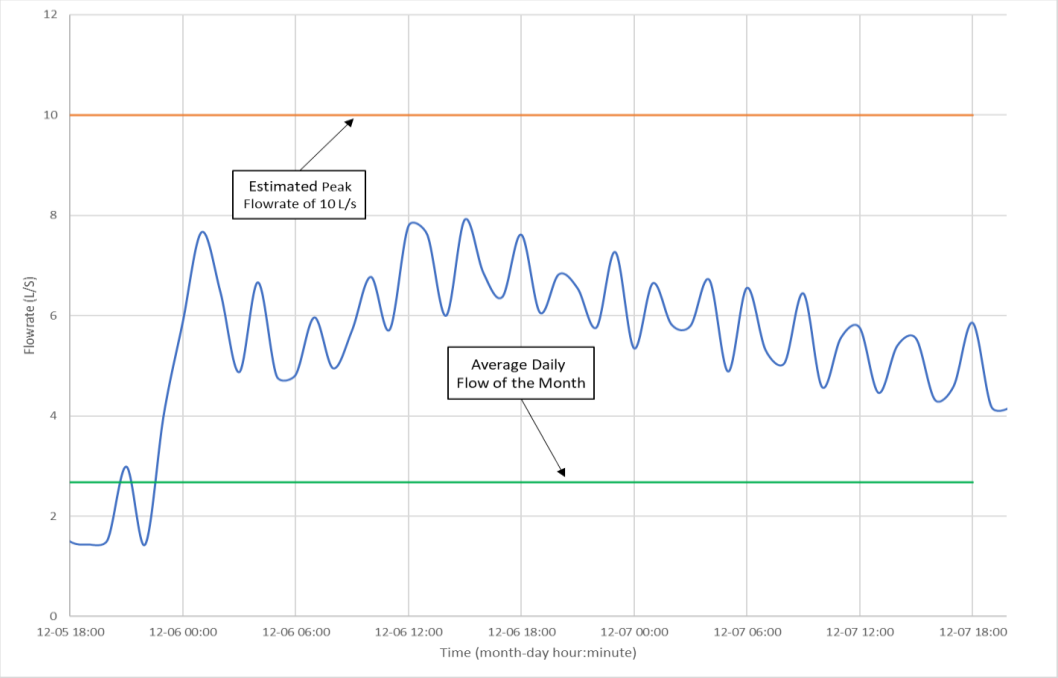


Figure 16. Peak Flow Event: December 2021

3.2 EXTRANEOUS FLOW CRITICAL ANALYSIS

It is clear from the SCADA data, that the flowrates being discharged from the SPS is unrealistically high, given the low build-out of the existing sanitary catchment area. We understand that the following upgrades to improve I&I have been made by Region and City staff in April/May of 2022:

- Significant quantities of inflow and infiltration have been detected and repaired/grouted at Maintenance Hole SMH – 8 (intersection of Montrose Road and Biggar Road)
- Maintenance Hole SMH05938 with defective stub was found and repaired. The stub at this inlet was originally installed in 2007.

We also understand that the following items represent additional improvements to reduce I&I within the existing sanitary catchment area:

- Additional areas of concern are along Montrose Road and Grassy Brook Road where I&I can enter the maintenance hole lids as a result of localized flooding.
- There is a potential cross connection between a catch basin (CB) at the ES Fox site, and the inlet to the sanitary sewer on Grassy Brook Road at Maintenance Hole SMH1262.

As a next steps, while SCADA data will be requested to analyze the quality of the improvements, we offer the following analysis of conventional I&I flowrates to this existing catchment area given existing development.

3.2.1 EXTRANEOUS FLOW CALCULATIONS

An infiltration allowance of no more than 1.85 L per day per mm diameter per 100 m of sewer is recommended for new constructed sewers by American Environmental Protection Agency (EPA). An alternate EPA method suggests that system-wide infiltration rates under 13.9 $^{L}/_{day.mm_{dia.}.100m_{sewer}}$ are acceptable. This criterion suggests an infiltration range of 0.3 L/s to 2 L/s seeping into Grassy Brook sewer system as per details represented in Table 4.

Table 4 Grassy Brook SPS Infiltration Flow Analysis

SEWER SECTIONS	LENGTH (M)	DIAMETER (MM)	INFILTRATION L/S (FOR NEW SEWERS)	INFILTRATION L/S (MAX. ACCEPTABLE)
Grassy Brook Road	1,466	375	0.12	0.88
Montrose Road	1,000	450	0.10	0.72
Lyon's Creek Road to Montrose Road	550	375	0.04	0.33
Total	**3,016**		**0.3**	**2**

In addition, the existing gravity sewer system was constructed to service parts of the lands within the Grand Niagara golf course and surrounding areas represented in Figure 17. An extraneous flow rate of 0.286 L/ha/s is utilized for extraneous flow calculations of Grassy Brook SPS catchment areas as per Niagara Region Master Servicing Plan (2016). Table 5 represents all the businesses within the Grassy Brook SPS catchment area along with their associated surface area and extraneous flows entering the sewer system. The total extraneous flow is 4.6 L/s.

