UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

Upper Canada Planning & Engineering Ltd.
3-30 Hannover Drive
St. Catharines, ON
L2W 1A3
Phone 905-688-9400
Fax 905-688-5274

FUNCTIONAL SERVICING REPORT

TAWNY RIDGE ESTATES (PHASE 3)

August 2025

INTRODUCTION

The purpose of this report is to address the servicing needs for the townhouse development, known as Tawny Ridge Estates (Phase 3), located in the Town of Niagara-on-the-Lake. The subject lands comprise of the third phase of the overall Tawny Ridge Estates subdivision, which is located south of Warner Road, west of Tanbark Road, and north of Tulip Tree Road.

The Tawny Ridge Estates Phase 3 lands are located within the northern portion of the Phase 2 lands as Block 27, fronting Warner Road and will consist of 18 townhouse dwellings.

A separate Functional Servicing Report (FSR) submitted for the Phase 2 lands, included in Appendix B, addressed the municipal servicing for the Phase 3 lands (referred to as Block 27 in the Phase 2 FSR). This report will confirm the individual servicing needs for Phase 3 that have been addressed in the Phase 2 FSR.

The objectives of this report are as follows:

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

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WATER SERVICING

There is an existing 150mm diameter watermain along Warner Road. It is proposed to service the units that front Warner Road with the existing 150mm watermain.

As summarized in the Phase 2 FSR it is proposed to extend a 150mm diameter watermain within the Phase 2 lands from Warner Road to the existing 150mm diameter watermain on Chestnut Avenue. It is proposed to service the units that front Chestnut Avenue with the proposed 150mm diameter watermain along Chestnut Avenue.

There is an existing fire hydrant fronting the northeast limits of the subject lands, on Warner Road, that will provide fire protection to Phase 3.

It is also proposed to construct two municipal fire hydrants within Phase 2 on Chestnut Avenue which will provide fire protection for the Phase 3 dwellings fronting on Angels Drive and Chestnut Avenue.

SANITARY SERVICING

There is an existing 200mm diameter sanitary sewer along Warner Road that flows north-easterly to Tanbark Road. It is proposed to service the units that front Warner Road with the existing 200mm Sanitary Sewer.

As summarized in the Phase 2 FSR it is proposed to extend a 200mm diameter sanitary sewer within the Phase 2 lands and outlet to the existing 200mm diameter sanitary sewer on Warner Road. It is proposed to service the units that front Chestnut Avenue with the proposed 200mm diameter sanitary sewer on Chestnut Avenue.

A revised Sanitary Sewer Drainage Area Plan and design sheet (DWG# 21178-PH3-SANDA) have been included in Appendix A. Based on a population density of 2.4 persons per unit the Tawny Ridge Estates (Phase 3) development will have a total residential population of 43 persons. As shown in Appendix A, the revised total population is 189 persons within the same 4.28 hectare drainage area including the external lands to the west which is lower then the previously assumed 190 persons. Therefore, there is expected to be adequate capacity within the existing sanitary sewer system to service the subject lands.

It was concluded in the Phase 2 FSR that there is adequate capacity in the downstream sanitary sewer system for a total sanitary drainage area of 4.32 hectares and a population of 190 persons, including Phase 3 and external lands to the west of Phase 2.

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STORMWATER MANAGEMENT

A separate Addendum to the Tawny Ridge Estates (Phase 2) Stormwater Management Plan has been prepared by Upper Canada Consultants.

The following conclusions regarding the Addendum to the Tawny Ridge (Phase 2) Stormwater Management Plan have been determined:

1. The 185mm diameter orifice and oversized storm sewer system proposed in the Tawney Ridge Phase 2 SWM Plan can provide quantity controls for the 5 and 100 year storm event including the proposed Phase 3 lands;

2. The Vineyard Creek Estates SWM facility can continue to provide quality controls for the entire Vineyard Creek Estates Storm Drainage Area to MECP Normal Protection Levels.

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ENGINEERS / PLANNERS

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 150mm diameter watermains within Phase 2 and on Warner Road will provide both domestic water supply and fire protection for Phase 3.

2. The receiving sanitary sewer system will have adequate capacity to service the Phase 3 lands.

3. On-site stormwater quantity controls will be provided by a 185mm diameter control orifice and oversized storm sewer storage within the subject lands to provide quantity controls for the 5 and 100 year design storm events.

4. The Vineyard Creek Estates SWM Pond permanent pool has capacity to provide stormwater quality controls to MECP Normal levels for the increased imperviousness of the subject lands without modification to the facility or additional on-site quality controls.

Based on the above and the accompanying calculations, there exists adequate municipal servicing for this 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.

Prepared By:

Zach Barber, E.I.T.

Reviewed By:

Brendan Kapteyn, P.Eng.
August 5th, 2025

LICENSED PROFESSIONAL ENGINEER
B. J. KAPTEYN
100509155
PROVINCE OF ONTARIO

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

APPENDICES

UPPER CANADA CONSULTANTS
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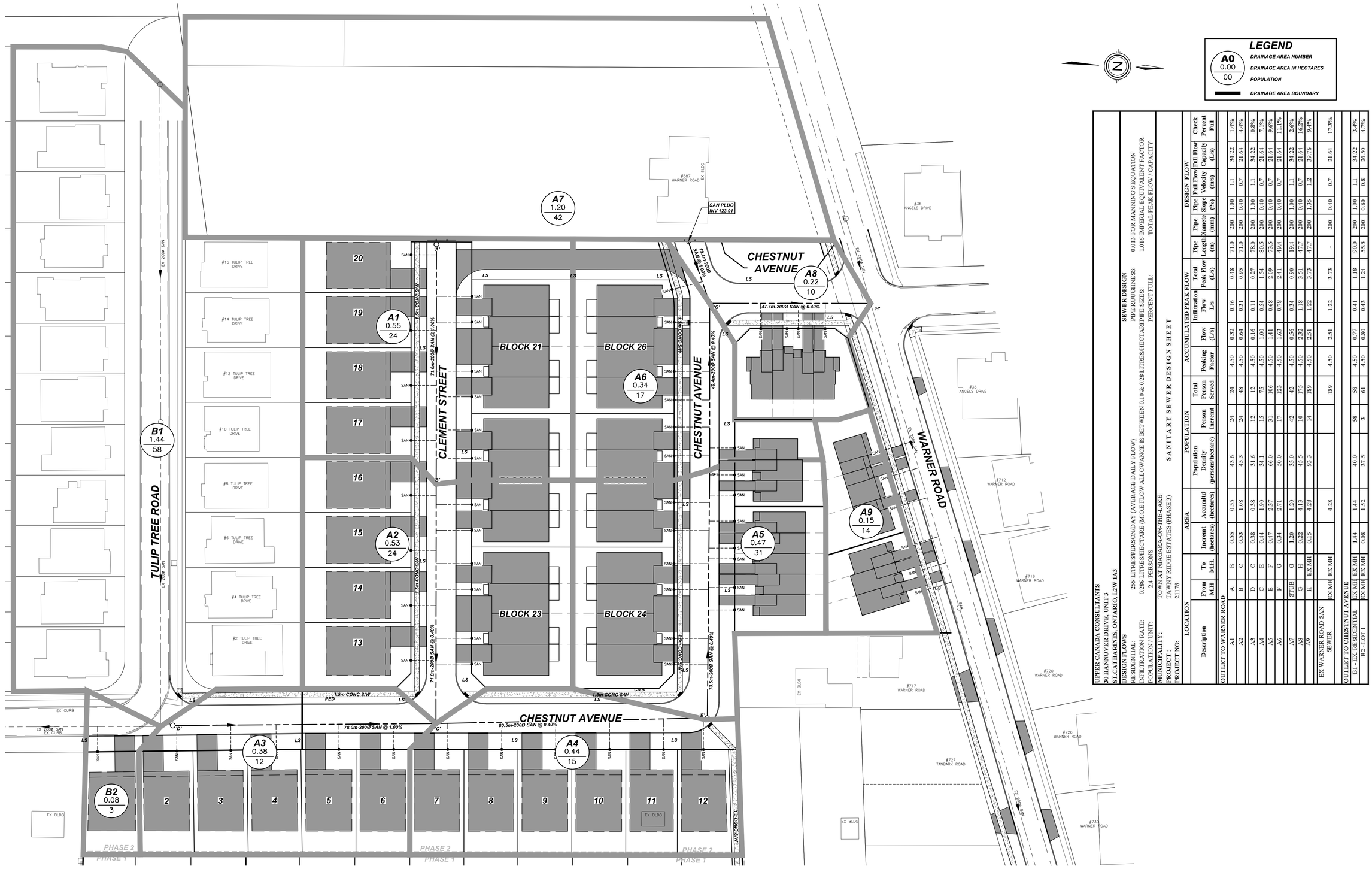
APPENDIX A

Sanitary Sewer Drainage Areas
Sanitary Sewer Design Sheet



SEWER DESIGN
PIPE ROUGHNESS: 0.013 FOR MANNING'S EQUATION
1 DAY (AVERAGE DAILY FLOW)
M.O.E FLOW ALLOWANCE IS BETWEEN 0.10 & 0.28 LITRES/HECTARE
PIPE SIZES: 1.016 IMPERIAL EQUIVALENT FACTOR
PERCENT FULL: TOTAL PEAK FLOW / CAPACITY

SANITARY SEWER DESIGN SHEET

LOCATION			AREA		POPULATION			ACCUMULATED PEAK FLOW				DESIGN FLOW					
Description	From M.H	To M.H.	Increm (hectares)	Accumltd (hectares)	Population Density (persons/hectare)	Person Increment	Total Person Served	Peaking Factor	Flow (L/s)	Infiltration Flow L/s	Total Peak Flow (L/s)	Pipe Length (m)	Pipe Diameter (mm)	Pipe Slope (%)	Full Flow Velocity (m/s)	Full Flow Capacity (L/s)	Check Percent Full
OUTLET TO WARNER ROAD																	
A1	A	B	0.55	0.55	43.6	24	24	4.50	0.32	0.16	0.48	71.0	200	1.00	1.1	34.22	1.4%
A2	B	C	0.53	1.08	45.3	24	48	4.50	0.64	0.31	0.95	71.0	200	0.40	0.7	21.64	4.4%
A3	D	C	0.38	0.38	31.6	12	12	4.50	0.16	0.11	0.27	78.0	200	1.00	1.1	34.22	0.8%
A4	C	E	0.44	1.90	34.1	15	75	4.50	1.00	0.54	1.54	80.5	200	0.40	0.7	21.64	7.1%
A5	E	F	0.47	2.37	66.0	31	106	4.50	1.41	0.68	2.09	73.5	200	0.40	0.7	21.64	9.6%
A6	F	G	0.34	2.71	50.0	17	123	4.50	1.63	0.78	2.41	49.4	200	0.40	0.7	21.64	11.1%
A7	STUB	G	1.20	1.20	35.0	42	42	4.50	0.56	0.34	0.90	19.4	200	1.00	1.1	34.22	2.6%
A8	G	H	0.22	4.13	45.5	10	175	4.50	2.32	1.18	3.51	47.7	200	0.40	0.7	21.64	16.2%
A9	H	EX MH	0.15	4.28	93.3	14	189	4.50	2.51	1.22	3.73	47.7	200	1.35	1.2	39.76	9.4%
EX WARNER ROAD SAN SEWER	EX MH	EX MH		4.28			189	4.50	2.51	1.22	3.73	-	200	0.40	0.7	21.64	17.3%
OUTLET TO CHESTNUT AVENUE																	
B1 - EX. RESIDENTIAL	EX MH	EX MH	1.44	1.44	40.0	58	58	4.50	0.77	0.41	1.18	90.0	200	1.00	1.1	34.22	3.4%
B2 - LOT 1	EX MH	EX MH	0.08	1.52	37.5	3	61	4.50	0.80	0.43	1.24	55.5	200	1.60	0.8	26.50	4.7%

UPPER CANADA CONSULTANTS
30 HANNOVER DRIVE, UNIT 3
ST.CATHARINES, ONTARIO, L2W 1A3
DESIGN FLOWS
RESIDENTIAL: 255 LITRES/PERSON/DAY (AVERAGE DAILY FLOW)
INFILTRATION RATE: 0.286 LITRES/HECTARE (M.O.E FLOW ALLOWANCE IS BETWEEN 0.10 & 0.28 LITRES/HECTARE)
POPULATION / UNIT: 2.4 PERSONS
MUNICIPALITY: TOWN AT NIAGARA-ON-THE-LAKE
PROJECT : TAWNY RIDGE ESTATES (PHASE 3)
PROJECT NO: 21178

#	REVISION	DATE	INIT
0	ISSUED FOR REVIEW	2025-08-05	G.S

NOTES:
1. THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWER, AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.
2. PROPERTY LINES WERE PLOTTED USING REGISTERED PLANS AND BARS LOCATED IN THE FIELD. TO VERIFY THE ACCURACY OF THESE PROPERTY LINES, A LEGAL SURVEY SHOULD BE PERFORMED PRIOR TO CONSTRUCTION.
3. ALL CONSTRUCTION MUST COMPLY WITH THE NIAGARA PENINSULA STANDARD CONTRACT DOCUMENT.

DRAFTING G.S
DESIGN B.K
CHECKED BY M.H
APPROVED BY B.K

Niagara-on-the-Lake EST.1781

UPPER CANADA CONSULTANTS
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OWNER
ST. DAVIDS RIVERVIEW ESTATES INC.
1755 STEVENSVILLE ROAD
FORT ERIE, ONT
L0S 1N0

TAWNY RIDGE ESTATES - PHASE 3
NIAGARA-ON-THE-LAKE
SANITARY DRAINAGE AREA PLAN

CONSULTANT FILE No. 21178
DATE 2025-08-05
PRINTED 2025-08-05
SCALE 1:500 m
REF No.
DWG No. 21178-PH3-SANDA
REV 1

DRAWING FILE: F:\21178\Engineering\Block 27 - Towns\21178-Eng_Base(PH3).dwg PLOTTED: Aug 05, 2025 - 11:57am PLOTTED BY: zachb

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

APPENDIX B

Functional Servicing Report – Tawny Ridge Estates (Phase 2) (UCC, June 2025)

UPPER CANADA CONSULTANTS
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Fax 905-688-5274

FUNCTIONAL SERVICING REPORT

TAWNY RIDGE ESTATES (PHASE 2)

Revised June 2025

INTRODUCTION

The purpose of this report is to address the servicing needs for the residential subdivision development, Tawny Ridge Estates (Phase 2), located in the Town of Niagara-on-the-Lake. The subject lands comprise of the second phase of the overall Tawny Ridge Estates subdivision, which is located south of Warner Road, west of Tanbark Road, and north of Tulip Tree Road.

The Tawny Ridge Estates Phase 2 lands are located immediately west of the approved Phase 1 lands. Phase 2 consists of the 20 single-family residential dwellings, 6 blocks of townhouse dwellings and one medium density residential block (Block 27).

A separate Functional Servicing Report concluding that the municipal services for the Phase 1 lands would be independent from the Phase 2 lands has been prepared by Upper Canada Consultants and submitted to the Town. Therefore, for the purposes of this report, only the Phase 2 lands will be considered and will be referred to as the "subject lands" herein.

As part of the construction of Phase 2, Warner Road from the western limit of the site to Tanbark Road will be reconstructed to an urban cross section. The construction will include an asphalt roadway with curb and gutters, catch basins, sidewalks and a new storm sewer that will outlet to the existing 600mm diameter storm sewer flowing northerly on Tanbark Road.

The objectives of this report are as follows:

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

WATER SERVICING

There is an existing 150mm diameter watermain stub located on Chestnut Avenue, at the southern limit of the subject lands, and an existing 150mm diameter watermain located on Warner Road, at the northern limit of the subject lands. It is proposed to construct a new 150mm diameter watermain within the site connecting to the existing 150mm diameter watermains located on Chestnut Avenue and Warner Road to provide a looped watermain system that will provide domestic water supply and fire protection.

There are external residential lands to the west of the subject lands to the west at #687 Warner Road that may be developed as a residential subdivision in the future. Therefore, the proposed watermain will be capped at the terminations of Chestnut Avenue and Street A for future extension.

It is proposed to provide 4 municipal fire hydrants connected to the proposed watermain within the site to provide fire protection. The spacing and locations of each proposed hydrant have been indicated on the General Servicing Plan and have been spaced per MECP Requirements.

SANITARY SERVICING

There are two existing sanitary sewers adjacent to the subject lands which ultimately discharge sanitary flows to the existing 200mm diameter sanitary sewer on Tanbark Road;

i) The existing 200mm diameter sewer on Chestnut Avenue, flowing southerly in front of Lots 1 and 2;
ii) The existing 200mm diameter sewer on Warner Road, flowing easterly.

It is proposed to connect the service for Lot 1 to the existing 200mm diameter sewer on Chestnut Avenue. The sanitary sewer on Chestnut Avenue has been designed to receive sanitary flows from this area as part of the Courtland Valley Subdivision.

The remaining 3.12 hectare sanitary drainage area from the subject lands will convey sanitary flows to the existing 200mm diameter sanitary sewers on Warner Road. There is an additional 1.20 hectare external drainage area, assigned to the #687 Warner Road property, along the western limit of the subject lands which may develop as residential a residential subdivision in the future. It is proposed to allocate capacity within the proposed internal sanitary sewers for this external area at an assumed density of 35 persons per hectare for a total population of 42 persons being allocated for this area.

The Sanitary Sewer Drainage Area Plan and design sheet (DWG# 21178-PH2-SANDA) have been included in Appendix A. Based on a population density of 2.4 persons per unit the Tawny Ridge Estates development will have a total residential population of 148 persons for a combined population of 190 persons including the external lands to the west. The combined population correlates to a total peak sanitary flow of 3.76 L/s being conveyed to the existing sanitary sewers on Warner Road which is approximately 17.4% of the full flow capacity of the existing 200mm diameter sanitary sewer on Warner Road.

Therefore, there is expected to be adequate capacity within the existing Warner Road and Chestnut Avenue Sanitary sewer to service the subject lands.

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St. Davids Sanitary Pumping Station #1 Analysis

Flows from the subject lands are conveyed to the existing sanitary sewers on Tanbark Road, and ultimately to the existing St. Davids No. 1 Sewage Pumping Station, which is located at 383 Four Mile Creek Road.

GM BluePlan was retained by the Town of Niagara-on-the-Lake to conduct sanitary flow monitoring at St. Davids No. 1 Sewage Pump Station (SPS) from March to July of 2022. GM BluePlan prepared a report summarizing the measured dry weather flows and infiltration rates at each flow monitor, and is included in Appendix C.

The existing flows at three flow monitors were reviewed, and the combination of flows from the three monitors represents the total sanitary flow that outlets to St. Davids SPS #1. The locations of the three flow monitors are shown in Figure 1 in the GM Blue Plan Investigation. Table 1 below summarizes the existing and future dry weather flows at St. Davids SPS #1.

The existing peak dry weather flow shown in Table 1 is the sum of the peak dry weather flows (PDWF) shown in Table 5 of GM BluePlans Flow Analysis and the future PDWF is summarized in the calculations provided in Appendix B.

Table 1 – Existing and Future Peak Dry Weather Flows at the St. Davids SPS #1

Location	Ex. PDWF @ SPS (L/s)	Fut. PDWF from Tawny Ridge Ph 2 (L/s)	Fut. PDWF @ SPS (L/s)
St. Davids SPS #1	15.7	2.5	18.2

As shown in Table 1, the future PDWF at St. Davids SPS #1 will be 18.2 L/s.

