UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

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File: 24016

FUNCTIONAL SERVICING REPORT

NEWCASTLE STANLEY

July 2024

INTRODUCTION

This report addresses the servicing needs and requirements for the proposed development located at 2220 Stanley Avenue in the City of Niagara Falls, as part of the Zoning By-Law Amendment application process. The site is located at the east side of Stanley Avenue, north of Morning Glory Court and south of Fruitbelt Parkway. Historically, the property has been occupied by a single detached dwelling.

The development site is approximately 0.26 hectares in size, and shall consist of 28 stacked townhouse units. The site will include an associated asphalt parking lot, concrete curbs, catch basins, storm sewers, sanitary service, and water service.

The objectives of this study are as follows:

1. Identify domestic and fire protection water service needs for the site;
2. Identify sanitary servicing needs for the site; and,
3. Identify stormwater management needs for the site.

WATER SERVICING

There is an existing 200mm diameter municipal watermain and 400mm diameter regional watermain on Stanley Avenue (Regional Road #102). It is proposed to connect a 150mm diameter watermain to the existing 200mm diameter municipal watermain to provide water supply and fire protection to the proposed development.

Table 1 summarizes the projected water demand calculations for the proposed 28 stacked townhouse units. The water demands were calculated based on the 2021 Niagara Water Master Servicing Plan Update (MSPU).

Table 1. Water Demand Calculations								
Number of Units	Density (ppu)	Population (persons)	Avg. Day Demand Rate (L/cap/day)	Avg. Day Demand (L/s)	Max Day Demand		Peak Hour Demand	
					Peak Factor	(L/s)	Peak Factor	(L/s)
28	1.81	51	240	0.14	1.65	0.23	3.00	0.42

As shown on Table 1, an assumed per capita rate of 1.81 people per unit was apply. Using a rate of 240L/cap/day for residential per MSPU, it is expected than the proposed development generates an Average Day Demand of 0.14L/s. A peak factor of 1.65 was apply to calculate the expected Max Day Demand of 0.23L/s, and the Peak Hour Demand of 0.42L/s was calculated using a peak factor of 3 per 2021 MSPU.

There is an existing municipal fire hydrant on the west side of Stanley Avenue fronting the site. To provide adequate fire protection, it is proposed to place a private hydrant within the site. An analysis has been conducted per the Fire Underwriters Survey (FUS) to determine the minimum fire flow required. The calculation determined that a minimum of approximately 151.67 L/s fire flow is required with the inclusion of fire walls and 172.92 L/s without the fire walls. The fire flow calculations are attached in Appendix A.

Therefore, the existing 200mm diameter watermain on Stanley Avenue (RR #102) will adequately provide domestic water supply, and the proposed fire hydrant will provide adequate fire protection for the site.

SANITARY SERVICING

There is an existing 375mm diameter municipal sanitary sewer on Stanley Avenue (RR #102) conveying flows southerly, which has a full flow capacity of approximately 70.84L/s. It is proposed to connect a 200mm sanitary sewer from the proposed site to the existing 375mm diameter sanitary sewer system.

The proposed development was included in the sanitary area plan for the sanitary sewer design of the 200mm diameter sanitary sewer on Morning Glory Court, as shown in the Sanitary Drainage Area Plan 05-CB-123, attached in Appendix B. Under the original sewer design is expected a sanitary peak flow of approximately 1.54L/s from drainage areas A1 & A2, occupying approximately 2.2% of the receiving 375mm diameter sanitary sewer on Stanley Avenue.

Figure 1, attached in Appendix B, delineates the future sanitary drainage areas contributing to the existing sanitary sewer systems. The proposed 28 stacked townhouse units will generate a peak sanitary flow of 0.68L/s. The analysis shows that approximately 2.9% of the existing 375mm

diameter sanitary sewer capacity will be utilized with the inclusion of the sanitary flows form the existing 200mm sanitary sewer on Morning Glory Court.

Table 2 summarizes the sanitary peak flows and compares the existing and proposed sanitary sewer conditions. All the sanitary sewer calculations can be found in Appendix B.

Table 2. Sanitary Peak Flow Summary

Location	Population		Peak Flow (L/s)		
	Original Design	Proposed	Original Design	Proposed	Change
Stanley Avenue	72	113	1.54	2.04	+ 0.5

As shown in Table 2, the proposed sanitary peak flow to discharge into the 375mm diameter sanitary sewer on Stanley Avenue is 0.5L/s more than the original sanitary sewer design and will occupy 0.7% of the 375mm sanitary sewer total capacity.

Therefore, it is expected that this will be an acceptable addition to the current capacity of the existing municipal 375mm diameter sanitary sewer on Stanley Avenue.

STORMWATER MANAGEMENT

The existing stormwater flows from the site currently flow overland to the catch basin in the adjacent rear yard. The collected stormwater is then conveyed south to the existing 450mm diameter stormwater sewer on Morning Glory Court and directed west to discharge into a 525mm diameter stormwater sewer flowing south, as shown in Figure 2, attached in Appendix C.

An existing 300mm diameter municipal stormwater sewer on Morning Glory Court currently flows east to the existing 525mm diameter stormwater sewer. It is proposed to connect a new stormwater sewer along Stanley Avenue from the site to the existing stormwater system on Morning Glory Court, as illustrated in Figure 3 attached in Appendix C.