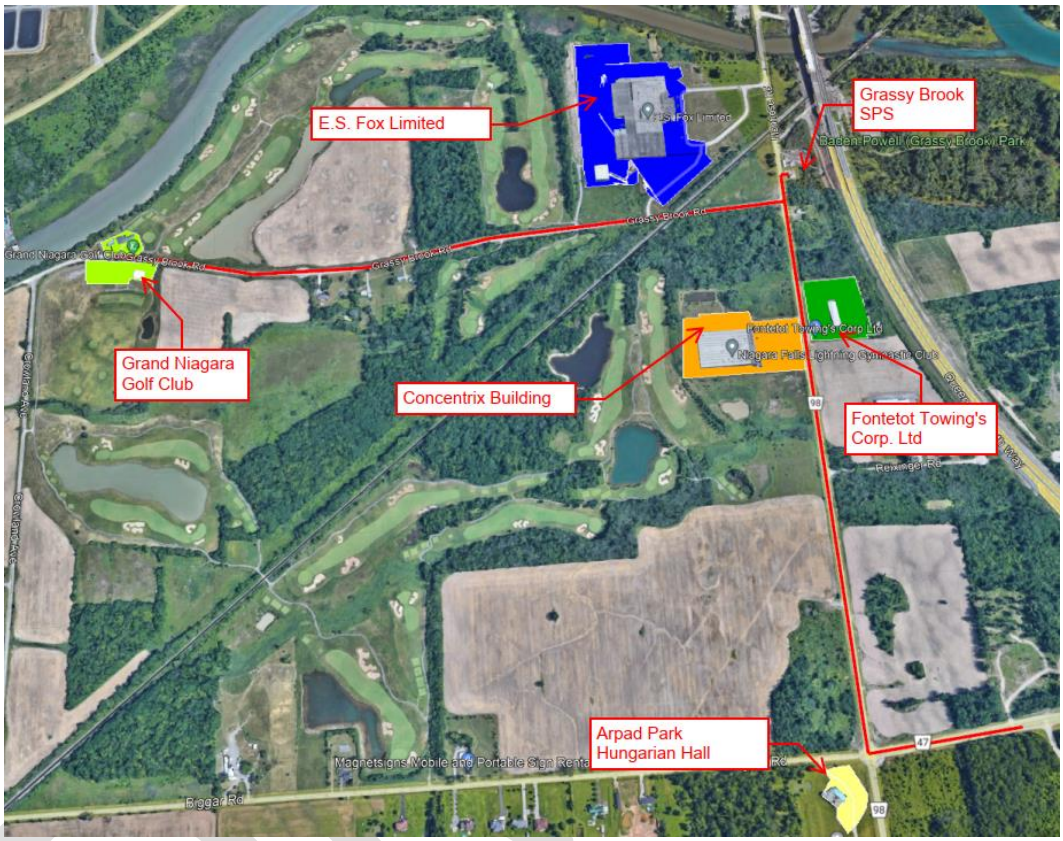


Figure 17 Grassy Brook SPS Catchment Area

Table 5 Grassy Brook SPS Extraneous Flow

CATCHMENT AREAS SERVICED BY GRASSY BROOK SEWERS	SURFACE AREA (M^2)	EXTRANEOUS FLOW RATE (L/HA/S)	EXTRANEOUS FLOW (L/S)
Grand Niagara Golf Club	12050	0.286	0.34
Concentrix Building	34000		0.97
Fontetot Towing's Corp Ltd	18200		0.52
E.S. Fox Limited	90000		2.57
Arpad Park Hungarian Hall	6500		0.19
Total	**160,750**		**4.60**

The Grassy Brook SPS total allowable Infiltration and Inflow (I&I) is expected to be 6.6 L/s after implementing I&I improvement by the Region and City.

The existing average dry weather flow of Grassy Brook SPS is 1.6 L/s as per Niagara Region Master Servicing Plan (2016). Applying peaking factor of 3 (based on industry norms for this type of development), the peak dry weather flow is 4.8 L/s. The total design peak wet weather flow discharged to the SPS is 11.4 L/s (4.8 L/s + 6.6 L/s).

The ECA firm capacity of the SPS is 20.9 L/s. This provides an available capacity of 9.5 L/s (20.9 L/s – 11.4 L/s) to accommodate new developments sanitary flow in the catchment area. Should a 3rd identical pump be added under the existing design conditions, the available capacity would increase to 11.1 L/s.

In accordance with the Master Plan, the highest allowable capacity of the existing Grassy Brook forcemain is 44.2 L/s. Then the maximum available capacity in the existing forcemain to accommodate new sanitary flows is 32.8 L/s (44.2 L/s – 11.4 L/s).

Furthermore, with an average dry weather flowrate of 1.6 L/s, there is certainly available capacity within the existing SPS to accommodate off-peak pumping. The following section outlines strategies to accommodate growth of the proposed Grand Niagara Development.

It should be indicated, that in accordance with Class EA Master Plan, an additional 27.7 L/s can be accommodated within the existing 400 m^3 of storage from the existing upstream sanitary sewers and wet well volume of the Grassy Brook SPS (Environmental Study Report – Volume 3 – GMBP File No. 718002 – July 2022). While we acknowledge this additional flowrate capacity, the following sanitary servicing strategies presented in section 5, do not incorporate it.

4 GRAND NIAGARA DEVELOPMENT PHASE 1 POPULATION AND SANITARY DESIGN FLOW RATE

Phase 1 of the Grand Niagara Development is expected to generate a range of 400 to 500 units. For the purpose of this memo, based on Niagara Region Master Servicing Plan, a value of 275 L/cap/d is employed to determine the average daily sanitary flow. Table 6 summarizes the design parameters and associated design values applied for the purpose of establishing an equivalent population density and sanitary flowrates for the Phase 1.

The Harmon peaking factor was used to calculate the peak daily flows. Infiltration is calculated based on the total proposed developable area for Phase 1. Table 7 below summarizes the equivalent population and the sanitary flowrate of Grand Niagara Phase 1.

Table 6. Summary of Design Values for Equivalent Population Density and Sanitary Flow Analysis

DESIGN CRITERIA	DESIGN VALUE	UNIT	REFERENCE	NOTE
Average Daily Domestic Sanitary Flow	275	L/cap/d	Niagara Region Master Servicing Plan - Volume 4 - P 12	225 to 450 L/cap/d
Infiltration Allowance	0.286	L/S/Ha	2016 Master Servicing Plan Update Volume IV - P 12	-
Proposed Developable Area for Phase 1	22.5	ha	Grand Niagara FSR	To be confirmed
Population Per Unit	3.5	PPU	From design criteria for sewers and watermains of city of Toronto - Table 4	Single family dwelling type of housing is considered

Table 7. Equivalent Population and Sanitary Flow Design

TOTAL POPULATION	AVERAGEDRY WAETHER FLOW (L/S)	PEAKING FACTOR	PEAK DRY WEATHER FLOW (L/S)	INFILTRATION (L/S)	AVERAGE WET WEATHER FLOW (L/S)	PEAK WET WEATHER FLOW (L/S)
2280	7.3	3.54	25.7	6.5	13.7	32.2

4.1 SOUTH NIAGARA HOSPITAL SANITARY FLOW ANALYSIS

The South Niagara Hospital will be located at the intersection of Biggar Road and Montrose Road in Niagara Falls, Ontario, providing 469 beds, 8 operation suites, and 42 hemodialysis stations with approximately 1.2 million ft^2 Gross Floor Area (GFA) (link). Based on "Ontario Design Guidelines for Sewage Works, 2008" common sewage flow rate for hospitals is in a range of 900

L/bed/d to 1800 L/bed/d. Table 8 summarizes the design parameters and associated design values applied for the purpose of establishing the South Niagara hospital sanitary flow.

Table 8 Summary of Design Values for the South Niagara Hospital Sanitary Flow Analysis

Design Criteria	Design Value	Unit	Reference	Note
Average Daily Domestic Sanitary Flow	1300	L/bed/d	Ontario Design Guidelines for Sewage Works, 2008	900 to 1800 L/cap/d
Infiltration Allowance	0.286	L/s/ha	2016 Master Servicing Plan Update Volume IV	-
Proposed Developable Area for Phase 1	19	ha	Grand Niagara FSR	To be confirmed
Peaking Factor	2.5		2016 Master Servicing Plan Update Volume IV	2 to 4 2.5 is suggested for the purpose of this memo given the South Niagara hospital size

The average daily sanitary flow of the hospital is calculated to be 7.8 L/s. With a peaking factor of 2.5, and infiltration allowance of 5.4 L/s, the peak wet weather sanitary flow of the hospital is 24.9 L/s.

It should be indicated that the sanitary servicing strategies presented in section 5, do not incorporate the South Niagara hospital sanitary flow.

5 PRELIMINARY DESIGN ALTERNATIVES FOR SANITARY SERVICING

The following are preliminary design alternatives for servicing the Grand Niagara Phase 1 lands. It should be noted that these alternatives are considered temporary sanitary solutions to service the Grand Niagara Development before the new South Niagara Falls Waste Water Treatment Plant comes in service. The ultimate solution is discussed in section 6.

1. Design Alternative No. 1 – Limit development such that a maximum peak discharge flowrate of the proposed Grand Niagara Phase 1 development is 9.5 L/s. This design alternative includes implementing I/I improvements (discussed in section 3.2) and proposes no upgrades to Grassy Brook SPS. It is assumed that the hospital is not yet discharging sanitary flows to the Grassy Brook SPS.