As part of the Region's Wastewater Master Servicing Plan (MSP) the Region has assessed the existing and future projected capacities of the SPS. As stated in Table 4.F.3 of the Regions MSP, the firm operational capacity of St. Davids SPS #1 is 28.8 L/s and is expected to be upgraded to a capacity of 174 L/s by 2031. Therefore, with the inclusion of Tawny Ridge Estates Phase 2 the future PDWF does not exceed the current firm operational capacity of the pumping station and there is adequate capacity for the proposed development and adjacent future development lands to the west.

The GM BluePlan investigation included monitoring of the existing wet weather flows at St. Davids SPS #1. Table 2 below summarizes the existing and future wet weather flows at St. Davids SPS #1.

To be conservative, the existing peak dry weather flow shown in Table2 is the sum of the "worst case" measured wet weather flows from July 18th, shown in Table 7 of GM Blue Plans Flow Analysis and the future PWWF is summarized in the calculations provided in Appendix B.

Table 2 – Existing and Future Wet Weather Peak Flows at the St. Davids SPS #1

Location	Ex. PWWF @ SPS (L/s)	Fut. PWWF from Tawny Ridge Ph 2 (L/s)	Fut. PWWF @ SPS (L/s)	Change (%)
St. Davids SPS #1	52.7	3.7	56.4	7%

Currently, the existing wet weather flows exceed the firm capacity of St. Davids SPS #1 during extreme rain events. However, as previously noted the existing firm operational capacity is projected to be increased to 174 L/s by 2031. As summarized in Table 2, the future PWWF at the SPS increases by 7%, which is expected to have negligible impact on the existing operations at St Davids SPS #1 under wet weather flow conditions, and the proposed upgrades increase the capacity well above the existing wet weather flows.

Therefore, the inclusion of the subject lands at the St. Davids Sanitary Pumping Station No. 1 will have no negative impact on the performance of the pumping station under dry or wet weather flows conditions.

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STORMWATER MANAGEMENT

A separate Stormwater Management Plan has been prepared by Upper Canada Consultants (UCC) and has been enclosed in Appendix B for reference.

As part of the construction of the proposed development Warner Road from the western limit of the site to Tanbark Road shall be reconstructed to an urban cross section. This will include associated curb, gutters, sidewalks and a 600mm diameter storm sewer. It is proposed to outlet flows from the site to the future 600mm diameter storm sewer on Warner Road.

The following conclusions regarding the Stormwater Management Plan for Tawny Ridge Estates (Phase 2) have been determined:

1. On-site stormwater **quality** controls are not required since the increased imperviousness within the subject lands does not exceed the design capacity of the existing Vineyard Creek estates SWM Facility to provide MECP Normal Protection (70% TSS Removal).

2. Stormwater **quantity** controls are to be provided from the subject lands are as follows:

    - The 5 year design storm event to the available capacity of the existing 600mm diameter storm sewers on Tanbark Road; and,
    - The 100 year design storm event to Existing levels downstream of the existing Vineyard Creek Estates SWM Facility, which was determined using the 100 year design storm specified in the Vineyard Creek Estates SWM Plan.

3. Major overland flows will be discharged to Tanbark Road and then ultimately to the Vineyard Creek Estates SWM pond.

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ENGINEERS / PLANNERS

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 subject lands will be serviced by a 150mm diameter watermain on Chestnut Avenue on the south side of the subject lands and a 150mm diameter watermain on Warner Road on the north side of the subject lands and will provide both domestic water supply and fire protection.

2. The receiving 200mm diameter sanitary sewers on Warner Road and Chestnut Avenue will have adequate capacity to service the Phase 2 lands.

3. The St. Davids Sanitary Pumping Station No. 1 has capacity to receive dry weather flows from the proposed development.

4. The increased drainage area that will outlet to the St. Davids Sanitary Pumping Station No. 1 as a result of the proposed development will not affect the performance of the pumping station under wet weather conditions.

5. On-site stormwater quantity controls will be provided by a 185mm diameter control orifice and oversized storm sewer storage within the subject lands to provide quantity controls for the 5 and 100 year design storm events.

6. The Vineyard Creek Estates SWM Pond permanent pool has capacity to provide stormwater quality controls to MECP Normal levels for the increased imperviousness of the subject lands without modification to the facility or additional on-site quality controls.

Based on the above and the accompanying calculations, there exists adequate municipal servicing for this 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.

Prepared By:

Zach Barber, E.I.T.

Reviewed By:

Brendan Kapteyn, P.Eng.
June 12, 2025

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

APPENDICES

UPPER CANADA CONSULTANTS
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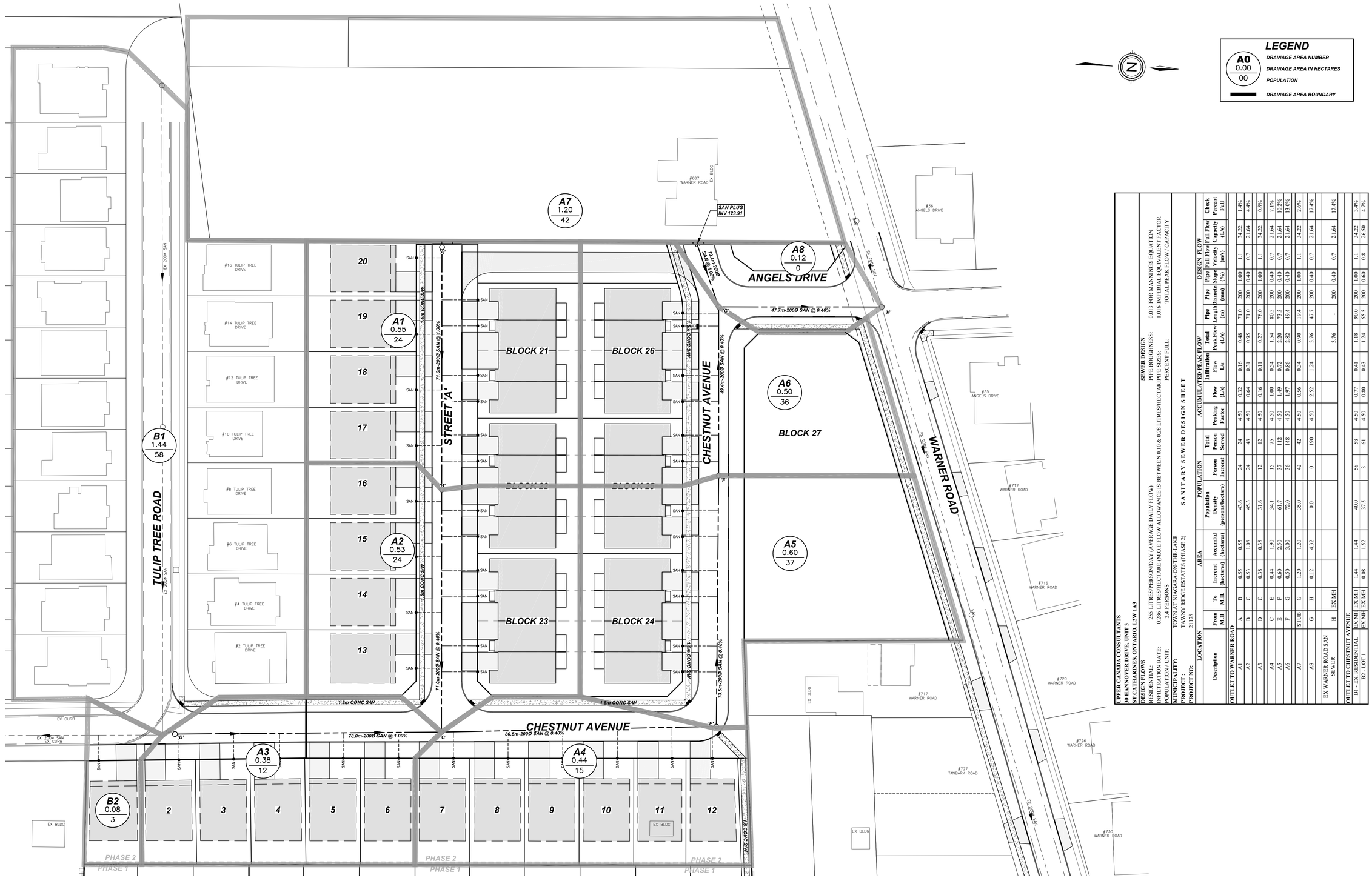
APPENDIX A

Sanitary Sewer Drainage Areas
Sanitary Sewer Design Sheet



LEGEND

- A0 / 0.00 / 00 — DRAINAGE AREA NUMBER / DRAINAGE AREA IN HECTARES / POPULATION
- DRAINAGE AREA BOUNDARY

SEWER DESIGN
PIPE ROUGHNESS: 0.013 FOR MANNINGS EQUATION
PIPE SIZES: 1.016 IMPERIAL EQUIVALENT FACTOR
PERCENT FULL: TOTAL PEAK FLOW / CAPACITY

SANITARY SEWER DESIGN SHEET

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

DESIGN FLOWS
RESIDENTIAL: 255 LITRES/PERSON/DAY (AVERAGE DAILY FLOW)
INFILTRATION RATE: 0.286 LITRES/HECTARE (M.O.E FLOW ALLOWANCE IS BETWEEN 0.10 & 0.28 LITRES/HECTARE)
POPULATION / UNIT: 2.4 PERSONS

MUNICIPALITY: TOWN AT NIAGARA-ON-THE-LAKE
PROJECT : TAWNY RIDGE ESTATES (PHASE 2)
PROJECT NO: 21178

LOCATION			AREA		POPULATION		ACCUMULATED PEAK FLOW				DESIGN FLOW							
Description	From M.H	To M.H.	Increm (hectares)	Accumltd (hectares)	Population Density (persons/hectare)	Person Increm	Total Person Served	Peaking Factor	Flow (L/s)	Infiltration Flow L/s	Total Peak Flow (L/s)	Pipe Length (m)	Pipe Diameter (mm)	Pipe Slope (%)	Full Flow Velocity (m/s)	Full Flow Capacity (L/s)	Check Percent Full
OUTLET TO WARNER ROAD																	
A1	A	B	0.55	0.55	43.6	24	24	4.50	0.32	0.16	0.48	71.0	200	1.00	1.1	34.22	1.4%
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A6	F	G	0.50	3.00	72.0	36	148	4.50	1.97	0.86	2.82	49.4	200	0.40	0.7	21.64	13.0%
A7	STUB	G	1.20	1.20	35.0	42	42	4.50	0.56	0.34	0.90	19.4	200	1.00	1.1	34.22	2.6%
A8	G	H	0.12	4.32	0.0	0	190	4.50	2.52	1.24	3.76	47.7	200	0.40	0.7	21.64	17.4%
EX WARNER ROAD SAN SEWER	H	EX MH									3.76	-	200	0.40	0.7	21.64	17.4%
OUTLET TO CHESTNUT AVENUE																	
B1 - EX. RESIDENTIAL	EX MH	EX MH	1.44	1.44	40.0	58	58	4.50	0.77	0.41	1.18	90.0	200	1.00	1.1	34.22	3.4%
B2 - LOT 1	EX MH	EX MH	0.08	1.52	37.5	3	61	4.50	0.80	0.43	1.24	55.5	200	0.60	0.8	26.50	4.7%

#	REVISION	DATE	INIT
1	REVISED PER COMMENTS	2025-06-02	G.S
0	ISSUED FOR REVIEW	2024-12-07	G.S

NOTES:
1. THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWER, AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.
2. PROPERTY LINES WERE PLOTTED USING REGISTERED PLANS AND BARS LOCATED IN THE FIELD, TO VERIFY THE ACCURACY OF THESE PROPERTY LINES, A LEGAL SURVEY SHOULD BE PERFORMED PRIOR TO CONSTRUCTION.
3. ALL CONSTRUCTION MUST COMPLY WITH THE NIAGARA PENINSULA STANDARD CONTRACT DOCUMENT.

DRAFTING G.S
DESIGN B.K
CHECKED BY M.H
APPROVED BY B.K

L'LICENSED PROFESSIONAL ENGINEER — B.J.KAPTEYN — 100509155 — Jun 6/25 — PROVINCE OF ONTARIO

Niagara-on-the-Lake EST.1781

UPPER CANADA CONSULTANTS — ENGINEERS / PLANNERS
30 Hannover Drive Unit 3, St. Catharines, Ontario L2W 1A3
Phone: (905)688-9400 Fax: (905)688-5274

OWNER
ST. DAVIDS RIVERVIEW ESTATES INC.
1755 STEVENSVILLE ROAD
FORT ERIE, ONT
L0S 1N0

TAWNY RIDGE ESTATES - PHASE 2
NIAGARA-ON-THE-LAKE
SANITARY DRAINAGE AREA PLAN

CONSULTANT FILE No. 21178
DATE 2025-06-02
PRINTED 2025-06-02
SCALE 1:500 m
REF No.
DWG No. 21178-PH2-SANDA
REV 1

DRAWING FILE: F:\21178\Engineering\21178-Eng_Base.dwg PLOTTED: Jun 02, 2025 - 4:17pm PLOTTED BY: gordon

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

APPENDIX B

Overall St. Davids Sanitary Pumping Station No.1 Sanitary Analysis

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

DESIGN FLOWS

RESIDENTIAL: 255 LITRES/PERSON/DAY (AVERAGE DAILY FLOW)
INFILTRATION RATE: 0.286 LITRES/HECTARE (M.O.E FLOW ALLOWANCE IS BETWEEN 0.10 & 0.28 LITRES/HECTARE)
POPULATION / UNIT: 2.4 PERSONS

SEWER DESIGN

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

MUNICIPALITY: TOWN AT NIAGARA-ON-THE-LAKE
PROJECT : TAWNY RIDGE ESTATES (PHASE 2) **ST. DAVIDS OVERALL SANITARY ANALYSIS**
PROJECT NO: 21178

LOCATION			AREA		POPULATION			ACCUMULATED PEAK FLOW									
Description	**From M.H**	**To M.H.**	**Incremt (hectares)**	**Accumltd (hectares)**	**Population Density (persons/hectare)**	**Person Incremt**	**Total Person Served**	**Peaking Factor**	**Ex Dry Weather Flow (L/s)**	**Fut Dry Weather Flow (L/s)**	**Infiltration Flow L/s**	**Total Peak Flow (L/s)**	**Pipe Diameter (mm)**	**Pipe Slope (%)**	**Full Flow Velocity (m/s)**	**Full Flow Capacity (L/s)**	**Check Percent Full**
TAWNEY RIDGE PH 2			3.12	3.12	47.4	148	148	4.50		1.97	0.89	2.86	200	0.40	0.7	21.64	13.2%
EXTERNAL FUT DEVLOPEMENT			1.20	1.20	35.0	42	42	4.00		0.50	0.34	0.84	200	0.40	0.7	21.64	3.9%
EX FLOW AT ST. DAVIDS SPS #1 AS MEASURED BY GM BLUE PLAN									15.70	18.16	37.00	52.70	300	0.50	1.0	71.33	73.9%
FUT FLOW AT ST. DAVIDS SPS #1									15.70	2.46	38.24	56.40	300	0.50	1.0	71.33	79.1%

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

APPENDIX C

St. Davids SPS – System Surcharging Investigation GM Blue Plan Engineering (October 2022)

Date:	10/14/2022	File:	622038
To:	Brett Ruck, Town of Niagara-on-the-Lake		
From:	Project Manager: Carla Coveart Flow Monitoring: Bryan Bortolon & Alessandra Bianco		
Project:	St. Davids SPS - System Surcharging Investigation		
Subject:	Flow Analysis from March to July 2022		

TECHNICAL MEMO

1 INTRODUCTION

GM BluePlan Engineering (GMBP) was retained by the Town of Niagara-on-the-Lake (Town) to conduct flow monitoring upstream of the St. Davids No.1 Sewage Pump Station (SPS) to assist the Town in understanding reasons behind recent surcharging at this facility, and overall system performance.

This memo presents a hydraulic review and analysis of the flow monitors, which were installed from March to July 2022. The rain event that occurred on May 3rd led to wet weather flows in excess of the SPS capacity resulting in system surcharging and backwater into the FM027 and FM028 subdivisions. The analysis of this event, and others, have provided a better understanding of how the system reacts during wet weather, including a high-level assessment of RDII.

2 FLOW MONITORS

Two (2) flow monitors were installed on February 19th, 2022, highlighted in green in Figure 1. An additional flow monitor, installed as part of the Town's ongoing PPCP study, was utilized to support the investigation.

Figure 1: Flow Monitor Locations – Surcharge Investigation (Green) & 2022 PPCP Monitor (Red)

See Table 1 for a detailed list of the flow monitor locations and specifications.

Table 1: Flow Monitor Specifications

Project	FM ID	FM Alias	Manhole ID	Pipe ID	Inflow / Outflow	Diameter	Installation Date
Surcharge Investigation	FM027	FourMile_FM027	NOTLSANMH-1866	NOTLSAN-1982	Inflow	200	2022-02-19
	FM028	AngelaCres_FM028	NOTLSANMH-1739	NOTLSAN-1853	Outflow	200	2022-02-19
2022 PPCP	FM032	Four Mile Creek Rd	NOTLSANMH-1199	NOTLSAN-1250	Inflow	300	2022-03-23

3 RAIN GAUGE

Many wet weather flow metrics are calculated and normalized to the precipitation that fell on the catchment area. The ideal distance of a rain gauge from the centroid of a catchment is 2.5-3.0 km. If a rain gauge is too far, the data may not be representative resulting in the magnitude of inflow and infiltration (I&I) potentially being overestimated or underestimated.

Niagara Region owns and operates one (1) rain gauge for the Town, the Line 2 Precipitation Station; see Figure 2 for the rain gauge location. This rain gauge was paired to the flow monitors and used for the analysis. The distance from the rain gauge to the centroid of the catchment areas is around 6.2 km; whilst not ideal, it was the closest rain gauge available.

Figure 2: Rain Gauge Location Map

The rainfall data was downloaded from Niagara Open Data and provided the rainfall events for flow analysis. Table 2 summarizes the critical events used for the analysis.

Table 2: Critical Events used for Analysis

Start of Rain	End of Rain	Rainfall Duration (dd:hh:mm)	Total Depth (mm)	Peak 1-hr (mm/hr)
03/23/2022 6:50	03/23/2022 23:25	00:16:35	17	5.3
04/25/2022 17:45	04/27/2022 5:45	01:12:00	15	8.5
05/03/2022 17:55	05/04/2022 8:55	00:15:00	22	5.8
06/01/2022 10:45	06/01/2022 17:25	00:06:40	15	5.0
06/06/2022 2:20	06/07/2022 16:40	01:14:20	22	6.3
07/17/2022 22:10	07/18/2022 12:00	00:13:50	51	12.5
07/20/2022 20:50	07/20/2022 22:05	00:01:15	17	16.5

4 ASSESSMENT OF SYSTEM PERFORMANCE

A suite of analyses was completed to assess the overall performance of the St. Davids system, including:

- Average Flow Assessment
- Depth Ratio Assessment
- Scatterplot Assessment
- Dry Weather Flow Analysis
- Wet Weather Flow Analysis

See Figure 3 for the catchment areas captured by each flow monitor, used to complete the analyses.

- FM027 – small new development west of Four Mile Creek Road, just upstream of the SPS
- FM028 – small new development east of Four Mile Creek Road, just upstream of the SPS
- FM032 – captures the majority of the St. Davids wastewater system flows.

