

Functional Servicing Report and Stormwater Management Plan FINAL

Black Bay Subdivision
Town of Petawawa

October 2023

Jp2g Project # 20-7031A





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Author and Review Panel

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1 Introduction

1.1 Background

Jp2g Consultants Inc. was retained by James W. Lapointe Motor Holdings Inc. to provide engineering services and design in support of a residential subdivision development. The lands are 16.6 ha in area and located within the Town of Petawawa. The subject lands have frontage on Black Bay Road and are located between Industrial Ave and Petawawa Boulevard on the north side of the street. The site is in an area of partial services, municipal water is available at Industrial Ave and the municipal ROW includes ditches.

The proposed civil work for the development consists of new municipal roads and infrastructure for municipal storm, watermain, and water services. The conceptual layout consists of fifty-six (56) residential lots, one Parkland block, and one foot (0.3m) reserves. Refer to Appendix A for the Draft Plan of Subdivision.

2 Roads and Grading

2.1 Black Bay Road

Black Bay Road is a 66ft (20m) wide dedicated municipal ROW. It was last rehabilitated in 2019. The roadway is a rural, paved section complete with ditches and includes hydro. Municipal water is located at the intersection of Industrial Ave and Black Bay Road. In order to provide the subdivision with municipal water, an extension of servicing from Industrial Ave to the site is required. As such, it is recommended that the detailed design of the extension of the watermain include details regarding rehabilitation of Industrial Ave to the satisfaction of the municipality. No modifications to the existing Black Bay Road street section is recommended.

2.2 Proposed Roads and Grading

The proposed subdivision streets will be designed and installed with the Town's typical semi-urban section. This section was recently approved for part of Radtke phase 2, and previously in the Kramer subdivision. The semi-urban section includes two, 3.25m wide paved driving aisles, shouldering and rounding to a shallow ditch, grassed boulevards, street lighting, tree plantings, a four-party utility trench (gas, hydro, telecommunications), storm sewers, and watermain, hydrants, and appurtenances. The 23.0m wide ROW permits installation of a sidewalk adjacent to shallow ditches with a perforated pipe below. A typical section is provided as part of Appendix B.

The proposed street grade will follow the natural terrain to produce a smooth finished travelled surface. Fill import/export will be minimized under the final design. The dwellings are proposed to be set close to the street line (zoning by-law minimum), with to the lots cleared to a depth of approximately 35m to minimize their impacts on existing tree cover. As the lots are of a significant depth (65-70m depth) there is room for native trees and vegetation to remain and also provide usable rear yards.

A separate geotechnical report prepared by Gemtec dated 2023-10-19, is attached under separate cover.



3 Sanitary

3.1 Existing Conditions

The subject lands are not in an area where the Town provides municipal sanitary services. The nearest sanitary service is on New Street, which drains to the Renfrew Street Pumping station. The Renfrew Street pumping station was not designed to provide municipal sanitary services to the subject lands. There are no other sanitary sewers in the vicinity that have the capacity to accommodate the subject lands.

3.2 Proposed Conditions

As there are no sanitary sewer in the vicinity with capacity for the development, private septic systems are proposed. A hydrogeological study, including nitrate impacts has been prepared under separate cover by Jp2g Consultants Inc. to demonstrate the suitability of the lands for private septic systems.

4 Water

4.1 Existing Conditions

The closest water is a 300mm diameter municipal watermain located at the corner of Industrial Ave and Black Bay Rd. This line is connected to the Industrial Park water tower and can be extended to service to the subdivision. North of the proposed subdivision, there is another 200mm water line on New Street, and east of the subject lands there is a 200mm diameter main on Petawawa Boulevard and further east, a 300mm trunk main on Laurentian Drive.

The subject lands are located in the former Township of Petawawa. The former township water system is part of Pressure Zone 2 in the Town of Petawawa current infrastructure plans. Pressure Zone 2 has higher available pressures compared to Zone 1 (the former village), as provided by the Janet Street Pumping Station.

4.2 Proposed Water Design

A new 200mm diameter main is proposed to be extended from Industrial Ave, along Black Bay Road, to the entrance of the subdivision and looped through the development. Hydrants will be provided at regular intervals along Black Bay and within the subdivision. New $\frac{3}{4}$ " (19mm) water services are proposed for each dwelling, complete with shutoff at the property line.

Existing available pressures are calculated based upon the current Petawawa WaterGEMS model. Based on the modelling, static pressure in the vicinity of the development is approximately 65 psi depending upon time of day. This pressure falls within the normal operating range of 50 to 70 psi. Accordingly, there are no pressure issues anticipated for the proposed development. Please refer to Appendix D for WaterGEMS output.

Available pressures, flow rates, and hydrant proximity meet the needs of the proposed dwellings. The minor increases in water demand on the system from 56 new dwellings will not adversely impact available pressures or capacity in the greater water distribution system.

Depending upon the Town's future plans for expanding water servicing, stub connections could be left to facilitate future expansion of water distribution in the area. Where new watermain passes existing dwellings on Black Bay Road, services can be extended to the property lines. This would permit existing owners to connect to the Town's water distribution system if the owners decide to.



5 Stormwater Management

5.1 Existing Conditions

The subject lands are an undeveloped parcel of land, and as such, there is currently no storm sewer infrastructure located on the property. The lands are vacant forest with existing surface drainage flows heading to the east. The property is approximately 500 meters wide and there is a fall of 10 meters going from the western to eastern boundary. The average grade is 2%. The western third of the property is relatively flat followed by a gentle slope to the property line adjacent to the Millennium Trail. The Millennium Trail is adjacent to Petawawa Boulevard (County Road 51).

The existing site is wooded and underlain with a deep layer of dry sand. A geotechnical investigation confirmed that the depth of groundwater is deeper than 10m. The subject lands are 16.6 ha in area(A). The runoff coefficient(C) for flat, sandy, wooded areas is 0.08 from MTO Design Chart B2-1 (see Appendix G). The time of concentration is calculated to be 59 minutes. Pre-development stormwater plans are included in Appendix E. Peak development flows are determined by the rational method ($Q = 2.78 C I A$). The expected pre-development offsite flows are therefore:

<u>Storm</u>	<u>Flow</u>
2 Year storm	77 L/s
100 Year storm	189 L/s

These offsite flows should not be exceeded under the post development conditions. Detailed calculations supporting this can be found in Appendix E.

5.2 Proposed Storm Sewer Design

As there is no municipal stormwater management infrastructure in the area, the development will provide for new municipal stormwater infrastructure. The proposed development is not proposed for intensive development, only low density units with municipal water and private septic are proposed. This infrastructure will include drywells, perforated pipes, infiltration trenches, and grassed swales to mitigate the stormwater in accordance with Municipal servicing policies. The stormwater management needs to be addressed on site, in terms of quantity and quality of release.

The site grading is proposed to separate rear yard drainage from road drainage with lots likely being split graded at the midpoint of the houses, from the midpoint lots would drain towards the back and front yards.

Description	Area	C
Rear Yard Drainage	10.67 ha	0.13
Front Yard Drainage and Road Drainage	5.99 ha	0.37

The rear yards should not be significantly changed as there is only minor additional drainage from building roofs. The largest change is in the proposed front yards and the new road drainage catchments. The area is presented as one for preliminary calculation purposes, however there will actually be four (4) main drainage branches as the roadway drainage is split clockwise and counterclockwise going around the road, and also split into the left and right side ditches, complete with perforated pipes.



5.2.1 Rear Yard Drainage

Rear yards would drain naturally to common property lines and drywells are proposed to facilitate removal of minor additional drainage resulting from the new dwellings and associated grading. The minor additional increase in runoff can be offset via the provided drywells which will allow the clean roof and landscaping drainage to infiltrate into the existing dry sandy soils. Perimeter ditches will be provided where appropriate at minimum grade to capture and convey water to the drywells and prevent uncontrolled releases onto neighbouring properties.

For the rear yards abutting the trail, the noise study recommends a berm, and additional drywells will be provided upslope from the berm to avoid any potential ponding or pooling issues.