2. Design Alternative No. 2

    - 2-a: Limit development such that a maximum peak discharge flowrate of the proposed Grand Niagara Phase 1 development is 11.1 L/s. This alternative would allow flows to directly drain to the Grassy Brook SPS. This design alternative includes implementing I/I improvements (discussed in section 3.2) and proposes addition of an identical pump to Grassy Brook SPS as well as any additional required infrastructure upgrade. It is assumed that the hospital is not yet discharging sanitary flows to the Grassy Brook SPS.
    - 2-b: Limit development such that a maximum peak discharge flowrate of the proposed Grand Niagara Phase 1 development is 32.8 L/s. This alternative would allow flows to directly drain to the Grassy Brook SPS. This design alternative includes implementing I/I improvements (discussed in section 3.2) and proposes replacement of the existing pumps with larger pumps to Grassy Brook SPS as well as additional infrastructure upgrade such as primary and secondary power and MCC. It is assumed that the hospital is not yet discharging sanitary flows to the Grassy Brook SPS.

3. Design Alternative No. 3 – Full development of Phase 1 such that a maximum peak discharge flowrate of the proposed Grand Niagara Phase 1 development is 32.2 L/s. Installation of a new SPS rated at 19.3 L/s, complete with a primary storage for 4 hours in Grand Niagara area to allow the wastewater discharges from Phase 1 to Grassy Brook SPS at off-peak times. As an option, we can also incorporate additional secondary storage in an earthen basin, pending Region preference. This design alternative includes implementing I/I improvements (discussed in section 3.2) and proposes no upgrades to Grassy Brook SPS. It is assumed that the hospital is not yet discharging sanitary flows to the Grassy Brook SPS.
4. Design Alternative No. 4 – Full development of Phase 1 such that a maximum peak discharge flowrate of the proposed Grand Niagara Phase 1 development of 31.7 L/s can be realized through the upgrade the Grassy Brook SPS forcemain to include a new ±300mm diameter forcemain to expand the capacity to 50.5 L/s with 1 duty pump, or 84.5 L/s with 2 duty pumps in operation.
5. Design Alternative No. 5 – Full development of Phase 1 such that a maximum peak discharge flowrate of the proposed Grand Niagara Phase 1 development of 31.7 L/s can be realized through the addition of an on-site package wastewater treatment plant to treat the sanitary flow and discharging the effluent to Welland River.

5.1 DESIGN ALTERNATIVE NO. 1

In this alternative, the sanitary flow drains directly from Grand Niagara development to Grassy Brook SPS, and it is assumed that the hospital is not yet discharging sanitary flows to the Grassy Brook SPS.

Considering the I&I improvement implementation (discussed in section 3.2), the peak wet weather flow entering the Grassy Brook SPS is expected to be 11.4 L/s as explained in section 2.3.

Total inlet flow to Grassy Brook SPS would be capped at its pump rated capacity of 20.9 L/s. The inlet flow is the current influent, plus sanitary flow from Grand Niagara Development. The recommended peak discharge flowrate from Grand Niagara new SPS to Grassy Brook SPS is 9.5 L/s (20.9 L/s – 11.4 L/s). This design alternative proposes no upgrades to the existing Grassy Brook SPS.

Table 9 summarizes the Design Alternative No. 1 flow analysis and population calculations for Grand Niagara Development.

Table 9 Summary of the Design Calculations - Design Alternative No. 1

RECOMMENDED PEAK WET WEATHER FLOWRATE OF GRAND NIAGARA DEVELOPMENT (L/S)	RECOMMENDED AVERAGE DRY WEATHER FLOWRATE OF GRAND NIAGARA DEVELOPMENT (L/S)	RECOMMENDED EQUIVALENT POPULATION	RECOMMENDED EQUIVALENT UNITS
9.5	2.0	620	177*

* Equivalent unit number is calculated based on the assumption of single-family dwelling housing (3.5 PPU)

5.2 DESIGN ALTERNATIVE NO. 2

In this alternative, the sanitary flow drains directly from Grand Niagara development to Grassy Brook SPS, and it is considered that the hospital is not yet discharging sanitary flows to the Grassy Brook SPS.

Considering the I&I improvement implementation (discussed in section 3.2), the peak wet weather flow entering the Grassy Brook SPS is expected to be 11.4 L/s as explained in section 2.3.

5.2.1 ALTERNATIVE NO. 2-A

This scenario proposes addition of an identical pump to Grassy Brook SPS. The Grassy Brook SPS wet well can accommodate the new additional pump. Should a third pump be added under the existing design conditions, the capacity of the SPS with 2 duty pumps (and a third standby pump), would marginally increase to 22.5 L/s. Total inlet flow to Grassy Brook SPS would be capped at its capacity of 22.5 L/s. The inlet flow is the current influent, plus sanitary flow from Grand Niagara Development. The recommended peak discharge flowrate from Grand Niagara new SPS to Grassy Brook SPS is 11.1 L/s (22.5 L/s – 11.4 L/s). This scenario may propose some additional infrastructure upgrade such as piping and electrical upgrades to the existing Grassy Brook SPS.

Table 10 summarizes the Design Alternative No. 2-a flow analysis and population calculations for Grand Niagara Development.

Table 10 Summary of the Design Calculations - Design Alternative No. 2-a

RECOMMENDED PEAK WET WEATHER FLOWRATE OF GRAND NIAGARA DEVELOPMENT (L/S)	RECOMMENDED AVERAGE DRY WEATHER FLOWRATE OF GRAND NIAGARA DEVELOPMENT (L/S)	RECOMMENDED EQUIVALENT POPULATION	RECOMMENDED EQUIVALENT UNITS
11.1	2.3	732	209*

* Equivalent unit number is calculated based on the assumption of single-family dwelling housing (3.5 PPU)

5.2.2 ALTERNATIVE NO. 2-B

This scenario proposes replacing the existing pumps with the new larger pumps to accommodate a flowrate of 44.2 L/s in Grassy Brook SPS forcemain in accordance with the Master Plan that states the maximum allowable velocity in the forcemain is 2.5 m/s.

Total inlet flow to Grassy Brook SPS would be capped at 44.2 L/s. The inlet flow is the current influent, plus sanitary flow from Grand Niagara Development. The recommended peak discharge flowrate from Grand Niagara new SPS to Grassy Brook SPS is 32.8 L/s (44.2 L/s – 11.4 L/s). This scenario proposes primary and secondary power, and MCC upgrades to the existing Grassy Brook SPS. This scenario can accommodate the Phase 1 full development sanitary flow.

Table 11 summarizes the Design Alternative No. 2-b flow analysis and population calculations for Grand Niagara Development.

Table 11 Summary of the Design Calculations - Design Alternative No. 2-b

RECOMMENDED PEAK WET WEATHER FLOWRATE OF GRAND NIAGARA DEVELOPMENT (L/S)	RECOMMENDED AVERAGE DRY WEATHER FLOWRATE OF GRAND NIAGARA DEVELOPMENT (L/S)	RECOMMENDED EQUIVALENT POPULATION	RECOMMENDED EQUIVALENT UNITS
32.8	7.4	2338	668*

* Equivalent unit number is calculated based on the assumption of single-family dwelling housing (3.5 PPU)

5.3 DESIGN ALTERNATIVE NO. 3

A new sanitary pumping station to service development within the Grand Niagara subdivision would be considered to pump the sanitary flow to existing Grassy Brook SPS at off-peak hours. The recommended peak discharge flowrate from Grand Niagara Phase 1 to the new proposed SPS is considered 32.2 L/s (full development pending approval from the Region) for this scenario.