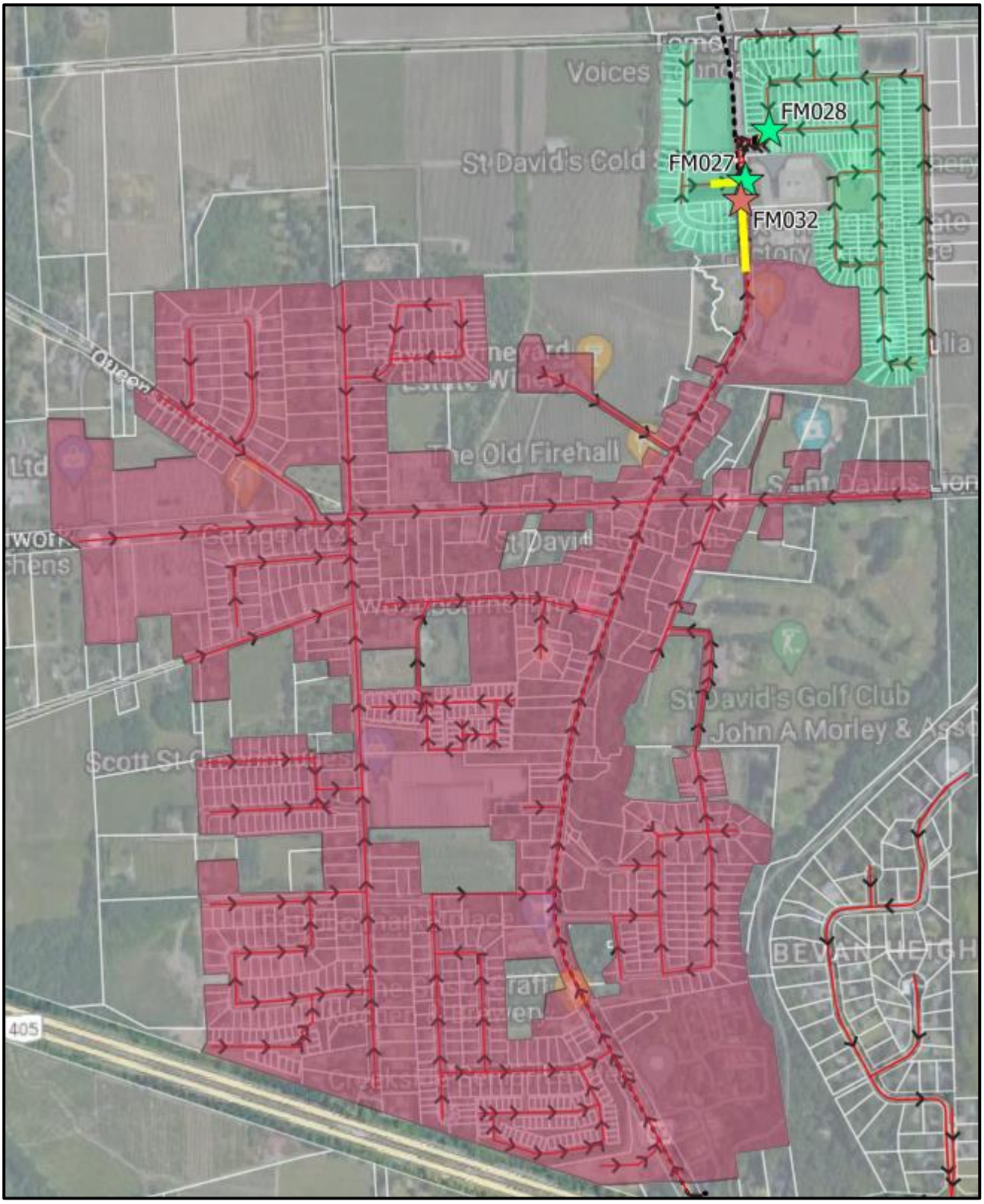


Figure 3: Contributing Catchment Areas

4.1 AVERAGE FLOW

The average flow is inclusive of base infiltration, sanitary flow, and rainfall derived inflow and infiltration. It is typically used to identify average flow rates at facilities and the presence of seasonality, e.g., higher average flows in the spring, or during months with snowmelt, than the summer.

The sum of these three monitors is approximately the average flow at the St Davids SPS, only the discharge from the Line 5 Landfill Leachate SPS is not captured.

Table 3: Average Flow (L/s)

Average Flow (L/s)												
FM ID	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
FM027			0.3	0.2	0.2	0.3	0.3					
FM028			1.5	1.4	1.3	1.3	1.2					
FM032			12.2	10.2	10.2	11.5	11.1					
Total			**14.0**	**11.8**	**11.7**	**13.1**	**12.6**					

4.2 DEPTH RATIO ASSESSMENT

The d/D (%) metric provides valuable information regarding the fullness of the flow monitoring sewer; where 'd' represents the depth of flow and 'D' represents the diameter of the sewer. Note that this assessment is for the monitored sewer only and cannot be assumed for other upstream and downstream pipes.

Table 4: Depth Ratio (d/D)

	Depth Ratio (d/D)												
FMID	**Statistics**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
FM027	**Max**			37%	34%	185%	26%	38%					
FM027	**Average**			14%	11%	12%	12%	13%					
FM028	**Max**			42%	262%	525%	35%	39%					
FM028	**Average**			22%	24%	21%	20%	19%					
FM032	**Max**			55%	49%	66%	52%	68%					
FM032	**Average**			39%	36%	37%	39%	39%					

Takeaways

- No system surcharge was observed during dry weather flow.
- One event (May 3rd) resulted in system surcharge.
    - Note that the max d/D value in April was for a single 5-min timestep and appears to be erroneous data or a result of a temporary operational issue with the facility.
- FM028 will surcharge first as it is located at a lower elevation in the system (inverts from GIS).
    - FM028 Invert: 100.31m
    - FM027 Invert: 100.74m
    - FM032 Invert: 103.80m
- Figure 4, and the scattergraphs in Section 4.3, suggest that the surcharging is due to the SPS capacity being exceeded and backwater occurring in the trunk system.
    - For both FM027 and FM028, the depth rises while the velocity decreases.

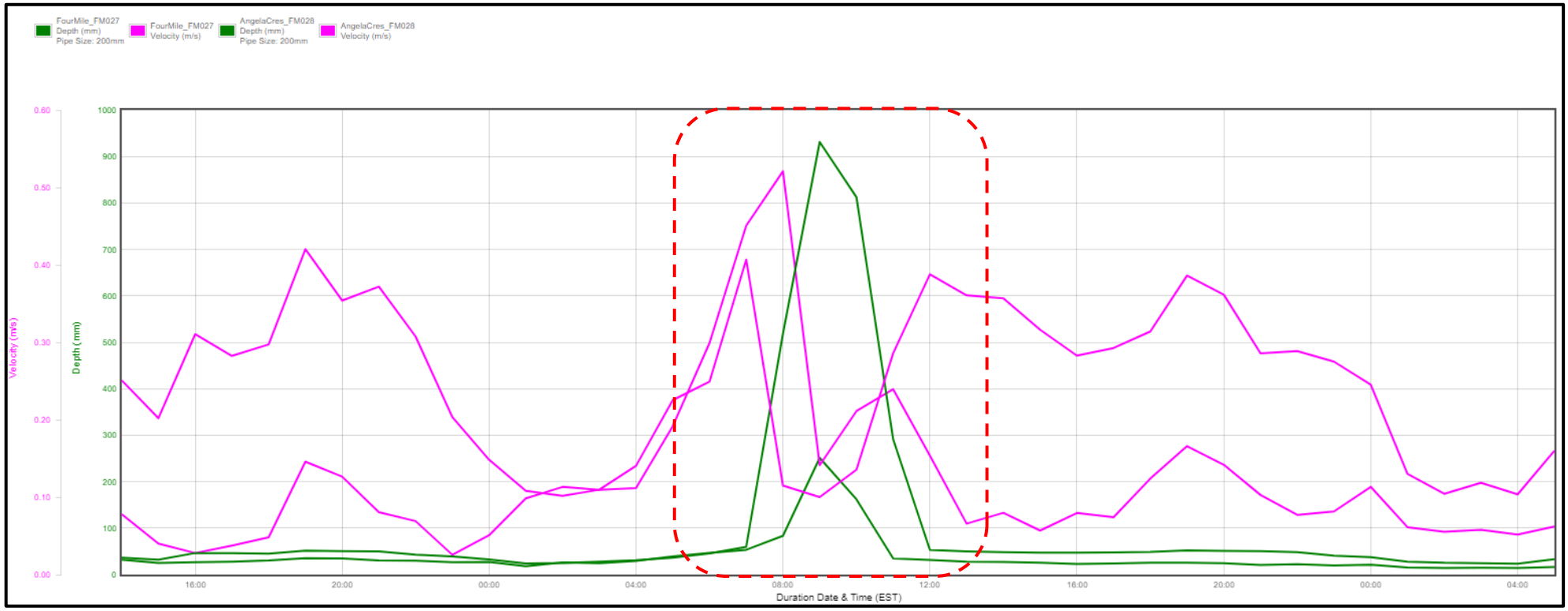


Figure 4: Velocity-Depth Graph from May 3rd Critical Event (FM027 & FM028)

4.3 SCATTERPLOT ANALYSIS AND THEORETICAL PIPE FULL CAPACITY

Velocity-depth scatterplots illustrate the flow hydraulics within the pipe where the flow monitor was installed, where velocity is along the x-axis and depth along the y-axis.

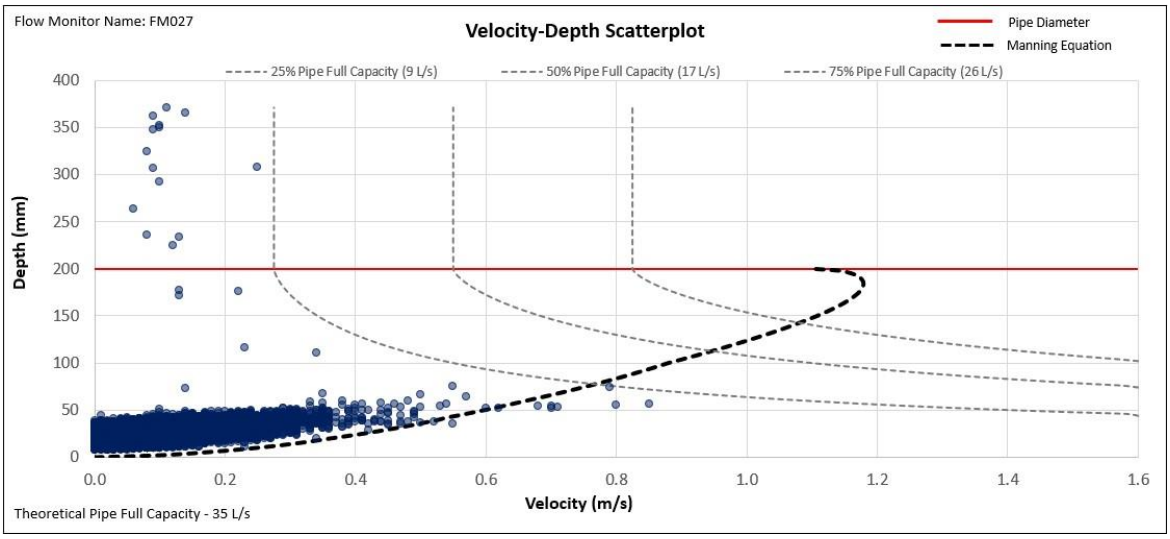
The scatterplots are used to graph data captured by the monitor against the following:

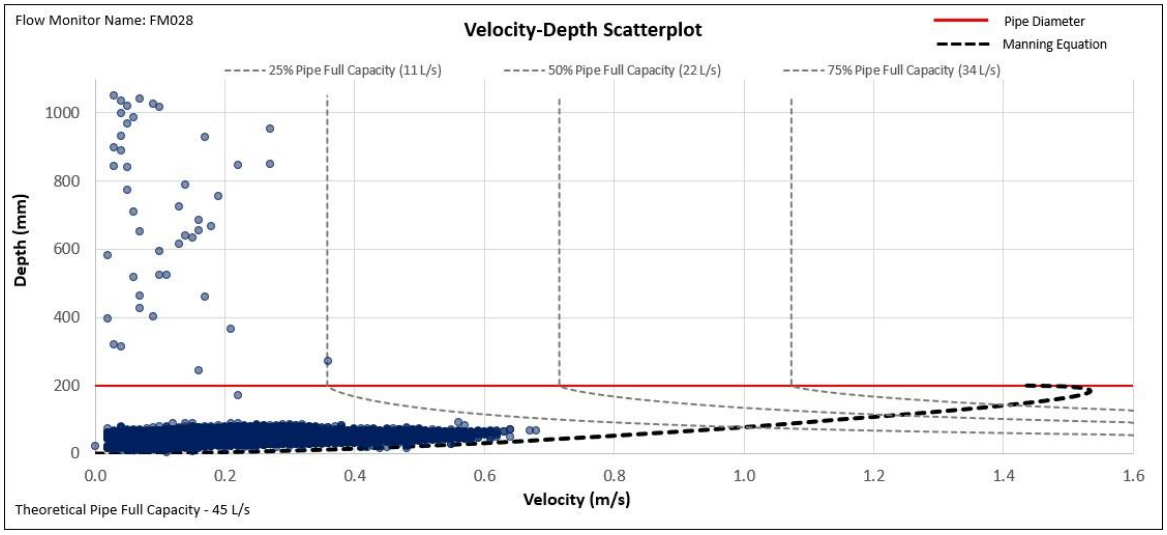
- Theoretical manning's equation represented by the black dashed line.
  - Based on GIS slope, pipe diameter and mannings roughness.
  - Data points should generally follow this manning curve or parallel to it under normal hydraulic conditions.
  - If there is an upstream blockage, downstream constraint, sewer surcharging, or inaccurate inputs such as slope, data points may not follow the mannings equation.
- Pipe diameter represented by the red line.
  - Any data point above this red line indicates that the pipe is full and surcharging.
- 25%, 50% and 75% pipe full capacity are represented by the grey dashed lines.
  - All combinations of velocity and depth along these lines represent the same flow rate.
  - Data usually follows these curves when flow is limited by downstream constraint.

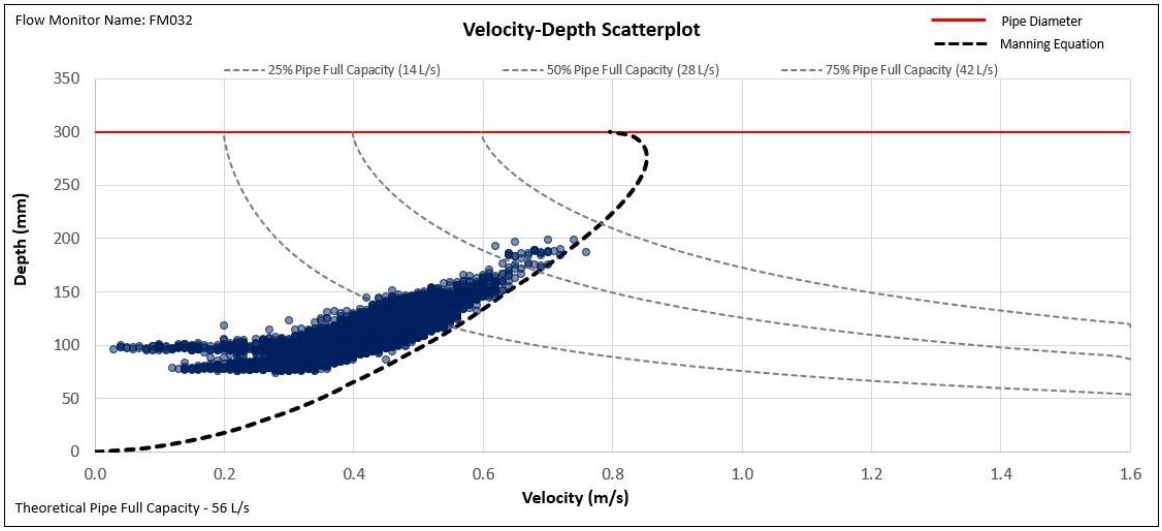
See figures on following page for each monitor's scatterplot.

<u>Takeaways</u>

- All sites have good flow hydraulics under dry and wet weather conditions.
- Theoretical Pipe Full Capacities
  - FM027: 35 L/s
  - FM028: 45 L/s
  - FM032: 56 L/s
- During significant events, when the downstream SPS capacity is surpassed, FM027 and FM028 experience backwater and surcharging.
  - FM028 surcharges first and then FM027, based on the inverts discussed in Section 4.2.
  - Flows in both sewers were under 25% pipe full capacity for the entire monitoring survey.
- FM032 experienced up to 70% pipe full capacity during the May 3rd event.


Flow Monitor Name: FM027
Velocity-Depth Scatterplot
Pipe Diameter
Manning Equation
25% Pipe Full Capacity (9 L/s)
50% Pipe Full Capacity (17 L/s)
75% Pipe Full Capacity (26 L/s)
Depth (mm)
Velocity (m/s)
Theoretical Pipe Full Capacity - 35 L/s


Flow Monitor Name: FM028
Velocity-Depth Scatterplot
Pipe Diameter
Manning Equation
25% Pipe Full Capacity (11 L/s)
50% Pipe Full Capacity (22 L/s)
75% Pipe Full Capacity (34 L/s)
Depth (mm)
Velocity (m/s)
Theoretical Pipe Full Capacity - 45 L/s


Flow Monitor Name: FM032
Velocity-Depth Scatterplot
Pipe Diameter
Manning Equation
25% Pipe Full Capacity (14 L/s)
50% Pipe Full Capacity (28 L/s)
75% Pipe Full Capacity (42 L/s)
Depth (mm)
Velocity (m/s)
Theoretical Pipe Full Capacity - 56 L/s

4.4 DRY WEATHER FLOW ANALYSIS

The Dry Weather Analysis was completed for each month of the survey period, which can be found in the individual flow analysis reports in Appendix A. Average values for key metrics are summarized in Table 5.

Table 5: DWF Analysis Results

Flow Monitor	ADWF	PDWF	BGWI	BGWI/ADWF
FM027	0.2 L/s	0.5 L/s	<0.1 L/s	10%
FM028	1.3 L/s	2.2 L/s	0.2 L/s	15%
FM032	8-11 L/s	13 L/s	2-7 L/s	25-60%

- ADWF: Average Dry Weather Flow (L/s)
- PDWF: Peak Dry Weather Flow (L/s)
- BGWI: Base Groundwater Infiltration (L/s)

Takeaways

- FM027 and FM028 have minimal BGWI.
- FM032: significant seasonality with a large amount of BGWI in March (7 L/s), decreasing into July (2 L/s).

4.5 WET WEATHER FLOW ANALYSIS

4.5.1 Assessment of RDII

Two industry standard metrics, amongst many others, are typically used in the assessment of RDII: Cv (%) and Unit Peak RDII (L/s/ha). Cv represents the percent of rain that fell on the catchment area and entered the sanitary system whereas the Unit Peak RDII is a metric that normalizes the peak RDII flow rate by the contributing area.

As discussed in section 3, the distance between the available rain gauge and the study area could impact the assessment of RDII; it is possible that the precipitation observed at the rain gauge is not representative and the lack of response sometimes observed could be due to localized rainfall. For this reason, the Cv metric, or any metric normalized by rainfall, should be interpreted with care.

See Table 6 and Table 7 for a summary of the Unit Peak RDII (L/s/ha) and the Peak RDII (L/s) for each catchment area, and Table 8 for the total estimated volume of RDII. *Note that May 3rd event was excluded for FM027 and FM028 due to system surcharge; the RDII peak flows and RDII volumes are inaccurate due to backwater in the system.*

The individual flow analysis reports for each monitor, which include the response for each critical event, can be found in Appendix A.