The site was allocated in the original stormwater sewer design of Golia Estates subdivision with a Runoff Coefficient of 0.4, as shown in the attached Storm Drainage Area Plan 05-CA-174 in Appendix C. The proposed drainage areas and associated Runoff Coefficient is shown in Figure 2. The drainage area being collected by the site system is 0.39ha, and its associated Runoff Coefficient from the impervious areas is 0.53.

The Modified Rational Method (MRM) was used to determine the peak flows and storage volume required for the 5 year storm event as shown in Appendix C. From the MRM analysis, Table 3 shows a comparison of the existing, allowable and proposed stormwater peak flows.

As shown in Table 3, the allowable outflow to the existing storm sewer system on Morning Glory Court is approximately 32.6L/s. The proposal includes controlling stormwater outflow prior to

discharge to the existing stormwater system in order to maintain the existing 300mm diameter pipe from MH S4 to MH S3. The required stormwater storage to control the proposed outflow of 23.5L/s is 9.5m³, which is equivalent to 58 metres of 450mm diameter pipe. The major flows from the site driveway and parking will be directed via overland sheet flow to Stanley Avenue.

Table 3. Peak Flow Summary

Area #	Area (ha)	Runoff Coefficient		Peak Flows (L/s)		Controlled Outflow (L/s)	
		Existing	Proposed	Existing	Proposed	Allowable	Proposed
5 Year Design Storm Event							
A1	0.35	0.40		32.6			
A10	0.39		0.53		48.2	32.6	23.5

To improve stormwater quality, an oil/grit separator typically provides Enhanced Level Protection (80% Total Suspended Solids) prior to discharging to the existing 300 mm diameter stormwater sewer on Morning Glory Court. The complete stormwater design for this development shall be identified as part of the future detailed design.

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CONCLUSIONS AND RECOMMENDATIONS

Therefore, based on the above comments and design calculations provided for this site, the following summarizes the servicing for this site.

1. The existing municipal 200mm diameter watermain on Stanley Avenue will have sufficient capacity to provide both domestic and fire protection water supply.

2. The existing 375mm diameter sanitary sewer on Stanley Avenue will have adequate capacity for the proposed residential development.

3. Stormwater quantity controls are being provided on site to the allowable capacity of the existing Morning Glory Court storm sewer.

4. Stormwater quality controls will be provided to MECP Enhanced protection (80% TSS removal) levels prior discharge from the site.

5. The site overland flow route from the site is to Stanley Avenue.

In conclusion, there exists adequate municipal infrastructure to service the proposed development. We trust the above comments and enclosed calculations are satisfactory for approval. If you have any questions or require additional information, please do not hesitate to contact our office.

Yours very truly,

Prepared by:

Roberto A. Duarte, B.Eng.

LICENSED PROFESSIONAL ENGINEER
J. P. SCHOOLEY
PROVINCE OF ONTARIO

Reviewed by:

Jason Schooley, P.Eng.

Encl.

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APPENDICES

UPPER CANADA CONSULTANTS
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APPENDIX A

Fire Underwriters Survey (FUS) Calculation Sheet

Fire Underwriters Survey

Water Supply for Public Fire Protection (2020) Calculations

Newcastle Stanley, Niagara Falls

Required Fire Flow in Litres per Minute	F=	9,100	(L/m)
		151.67	(L/s)
		2,404	(USgmp)
Type of Construction			
Ordinary Construction (brick or other masonry walls, combustible floor and interior).	C=	1.00	
Total Floor Area in square metres	A=	92.5	(m2)
Note: Fire wall every 2 units.			
Total Number of Floors		3	
2. Combustibility of Contents *(may not reduce fire flow demand below 2,000 L/min)*			
Limited Combustible	=	-15%	
3. Sprinkler Systems			
Is there a complete automatic sprinkler protection system per NFPA (Yes/No).	No	0%	
Water supply standard for both system and fire department hose lines (Yes/No).	No	0%	
Is system fully monitored (Yes/No).	No	0%	
Total Sprinker Reduction to Overall Fire Flow Demand		0%	
4. Spacial Separation of Neighbouring Structures (within 45 metres)			
Location of Building:			
2220 Stanley Avenue, Niagara Falls (Units 1-14)			
Distance to Nearest Building to the North	34.0 m	5%	
Distance to Nearest Building to the South	33.0 m	5%	
Distance to Nearest Building to the East	1.5 m	25%	
Distance to Nearest Building to the West	10.7 m	15%	
Total Spacial Separation to Adjacent Structures		50%	
Additions			
Is roof wood shingles or shakes (Yes/No).	Yes		