5.2.2 Front Yard and Road Drainage

Front yard drainage will be conveyed via overland flow from the lots and roadway to the shallow roadside ditches and captured by drywells complete with perforated pipes between them. The perforated pipes between the drywells allow for water to continuously exfiltrate into the sandy soil during rainfall events and minimize development impacts. This type of low impact development (LID) stormwater management feature has been used previously in the Town for low density subdivisions (Kramer and more recently Radtke Phase 2). In this case, there would be drywells or drainage basins in front of each lot, between driveways, and located to provide approximately a 30m spacing between drywells.

5.2.3 Site Exfiltration and Storage Potential

A geotechnical investigation was undertaken to determine the exfiltration potential of the site. Based upon an average percolation rate from the site tests of 148 mm/hr (range 86 to 219 mm/hr), and using a conservative assumption that over the long term exfiltration capacity will be reduced by 50%, a value of 75 mm/hr will be used for design purposes. Rearranging the MOE filter area equation 4.12 (Stormwater Management Planning and Design Manual) the time to exfiltrate a known volume of water can be determined.

$$A = \frac{1,000 V d}{k (h + d) t} \quad \text{Equation 4.12: Surface Area of Filter}$$

- where A = surface area of the filter in m²
- V = design volume (m³) derived from Table 3.2
- d = depth (m) of the controlling filter medium (e.g., the sand or peat layer)
- k = coefficient of permeability of the controlling filter media (mm/hr)
- h = operating head of water on the filter (m)
- t = design drawdown time in hours

Based upon 854 cu.m. of runoff volume for a 100 year storm for the Post-Development Front Yard and Road Drainage area (5.99 ha, c = 0.37, ToC = 25 min), and given that there is 2210m of pipe length available in the subdivision to exfiltrate with a normal trench bottom width of 1m, and allowing for half of the average percolation rate (148/2 = 75mm/hr), the rearranged equation follows:

$$\frac{A k (h+d)}{1000Vd} = \frac{1}{t}$$

$$\frac{1000Vd}{A k (h+d)} = t$$

$$\frac{1000(854)(10)}{2210(75)(0+10)} = t$$

$$t = 5.2 \text{ hrs}$$

The expected rainfall from the 100 year storm can be infiltrated by the proposed exfiltration pipe & trench in 5.2 hours. The calculated water quality storage volume of 164 cu.m. would be exfiltrated in approximately 53 minutes. Given that all the water infiltrates, this is regarded to meet or exceed the MECP water quality control requirements.



The 2210 sq.m. (2210 m long, 1 m wide) of infiltration trench provide approximately 2210m x 0.075 m/hr / 3600 s/hr = 0.046 m³/sec or 46 L/s of infiltration potential and it also provides approximately 948 cu.m. of storage below the perforated pipe invert and 2210 cu.m. of storage to the top of the stone. The stormwater system would include strategically placed structures where the outlet is higher than the inlet. In this way infiltration can be encouraged and the full storage in the infiltration trench can be reached.

Preliminary modified rational method calculations for the infiltration trench demonstrates that volume of storage provided exceeds the storage requirements. No offsite flows are anticipated. Therefore, as the peak runoff from the site is less than the Pre-Development runoff, it has been demonstrated that offsite flows will be controlled under post development conditions. As a result, no stormwater management pond is proposed or warranted for this site. No adverse impacts to adjacent properties are anticipated from the proposed development with the proposed stormwater management strategy.

6 Conclusions and Recommendations

Based upon our review, the proposed development can be serviced by new municipal roadways, new storm sewers including a trench, and new water services in accordance with the MECP guidelines and the Municipality's standards and servicing policies. No adverse impacts are anticipated on those municipal services as a result of the approval, detailed design, and construction of this development. This Functional Servicing Report should be filed in support of the development application and any other required filings.

The detailed design of the subdivision will implement the following measures:

- All utility, road, and grading designs are to be prepared in accordance with the Municipality's standards and requirements, as well as other authorities having jurisdiction.
- The infiltration trench will provide water quality and quantity control. The native sandy soils can accept the increased runoff to reduce post-development flows to less than pre-development.
- Detailed designs of the development are to be prepared and submitted to the authorities having jurisdiction for their review and approval.

End of report.



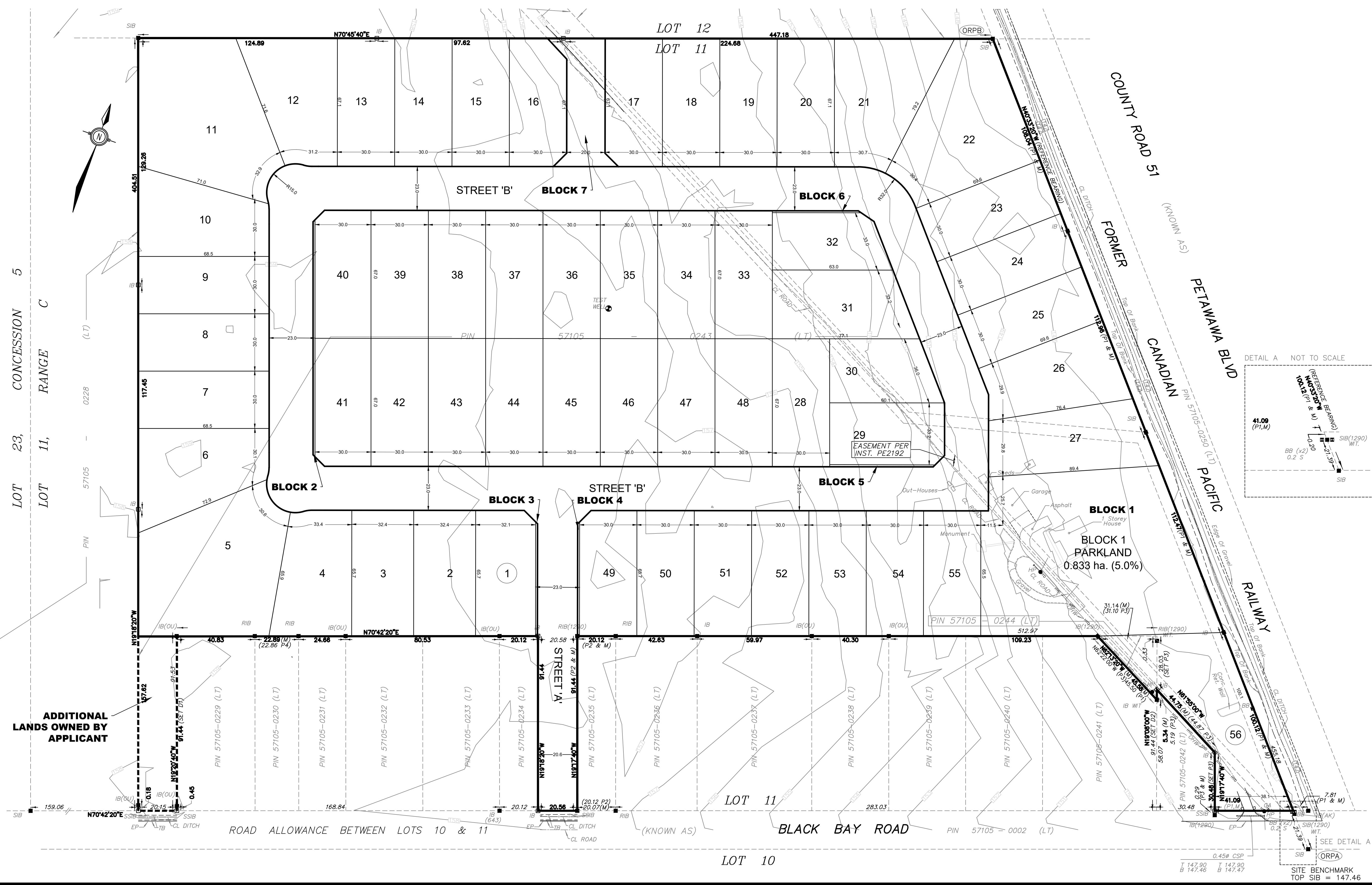
Appendix A

Draft Plan of Subdivision

LOT #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
FRONTAGE (m)	32.1	32.4	32.4	33.6	30.6	30.2	30.0	30.0	30.0	30.0	32.9	31.2	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.7	30.4	30.0	30.0	30.0	30.0	30.0	33.2	36.0
LOT DEPTH	65.8	65.8	65.9	65.9	65.9	67.1	68.5	68.5	67.6	67.6	67.1	67.1	67.1	67.1	67.1	67.1	67.1	67.1	67.1	67.1	67.1	69.6	69.6	69.6	69.6	69.6	67.0	90.1	77.1	
LOT AREA (ac)	0.5	0.5	0.5	0.6	0.7	0.7	0.5	0.5	0.6	0.5	0.9	1.1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.8	1.0	0.5	0.5	0.6	0.7	0.5	0.8	0.4
LOT AREA (ha)	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.3	0.2	0.4	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.2	0.2	0.2	0.3	0.2	0.3	0.2