Table 6: Wet Weather Flow Metrics – Peak Unit RDII (L/s/ha)

Flow Monitor	March 23	April 25	May 3	June 1	June 6	July 18	July 20
FM027	0.69	0.33	-	0.42	0.40	1.13	0.86
FM028	0.19	0.15	-	0.30	0.42	0.64	0.19
FM032	0.10	0.06	0.17	0.05	0.09	0.18	0.19

Table 7: Wet Weather Flow Metrics – Peak RDII (L/s)

Flow Monitor	March 23	April 25	May 3	June 1	June 6	July 18	July 20
FM027	3	2	-	2	2	5	4
FM028	2	2	-	4	5	8	2
FM032	13	11	23	7	12	24	25

Table 8: Wet Weather Flow Metrics – Total RDII Volume (m^3)

Flow Monitor	March 23	April 25	May 3	June 1	June 6	July 18	July 20
FM027	22	10	-	13	25	46	6
FM028	23	14	-	36	66	59	15
FM032	791	384	1,279	192	1,801	711	221
Total	**836**	**408**	**-**	**241**	**1,892**	**816**	**242**

Takeaways

- May 3rd event was not assessed for FM027 and FM028 due to backwater and system surcharging.
- July 18th event is the best event for assessing RDII as each monitor showed significant response with no system surcharging or backwater.
- Assessment of RDII by catchment area:
    - FM028: significant RDII when normalized by area. Further investigation could be warranted as it is a new development. Follow-up investigation should confirm whether construction was ongoing during monitoring period.
    - FM027: moderate RDII when normalized by area. Further investigation could be warranted; however, it is recommended that the Town invest in FM032 catchment first as it contributes the majority of the RDII and would provide more benefit per dollar spent.
    - FM032: moderate to low RDII when normalized by the area, however, it is a large area contributing 90%+ of the RDII in St Davids. Additional investigation is recommended to further isolate the sources of RDII and develop a rehabilitation strategy sufficient to reduce peak flows at the SPS and minimize future risk of system surcharge.
        - There is likely a significant amount of infiltration, suggested by a slow response and lengthy recovery, in line with the high BGWI observed as part of the dry weather flow analysis.
    - Estimated percentage of RDII contribution upstream of the SPS:
        - FM027: 2-5%
        - FM028: 3-5%
        - FM032: 90-95%
    - Note that the discharge from the regional leachate forcemain has not been included in this analysis.

4.5.2 Surcharging State

The St David's Sewage Pumping Station No.1 (383 Four Mile Creek Road) has an existing rated capacity of 40.9 L/s. *Note that this does not necessarily represent that operational capacity of the facility as that depends on the condition and performance of the pumps and forcemains*. Additionally, there is no overflow and bypass pumping trucks are required when the wet well surcharges beyond alarm levels.

No system surcharge was observed during dry weather flow and only the rainfall event on May 3rd resulted in wet weather flows exceeding the capacity of the SPS. The findings of section 4.2, the scattergraphs in section 4.3, and the analysis results in Appendix A suggest that the capacity of the SPS was surpassed and the system began to surcharge, first observed at FM028 and then FM027. Note that FM032, along the Four Mile Creek Road trunk sewer, did not experience any surcharge, only reaching 70% pipe full capacity.

The total aggregated peak flow during the May 3rd event was 46 L/s, surpassing the rated capacity of 41 L/s. Furthermore, the analysis suggests that the elevation in the wet well reached approximately 101.36m;

a flow depth of 1.05m at FM028, which has an install elevation of 100.31m. See Figure 5 for the St David's No.1 SPS wet well elevations.

A draw down test is recommended for this facility to assess the operational capacity of the SPS, which will be considered and reviewed as part of the Town's PPCP update, also being completed by GMBP.

5 CONCLUSION AND RECOMMENDATIONS

This technical analysis and memo provide a high-level assessment of RDII within the St. Davids No.1 SPS sewershed and an overview of the system under surcharge state.

- Surcharging is due to exceedance of St Davids No.1 SPS during wet weather flow.
    - No surcharging during dry weather and only the May 3rd event resulted in surcharging at FM027 and FM028. Note that FM032 did not experience any surcharging during the survey period and only reached 70% pipe full capacity.
- Dry Weather Flow Analysis
    - FM027 and FM028 have minimal BGWI.
    - FM032: seasonality with large amount of BGWI in March (7 L/s), decreasing into July (2 L/s).
- Wet Weather Flow Analysis of the July 18th event:
    - FM028: significant RDII when normalized by area. Further investigation could be warranted as it is a new development. Follow-up investigation should confirm whether construction was ongoing during monitoring period.
    - FM027: moderate RDII when normalized by area. Further investigation could be warranted; however, it is recommended that the Town invest in FM032 catchment first as it contributes the majority of the RDII and would provide more benefit per dollar spent.
    - FM032: moderate to low RDII when normalized by the area, however, it is a large area contributing 90%+ of the RDII in St Davids. Additional investigation is recommended to further isolate the sources of RDII and develop a rehabilitation strategy sufficient to reduce peak flows at the SPS and minimize future risk of system surcharge.
        - There is likely a significant amount of infiltration, suggested by a slow response and lengthy recovery, in line with the high BGWI observed as part of the dry weather flow analysis.
    - Estimated percentage of RDII contribution upstream of the SPS:
        - FM027: 2-5%
        - FM028: 3-5%
        - FM032: 90-95%

Recommended Next Steps:

- A comparison of the lowest basement elevation to past surcharge levels and calculation of critical surcharge levels.
- A tactical RDII analysis and development of RDII reduction strategy. This will include additional flow monitoring and field investigation to further isolate and qualify the sources of RDII (fast, medium, and slow or inflow vs infiltration).
    - Note that the analysis summarized in this memo will be incorporated into the ongoing PPCP, being completed by GMBP. Any additional field investigation in the St Davids sewershed needs to be accounted for and coordinated with the master plan to ensure the strategies are aligned.
- Monitors and alarms have since been removed. There was formerly a depth sensor at the Angela Crescent monitor (FM028) to warn the Town when surcharging occurs. A quote has been provided to the Town for additional alarm services.

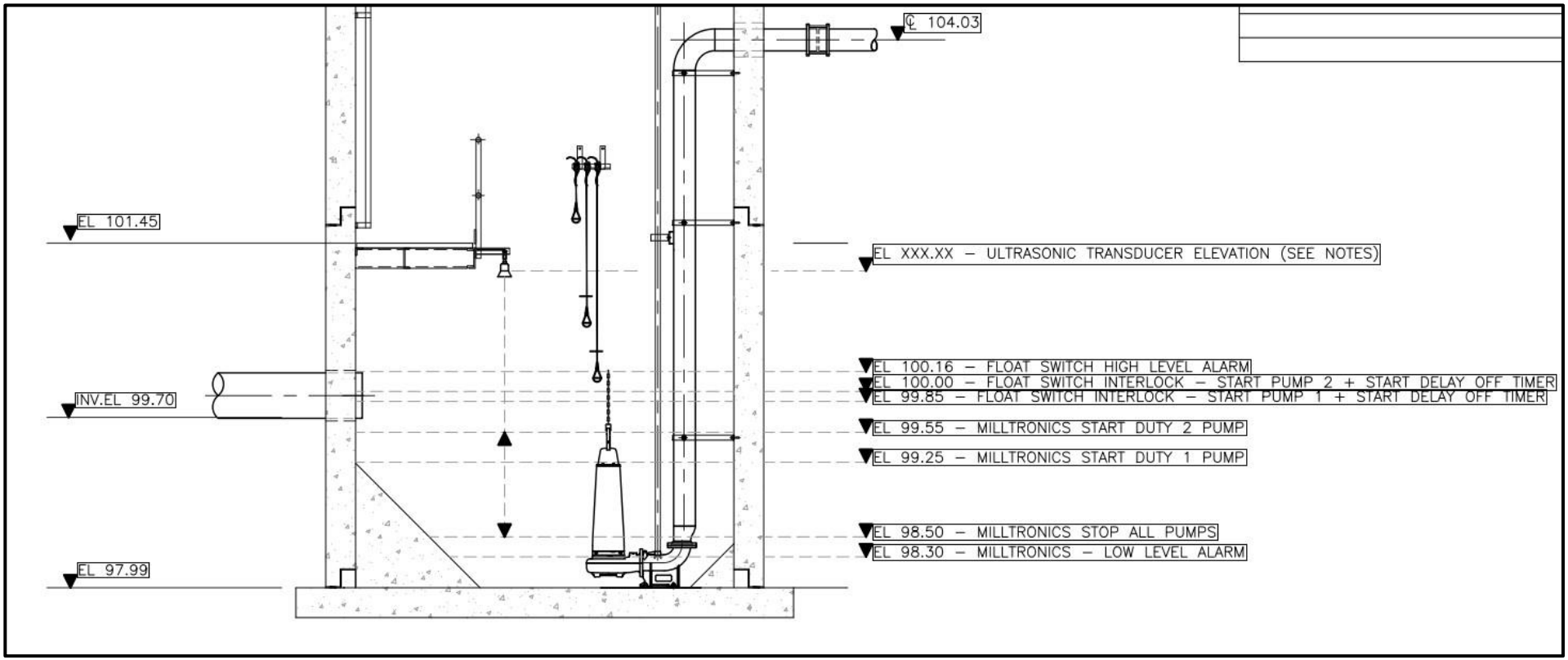


Figure 5: St. Davids SPS Wet Well Drawing (elevations)

Appendix A

Individual Flow Analysis Reports

Flow Monitor IDs

Name	Alias
FM027	FourMile_FM027

Install Pipe Specifications

Sewer System	Measured Pipe Size (mm)	GIS Pipe Size (mm)	Associated Rain Gauge
Sanitary	200	200	RoN_RG14

Catchment Specifications

Catchment Area (ha)	Pipe Surface Area (m^2)	Population	Catchment Tc
4.4	278	93	

SSEA Specifications

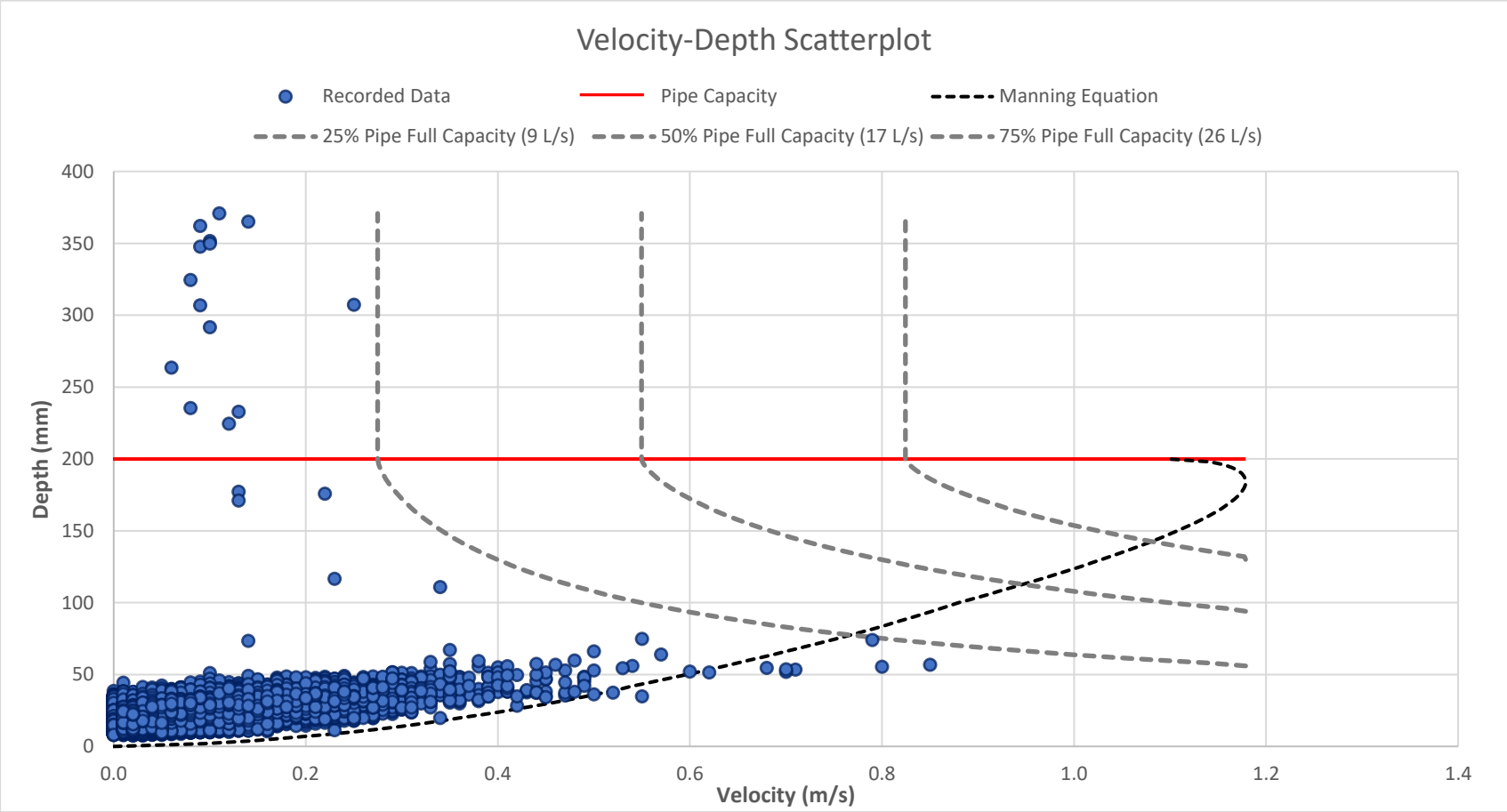
SSEA Area (ha)

This report summarizes the flow analysis outputs for the following reporting period:
Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake
Flow Analysis Report

Flow Monitor: FM027

From: March 01, 2022 To: June 16, 2022



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.0042
Roughness Coefficient	0.008

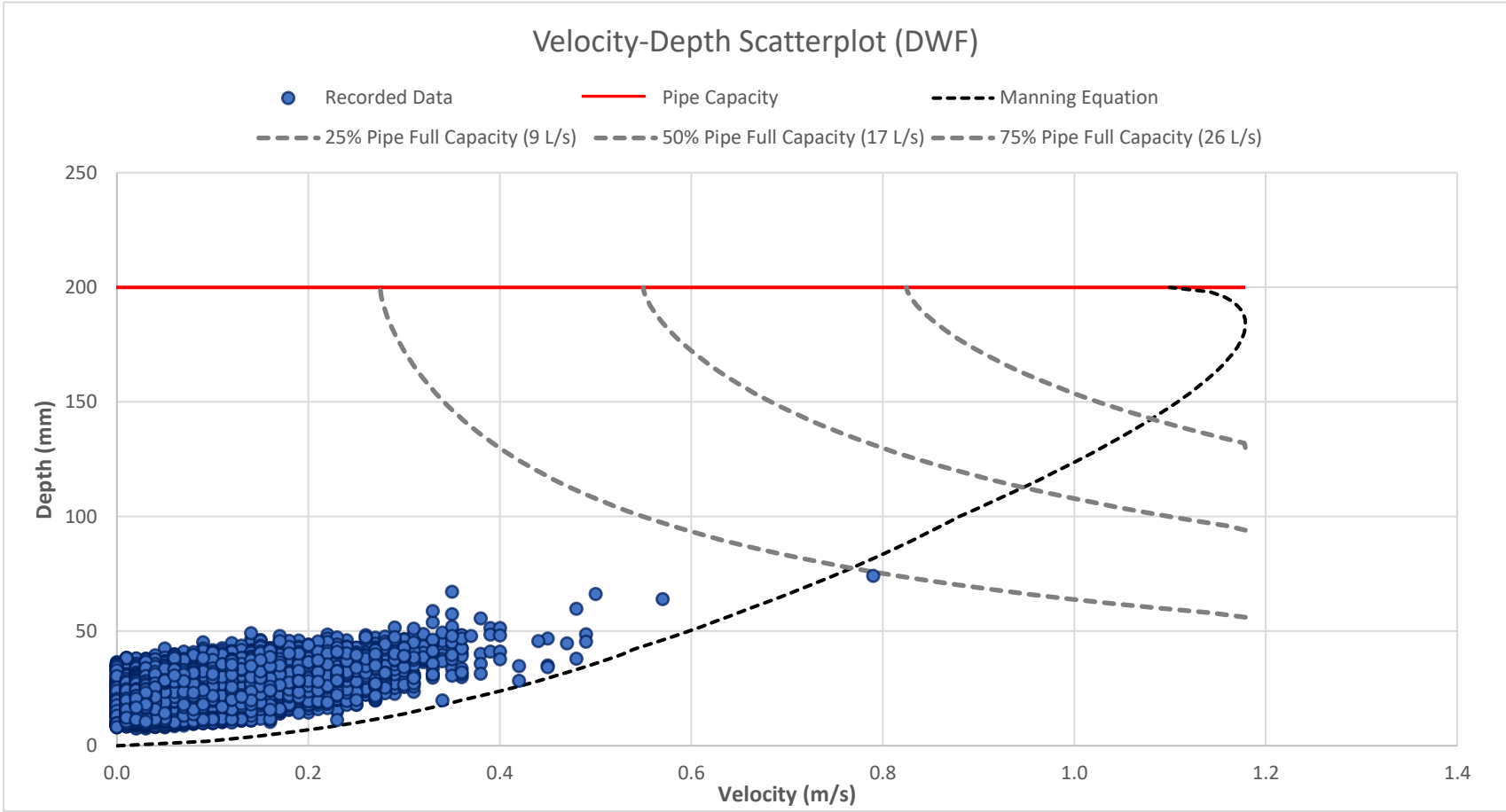
Commentary

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake
Flow Analysis Report

Flow Monitor: FM027

From: March 01, 2022 To: June 15, 2022



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.0042
Roughness Coefficient	0.008

Commentary

Analysis Period: March 01, 2022 - June 15, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM027

From: March 01, 2022 To: June 16, 2022

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM027

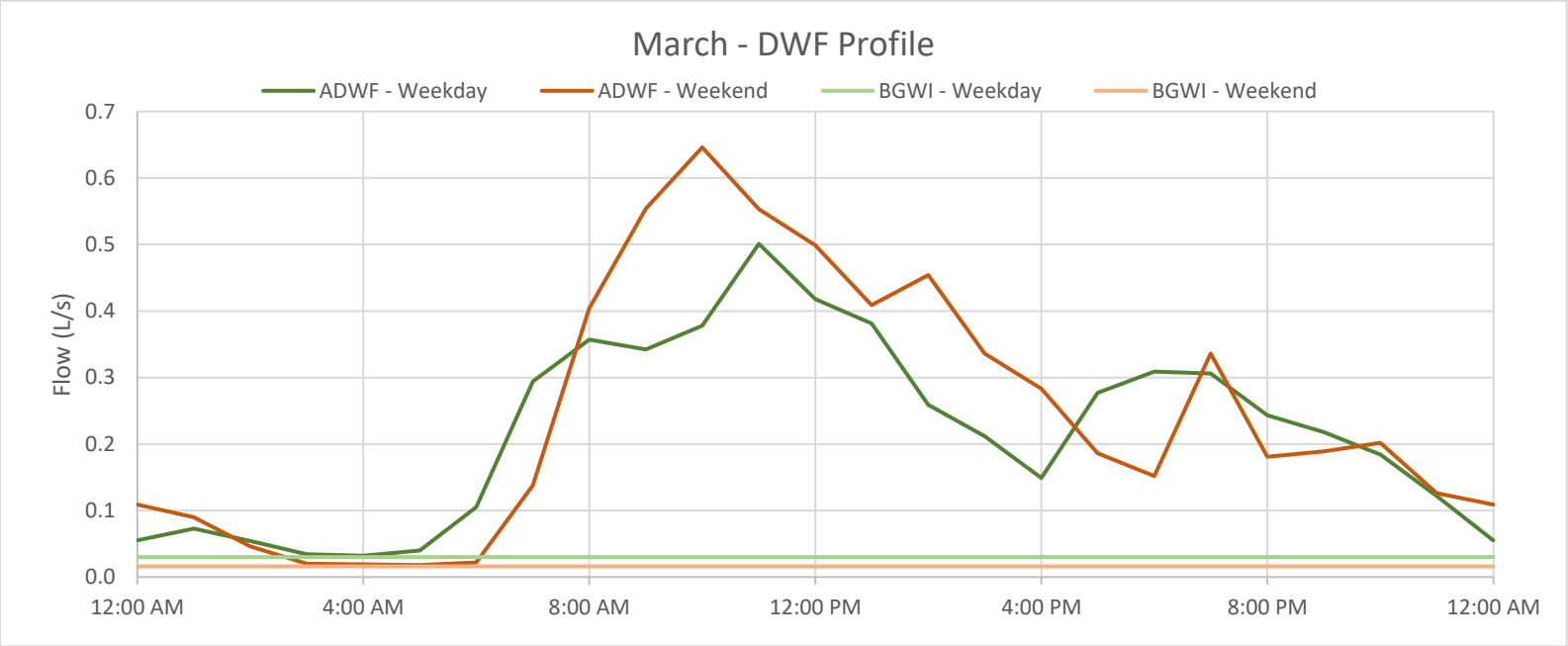
From: July 01, 2022 To: July 31, 2022

Analysis Period: July 01, 2022 - July 31, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM027 — March 2022