Fire Underwriters Survey

Water Supply for Public Fire Protection (2020) Calculations

Newcastle Stanley, Niagara Falls

Required Fire Flow in Litres per Minute	F=	10,375	(L/m)
		172.92	(L/s)
		2,741	(USgmp)
Type of Construction			
Ordinary Construction (brick or other masonry walls, combustible floor and interior).	C=	1.00	
Total Floor Area in square metres	A=	185	(m2)
Total Number of Floors		3	
2. Combustibility of Contents *(may not reduce fire flow demand below 2,000 L/min)*			
Limited Combustible	=	-15%	
3. Sprinkler Systems			
Is there a complete automatic sprinkler protection system per NFPA (Yes/No).		No	0%
Water supply standard for both system and fire department hose lines (Yes/No).		No	0%
Is system fully monitored (Yes/No).		No	0%
Total Sprinker Reduction to Overall Fire Flow Demand			0%
4. Spacial Separation of Neighbouring Structures (within 45 metres)			
Location of Building:			
2220 Stanley Avenue, Niagara Falls (Units 1-14)			
Distance to Nearest Building to the North		34.0 m	5%
Distance to Nearest Building to the South		33.0 m	5%
Distance to Nearest Building to the East		1.5 m	25%
Distance to Nearest Building to the West		10.7 m	15%
Total Spacial Separation to Adjacent Structures			50%
Additions			
Is roof wood shingles or shakes (Yes/No).		Yes	

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APPENDIX B

Golia Estates - Sanitary Drainage Area Plan (05-CB-123)
Figure 1 – Proposed Sanitary Drainage Area Plan
Sanitary Sewer Design Sheet

Sanda

Golia Estates

0363

LEGEND

- PROPOSED SANITARY SEWER
- DRAINAGE AREA BOUNDARY
- A1 / 1.27ha / 42 — DRAINAGE AREA NUMBER, DRAINAGE AREA IN HECTARES, POPULATION

ACCEPTED BY
SEP 29 '05
MUNICIPAL WORKS
CITY OF NIAGARA FALLS

No.	REVISION	DATE	INT.
4	ISSUED FOR CONSTRUCTION	SEPT /05	J.S.
3	REVISED PER CITY COMMENTS	JUL /05	J.S.
2	REVISED PER REGIONAL ROAD #102 RECONSTRUCTION	JUL /05	J.S.
1	REVISED PER CITY COMMENTS	MAR /05	J.S.
0	ISSUED FOR APPROVALS	JAN /05	J.S.

LEGEND

LS	LIGHT STANDARD	HYDRO CABLES	
TL	TRAFFIC LIGHT	WATERMAINS	
S	SIGN	GASMAINS	
H	BELL POLE	BELL CABLES	
HP	HYDRO POLE	CAP OR PLUG	
FH	HYDRANT	SANITARY SEWER	
	GUY AND ANCHOR	STORM SEWER	
	MANHOLE EXISTING	COMBINED SEWER	
	MANHOLE PROPOSED		
	CATCHBASIN EXISTING		
	CATCHBASIN PROPOSED		
SIB	STANDARD IRON BAR		

UNDERGROUND UTILITIES

DRAFTING: N.G.
DESIGN: M.H.
CHECKED BY: J.S.
PROJ. SUPVR.: N.G.

LICENCED PROFESSIONAL ENGINEER — J. P. SCHOOLEY — PROVINCE OF ONTARIO

The City of Niagara Falls Canada

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Port Colborne, ON L3K 5Z2
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Fax (905)834-5274

BENCH MARK DATUM

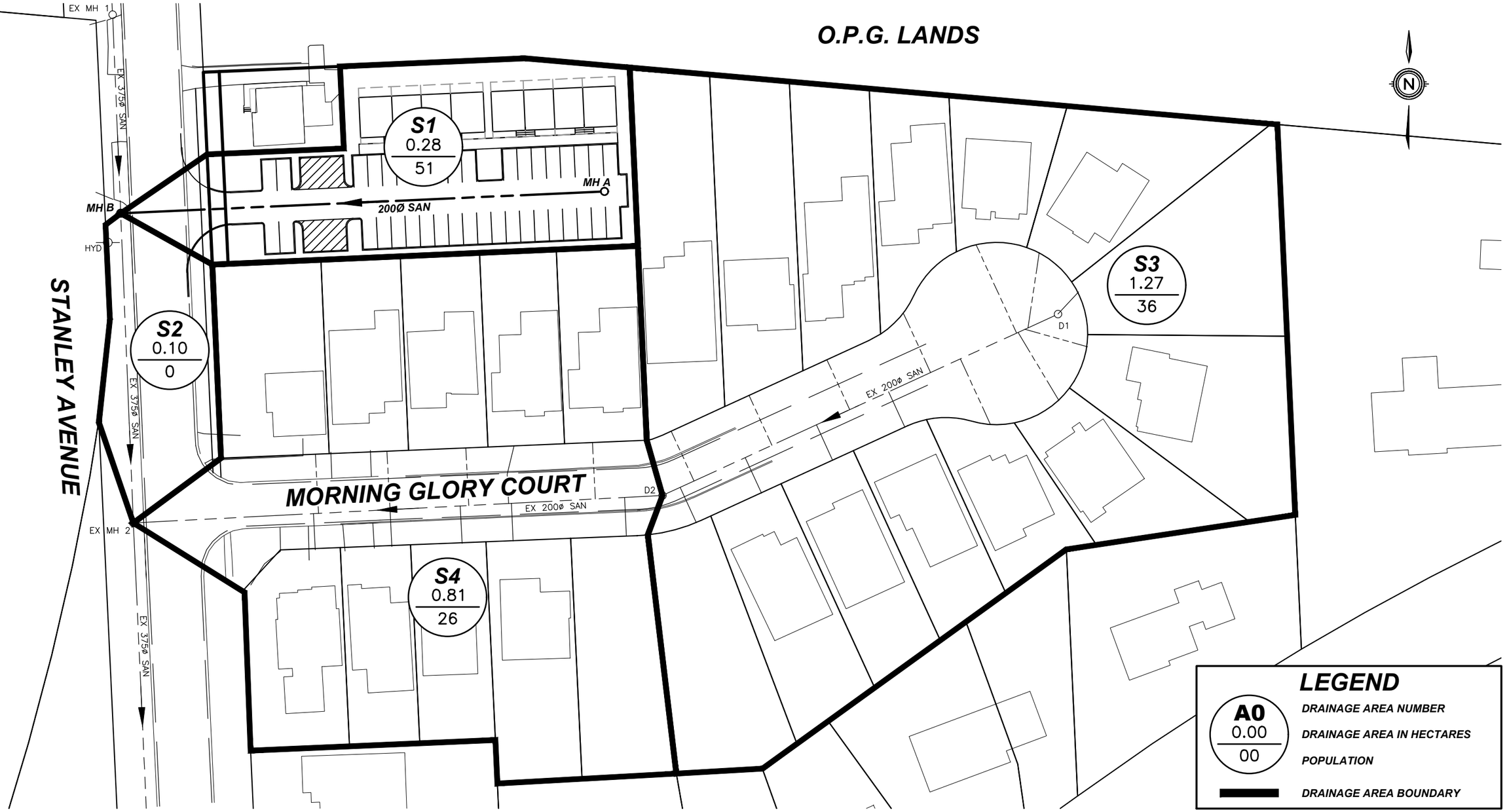
B.M. #670433
BRASS TABLET IN CONCRETE CYLINDER, GRASS BOULEVARD ON NORTH SIDE OF THOROLD STONE ROAD