Grassy Brook SPS has an existing average dry weather flowrate of 1.6 L/s as per the Master Plan. the new proposed SPS will be rated at 19.3 L/s (20.9 L/s – 1.6 L/s) so that the total sanitary flow discharging to Grassy Brook SPS during off-peak hours would be capped at 20.9 L/s.

We assumed there is no discharge flow from Grand Niagara SPS to Grassy Brook SPS during peak flow periods of Grassy Brook SPS. During this period, the sanitary flow from Grand Niagara Phase 1 development would be stored in a new storage tank integrated with the new SPS, prior to any conveyance to the Grassy Brook SPS.

The peak wet weather flow of 32.2 L/s is being used to calculate the required storage capacities.

The required emergency storage capacity during primary usage of Grassy Brook SPS is expected to be 464 m^3 for 4 hours. It is proposed to construct it as twinned overflow emergency cells integrated into the design of the pumping station wet well cell as shown in Figure 18. As an option, we can also incorporate additional secondary storage in an earthen basin, pending Region preference.

Pumping of sanitary flows from Grand Niagara SPS to the existing Grassy Brook SPS, would be SCADA controlled and monitored. Flow would only be able to the pumped during low diurnal flow periods (e.g., between the hours of 8PM to 6AM). In addition, the pumps at the proposed Grand Niagara SPS would only be able to operate provided that the wet well level at the Grassy Brook SPS was below the high operating level. SCADA control logic would be integrated to facilitate this pumping strategy.

This design alternative proposes no upgrades to the existing Grassy Brook SPS.

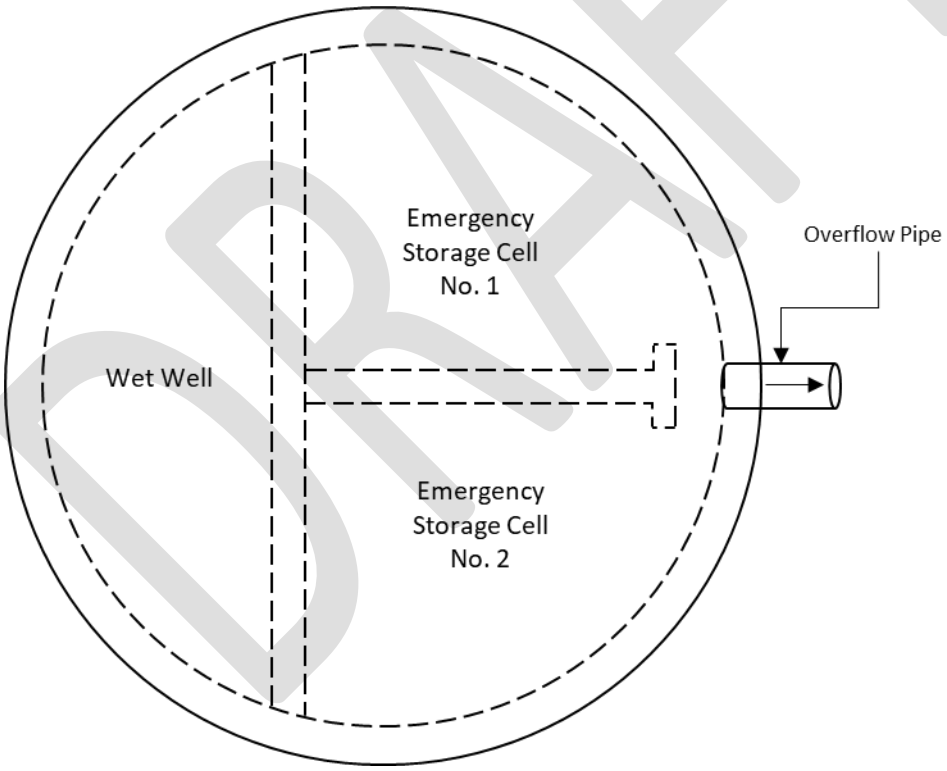


Figure 18. Integrated Wet well and Emergency Storage Cells schematic – Design Alternative 1

Figure 19 shows the potential location of Grand Niagara SPS and the Storage Tanks.

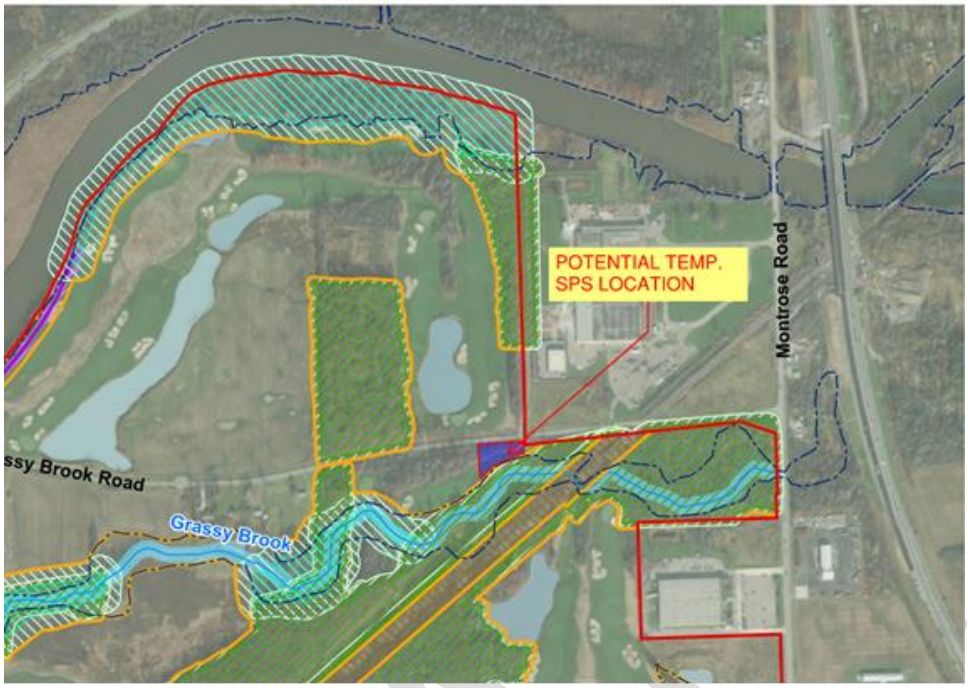


Figure 19. Potential Location of Grand Niagara SPS and Storage Tanks

Table 12 summarizes the Design Alternative No. 3 calculations for Grand Niagara Development.