Dry Weather Flow Statistics			
Variable	Weekday	Weekend	Units
ADWF	0.2	0.2	L/s
MDWF	0.0	0.0	L/s
BGWI	0.0	0.0	L/s
Unit BGWI	0.01	0.00	L/s/ha
Unit BGWI			$L/s/km^2$
Sanitary Flow	0.2	0.2	L/s
Per Capita Sanitary Flow (model)			L/cap/day
Per Capita Sanitary Flow (DC)			L/cap/day
PDWF	0.5	0.6	L/s
BGWI/ADWF	13.37	6.48	%
Average d/D	13.37	12.80	%

Catchment Specifications

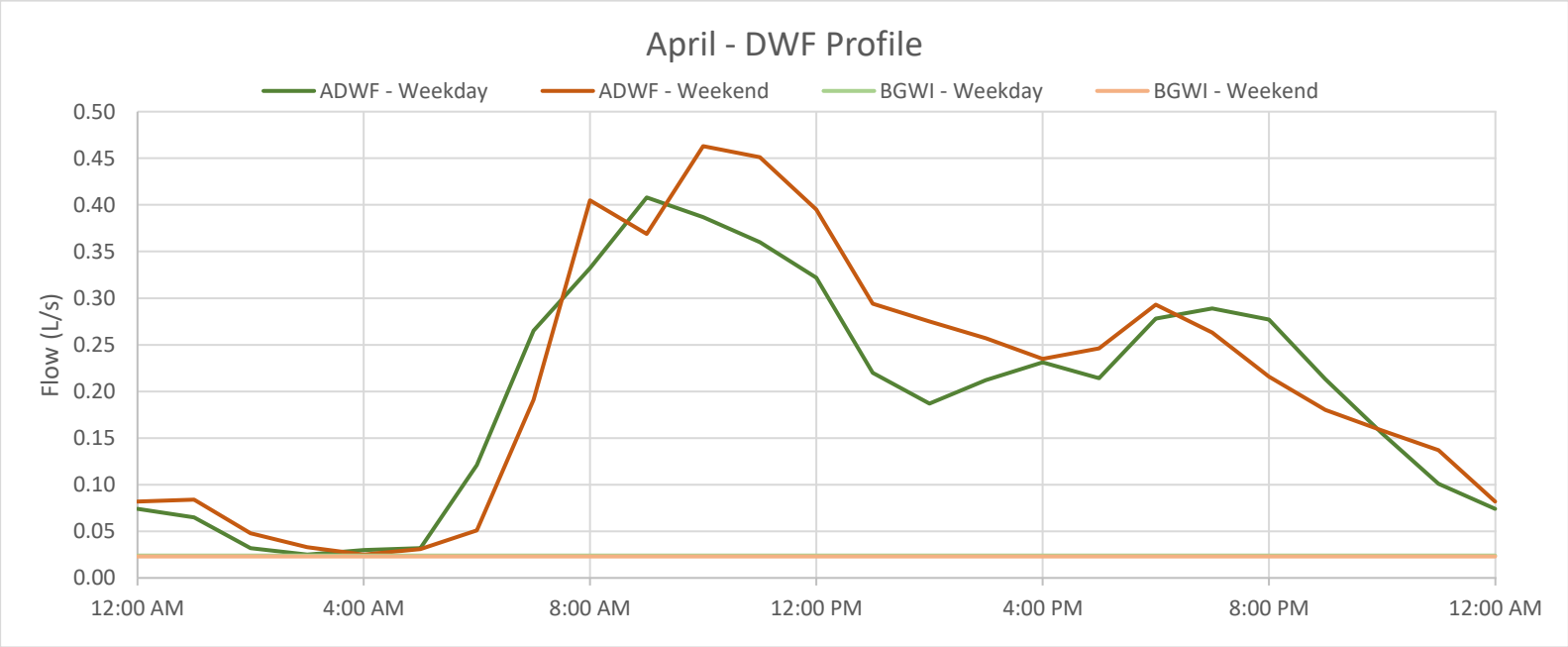
Catchment Area (ha)	4.4
Total Pipe Surface Area (m^2)	278
Population	93

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM027 — April 2022



Dry Weather Flow Statistics			
Variable	Weekday	Weekend	Units
ADWF	0.2	0.2	L/s
MDWF	0.0	0.0	L/s
BGWI	0.0	0.0	L/s
Unit BGWI	0.01	0.01	L/s/ha
Unit BGWI			$L/s/km^2$
Sanitary Flow	0.2	0.2	L/s
Per Capita Sanitary Flow (model)			L/cap/day
Per Capita Sanitary Flow (DC)			L/cap/day
PDWF	0.4	0.5	L/s
BGWI/ADWF	11.81	10.73	%
Average d/D	10.72	11.24	%

Catchment Specifications

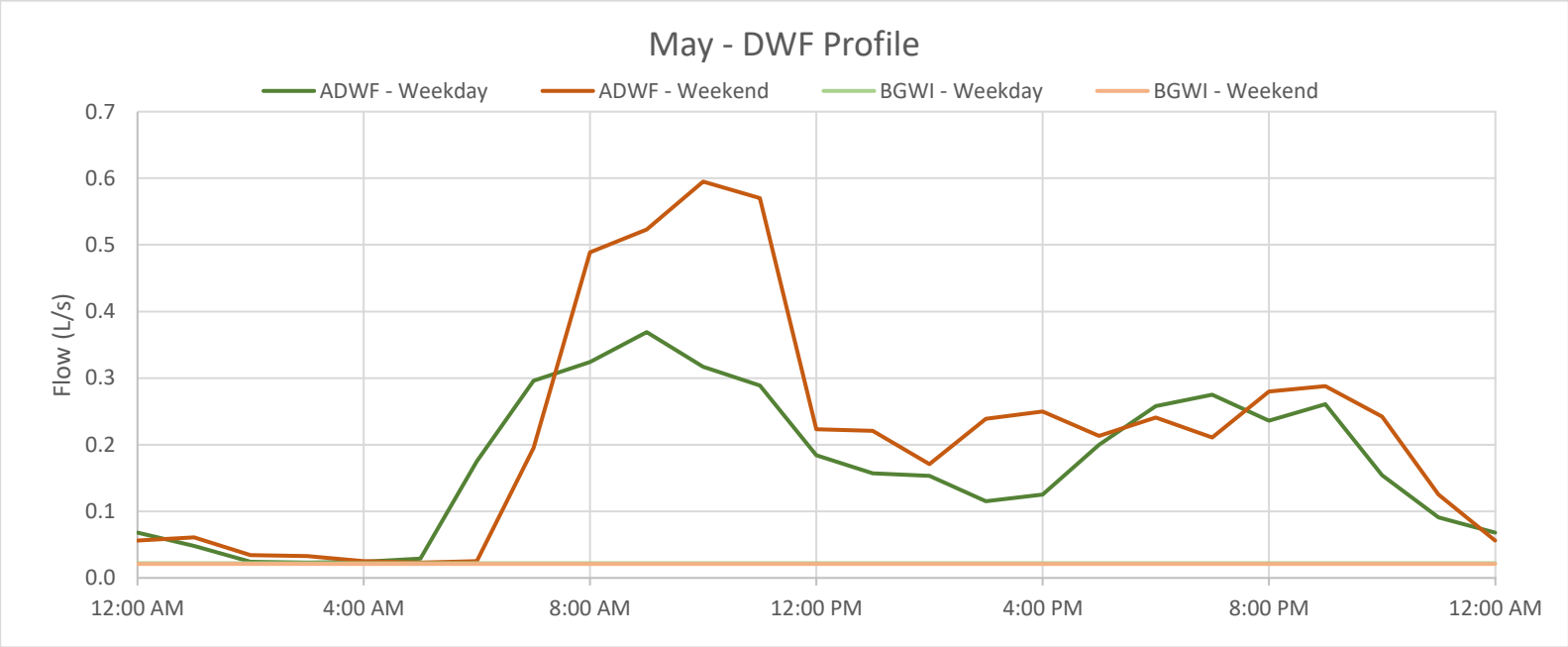
Catchment Area (ha)	4.4
Total Pipe Surface Area (m^2)	278
Population	93

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM027 — May 2022



Dry Weather Flow Statistics			
Variable	Weekday	Weekend	Units
ADWF	0.2	0.2	L/s
MDWF	0.0	0.0	L/s
BGWI	0.0	0.0	L/s
Unit BGWI	0.00	0.00	L/s/ha
Unit BGWI			$L/s/km^2$
Sanitary Flow	0.2	0.2	L/s
Per Capita Sanitary Flow (model)			L/cap/day
Per Capita Sanitary Flow (DC)			L/cap/day
PDWF	0.4	0.6	L/s
BGWI/ADWF	12.35	9.53	%
Average d/D	11.22	11.23	%

Catchment Specifications

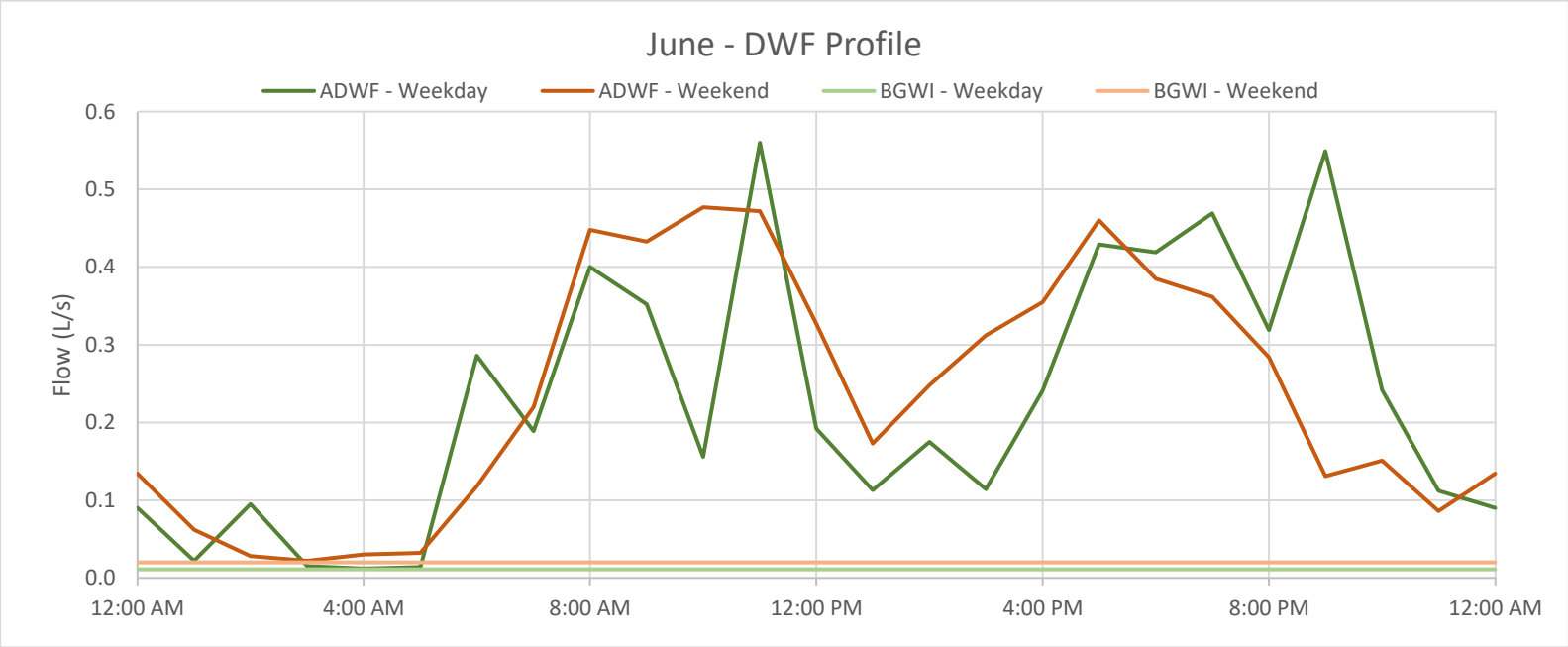
Catchment Area (ha)	4.4
Total Pipe Surface Area (m^2)	278
Population	93

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM027 — June 2022



Dry Weather Flow Statistics			
Variable	Weekday	Weekend	Units
ADWF	0.2	0.2	L/s
MDWF	0.0	0.0	L/s
BGWI	0.0	0.0	L/s
Unit BGWI	0.00	0.00	L/s/ha
Unit BGWI			$L/s/km^2$
Sanitary Flow	0.2	0.2	L/s
Per Capita Sanitary Flow (model)			L/cap/day
Per Capita Sanitary Flow (DC)			L/cap/day
PDWF	0.6	0.5	L/s
BGWI/ADWF	4.87	8.29	%
Average d/D	12.41	12.15	%

Catchment Specifications

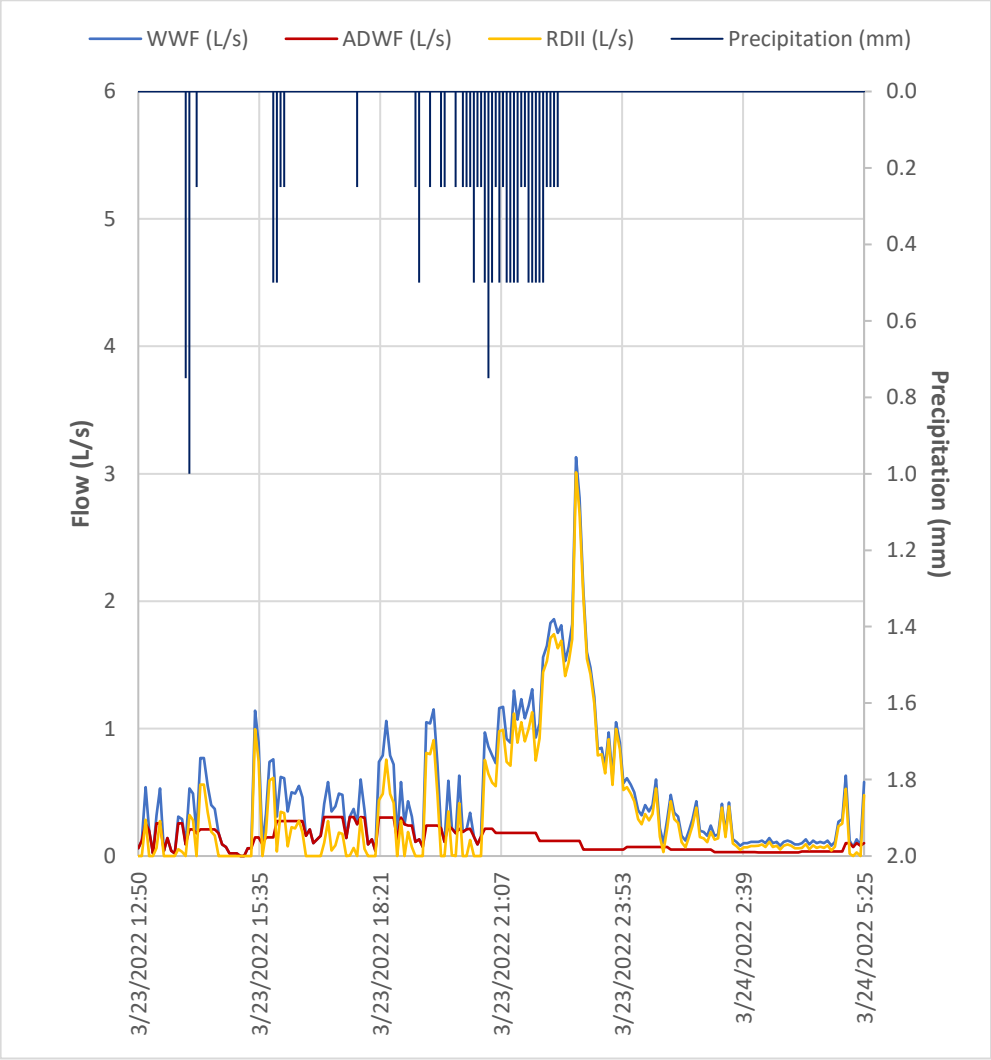
Catchment Area (ha)	4.4
Total Pipe Surface Area (m^2)	278
Population	93

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM027 — 2022-03-23



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	16	mm
Rainfall Duration	9	hr
Peak 1-hr Intensity	5	mm/hr
Peak 5-min Intensity	12	mm/hr