ELEV. 186.428

GOLIA ESTATES

SANITARY DRAINAGE AREA PLAN

FIELD NOTES
DATE: SEPTEMBER 28, 2005
SCALE: 1 : 750
DWG No.: 0363-SANDA
MUN. REF. No.: 05-CB-123
REV.: 4



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NEWCASTLE STANLEY
2220 STANLEY AVENUE
NIAGARA FALLS
FUTURE SANITARY DRAINAGE AREA PLAN

DATE	2024–06–13
SCALE	1:750 m
REF No.	.
DWG No.	FIGURE 1

DRAWING FILE: F:\24016\SWM\24016–BASEPLAN_fsr.dwg PLOTTED: Jun 13, 2024 – 11:11am PLOTTED BY: roberto

UPPER CANADA CONSULTANTS
3-30 HANNOVER DRIVE
ST.CATHARINES, ONTARIO
L2W 1A3

DATE: JUNE 2024

DESIGN FLOWS

RESIDENTIAL:	255	LITRES/PERSON/DAY (AVERAGE DAILY FLOW)
INFILTRATION RATE:	0.286	L / s / ha (M.O.E FLOW ALLOWANCE IS BETWEEN 0.10 & 0.28 L / s / ha)
POPULATION DENSITY:	1.81	PERSONS /TOWNHOUSE UNIT
	2.59	PERSONS / SINGLE UNIT

SEWER DESIGN

PIPE ROUGHNESS:	0.013	FOR MANNING'S EQUATION
PIPE SIZES:	1.016	IMPERIAL EQUIVALENT FACTOR
PERCENT FULL:		TOTAL PEAK FLOW / CAPACITY

MUNICIPALITY: CITY OF NIAGARA FALLS
PROJECT : NEWCASTEL STANLEY
PROJECT NO: 24016

SANITARY SEWER DESIGN SHEET

Peaking Factor= $M = 1 + \frac{14}{4 + P^{0.5}}$ Where P = design population in thousands

LOCATION			AREA		POPULATION			ACCUMULATED PEAK FLOW				DESIGN FLOW					
Location and Description	**From M.H**	**To M.H.**	**Increment (hectares)**	**Accum. (hectares)**	**Number of Units**	**Population Increment**	**Total Population Served**	**Peaking Factor**	**Flow (L/s)**	**Infiltration Flow L/s**	**Total Peak Flow (L/s)**	**Pipe Diameter (mm)**	**Pipe Length (m)**	**Pipe Slope (%)**	**Full Flow Velocity (m/s)**	**Full Flow Capacity (L/s)**	**Percent Full**
ORIGINAL DESIGN																	
A1	D1	D2	1.27	1.27		42	42	4.00	0.50	0.36	0.86	200	83.5	1.00	1.06	34.22	2.5%
A2	D2	EX MH 2	1.13	2.40		30	72	4.00	0.85	0.69	1.54	200	101.7	0.40	0.67	21.64	7.1%
	EX MH 2	EX MH 3		2.40			72	4.00	0.85	0.69	1.54	375	92.4	0.15	0.62	70.84	2.2%
POST DEVELOPMENT CONDITIONS																	
S1	A	B	0.28	0.28	28	51	51	4.00	0.60	0.08	0.68	200	93.0	0.40	0.67	21.64	3.1%
S2	B	EX MH 2	0.10	0.38		0	51	4.00	0.60	0.11	0.71	375	59.5	0.15	0.62	70.84	1.0%
S3	D1	D2	1.27	1.27	14	36	36	4.00	0.43	0.36	0.79	200	83.5	1.00	1.06	34.22	2.3%
S4	D2	EX MH 2	0.81	2.08	10	26	62	4.00	0.73	0.59	1.33	200	101.7	0.40	0.67	21.64	6.1%
	EX MH 2	EX MH 3		2.46			113	4.00	1.33	0.70	2.04	375	92.4	0.15	0.62	70.84	2.9%