LOT #	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
FRONTAGE (m)	35.4	36.2	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	38.1	
LOT DEPTH	64.2	64.2	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	67.0	65.7	65.7	65.7	65.7	65.5	65.5	100.1	
LOT AREA (ac)	0.4	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	
LOT AREA (ha)	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	

BLOCK #	1	2	3	4	5	6	7
LOT AREA (sq.m)	9848	37	20	19	29	14	1452
LOT AREA (ac)	2.433	0.009	0.005	0.005	0.007	0.003	0.359
LOT AREA (ha)	0.985	0.004	0.002	0.002	0.003	0.001	0.145



- ADDITIONAL INFORMATION**
- UNDER SECTION 51 (17) OF THE PLANNING ACT R.S.O., 1990 CHAPTER P.13.
 - a) AS SHOWN ON DRAFT PLAN.
 - b) AS SHOWN ON DRAFT AND KEY PLANS.
 - c) AS SHOWN ON DRAFT AND KEY PLANS.
 - d) LOTS 1-56 SINGLE DETACHED RESIDENTIAL LOTS. BLOCK 1 - PARKLAND DEDICATION. BLOCK 2-6 ONE FOOT RESERVE BLOCK 7 FUTURE ACCESS
 - e) TO THE NORTH - FOREST, VACANT
 - TO THE EAST - TRAIL
 - TO THE SOUTH - RESIDENTIAL
 - TO THE WEST - FOREST, VACANT
 - f) AS SHOWN ON DRAFT PLAN.
 - g) AS SHOWN ON DRAFT PLAN.
 - h) MUNICIPAL WATER
 - i) SAND/SANDY LOAM
 - j) AS SHOWN ON DRAFT PLAN.
 - k) MUNICIPAL ROADS, WATER & STORM SEWERS. PRIVATE SANITARY SERVICES.
 - l) AS SHOWN DRAFT PLAN.

OWNER'S AUTHORIZATION

I AUTHORIZE Jp2g Consultants Inc. TO SUBMIT THIS DRAFT PLAN OF SUBDIVISION TO THE COUNTY OF RENFW FOR APPROVAL.

DATE _____ JAMES W. LAPOINTE MOTOR HOLDINGS INC.

SURVEYOR'S CERTIFICATION

I CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED ARE CORRECTLY SHOWN.

DATE _____ SIMON KASPRZAK, O.L.S.

THIS DRAFT PLAN OF SUBDIVISION IS APPROVED UNDER SECTION 51(31) OF THE PLANNING ACT ON _____ DAY OF _____ 2023

BRUCE HOWARTH, M.C.P., R.P.P. MANAGER OF PLANNING, DEVELOPMENT & PROPERTY DEPARTMENT, COUNTY OF RENFW

TOTAL LAND AREA 16.66 HA (41.17 ACRES)

UNIT DENSTY
 - 56 UNITS TOTAL
 - 1.36 UNITS/ACRE

No.	REVISION COMMENTS
1	XXXX-AM-02 05/09/2023

BLACK BAY SUBDIVISION

PETAWAWA, ONTARIO

DRAFT PLAN OF SUBDIVISION

Jp2g Consultants Inc.
 ENGINEERS · PLANNERS · PROJECT MANAGERS

12 INTERNATIONAL DRIVE, PEMBROKE, ON
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 Phone: (613) 828-7800 Fax: (613) 828-2600

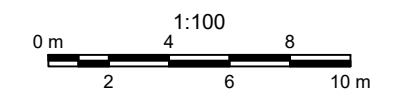
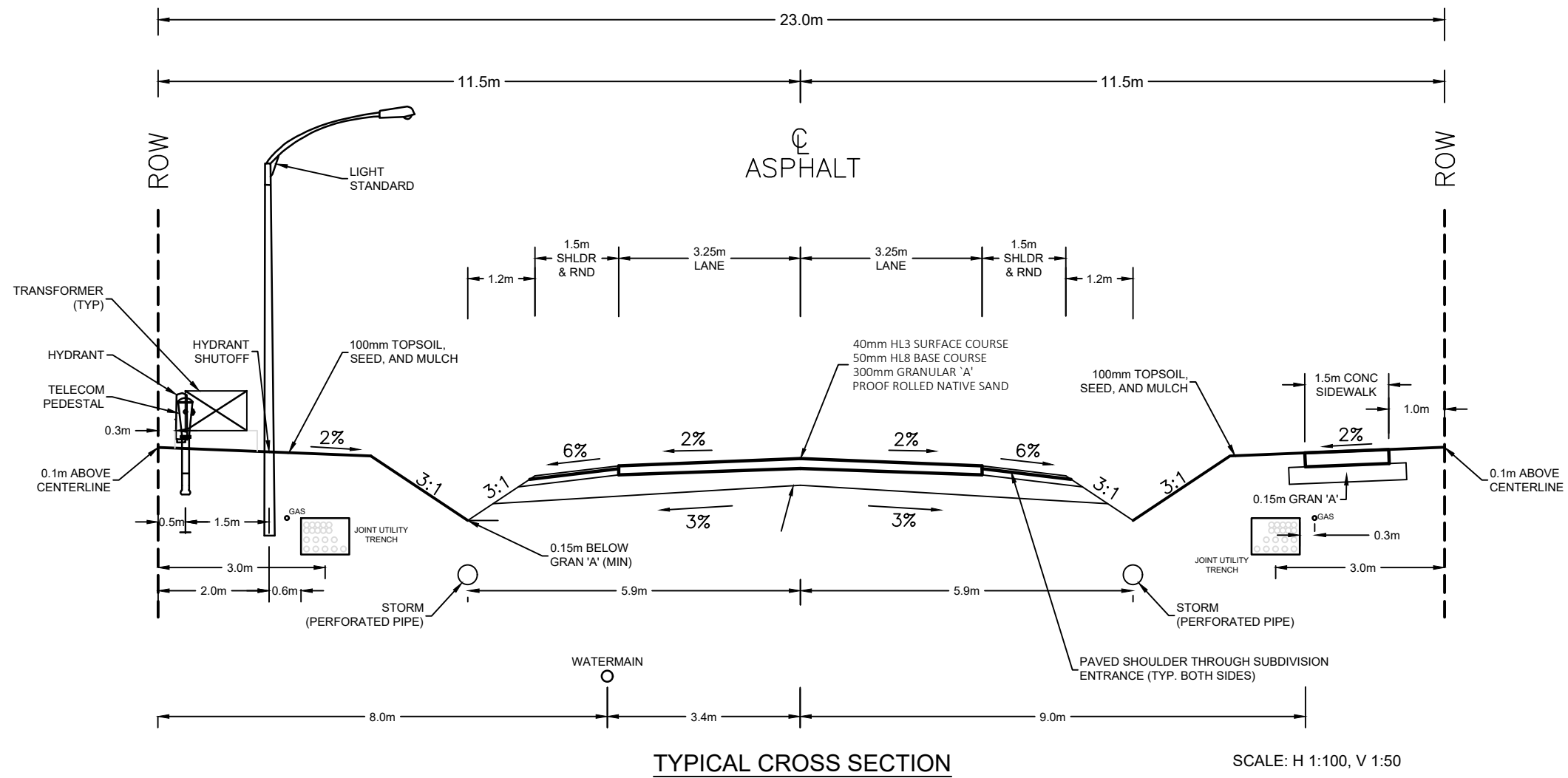
DESIGNED: MNF
 DRAFTED: MNF
 CHECKED: AH APPROVED: BW
 SCALE: 1:1000