Table 12 Summary of the Design Calculations - Design Alternative No. 3

PEAK WET WEATHER FLOWRATE OF GRAND NIAGARA DEVELOPMENT (L/S)	AVERAGE DRY WEATHER FLOWRATE OF GRAND NIAGARA DEVELOPMENT (L/S)	EQUIVALENT POPULATION	EQUIVALENT UNITS	WET WELL + TWINNED CELL VOLUME (M3)
32.2	7.3	2280	651*	464

* Equivalent unit number is calculated based on the assumption of single-family dwelling housing (3.5 PPU)

5.4 DESIGN ALTERNATIVE NO. 4

The Grassy Brook SPS is designed for an ultimate design capacity of 138 L/s. Total discharge sanitary flow including the existing Grassy Brook SPS flow and Grand Niagara Phase 1 sanitary flow is 42.1 L/s (31.7 L/s for Grand Niagara, and 11.4 L/s is the existing peak wet weather flow at Grassy Brook; flow velocity of 2.4 m/s in the existing 150mm dia. forcemain). The main bottleneck to increase the existing station's capacity is upgrading the forcemain from a 150 mm to a 300 mm dia. The proposed forcemain will follow the same alignment as the existing 150mm dia. forcemain. The total length of the forcemain is approximately 1,838m, from the Grassy Brook SPS to the discharge MH at the Brown Road and Montrose Road intersection. The forcemain pipe material is considered DR26, 160 psi, PVC pipe (1399m length) and DR11, 160 psi HDPE pipe (438m length).

Total discharge sanitary flow from Grand Niagara Phase 1 is 31.7 L/s. A 300 mm dia. forcemain is considered to develop the system curve illustrated in Figure 20. Flygt pump NP3153.091 HT (the existing pump at the Grassy Brook SPS) has been applied to calculate the capacity of the proposed new SPS. It has a rated capacity of 50.5 L/s at 19.3 TDH, that meets design requirement. The flow velocity is 0.94 m/s that is in the recommended range of 0.8 to 1.1 m/s. Should a third identical pump be added under the same design conditions, the capacity of the SPS with 2 duty pumps (and a third standby pump), would increase to 76 L/s.

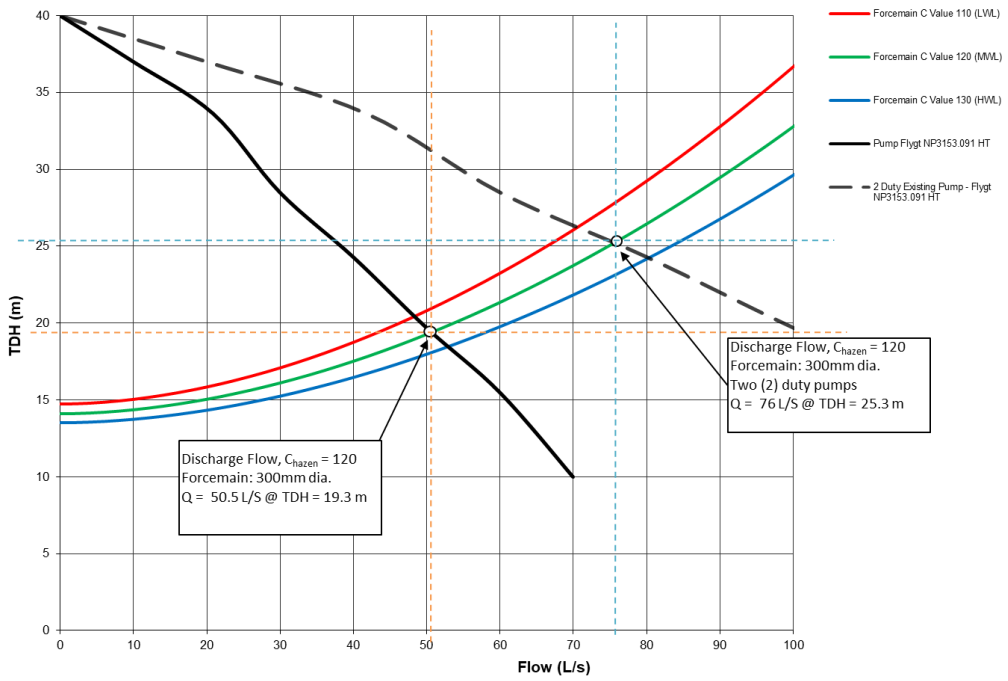


Figure 20. Grassy Brook SPS Pump Curve & 300 mm dia. Forcemain System Curve

5.4.1 FORCEMAIN MATERIAL AND ROUTING

PVC and HDPE are being considered as pipeline materials to be discussed for the proposed SPS forcemain. Both materials are plastic, generally light weight, provide resistance to corrosion and chemicals, and have higher life expectancies in underground applications, especially when compared to metal pipes. However, PVC is simpler and faster to install, and has lower installation costs. PVC is recommended as it supports better constructability in a direct burial context for open cut installation. However, as the forcemain will be crossing through a river, a railway, and have multiple culvert crossings, HDPE will be used as the material for these segments of the forcemain routing. The HDPE segments will be installed through horizontal directional drilling (HDD) boring methods since open cut installation is not feasible.

The proposed forcemain will follow the same alignment as the existing 150mm forcemain of Grassy Brook SPS, for the total length of 1,838m, to the discharge location at the Brown Road and Montrose Road intersection. Only 438m of the total length will be installed through HDD boring due to the river crossing, railway crossing, and multiple culvert crossings. The HDPE segments of the forcemain will be installed via jack and bore shafts for directional drilling. The alignment is shown below in Figure 21.

Please note that this Alternative is not recommended as this would involve the construction of a significant amount of infrastructure within an existing right-of-way that would become obsolete/abandoned once the new treatment plant is operational. This alternative also included additional risk associated with the crossing of Welland River.

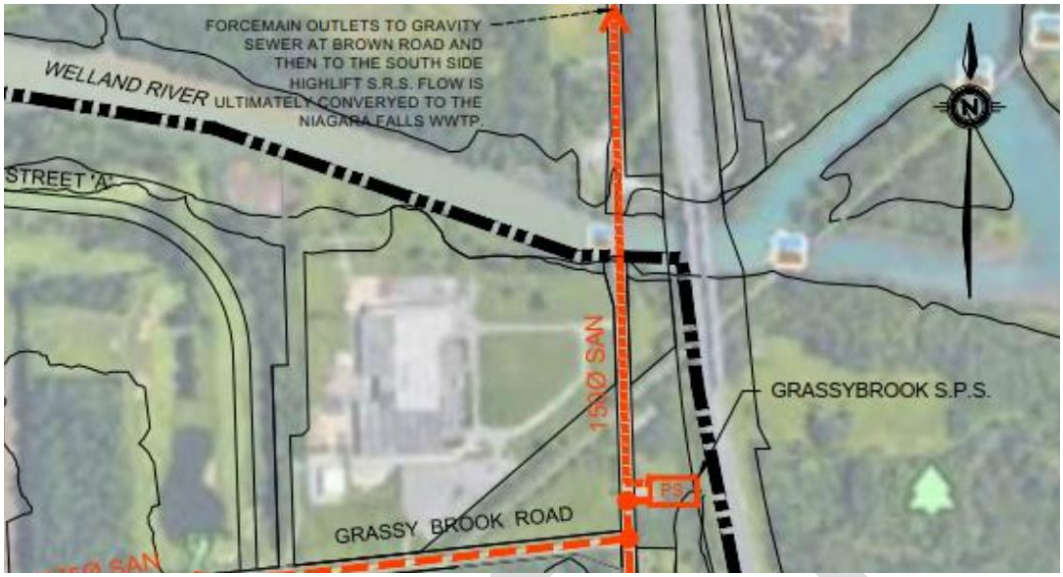


Figure 21. Grassy Brook SPS and Forcemain Alignment

5.5 DESIGN ALTERNATIVE NO. 5

This scenario would allow a full development of Phase 1 of Grand Niagara. The sanitary peak flow from Grand Niagara Phase 1 is 31.7 L/s as provided in Table 7. In this alternative, the sanitary flow will be directed to an on-site package wastewater treatment plant (WWTP) and the effluent will be discharged to Welland River. Based on our preliminary analysis, we have selected Anaerobic Sequencing Batch Reactor (ASBR). The ASBR system is to be considered to treat an average daily flow of 1,555 m3/d (18 L/s) of domestic wastewater. Two (2) ASBR basins with a dimension of 20m*6m*6.6m (Length*Width*Depth) are considered as shown in below Figure 22.