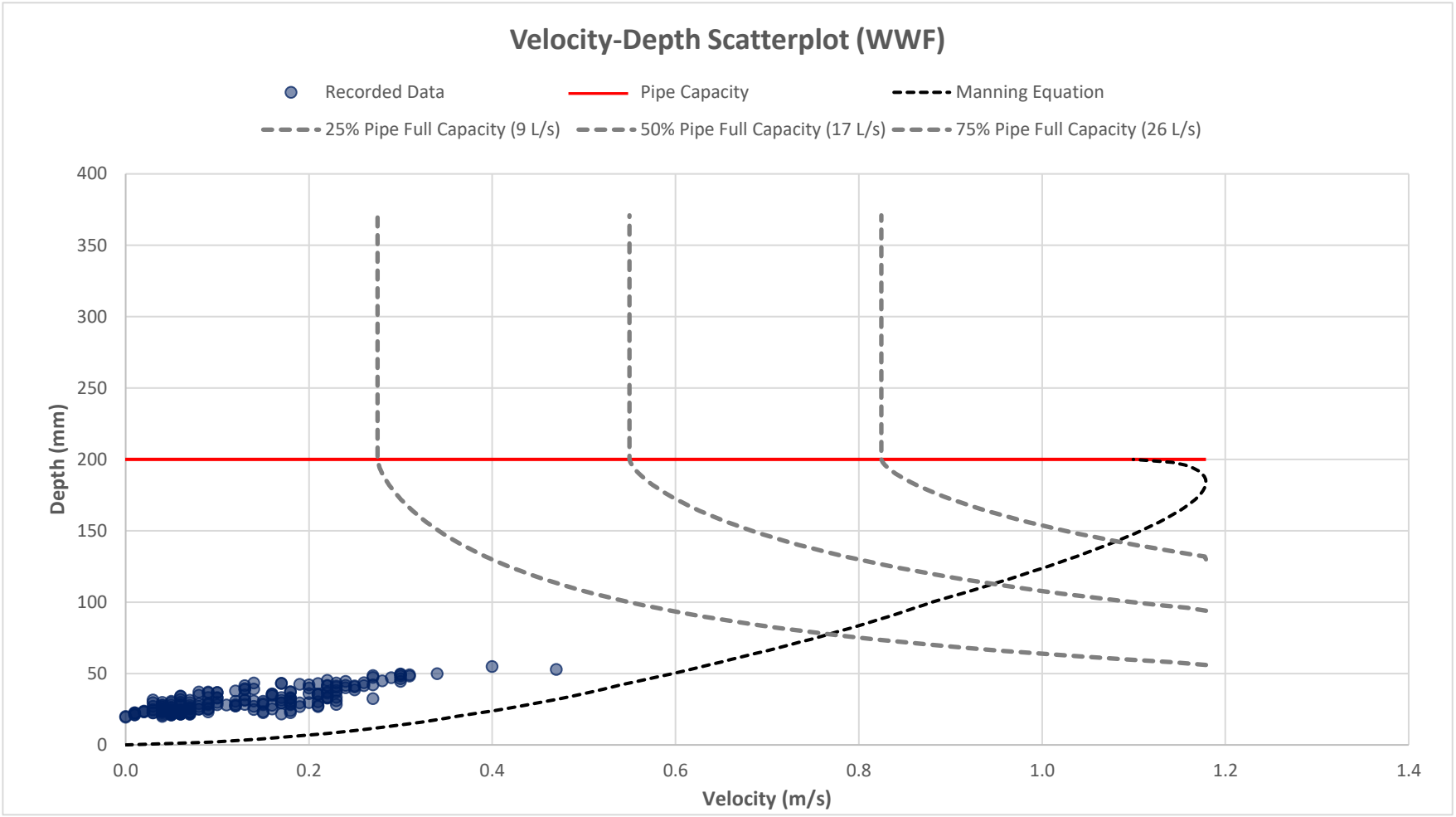
Monitored Area Statistics		
Catchment Area (ha)	4.4	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	3/23/2022 12:50	
End of Analysis	3/24/2022 5:25	
Peak Flow (PF)	3.130	L/s
Time of PF	3/23/2022 22:50	
DWF at Time of PF	0.119	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	3.011	L/s
Volume of RDII	22	m^3
Peak Unit RDII	0.69	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	3.14	%
WWF Vol./DWF Vol.	3.8	
PWWF/ADWF	24.2	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM027 — 2022-03-23



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.0042
Roughness Coefficient	0.008

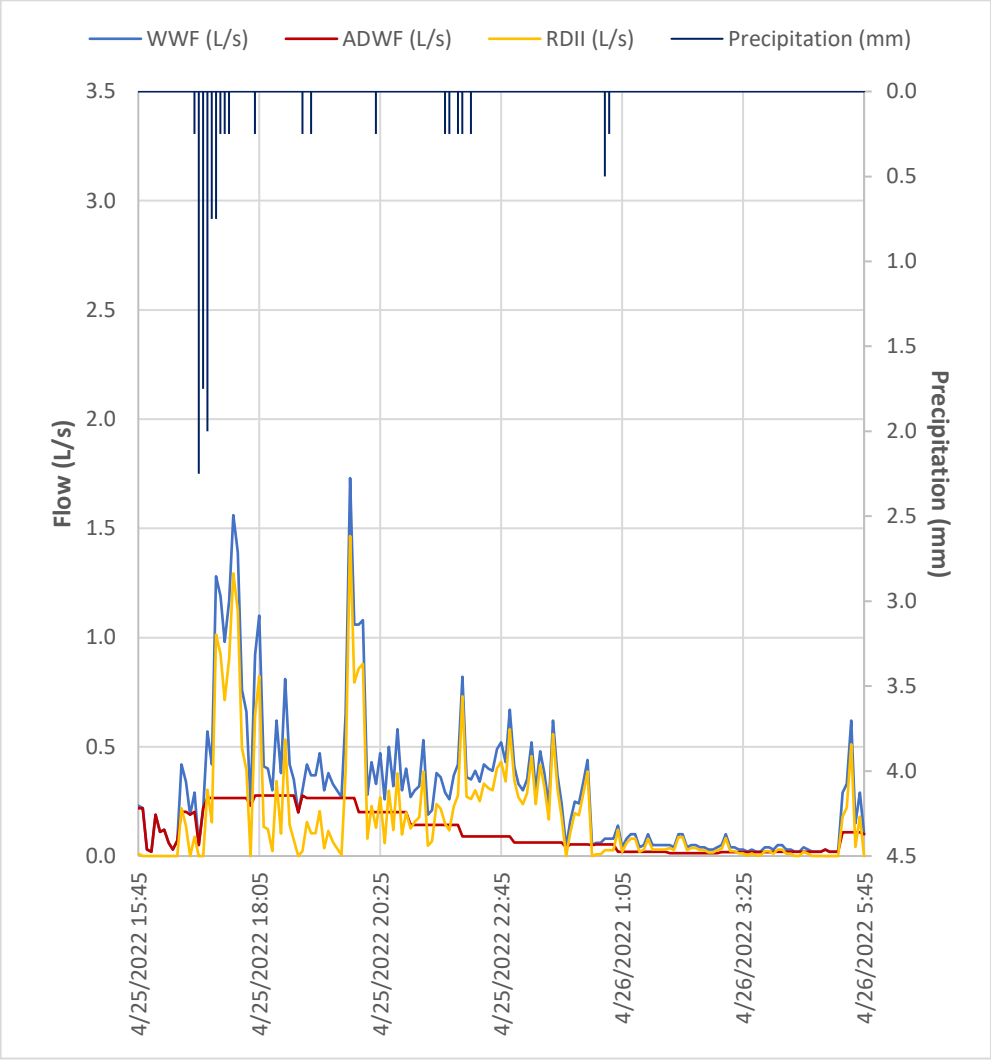
Analysis Period: March 01, 2022 - June 16, 2022

BluePlan ENGINEERING

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM027 — 2022-04-25



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	12	mm
Rainfall Duration	8	hr
Peak 1-hr Intensity	9	mm/hr
Peak 5-min Intensity	27	mm/hr

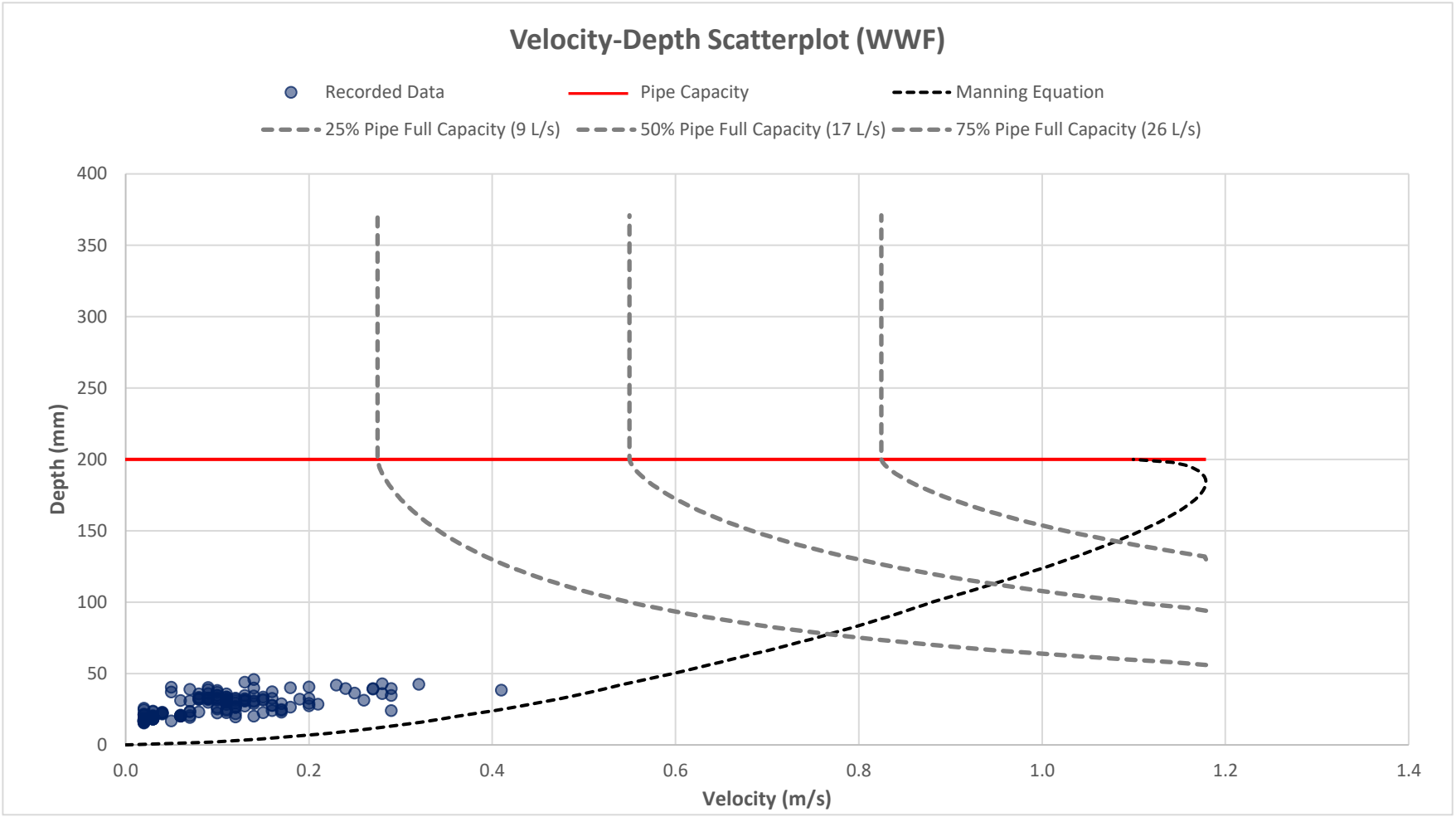
Monitored Area Statistics		
Catchment Area (ha)	4.4	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	4/25/2022 15:45	
End of Analysis	4/26/2022 5:45	
Peak Flow (PF)	1.730	L/s
Time of PF	4/25/2022 19:50	
DWF at Time of PF	0.265	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	1.465	L/s
Volume of RDII	10	m^3
Peak Unit RDII	0.33	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	1.91	%
WWF Vol./DWF Vol.	2.6	
PWWF/ADWF	14.9	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM027 — 2022-04-25



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.0042
Roughness Coefficient	0.008

Analysis Period: March 01, 2022 - June 16, 2022

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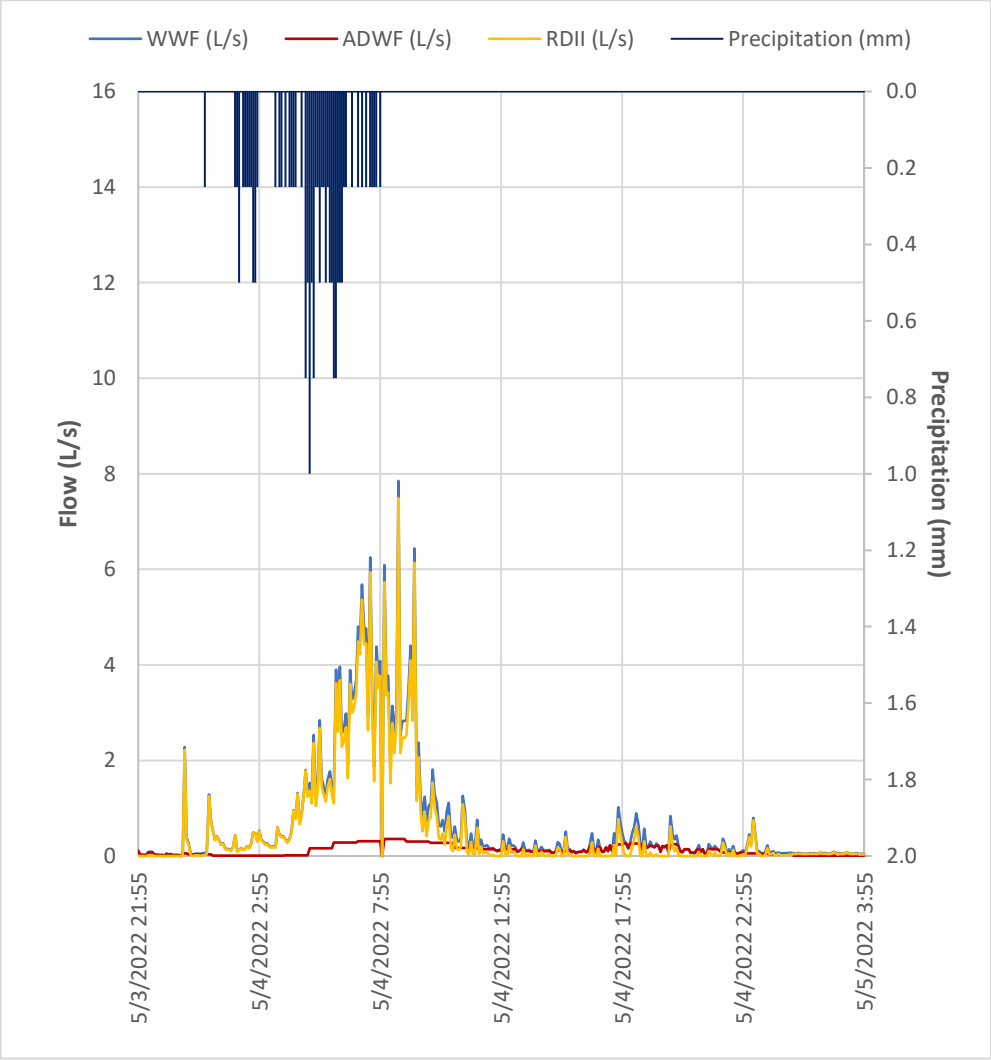
Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM027 — 2022-05-03



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	19	mm
Rainfall Duration	7	hr
Peak 1-hr Intensity	6	mm/hr
Peak 5-min Intensity	12	mm/hr

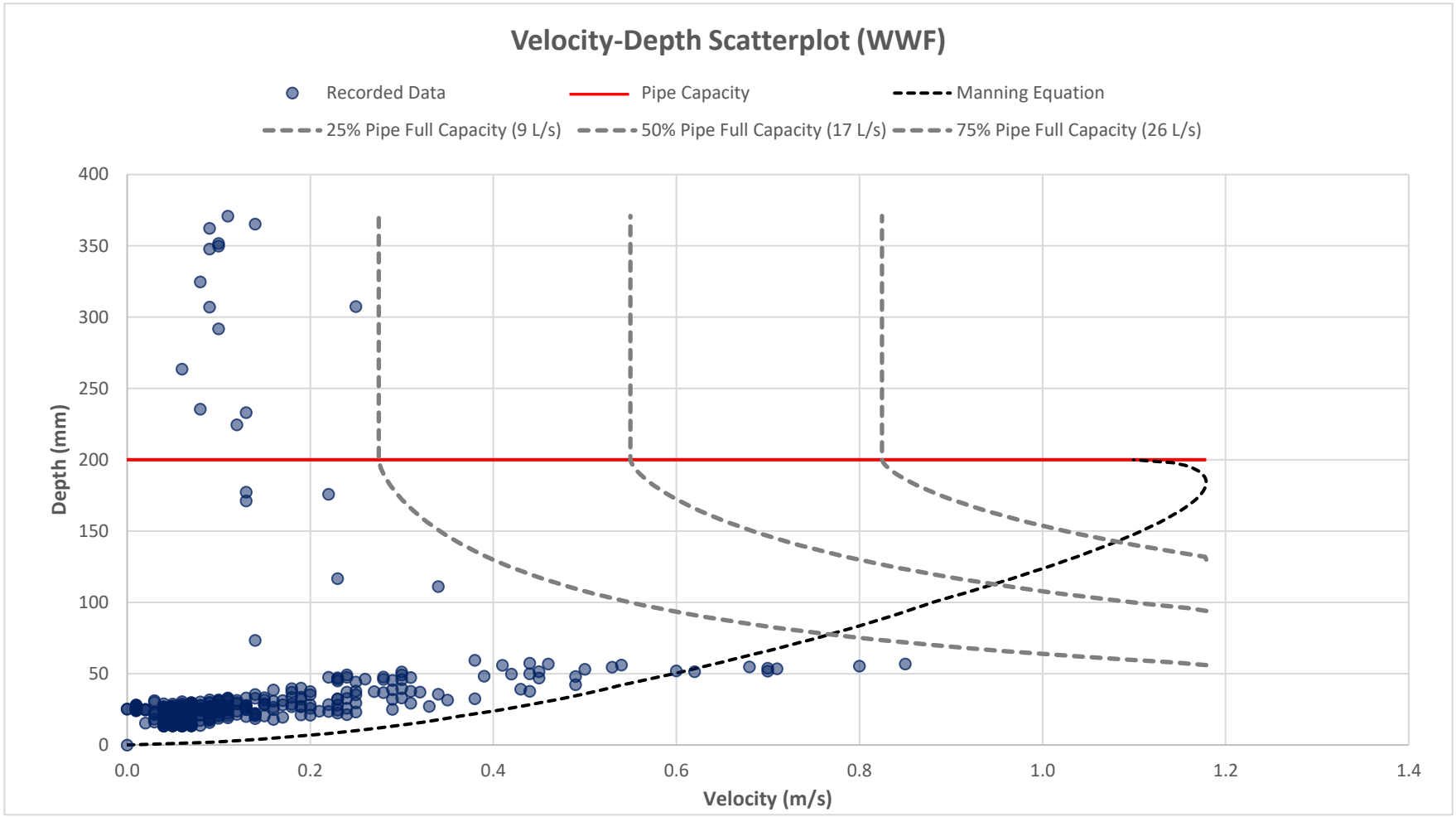
Monitored Area Statistics		
Catchment Area (ha)	4.4	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	5/3/2022 21:55	
End of Analysis	5/5/2022 3:55	
Peak Flow (PF)	7.850	L/s
Time of PF	5/4/2022 8:40	
DWF at Time of PF	0.357	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	7.493	L/s
Volume of RDII	63	m^3
Peak Unit RDII	1.71	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	7.76	%
WWF Vol./DWF Vol.	5.8	
PWWF/ADWF	64.9	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM027 — 2022-05-03



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.0042
Roughness Coefficient	0.008