DRAFT PLAN OF SUBDIVISION



Appendix B

Road Cross Section



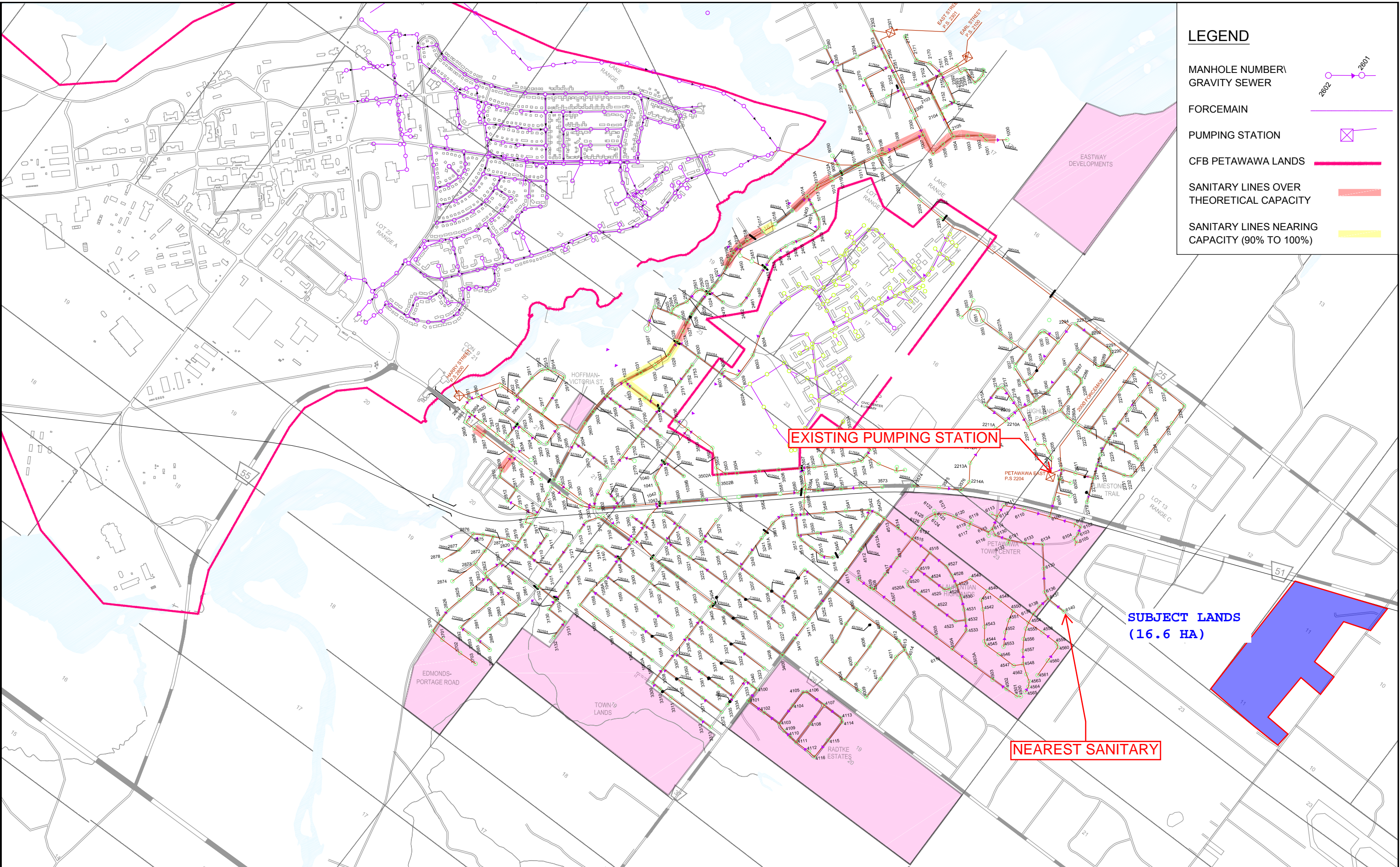
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DRAFTED: MNF	
CHECKED: MNF	APPROVED: MNF



Appendix C

Existing Sanitary Service Area

DWG NAME: P:\DRAWINGS\5 - MUNICIPAL SERVICES\2115331E - PETAWAWA GIS\PETAWAWA INFRASTRUCTURE MAP\SANITARY LAYERS.DWG LAYOUT: 2-5



LEGEND

- MANHOLE NUMBER GRAVITY SEWER:
- FORCE MAIN:
- PUMPING STATION:
- CFB PETAWAWA LANDS:
- SANITARY LINES OVER THEORETICAL CAPACITY:
- SANITARY LINES NEARING CAPACITY (90% TO 100%):





Appendix D

Town of Petawawa Municipal Water System

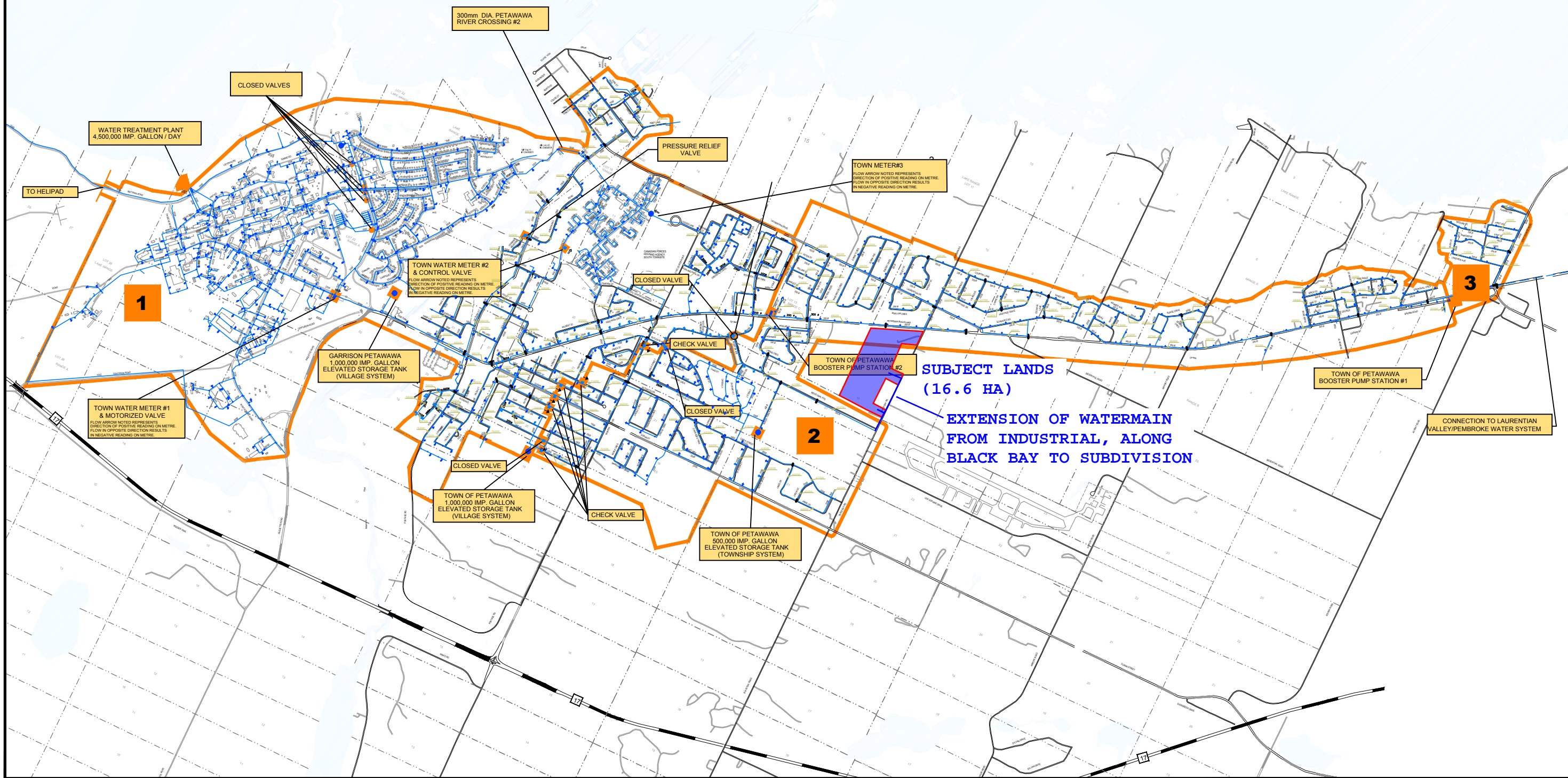
LEGEND

- Denotes Highlighted Items in Water System
- Pressure Zone Boundary
- Feeder mains