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APPENDIX C

Golia Estates - Storm Drainage Area Plan (05-CA-174)
Weighted Percent Impervious Calculations
Figure 2 – Existing Storm Drainage Area Plan
Figure 3 – Proposed Storm Drainage Area Plan
Sanitary Sewer Design Sheet
Modified Rational Method (MNR) Required Storage Volume

COMMERCIAL

STANLEY AVENUE
REGIONAL ROAD #102

BLOCK 28
0.3m RESERVE
3.05m ROAD WIDENING

BLOCK 27
0.3m RESERVE

BLOCK 29
0.3m RESERVE

BLOCK 30
DAYLIGHT TRIANGLE

BLOCK 31
0.3m RESERVE

BLOCK 28
DAYLIGHT TRIANGLE

BLOCK 32
ADDITIONAL LANDS TO BE ACQUIRED BY OTHERS

MORNING GLORY COURT

THOMPSON ROAD

PORTAGE ROAD

A1 0.80ha R=0.4
A2 0.22ha R=0.4
A3 0.29ha R=0.4
A4 0.21ha R=0.4
A5 0.41ha R=0.4
A6 0.19ha R=0.4
A7 0.37ha R=0.4
A8 0.54ha R=0.4
A9 0.20ha R=0.4
A10 0.18ha R=0.4
A11 0.28ha R=0.4

LEGEND

- PROPOSED STORM SEWER
- DRAINAGE AREA BOUNDARY
- A1 / 0.80ha / R=0.4 — DRAINAGE AREA NUMBER / DRAINAGE AREA IN HECTARES / RUNOFF COEFFICIENT

ACCEPTED BY
SEP 29 '05
MUNICIPAL WORKS
CITY OF NIAGARA FALLS

No.	REVISION	DATE	INT.
4	ISSUED FOR CONSTRUCTION	JUL /05	J.S.
3	REVISED PER CITY COMMENTS	JUL /05	J.S.
2	REVISED PER REGIONAL ROAD #102 RECONSTRUCTION	JUL /05	J.S.
1	REVISED PER CITY COMMENTS	MAR /05	J.S.
0	ISSUED FOR APPROVALS	JAN /05	J.S.

LEGEND

LIGHT STANDARD, TRAFFIC LIGHT, SIGN, BELL POLE, HYDRO POLE, HYDRANT, GUY AND ANCHOR, MANHOLE EXISTING, MANHOLE PROPOSED, CATCHBASIN EXISTING, CATCHBASIN PROPOSED, STANDARD IRON BAR

UNDERGROUND UTILITIES: HYDRO CABLES, WATERMAINS, GASMAINS, BELL CABLES, CAP OR PLUG, SANITARY SEWER, STORM SEWER, COMBINED SEWER

DRAFTING: N.G.
DESIGN: M.H.
CHECKED BY: J.S.
PROJ. SUPVR.: N.G.