Analysis Period: March 01, 2022 - June 16, 2022

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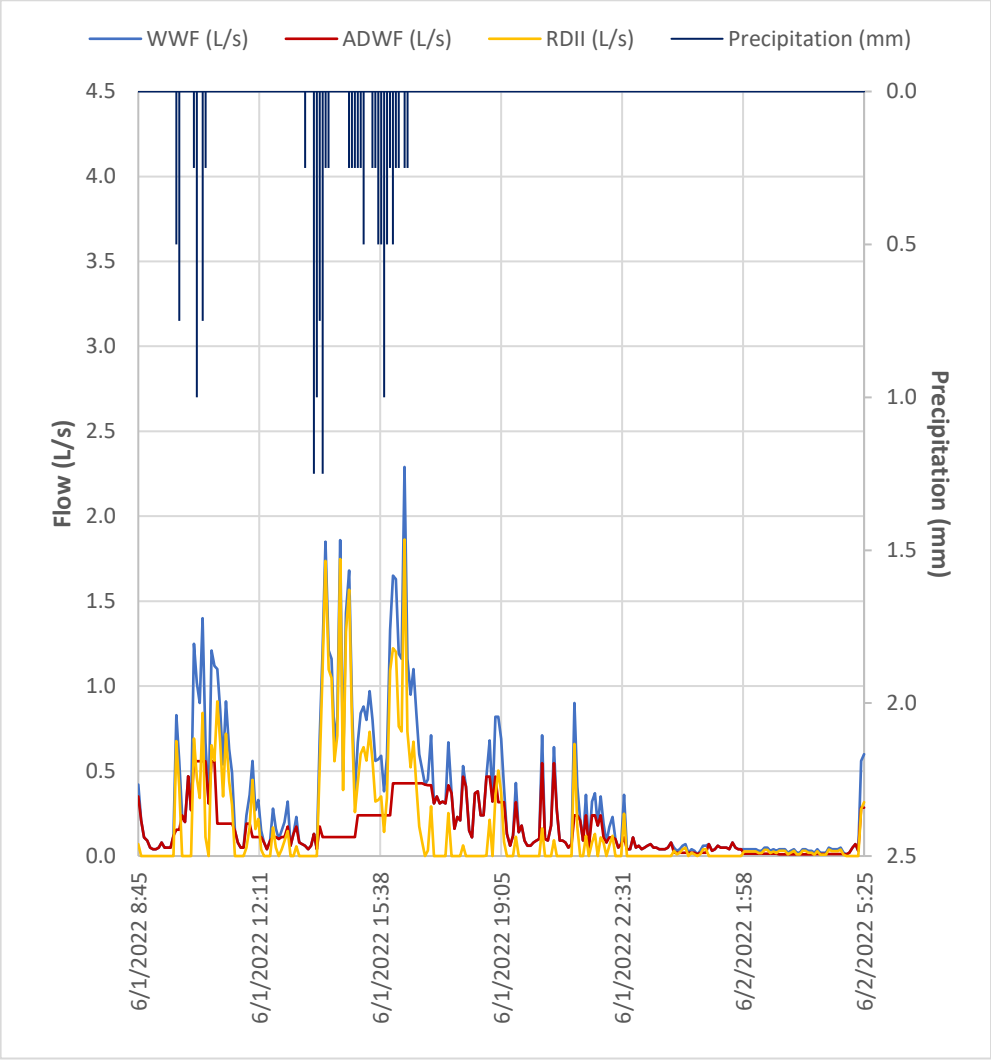
Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM027 — 2022-06-01



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	15	mm
Rainfall Duration	7	hr
Peak 1-hr Intensity	5	mm/hr
Peak 5-min Intensity	15	mm/hr

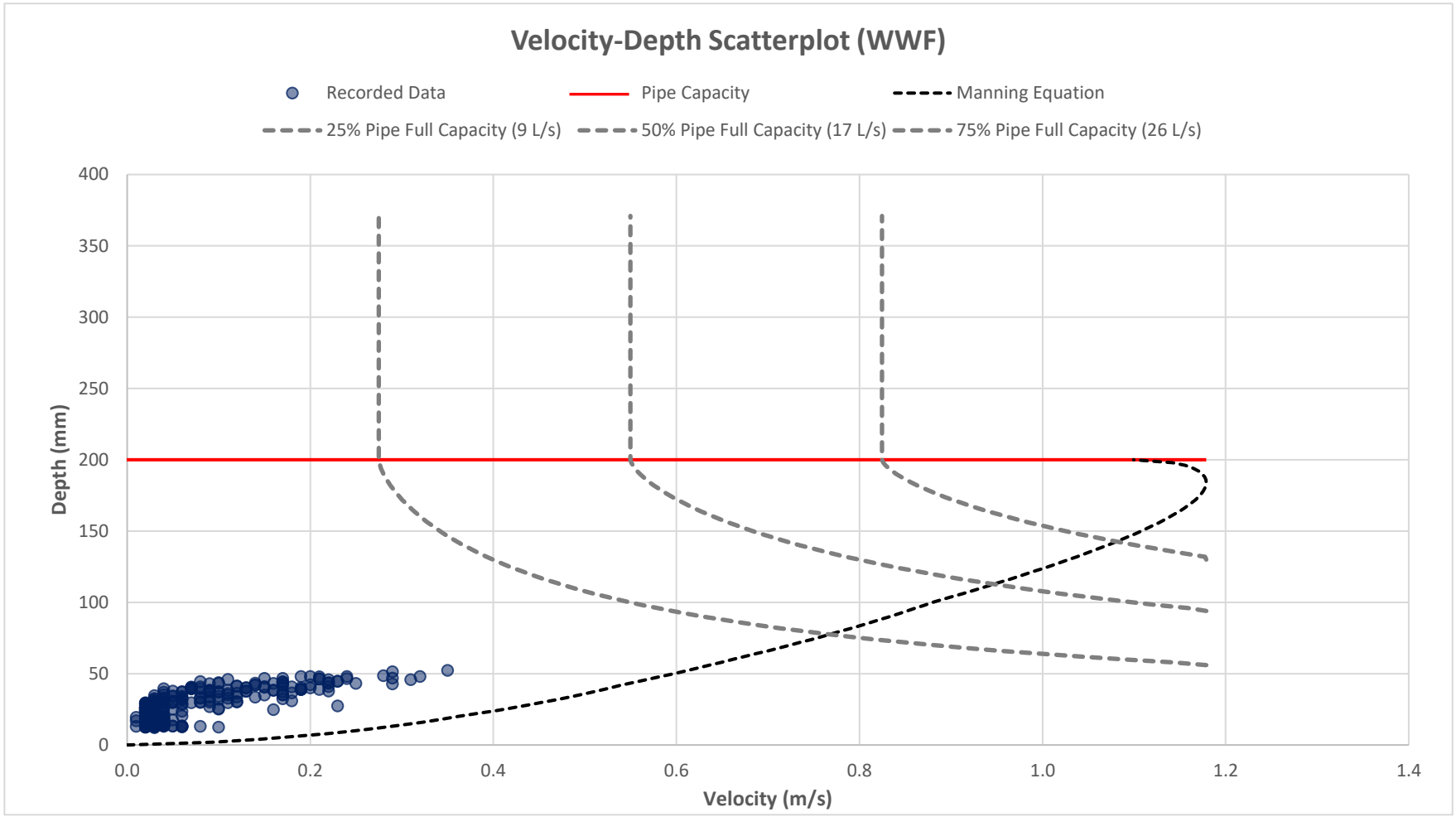
Monitored Area Statistics		
Catchment Area (ha)	4.4	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	6/1/2022 8:45	
End of Analysis	6/2/2022 5:25	
Peak Flow (PF)	2.290	L/s
Time of PF	6/1/2022 16:20	
DWF at Time of PF	0.427	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	1.863	L/s
Volume of RDII	13	m^3
Peak Unit RDII	0.42	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	1.97	%
WWF Vol./DWF Vol.	2.1	
PWWF/ADWF	14.8	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM027 — 2022-06-01



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.0042
Roughness Coefficient	0.008

Analysis Period: March 01, 2022 - June 16, 2022

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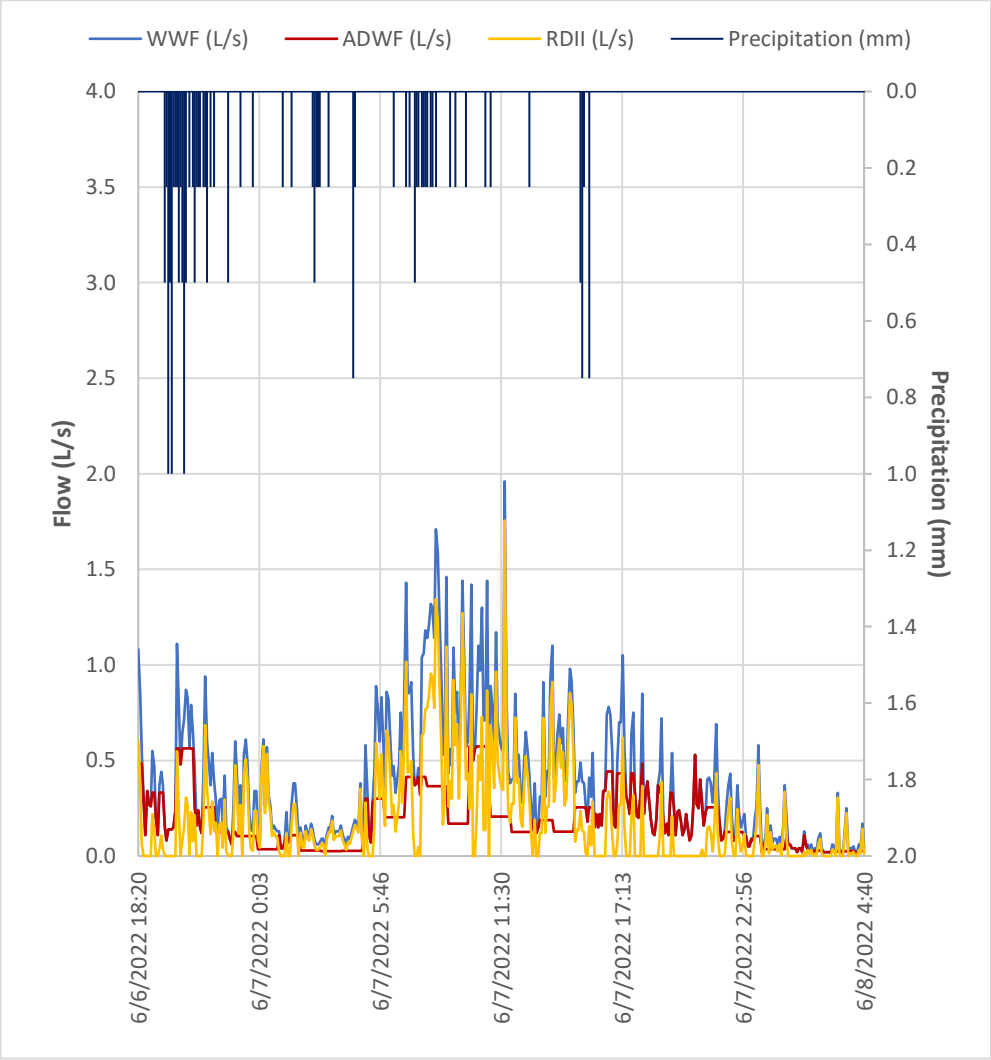
Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM027 — 2022-06-06



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	22	mm
Rainfall Duration	20	hr
Peak 1-hr Intensity	6	mm/hr
Peak 5-min Intensity	12	mm/hr

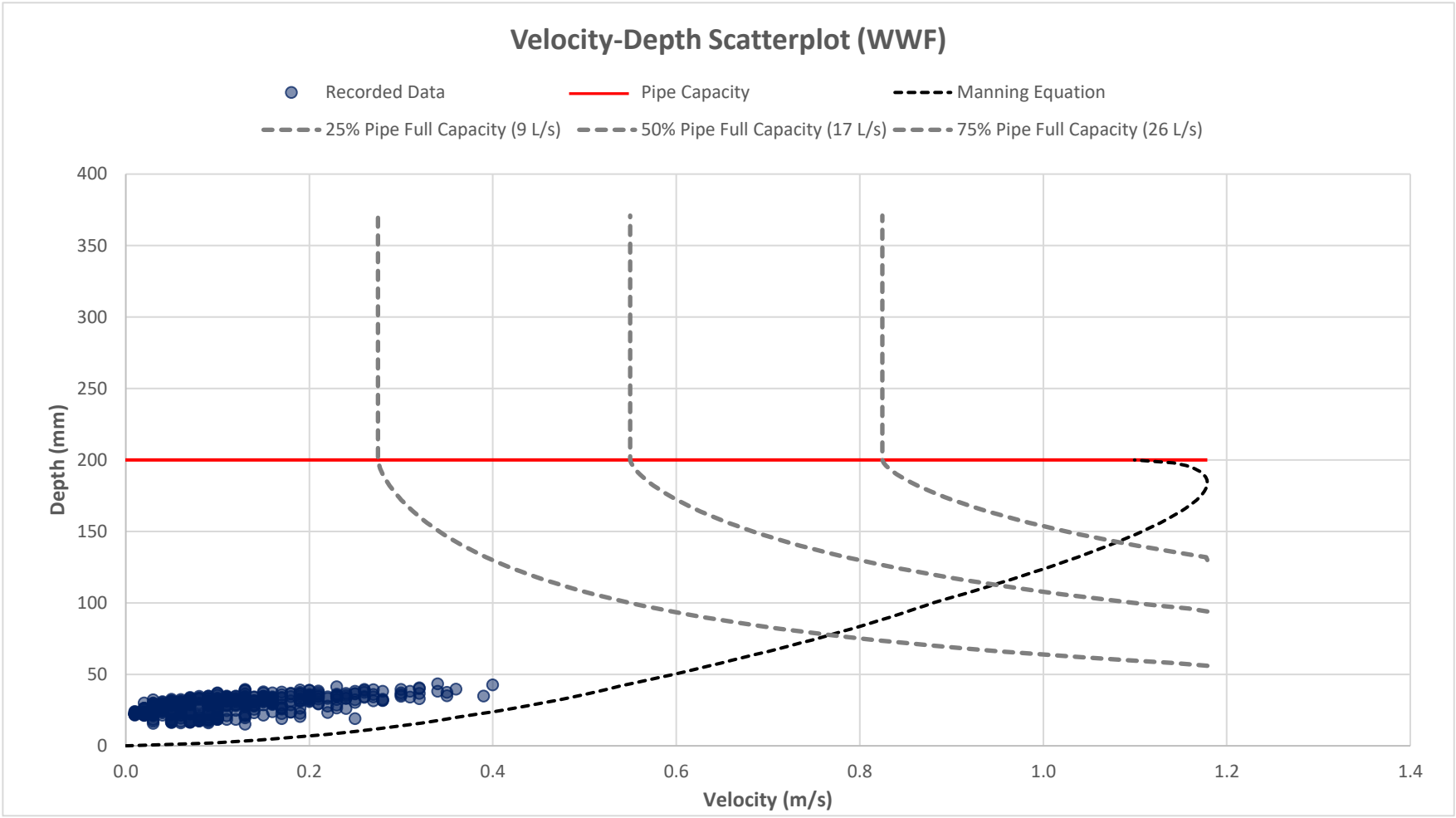
Monitored Area Statistics		
Catchment Area (ha)	4.4	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	6/6/2022 18:20	
End of Analysis	6/8/2022 4:40	
Peak Flow (PF)	1.960	L/s
Time of PF	6/7/2022 11:40	
DWF at Time of PF	0.205	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	1.755	L/s
Volume of RDII	25	m^3
Peak Unit RDII	0.40	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	2.60	%
WWF Vol./DWF Vol.	2.1	
PWWF/ADWF	10.6	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM027 — 2022-06-06



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.0042
Roughness Coefficient	0.008

Analysis Period: March 01, 2022 - June 16, 2022

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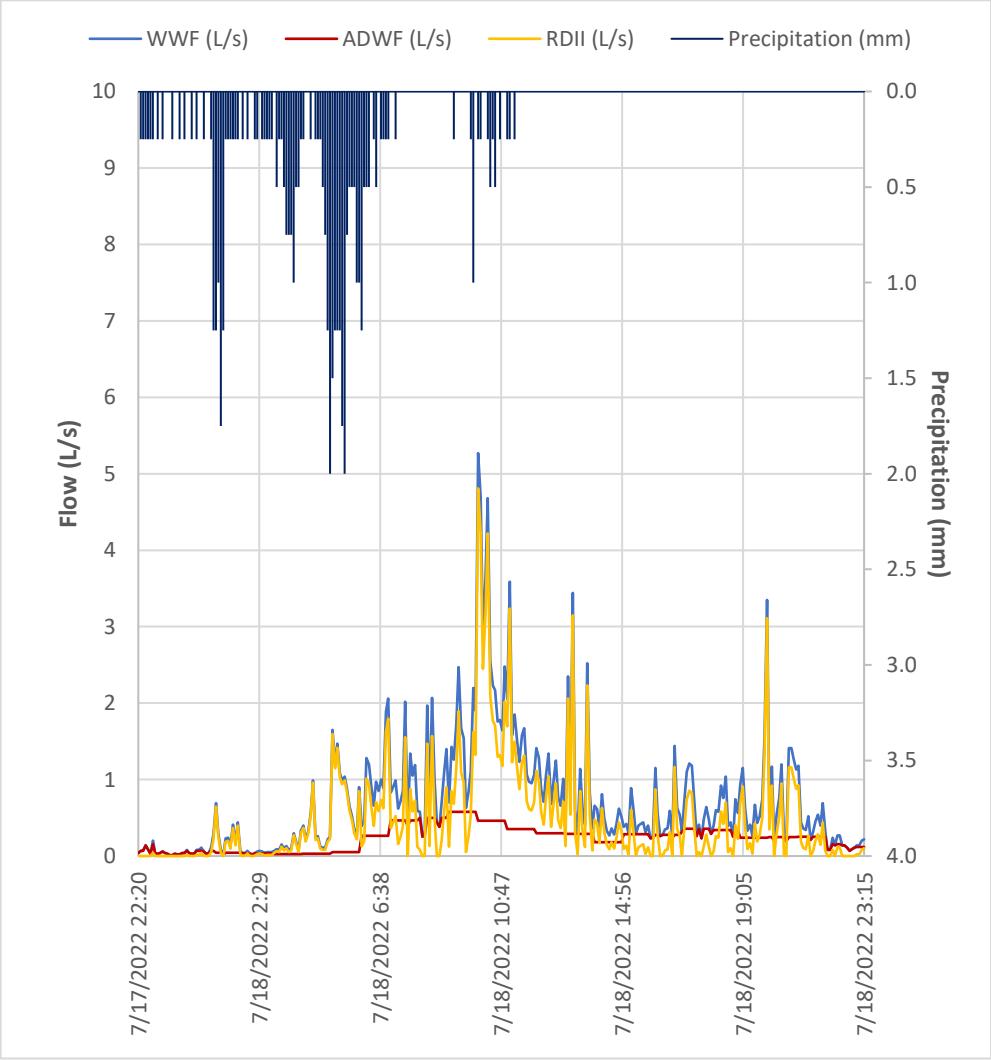
Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM027 — 2022-07-17



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	48	mm
Rainfall Duration	13	hr
Peak 1-hr Intensity	15	mm/hr
Peak 5-min Intensity	24	mm/hr