EXISTING PRESSURE ZONES

- 1** TOWN OF PETAWAWA - URBAN AREA (INCLUDING GARRISON PETAWAWA) (KNOWN AS VILLAGE SYSTEM)
- 2** TOWN OF PETAWAWA - SEMI-URBAN AREA (KNOWN AS TOWNSHIP SYSTEM)
- 3** MCGUIRE SUBDIVISION AREA (SUPPLIED FROM CITY OF PEMBROKE)

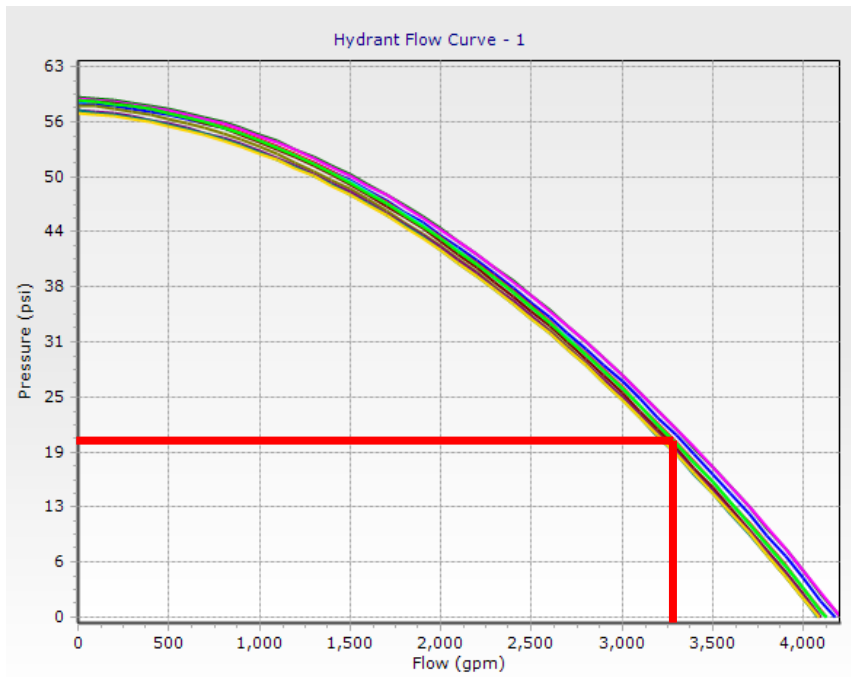
DWG NAME: P:\DRAWINGS\5 - MUNICIPAL SERVICES\2115331E - PETAWAWA GIS\PETAWAWA INFRASTRUCTURE MAPS\WATER LAYERS.DWG LAYOUT: 5-1



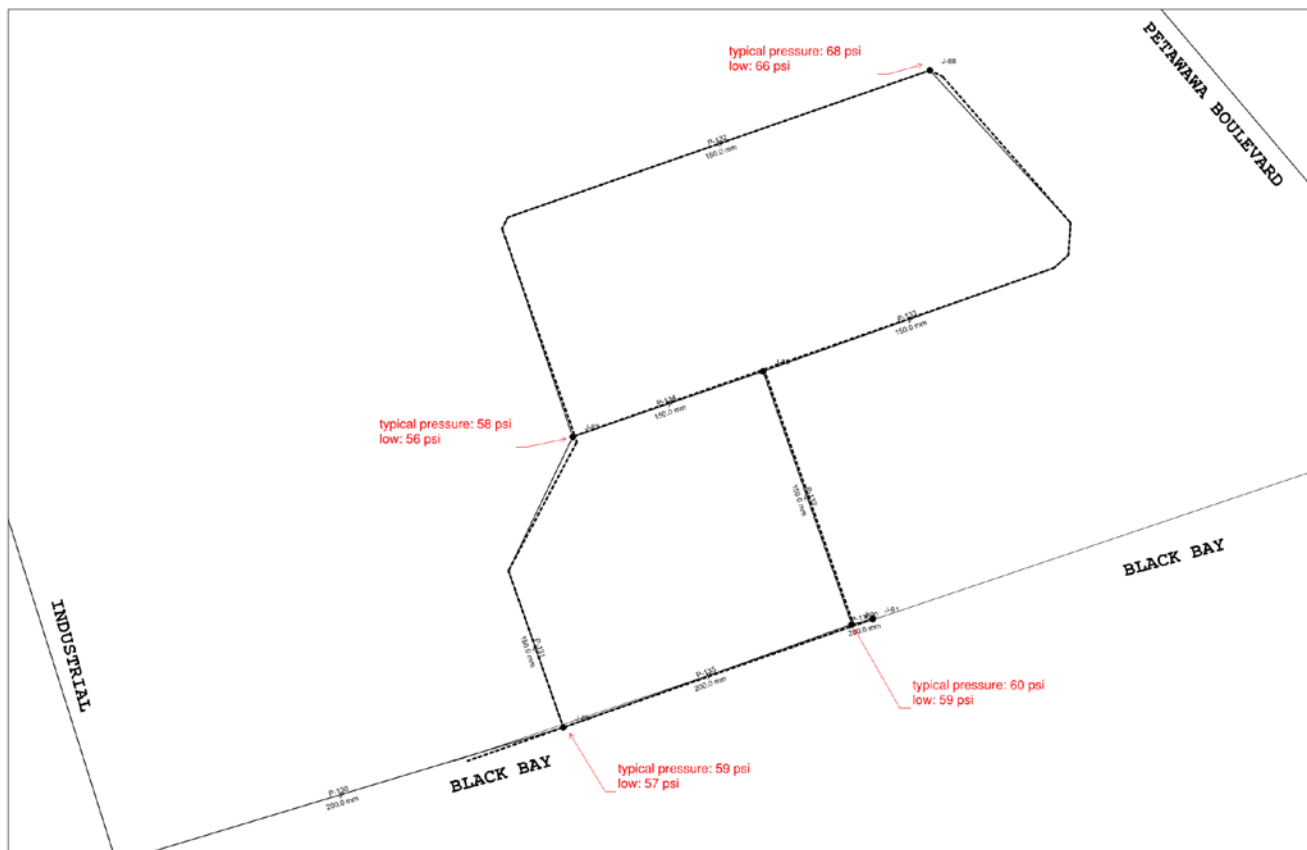


Appendix E

Water Route & Fire Hydrant Flows, WaterGEMs Output



WaterGEMs output at the intersection of Industrial Ave and the first 200x150mm TEE. A 20 psi residual corresponds to approximately 3300 gpm (208 L/S)