LICENCED PROFESSIONAL ENGINEER — J. P. SCHOOLEY — PROVINCE OF ONTARIO

The City of Niagara Falls Canada

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Fax: (905)688-5274

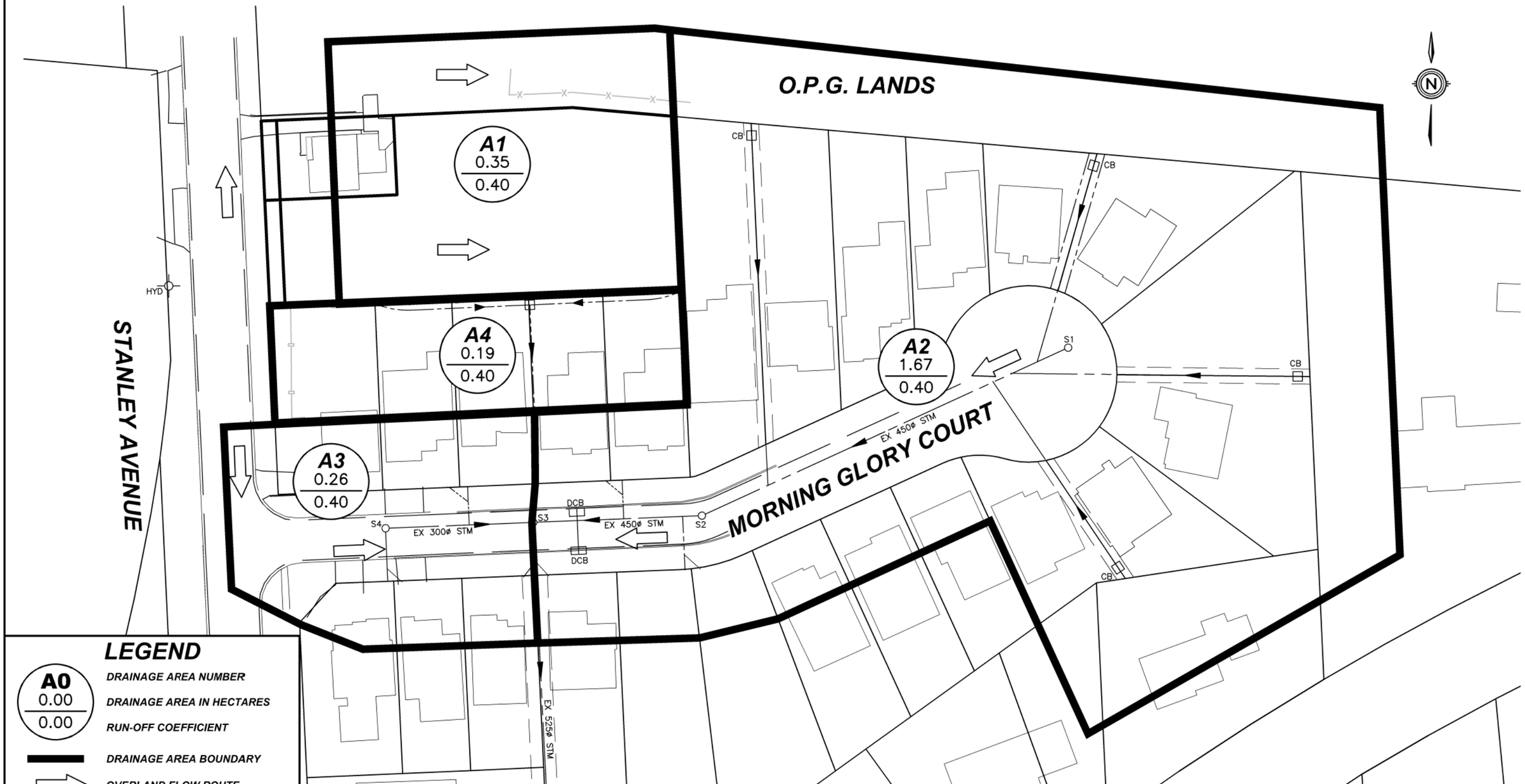
BENCH MARK DATUM
B.M. #670433
BRASS TABLET IN CONCRETE CYLINDER, GRASS BOULEVARD ON NORTH SIDE OF THOROLD STONE ROAD
ELEV. 186.428

GOLIA ESTATES

STORM DRAINAGE AREA PLAN

FIELD NOTES
DATE: SEPTEMBER 28, 2005
SCALE: 1 : 750
DWG No.: 0363-STMDA
MUN. REF. No.: 05-CA-174
REV.: 4

Golia Estates
STMDA
0363



LEGEND

- **A0 / 0.00 / 0.00** — DRAINAGE AREA NUMBER / DRAINAGE AREA IN HECTARES / RUN-OFF COEFFICIENT
- DRAINAGE AREA BOUNDARY
- OVERLAND FLOW ROUTE

UPPER CANADA CONSULTANTS
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NEWCASTLE STANLEY
2220 STANLEY AVENUE
NIAGARA FALLS
EXISTING STORM DRAINAGE AREA PLAN