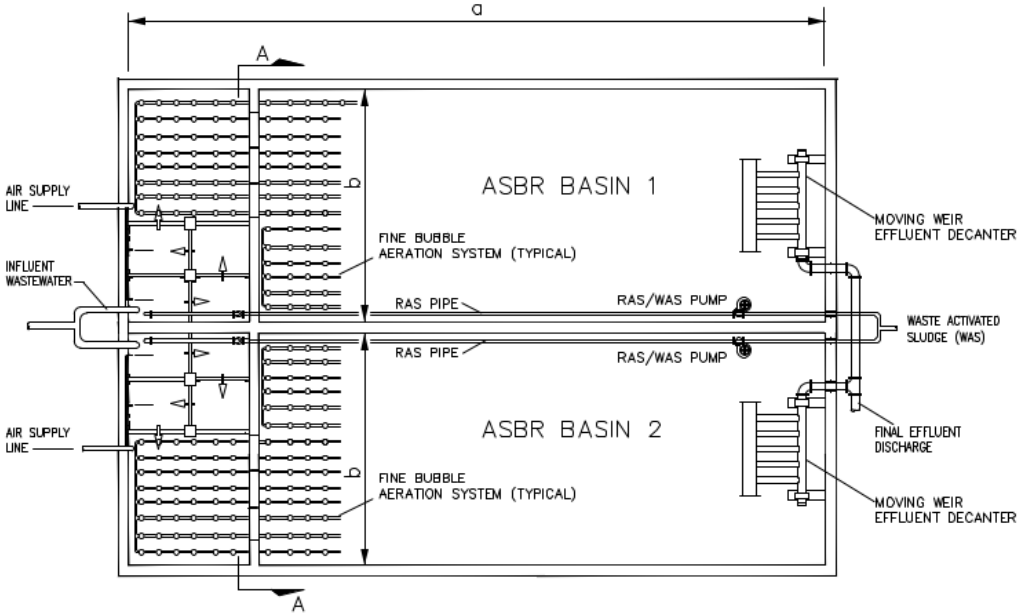


Figure 22 General Arrangement Concrete Basins

Services by Empire during start-up:

The following is a list of services required by Empire for the project, for the installation, start-up and commissioning and operational phases. These are in addition to construction and installation.

- 3 phase supply for the equipment listed in the scope of works for the plant
- Water for wet commissioning plant
- Seed activated sludge for the WWTP (perhaps from a nearby facility)
- Basic laboratory facilities for measurement of TSS, BOD, pH and SVI. Also, it may be necessary for samples to be sent to a laboratory especially during the start-up phase.
- Safety showers, hazardous area classification etc.
- Pump hoists and lifting davits (if required)
- Access Platforms and stairways etc.
- Lightning Protection etc.

6 ULTIMATE SANITARY SOLUTION FOR GRAND NIAGARA DEVELOPMENT

The ultimate solution to service the Grand Niagara Development lands is to extend the existing gravity sewers inside the development and connect them to the new South Niagara Falls (SNF) Trunk Sewer on Montrose Road which eventually discharges to the future-built South Niagara Falls WWTP via gravity. The SNF Trunk sewer alignment is depicted in Figure 23. The in-service date for all infrastructure components is approximately the end of 2027.

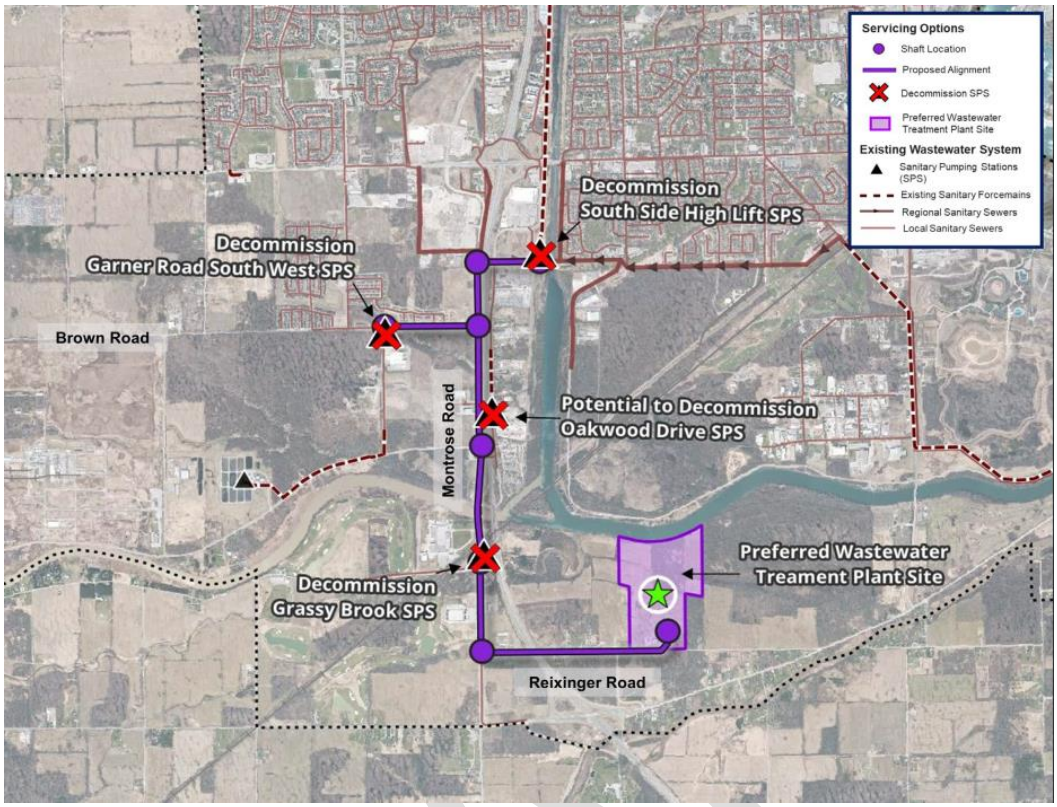


Figure 23 Preferred South Niagara Falls Trunk Sewer Alignment

7 SUMMARY OF FINDINGS AND NEXT STEPS

Below is a summary of key findings about servicing Grand Niagara Development sanitary flow:

1. The existing Grassy Brook SPS's rated capacity is 20.9 L/s (1 duty pump, 1 standby pump).
2. The capacity of Grassy Brook SPS would increase to 22.5 L/s through the incorporation of a 3rd pump, leading to 2 duty pumps. The maximum allowable capacity of Grassy Brook SPS is 44.2 L/s through the existing forcemain as per Niagara Region Master Plan.
3. The ultimate capacity of the existing Grassy Brook SPS is 138 L/s.
4. Infiltration and Inflow (I&I) improvement has been done by Region and City staff in April/May of 2022. Empire, the City and the Region should continue to monitor the improvements already made and pursue the additional recommended improvements.
5. The Grassy Brook SPS total allowable Infiltration and Inflow (I&I) is expected to be 6.6 L/s, based on industry norms and guidelines.
6. The greatest significant factor to upgrading the existing Grassy Brook SPS is the 150mm dia. forcemain. The most efficient method to increase the existing SPS's capacity is by upgrading the forcemain to 300mm. However, the implementation of this solution is not recommended.
7. It is recommended to discuss these design alternatives with Niagara Region to arrive at the preferred design solution to facilitate development of the Grand Niagara subdivision.