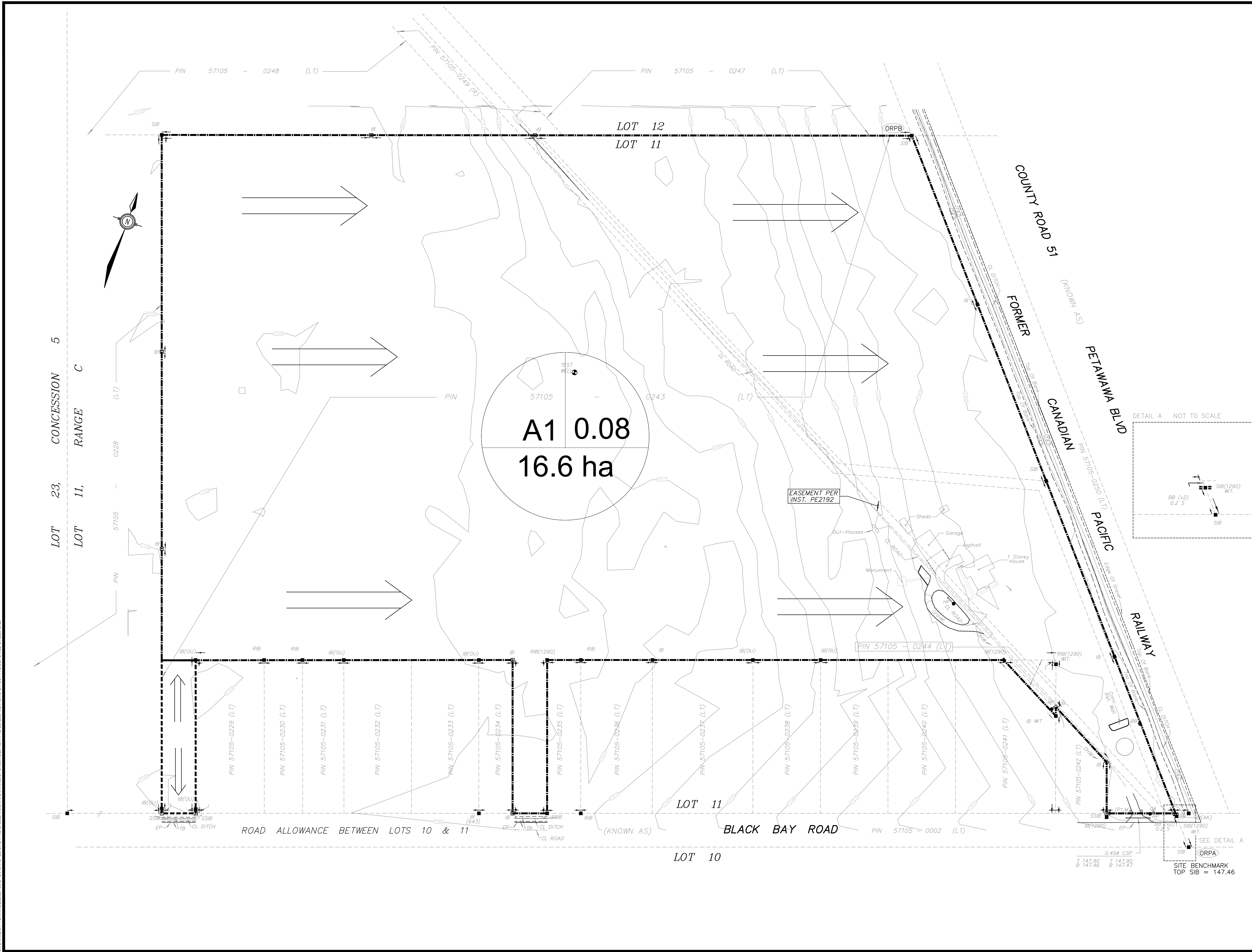


WaterGEMs output at the intersection of Industrial Ave and the 200x150mm TEE. Pressures vary between 55 and 70 psi.



Appendix F

Pre & Post-Development Stormwater Plans



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

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STORMWATER LEGEND

DRAINAGE AREA LABEL

REFERENCE NUMBER: ID °c, AREA ha

AREA

DRAINAGE BOUNDARY

DIRECTION OF SURFACE DRAINAGE

No.	YYYY-MM-DD	BY	REVISION COMMENTS

**BLACK BAY
PETAWAWA, ONTARIO**

~

**STORMWATER MANAGEMENT
PRE-DEVELOPMENT**

Jp2g Consultants Inc.
ENGINEERS • PLANNERS • PROJECT MANAGERS

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Phone: (613) 828-7800, Fax: (613) 828-2600

Jp2g Project No.: 20-7031A 16 EDWARDS STREET SOUTH, UNIT 538, ARNPRIOR, ON

SCALE: H=1:1000

DESIGNED: MNF
DRAFTED: MNF
CHECKED: MNF
APPROVED: MNF

1:1,000
0 m 10 20 30 40 50 m

SWMP-PRE

20-7031A-PRE-DEVELOPMENT DWG



Appendix G

Stormwater Calculations

CHARTS B2 - 1 & 2

CHART B2-1 - RUNOFF COEFFICIENTS

LAND USE & TOPOGRAPHY*	SOIL TEXTURE		
	Open Sand Loam	Loam or Silt Loam	Clay Loam or Clay
CULTIVATED			
Flat 0 - 5% Slopes	0.22	0.35	0.55
Rolling 5 - 10% Slopes	0.30	0.45	0.60
Hilly 10 - 30% Slopes	0.40	0.65	0.70
PASTURE			
Flat 0 - 5% Slopes	0.10	0.28	0.40
Rolling 5 - 10% Slopes	0.15	0.35	0.45
Hilly 10 - 30% Slopes	0.22	0.40	0.55
WOODLAND OR CUTOVER			
Flat 0 - 5% Slopes	0.08	0.25	0.35
Rolling 5 - 10% Slopes	0.12	0.30	0.42
Hilly 10 - 30% Slopes	0.18	0.35	0.52
URBAN AREAS OR BARE ROCK			
IMPERVIOUSNESS**			
30% imperv. 50% imperv. 70% imperv.			
Flat 0 - 5% Slopes	0.40	0.55	0.75
Rolling 5 - 10% Slopes	0.50	0.65	0.80
Hilly 10 - 30% Slopes	0.55	0.70	0.85
LAKES AND WETLANDS		0.05	

PRE

* Slopes of terrain.

** Interpolate for other values of % imperviousness.

For calculation of runoff coefficients see Form B4-1 (MTC Form PH-D-532).

For percent imperviousness of urban areas see Chart B2-2 if estimation by airphoto interpretation is not feasible.

CHART B2-2 - PERCENT IMPERVIOUSNESS OF URBAN AREAS

Urban Land Use	% Imperviousness
Business - Commercial	40 - 90
Industrial - Light	45 - 65
Industrial - Heavy	50 - 70
Residential - Low density	x 20 - 30
Residential - Medium density	25 - 35
Residential - High density	30 - 40

Source: SCS National Engineering Handbook, Chapter 15. (18).

Design Chart 1.07: Runoff Coefficients

- Urban for 5 to 10-Year Storms

Hard Surfaces
= 0.90

Land Use		Runoff Coefficient	
		Min.	Max.
Pavement	- asphalt or concrete	0.80	0.95
	- brick	0.70	0.85
Gravel roads and shoulders		0.40	0.60
Roofs		0.70	0.95
Business	- downtown	0.70	0.95
	- neighbourhood	0.50	0.70
	- light	0.50	0.80
	- heavy	0.60	0.90
Residential	- single family urban	0.30	0.50
	- multiple, detached	0.40	0.60
	- multiple, attached	0.60	0.75
	- suburban	0.25	0.40
Industrial	- light	0.50	0.80
	- heavy	0.60	0.90
Apartments		0.50	0.70
Parks, cemeteries		0.10	0.25
Playgrounds (unpaved)		0.20	0.35
Railroad yards		0.20	0.35
Unimproved areas		0.10	0.30
Lawns	- Sandy soil		
	- flat, to 2%	0.05	0.10
	- average, 2 to 7%	0.10	0.15
	- steep, over 7%	0.15	0.20
	- Clayey soil		
	- flat, to 2%	0.13	0.17
	- average, 2 to 7%	0.18	0.22
- steep, over 7%	0.25	0.35	

Lawns and
undeveloped
= 0.08

For flat or permeable surfaces, use the lower values. For steeper or more impervious surfaces, use the higher values. For return period of more than 10 years, increase above values as 25-year - add 10%, 50-year - add 20%, 100-year - add 25%.

The coefficients listed above are for unfrozen ground.