DATE	2024–06–13
SCALE	1:750 m
REF No.	.
DWG No.	FIGURE 2

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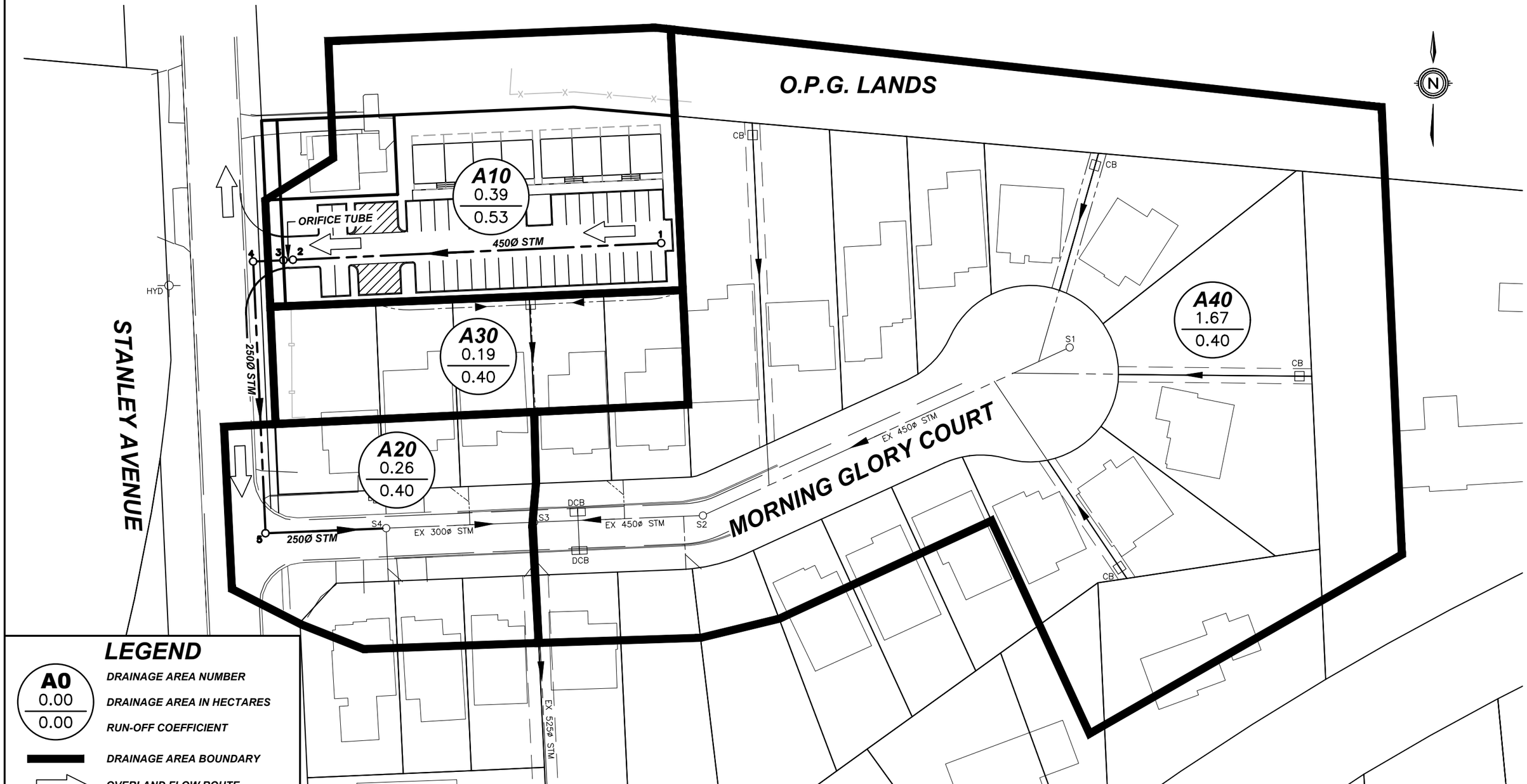

LEGEND

- A0 / 0.00 / 0.00 — DRAINAGE AREA NUMBER / DRAINAGE AREA IN HECTARES / RUN-OFF COEFFICIENT
- DRAINAGE AREA BOUNDARY
- OVERLAND FLOW ROUTE

UPPER CANADA CONSULTANTS
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NEWCASTLE STANLEY
2220 STANLEY AVENUE
NIAGARA FALLS
FUTURE STORM DRAINAGE AREA PLAN

DATE	2024-06-13
SCALE	1:750 m
REF No.	.
DWG No.	FIGURE 3

DRAWING FILE: F:\24016\SWM\24016-BASEPLAN_fsr.dwg PLOTTED: Jun 24, 2024 - 3:51pm PLOTTED BY: roberto

Weighted Percent Impervious Calculations

Project Name:	Newcastle Stanley
UCC Project Number:	24016
Date:	June 12, 2024

Proposed Conditions

Area Type	Area (m^2)	% Impervious	Impervious Area (m^2)
Proposed Buildings	370	100%	370.0
Existing Buildings	186	100%	186.3
Asphalt Road/Parking & concrete areas	1,220	100%	1,220.0
Landscape/Greenspace	2,043	0.1%	2.0
		Total Catchment Impervious Area (m^2)	1,778
		Total Catchment Area (m^2)	3,819
		Weighted Percent Impervious (%)	46.6%
		Weighted Runoff Coefficent [c]	0.53

UPPER CANADA CONSULTANTS
3-30 HANNOVER DRIVE
ST. CATHARINES, ON L2W 1A3

STORM SEWER DESIGN

MUNICIPALITY: NIAGARA FALLS — A = 719.50 mm/hr — 5 YEAR DESIGN IDF
PROJECT: NEWCASTLE STANLEY — B = 6.34 minutes — PIPE ROUGHNESS = 0.013
UCC PROJECT NO.: 24016 — C = 0.769 — PIPE CONVERSION FACTOR = 1.016