APPENDIX

A Grassy Brook SPS Background Information

Environmental Compliance Approval (ECA)

Ontario

Ministry of the Environment | Ministère de l'Environnement

CERTIFICATE OF APPROVAL
MUNICIPAL AND PRIVATE SEWAGE WORKS
NUMBER 7765-6XGS37
Issue Date: March 1, 2007

The Corporation of the City of Niagara Falls
4310 Queen St
Post Office Box, No. 1023
Niagara Falls, Ontario
L2E 6X5

Site Location: Grassy Brook
9240 Montrose Rd
Niagara Falls City,
Regional Municipality of Niagara, Ontario

You have applied in accordance with Section 53 of the Ontario Water Resources Act for approval of:

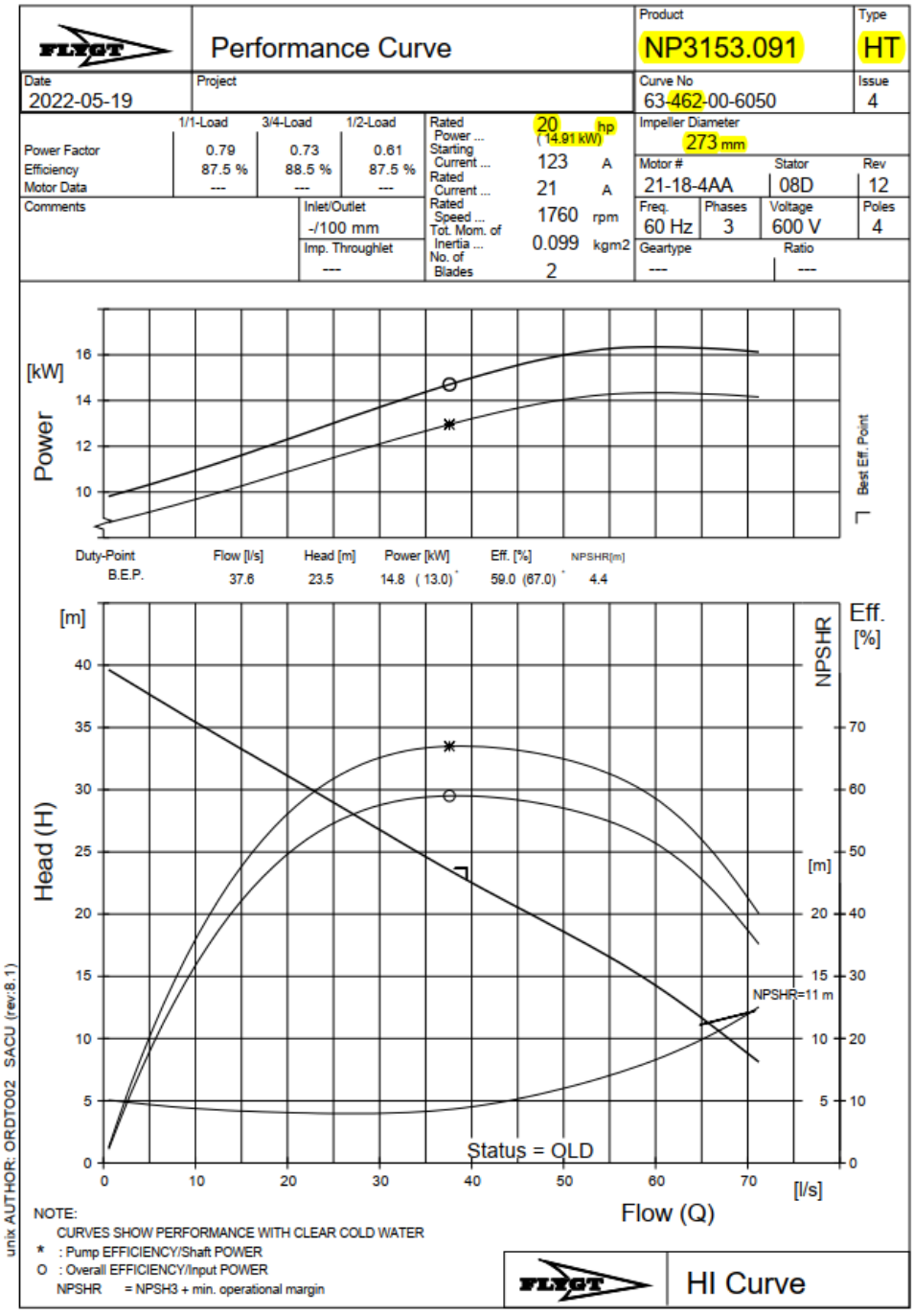
a sanitary sewage pumping station, and forcemains to be constructed to service the 'Grassy Brook Service Area', bounded by the Queen Elizabeth Way Highway (QEW), Biggar Road, Coon Road and the Welland River, draining to the existing trunk sanitary sewer on Canadian Drive at Montrose Road in the Regional Municipality of Niagara, comprising the following:

- one (1) ***sanitary sewage pumping station*** located on the east side of Montrose Road, about 70 metres north of the intersection of Montrose Road and Grassy Brook Road, designed for a peak flow of about 19.89 L/s, consisting of a rectangular wet well for the ultimate condition (138 L/s) and two temporary low inner walls (about 2.4 m long x 2.06 m high and 1.3 m apart) for the initial period, equipped with two (2) submersible pumps for the initial period, one for duty and one for standby, each pump has a rated capacity of approximately 20.9 L/s at a total dynamic head of 33.62 m, complete with electrical and electronic control systems, an ultrasonic level transmitter with back-up float switches connected to the Niagara Falls WWTP, discharge piping, ventilation system, valves, by-pass piping with use of portable pump in adjacent manhole, a 200 kW standby generator set approved under Ministry of the Environment Certificate of Approval No. **2948-6XKLQQ**, and all other appurtenances necessary to have a complete and operable pumping station, discharging to the proposed 150 mm inside diameter forcemain;

- one (1) ***sanitary forcemain*** (150 mm inside diameter, about 1800 metres in length) on Montrose Road from the pumping station to the existing sanitary manhole "MH11A" at the intersection of Montrose Road and Brown Street;

- one (1) ***sanitary forcemain*** (250 mm inside diameter, about 325 metres in length) on Montrose Road crossing under the Welland River;