Environment and Climate Change Canada
 Environnement et Changement climatique Canada

Short Duration Rainfall Intensity-Duration-Frequency Data
 Données sur l'intensité, la durée et la fréquence des chutes
 de pluie de courte durée

Gumbel - Method of moments/Méthode des moments

2022/10/31

```
=====
PEMBROKE CLIMATE                                ON          6106367
Latitude:  45 52'N   Longitude: 77 15'W   Elevation/Altitude: 161      m
Years/Années : 1996 - 2021           # Years/Années :    18
=====
```

Table 1 : Annual Maximum (mm)/Maximum annuel (mm)

Year Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1996	6.8	9.0	9.9	12.1	14.6	17.4	-99.9	-99.9	37.6
1997	7.1	10.2	11.4	11.7	11.7	13.4	20.7	23.2	29.1
1998	9.5	11.5	13.8	16.5	23.4	35.1	58.3	61.6	61.6
1999	9.5	11.6	12.6	16.5	24.9	35.3	45.4	55.4	56.2
2001	4.3	7.3	10.1	14.8	21.3	26.1	-99.9	-99.9	40.6
2002	8.3	10.1	10.3	16.8	17.5	17.5	24.2	35.4	57.9
2003	6.6	10.6	12.2	18.3	24.7	33.1	44.3	46.4	54.8
2004	6.2	10.4	12.6	14.8	19.5	27.1	30.7	33.5	35.1
2006	8.5	14.1	15.7	16.1	18.4	35.6	53.4	62.5	63.5
2011	15.8	19.6	20.8	21.8	23.8	31.4	34.3	41.6	52.9
2012	7.3	13.1	17.8	20.2	20.2	20.2	20.6	24.4	38.3
2013	9.1	13.2	16.1	22.9	37.1	44.0	50.3	52.0	52.0
2014	8.6	13.0	15.0	17.4	24.0	31.9	40.2	40.2	40.2
2015	9.6	11.2	12.2	12.8	16.8	23.4	27.6	29.0	29.4
2016	9.8	14.6	17.4	17.6	20.6	29.2	38.0	53.2	53.4
2017	13.0	18.4	23.4	28.0	28.2	28.4	31.4	39.8	43.6
2018	6.0	9.2	12.6	23.2	35.8	39.2	57.6	57.6	57.8
2019	5.4	9.4	12.4	14.8	18.2	23.2	25.0	30.6	41.0
2020	10.0	16.0	21.8	31.8	36.4	38.8	40.8	45.8	55.8
2021	5.8	10.6	15.0	21.6	24.2	33.0	37.4	48.0	60.6

# Yrs.	20	20	20	20	20	20	18	18	20
Années									
Mean	8.4	12.2	14.7	18.5	23.1	29.2	37.8	43.3	48.1
Moyenne									
Std. Dev.	2.7	3.2	3.9	5.2	7.0	8.1	12.1	12.3	10.9
Écart-type									
Skew.	1.15	0.96	0.92	1.06	0.79	-0.25	0.25	-0.07	-0.33
Dissymétrie									
Kurtosis	5.33	3.96	3.44	4.38	3.62	2.84	2.51	2.42	2.18

*-99.9 Indicates Missing Data/Données manquantes

Table 2a : Return Period Rainfall Amounts (mm)
Quantité de pluie (mm) par période de retour

Duration/Durée	2	5	10	25	50	100	#Years
	yr/ans	yr/ans	yr/ans	yr/ans	yr/ans	yr/ans	Années
5 min	7.9	10.3	11.9	13.8	15.3	16.8	20
10 min	11.6	14.4	16.3	18.6	20.3	22.1	20
15 min	14.0	17.5	19.7	22.6	24.8	26.9	20
30 min	17.6	22.2	25.3	29.1	31.9	34.8	20
1 h	21.9	28.1	32.1	37.3	41.1	44.9	20
2 h	27.8	35.0	39.8	45.8	50.3	54.7	20
6 h	35.8	46.5	53.5	62.4	69.0	75.6	18
12 h	41.3	52.2	59.4	68.5	75.3	82.0	18
24 h	46.3	55.9	62.4	70.4	76.4	82.4	20

Table 2b :

Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

Duration/Durée	2	5	10	25	50	100	#Years
	yr/ans	yr/ans	yr/ans	yr/ans	yr/ans	yr/ans	Années
5 min	95.0	123.5	142.3	166.1	183.8	201.3	20
	+/- 12.9	+/- 21.8	+/- 29.5	+/- 39.7	+/- 47.5	+/- 55.4	20
10 min	69.8	86.5	97.6	111.6	122.0	132.3	20
	+/- 7.6	+/- 12.8	+/- 17.3	+/- 23.4	+/- 27.9	+/- 32.6	20
15 min	56.1	69.9	79.0	90.5	99.1	107.6	20
	+/- 6.3	+/- 10.6	+/- 14.3	+/- 19.3	+/- 23.1	+/- 26.9	20
30 min	35.3	44.4	50.5	58.2	63.9	69.5	20

	+/-	4.2	+/-	7.0	+/-	9.5	+/-	12.8	+/-	15.3	+/-	17.8	20
1 h		21.9		28.1		32.1		37.3		41.1		44.9	20
	+/-	2.8	+/-	4.7	+/-	6.4	+/-	8.6	+/-	10.3	+/-	12.0	20
2 h		13.9		17.5		19.9		22.9		25.1		27.3	20
	+/-	1.6	+/-	2.8	+/-	3.7	+/-	5.0	+/-	6.0	+/-	7.0	20
6 h		6.0		7.7		8.9		10.4		11.5		12.6	18
	+/-	0.9	+/-	1.4	+/-	1.9	+/-	2.6	+/-	3.1	+/-	3.6	18
12 h		3.4		4.4		5.0		5.7		6.3		6.8	18
	+/-	0.4	+/-	0.7	+/-	1.0	+/-	1.3	+/-	1.6	+/-	1.9	18
24 h		1.9		2.3		2.6		2.9		3.2		3.4	20
	+/-	0.2	+/-	0.3	+/-	0.4	+/-	0.6	+/-	0.7	+/-	0.8	20

Table 3 : Interpolation Equation / Équation d'interpolation: $R = A \cdot T^B$

R = Interpolated Rainfall rate (mm/h)/Intensité interpolée de la pluie (mm/h)

RR = Rainfall rate (mm/h) / Intensité de la pluie (mm/h)

T = Rainfall duration (h) / Durée de la pluie (h)

Statistics/Statistiques	2	5	10	25	50	100
	yr/ans	yr/ans	yr/ans	yr/ans	yr/ans	yr/ans
Mean of RR/Moyenne de RR	33.7	42.7	48.7	56.2	61.8	67.3
Std. Dev. /Écart-type (RR)	33.2	42.4	48.5	56.2	62.0	67.7
Std. Error/Erreur-type	7.5	8.7	9.5	10.5	11.3	12.1
Coefficient (A)	20.2	25.5	29.0	33.4	36.6	39.9
Exponent/Exposant (B)	-0.698	-0.702	-0.703	-0.705	-0.706	-0.707
Mean % Error/% erreur moyenne	8.1	8.7	8.9	9.2	9.4	9.5