DESCRIPTION			STORMWATER ANALYSIS										STORM SEWER DESIGN					
LOCATION	FROM MH	TO MH	AREA (ha)	ACCUMLTD AREA (ha)	RUNOFF COEFFICNT	A*R	ACCUMLTD A*R	T of C (min.)	PIPE TIME (min.)	T of C (sum)	INTENSITY (mm/hr)	FLOW (L/s)	LENGTH (m)	DIAMETER (mm)	SLOPE (%)	CAPACITY (L/s)	VELOCITY (m/s)	PERCENT FULL
EXISTING CONDITIONS																		
A1	SITE		0.35	0.35	0.40	0.140	0.140	10.00			84.0	32.6						
A2	S2	S3	1.67	2.02	0.40	0.668	0.808	12.47	0.52	12.99	75.3	169.1	33.6	450	0.35	176.03	1.1	96.1%
A3	S4	S3	0.26	0.26	0.40	0.104	0.104	10.00	0.60	10.60	84.0	24.3	29.5	300	0.35	59.71	0.8	40.6%
A4	RYCB	S3	0.19	0.19	0.40	0.076	0.076	10.00	0.54	10.54	84.0	17.7	43.0	200	1.60	43.30	1.3	40.9%
	S3	S5		2.47		0.000	0.988	12.99	1.31	14.30	73.8	**202.5**	93.4	525	0.35	265.53	1.2	76.2%
FUTURE CONDITIONS																		
A10	MH1	MH2	0.39	0.39	0.53	0.207	0.207	10.00	1.52	11.52	84.0	48.2	74.0	450	0.20	133.07	0.8	36.2%
	MH2	MH3					PEAK CONTROLLED FLOW BY ORIFICE TUBE					**23.5**						
	MH3	MH4						11.52	0.13	11.65	78.4	23.5	6.0	250	0.40	39.25	0.8	59.9%
	MH4	MH5						11.65	1.16	12.81	78.0	23.5	53.9	250	0.40	39.25	0.8	59.9%
	MH5	S4						12.81	0.50	13.31	74.3	23.5	23.2	250	0.40	39.25	0.8	59.9%
A20	S4	S3	0.260	0.26	0.40	0.104	0.104	13.31	0.60	13.91	72.8	44.5	29.5	300	0.35	59.71	0.8	74.6%
A30	RYCB	S3	0.19	0.19	0.40	0.076	0.076	10.00	0.54	10.54	84.0	17.7	43.0	200	1.60	43.30	1.3	40.9%
A40	S2	S3	1.67	1.67	0.40	0.668	0.668	12.47	0.52	12.99	75.3	139.8	33.6	450	0.35	176.03	1.1	79.4%
	S3	S5										**202.1**	93.4	525	0.35	265.53	1.2	76.1%

Modified Rational Method (MRM) Required Storage Volume

Project:	NEWCASTLE STANLEY
Project No:	24016
Date:	June 12, 2024
Design By:	Roberto Duarte, B.Eng.
Description:	*Stormwater Management Plan, Quantity Control Storage Volume Calculation*

Storm Event: **City of Niagara Falls - 5 Year IDF Curve**

a =	719.50	mm/hr
b =	6.34	minutes
c =	0.77	

Critical Storm Duration:	30.00	minutes	Tail Multiplier (x1-1.5) 1.5
Tc From Design:	10.00	minutes	
Storm Tail Time:	15.00	minutes	
Accumulated Area x R (Ha):	0.207		<-- Area x Runoff Coefficient (Sewer Design Sheet)
Peak Rainfall Intensity:	68.37	mm/hr	
Peak Inflow at Tc:	39.26	L/s	
Maximum Release Rate:	23.50		<-- Outlet Full Flow Capacity (Design Sheet)
Time When Outlet Exceeded:	5.99		

Time (min)	Intensity (mm/hr)	Inflow (L/s)	Outflow (L/s)	Interval Volume (m3)	Total Required Volume (m3)
0.0	0.00	0.00	23.50	-1.4	0.0
1.0	6.84	3.93	23.50	-1.2	0.0
2.0	13.67	7.85	23.50	-0.9	0.0
3.0	20.51	11.78	23.50	-0.7	0.0
4.0	27.35	15.70	23.50	-0.5	0.0
5.0	34.19	19.63	23.50	-0.2	0.0
6.0	41.02	23.55	23.50	0.0	0.0
7.0	47.86	27.48	23.50	0.2	0.2
8.0	54.70	31.41	23.50	0.5	0.7
9.0	61.54	35.33	23.50	0.7	1.4
10.0	68.37	39.26	23.50	0.9	2.4
11.0	68.37	39.26	23.50	0.9	3.3
12.0	68.37	39.26	23.50	0.9	4.3
13.0	68.37	39.26	23.50	0.9	5.2
14.0	68.37	39.26	23.50	0.9	6.2
15.0	68.37	39.26	23.50	0.9	7.1
16.0	63.81	36.64	23.50	0.8	7.9
17.0	59.26	34.02	23.50	0.6	8.5
18.0	54.70	31.41	23.50	0.5	9.0
19.0	50.14	28.79	23.50	0.3	9.3
20.0	45.58	26.17	23.50	0.2	9.5
21.0	41.02	23.55	23.50	0.0	***9.5***
22.0	36.47	20.94	23.50	-0.2	9.3
23.0	31.91	18.32	23.50	-0.3	9.0
24.0	27.35	15.70	23.50	-0.5	8.5
25.0	22.79	13.09	23.50	-0.6	7.9
26.0	18.23	10.47	23.50	-0.8	7.1
27.0	13.67	7.85	23.50	-0.9	6.2
28.0	9.12	5.23	23.50	-1.1	5.1
29.0	4.56	2.62	23.50	-1.3	3.8
30.0	0.00	0.00	23.50	-1.4	2.4

Variable Storm Duration Storage Requirements

Duration	*Max Storage*	*Duration*	*Max Storage*	*Duration*	*Max Storage*
25 Min	8.1 m3	50 Min	5.7 m3	80 Min	0.0 m3
30 Min	**9.5 m3**	60 Min	2.8 m3	90 Min	0.0 m3
40 Min	8.3 m3	70 Min	0.1 m3	100 Min	0.0 m3