Grassy Brook SPS Existing Pump Performance Curve



APPENDIX

B

Grassy Brook SPS System Curve Calculations

Grassy Brook SPS System Curve Calculations – Equivalent Length

Grassy Brook Wastewa	Forcemain Dia.	150 mm Dia.					
Pump System Curve - 150mm Forcemain	f =	0.015					
	No.	Element	No. of Elements	Headloss Co-efficient (K)	Friction Factor (f)	Diameter (mm)	Equivalent Length of Element (m)	Equivalent Length @ 150 mm (m)
	1	Increaser (100mm - 150mm)	1	0.12	0.017	100	0.7	5.9
	2	90° Elbow (Long Radius)	1	0.24	0.015	150	2.3	2.3
	3	Straight Pipe	1	-	0.015	150	13.0	13.0
Within property including	4	90° Elbow (Long Radius)	1	0.24	0.015	150	2.3	2.3
Pumping Station, and Valve	5	Straight Pipe	1	-	0.015	150	20.4	20.4
Chamber	6	Swing Check Valve	1	0.75	0.015	150	7.3	7.3
	7	45° Elbow	2	0.21	0.015	150	2.0	4.1
	8	Plug Valve	3	0.25	0.015	150	2.4	7.3
		Sub-Total of Equivalent - Length Interior Pumping Station Losses from Discharge Header to Forcemain (m) - Le_1:						54.4
	No.	Element	No. of Elements	Headloss Co-efficient (K)	Friction Factor (f)	Diameter (mm)	Equivalent Length of Element (m)	Equivalent Length @ 150 mm (m)
Outside of the property -	11	Straight Pipe	1	-	0.015	150	1.0	1.0
Exterior Forcemain Loses	12	45° Elbow	1	0.21	0.015	150	2.0	2.0
From Pumping Station to	13	Straight Pipe - Montrose Road	1	-	0.015	150	491.6	491.6
the existing sanitary	14	45° Elbow	2	0.21	0.015	150	2.0	4.1
manhole MH11A at	15	Straight Pipe - Montrose Road	1	-	0.015	150	20.0	20.0
intersection of Montrose	16	45° Elbow	1	0.21	0.015	150	2.0	2.0
Road and Brown Street	17	Straight Pipe - Montrose Road	1	-	0.015	150	355.0	355.0
	18	45° Elbow	1	0.21	0.015	150	2.0	2.0
	19	Straight Pipe - Montrose Road	1	-	0.015	150	20.0	20.0
	20	45° Elbow	1	0.21	0.015	150	2.0	2.0
	21	Straight Pipe - Montrose Road	1	-	0.015	150	220.0	220.0
	22	45° Elbow	1	0.21	0.015	150	2.0	2.0
	23	Straight Pipe - Montrose Road	1	-	0.015	150	10.0	10.0
	24	45° Elbow	1	0.21	0.015	150	2.0	2.0
	25	Straight Pipe - Montrose Road	1	-	0.015	150	680.0	680.0
	26	Exit Loss	1	1.00	0.015	150	9.7	9.7
		Sub-Total of Equivalent Length - Exterior Station Forcemain Losses (m) - Le_2:						1,823.6
		Total Equivalent Length (m) - Le_{Total}:						1,878.0

Grassy Brook SPS System Curve Calculations – Headloss

Grassy Brook Sewage Pumping Station
Pump System Curve - 250mm Forcemain

Forcemain ID	**0.150**	**mm**
Discharge El.	**176.5**	**m**

		LWL	**161.78**	**m**		**MWL**	**162.38**	**m**		**HWL**	**162.98**	**m**	
		Static Head	**14.72**	**m**		**Static Head**	**14.12**	**m**		**Static Head**	**13.52**	**m**	
		C	**120**			**C**	**129**			**C**	**140**		

Q_T	hf1	hf2	TDH	hf1	hf2	TDH	hf1	hf2	TDH
(L/s)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
0.00	0.0	0.0	**14.72**	0.0	0.0	**14.12**	0.0	0.0	**13.52**
2.00	0.0	0.3	**15.01**	0.0	0.2	**14.37**	0.0	0.2	**13.74**
4.00	0.0	1.0	**15.76**	0.0	0.9	**15.03**	0.0	0.8	**14.30**
6.00	0.1	2.1	**16.93**	0.1	1.9	**16.05**	0.0	1.6	**15.18**
8.00	0.1	3.7	**18.49**	0.1	3.2	**17.41**	0.1	2.7	**16.35**
10.00	0.2	5.5	**20.41**	0.1	4.8	**19.10**	0.1	4.2	**17.80**
12.00	0.2	7.7	**22.70**	0.2	6.8	**21.10**	0.2	5.8	**19.52**
14.00	0.3	10.3	**25.33**	0.3	9.0	**23.40**	0.2	7.7	**21.50**
16.00	0.4	13.2	**28.31**	0.3	11.5	**26.01**	0.3	9.9	**23.74**
18.00	0.5	16.4	**31.63**	0.4	14.4	**28.91**	0.4	12.3	**26.23**
20.00	0.6	20.0	**35.27**	0.5	17.5	**32.09**	0.4	15.0	**28.97**
20.90	0.6	21.6	**37.01**	0.6	18.9	**33.62**	0.5	16.3	**30.28**
22.00	0.7	23.8	**39.24**	0.6	20.8	**35.56**	0.5	17.9	**31.95**
24.00	0.8	28.0	**43.52**	0.7	24.5	**39.31**	0.6	21.0	**35.17**
26.00	1.0	32.4	**48.13**	0.8	28.4	**43.34**	0.7	24.4	**38.63**
28.00	1.1	37.2	**53.04**	1.0	32.5	**47.64**	0.8	28.0	**42.32**
30.00	1.3	42.3	**58.26**	1.1	37.0	**52.20**	0.9	31.8	**46.25**
32.00	1.4	47.7	**63.79**	1.2	41.7	**57.04**	1.1	35.8	**50.40**
34.00	1.6	53.3	**69.62**	1.4	46.6	**62.14**	1.2	40.1	**54.79**
36.00	1.8	59.3	**75.75**	1.5	51.8	**67.50**	1.3	44.5	**59.39**
38.00	2.0	65.5	**82.18**	1.7	57.3	**73.12**	1.5	49.2	**64.23**
40.00	2.1	72.0	**88.90**	1.9	63.0	**79.00**	1.6	54.1	**69.28**
42.00	2.4	78.8	**95.92**	2.1	69.0	**85.14**	1.8	59.3	**74.55**
44.00	2.6	85.9	**103.22**	2.2	75.2	**91.53**	1.9	64.6	**80.04**
46.00	2.8	93.3	**110.82**	2.4	81.6	**98.17**	2.1	70.1	**85.75**
48.00	3.0	101.0	**118.70**	2.6	88.3	**105.06**	2.3	75.9	**91.68**
50.00	3.2	108.9	**126.86**	2.8	95.2	**112.21**	2.4	81.9	**97.81**
52.00	3.5	117.1	**135.31**	3.1	102.4	**119.60**	2.6	88.0	**104.16**
54.00	3.7	125.6	**144.04**	3.3	109.8	**127.23**	2.8	94.4	**110.73**
56.00	4.0	134.3	**153.05**	3.5	117.5	**135.11**	3.0	101.0	**117.50**
58.00	4.3	143.3	**162.34**	3.7	125.4	**143.24**	3.2	107.7	**124.48**
60.00	4.5	152.6	**171.91**	4.0	133.5	**151.60**	3.4	114.7	**131.67**