TABLE F-1: PRE AND POST-DEVELOPMENT DRAINAGE AREA PARAMETERS AND DATA

Drainage Area ID	Comment	Area (ha)	Land Use	Land Use Area (ha)	Runoff Coefficient				Weighted Runoff Coefficient				
					<= 10-Year	25-Year Increase (10%)	50-Year Increase (20%)	100-Year Increase (25%)	<= 10-Year	25-Year	50-Year	100-Year	
Pre Development													
A1		16.66	Hard Surface Impervious	0.06	0.90	0.99	1.00	1.00	0.08	0.09	0.10	0.10	
			Woodland_Forest_Sandy_Flat	16.60	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.000	0.08	0.09	0.10	0.10					
Post Development													
B1		2.50	Hard Surface Impervious	0.19	0.90	0.99	1.00	1.00	0.14	0.15	0.16	0.17	
			Woodland_Forest_Sandy_Flat	2.31	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
B2		0.94	Hard Surface Impervious	0.06	0.90	0.99	1.00	1.00	0.13	0.14	0.15	0.16	
			Woodland_Forest_Sandy_Flat	0.88	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
B3		1.24	Hard Surface Impervious	0.08	0.90	0.99	1.00	1.00	0.13	0.15	0.16	0.16	
			Woodland_Forest_Sandy_Flat	1.15	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
B4		1.36	Hard Surface Impervious	0.07	0.90	0.99	1.00	1.00	0.12	0.13	0.14	0.15	
			Woodland_Forest_Sandy_Flat	1.29	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
B5		2.00	Hard Surface Impervious	0.13	0.90	0.99	1.00	1.00	0.13	0.15	0.15	0.16	
			Woodland_Forest_Sandy_Flat	1.87	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
B6		2.45	Hard Surface Impervious	0.12	0.90	0.99	1.00	1.00	0.12	0.13	0.14	0.15	
			Woodland_Forest_Sandy_Flat	2.33	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
O1		0.18	Hard Surface Impervious	0.00	0.90	0.99	1.00	1.00	0.08	0.09	0.10	0.10	
			Woodland_Forest_Sandy_Flat	0.18	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
R1		1.50	Hard Surface Impervious	0.71	0.90	0.99	1.00	1.00	0.47	0.52	0.53	0.53	
			Woodland_Forest_Sandy_Flat	0.79	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
R2		0.85	Hard Surface Impervious	0.33	0.90	0.99	1.00	1.00	0.40	0.44	0.45	0.45	
			Woodland_Forest_Sandy_Flat	0.52	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
R3		0.00	Hard Surface Impervious	0.00	0.90	0.99	1.00	1.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	
			Woodland_Forest_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
R4		1.50	Hard Surface Impervious	0.57	0.90	0.99	1.00	1.00	0.39	0.43	0.44	0.44	
			Woodland_Forest_Sandy_Flat	0.94	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
R5		1.18	Hard Surface Impervious	0.32	0.90	0.99	1.00	1.00	0.30	0.33	0.34	0.34	
			Woodland_Forest_Sandy_Flat	0.86	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
R6		0.96	Hard Surface Impervious	0.17	0.90	0.99	1.00	1.00	0.22	0.25	0.25	0.26	
			Woodland_Forest_Sandy_Flat	0.79	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
POST		16.66	Hard Surface Impervious	2.74	0.90	0.99	1.00	1.00	0.21	0.24	0.24	0.25	
			Woodland_Forest_Sandy_Flat	13.92	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
SUM REAR YARDS		10.67	Hard Surface Impervious	0.64	0.90	0.99	1.00	1.00	0.13	0.14	0.15	0.15	
			Woodland_Forest_Sandy_Flat	10.03	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					
SUM ROADS		5.99	Hard Surface Impervious	2.10	0.90	0.99	1.00	1.00	0.37	0.40	0.41	0.41	
			Woodland_Forest_Sandy_Flat	3.89	0.08	0.09	0.10	0.10					
			Woodland_Lawn_Sandy_Flat	0.00	0.08	0.09	0.10	0.10					
			Gravel	0.00	0.50	0.55	0.60	0.63					

TABLE A-8: PRE & POST-DEVELOPMENT TIME OF CONCENTRATION
The Airport Formula

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

where: t_c = time of concentration, min.
 C = runoff coefficient
 S_w = watershed slope, %
 L = watershed length, m.

The Bransby Williams Formula

$$t_c = \frac{0.057 * L}{(S_w^{0.2} * A^{0.1})}$$

where: t_c = time of concentration, min.
 C = runoff coefficient
 S_w = watershed slope, %
 L = watershed length, m.

Drainage Area ID	Total Area (ha)	Weighted Runoff Coefficient				Physical Parameters		Airport/Bransby Williams Tc (minutes)			
		<=10-Year	25-Year	50-Year	100-Year	85/10 S_w (%)	Total Length (m)	<=10-Year	25-Year	50-Year	100-Year
A1	16.66	0.08	0.09	0.10	0.10	2.00	500	59	58	58	58

*if Tc<10 use Tc=10 min as a minimum for the Rational Method.

TABLE F-2: PRE & POST-DEVELOPMENT STORM SEWER DRAINAGE AREA AND FLOWS

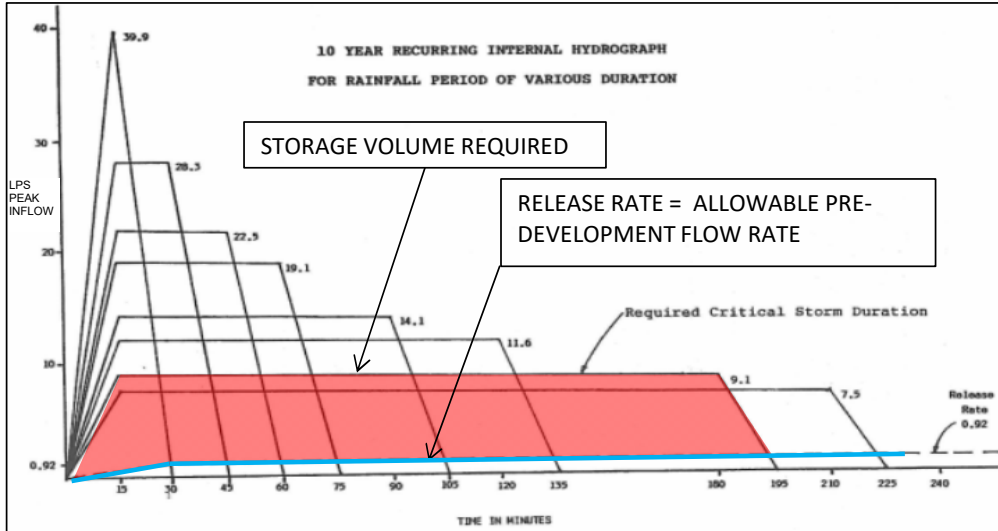
STORM INFORMATION										
Area	Time of concentration (min.)				Pembroke Airport IDF Curve					
	<=10-Year	25-Year	50-Year	100-Year	2-Year (mm/hr)	5-Year (mm/hr)	10-Year (mm/hr)	25-Year (mm/hr)	50-Year (mm/hr)	100-Year (mm/hr)
A1	59	58	58	58	20.0	25.3	28.6	33.0	36.2	39.5

IDF Curve- PEMBROKE

PRE and POST-DEVELOPMENT RUNOFF COEFFICIENT CALCULATIONS, RATIONAL METHOD											
Drainage Area ID	Drainage Area (ha)	Weighted R _o Coeff. (C) <=10-yr	Weighted R _o Coeff. (C) 25-yr	Weighted R _o Coeff. (C) 50-yr	Weighted R _o Coeff. (C) 100-yr	2-Year Flow Rate (L/s)	5-Year Flow Rate (L/s)	10-Year Flow Rate (L/s)	25-Year Flow Rate (L/s)	50-Year Flow Rate (L/s)	100-Year Flow Rate (L/s)
A1	16.66	0.08	0.09	0.10	0.10	77	97	110	140	167	189
Rear Yards	10.67	0.13	0.14	0.15	0.15	86	109	123	156	181	194
Roadways	5.99	0.37	0.40	0.41	0.41	154	194	220	283	321	569
					Runoff Volume (m3)	230	291	329	424	482	854

TABLE A-1: STORM STORAGE REQUIREMENTS - MODIFIED RATIONAL METHOD

Objective: Determine Modified Rational Method storage requirements for infiltration trench.



Determine Pond Storage Requirements

Weighted Runoff Coefficients

Site Area	5.990 ha	<u><=10 Year</u>	<u>25 Year</u>	<u>50 Year</u>	<u>100 Year</u>
Weighted R_0 Coefficient	0.37	0.37	0.40	0.41	0.41
Time of Concentration	25.0 mins				

Storm Frequency	A	B	Critical Storm Duration	i (mm/hr)	Q_{actual} (l/s)	Q_{allow} (Trench) (l/s)	Q_{stored} (l/s)	V_{stored} (Basin) (m ³)	Infil Trench Elevation (max 1.0m)
			(min)						(elev)
2yr - 2010	20.2	-0.698	45	24.7	152.3	46.0	106.3	286.6	0.29
5yr - 2010	25.5	-0.702	62	25.1	154.4	46.0	108.4	400.0	0.41
10yr - 2010	29.0	-0.703	74	25.1	154.9	46.0	108.9	480.3	0.49
25yr - 2010	33.4	-0.705	99	23.4	155.9	46.0	109.9	655.2	0.67
50yr - 2010	36.6	-0.706	116	22.9	156.5	46.0	110.5	771.8	0.79
100yr - 2010	39.9	-0.707	131	23.0	157.0	46.0	111.0	871.2	0.89