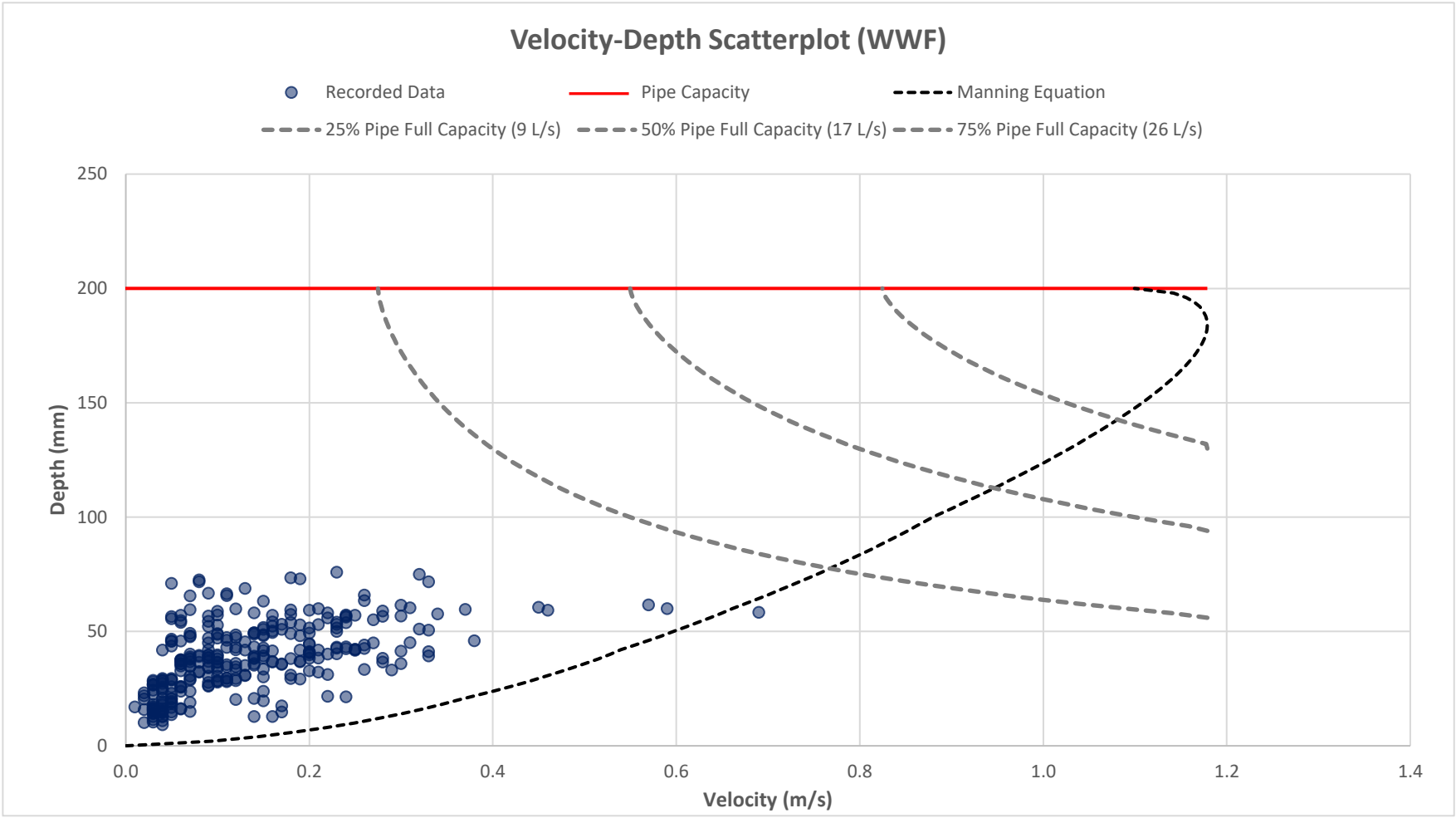
Monitored Area Statistics		
Catchment Area (ha)	4.4	ha
Total Pipe Surface Area (m^2)	278	m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	7/17/2022 22:20	
End of Analysis	7/18/2022 23:15	
Peak Flow (PF)	5.270	L/s
Time of PF	7/18/2022 10:00	
DWF at Time of PF	0.292	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	4.978	L/s
Volume of RDII	46	m^3
Peak Unit RDII	1.13	L/s/ha
Peak Unit RDII	17904.8796	$L/s/km^2$
Volumetric Coefficient	2.18	%
WWF Vol./DWF Vol.	3.5	
PWWF/ADWF	25.3	
Return Period at Tc		

Commentary:

Analysis Period: July 01, 2022 - July 31, 2022

Flow Monitor: FM027 2022-07-17



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.0042
Roughness Coefficient	0.008

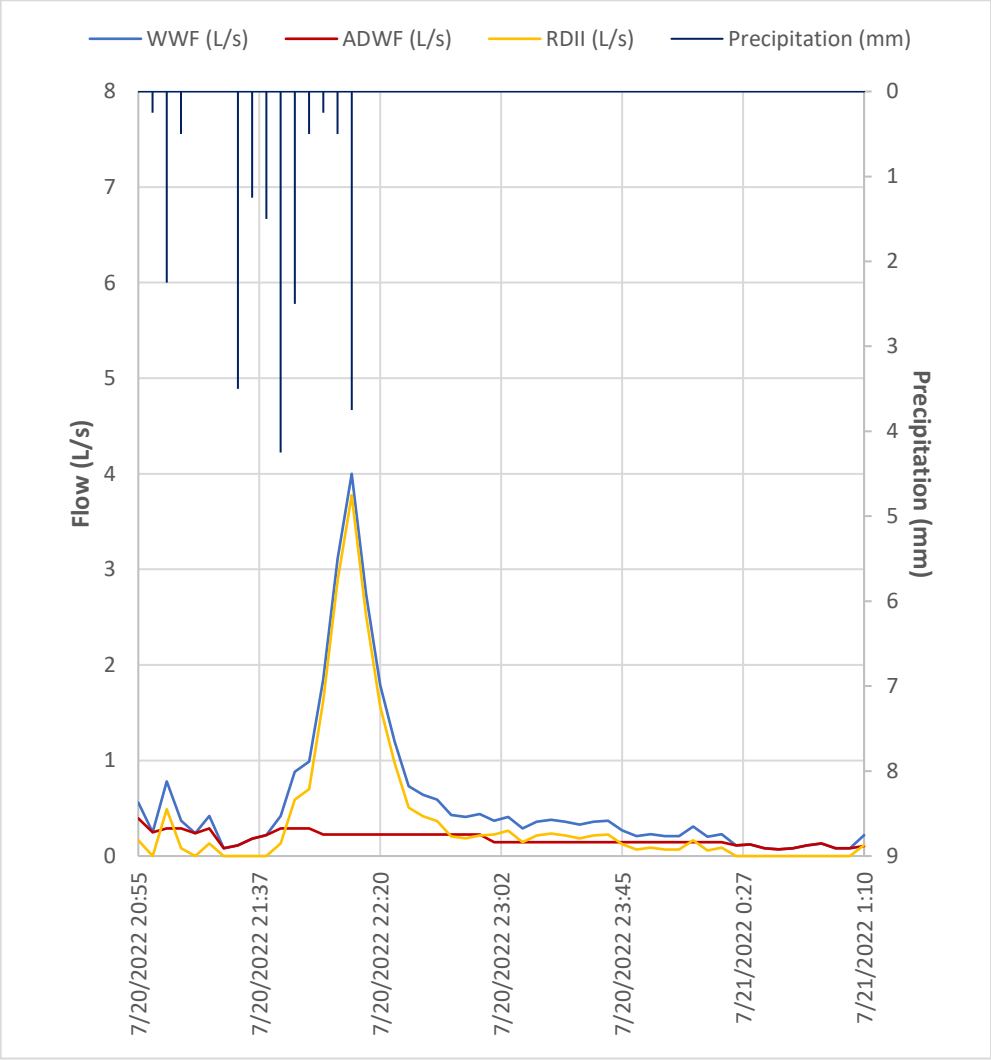
Analysis Period: July 01, 2022 - July 31, 2022

BluePlan ENGINEERING

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM027 — 2022-07-20



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	21	mm
Rainfall Duration	1	hr
Peak 1-hr Intensity	18	mm/hr
Peak 5-min Intensity	51	mm/hr

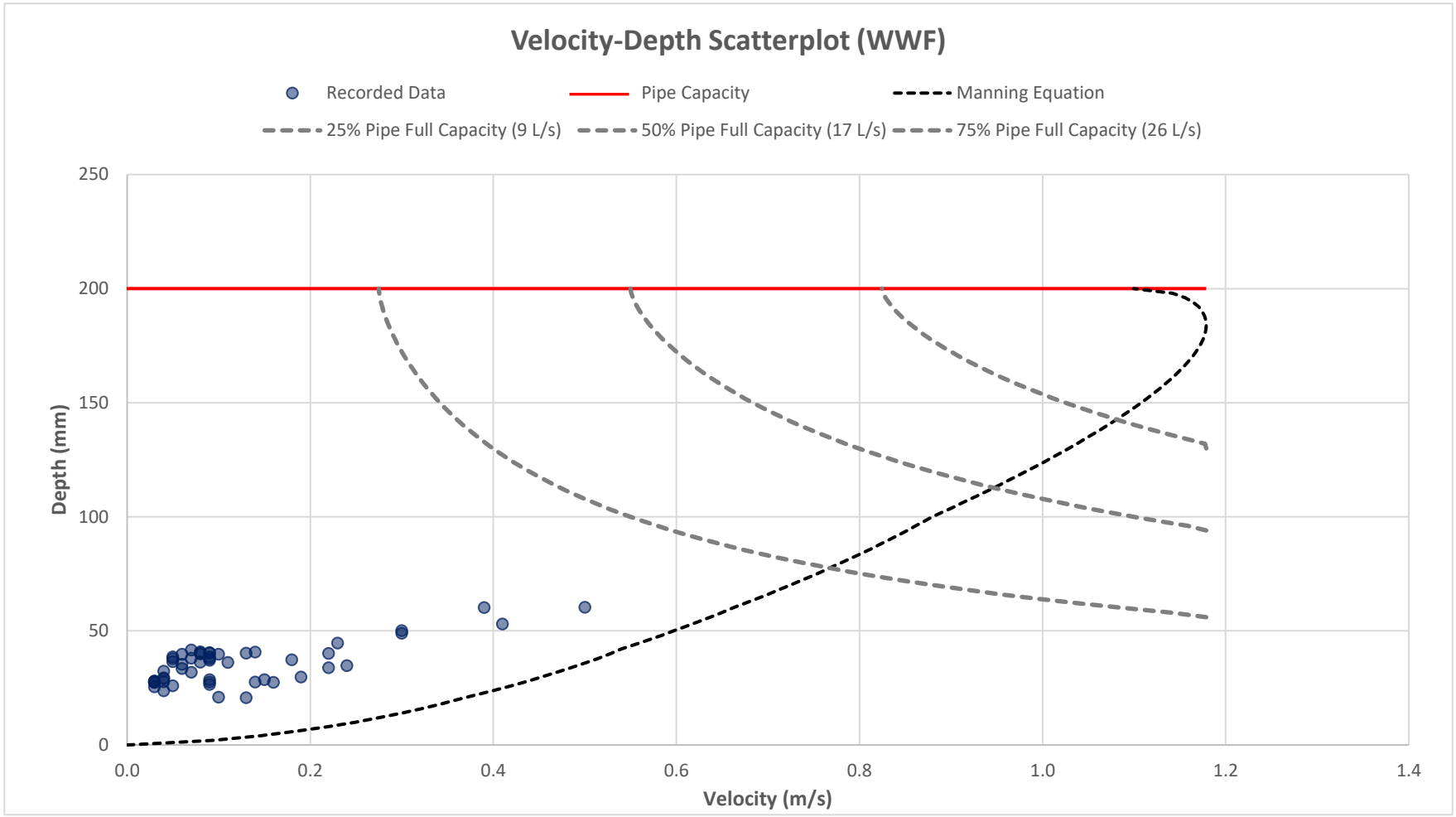
Monitored Area Statistics		
Catchment Area (ha)	4.4	ha
Total Pipe Surface Area (m^2)	278	m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	7/20/2022 20:55	
End of Analysis	7/21/2022 1:10	
Peak Flow (PF)	4.000	L/s
Time of PF	7/20/2022 22:10	
DWF at Time of PF	0.224	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	3.776	L/s
Volume of RDII	6	m^3
Peak Unit RDII	0.86	L/s/ha
Peak Unit RDII	13581.3895	$L/s/km^2$
Volumetric Coefficient	0.66	%
WWF Vol./DWF Vol.	3.2	
PWWF/ADWF	22.4	
Return Period at Tc		

Commentary:

Analysis Period: July 01, 2022 - July 31, 2022

Flow Monitor: FM027 — 2022-07-20



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.0042
Roughness Coefficient	0.008

Analysis Period: July 01, 2022 - July 31, 2022

BluePlan ENGINEERING

Flow Monitor IDs

Name	Alias
FM028	AngelaCres_FM028

Install Pipe Specifications

Sewer System	Measured Pipe Size (mm)	GIS Pipe Size (mm)	Associated Rain Gauge
Sanitary	200	200	RoN_RG14

Catchment Specifications

Catchment Area (ha)	Pipe Surface Area (m^2)	Population	Catchment Tc
12.3	1,344	605	

SSEA Specifications

SSEA Area (ha)

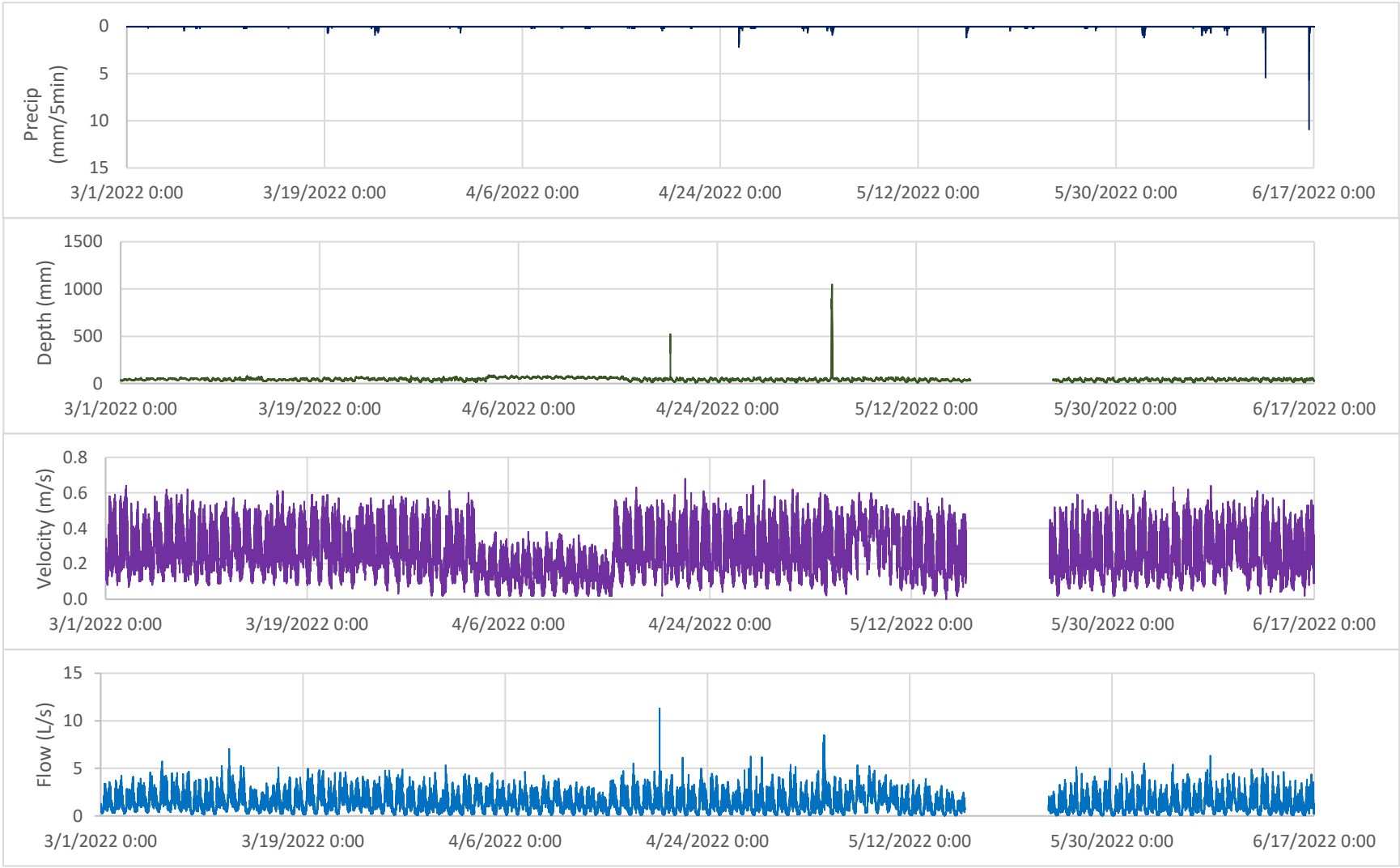
This report summarizes the flow analysis outputs for the following reporting period:
Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028

From: March 01, 2022 To: June 16, 2022



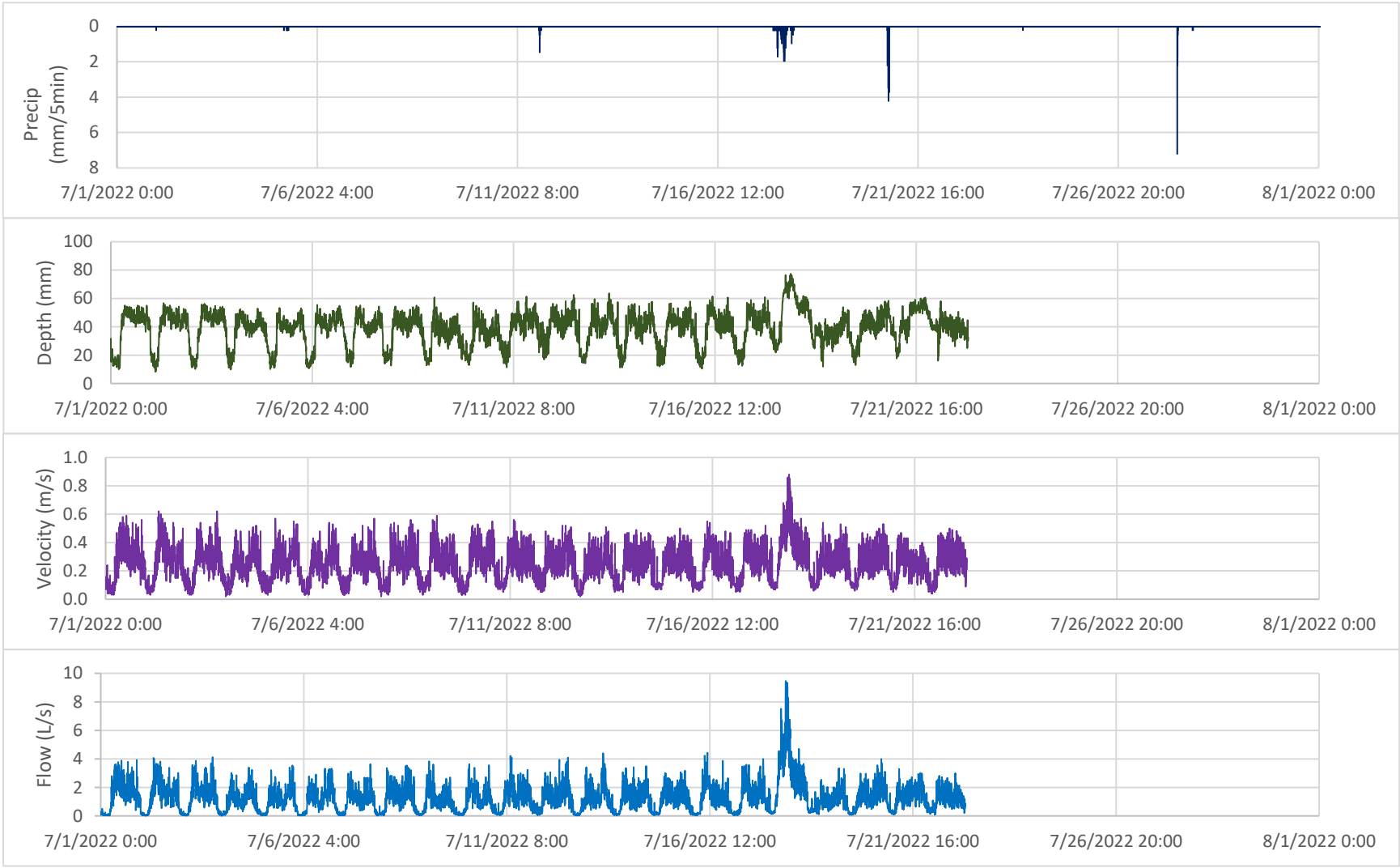
Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028

From: July 01, 2022 To: July 31, 2022



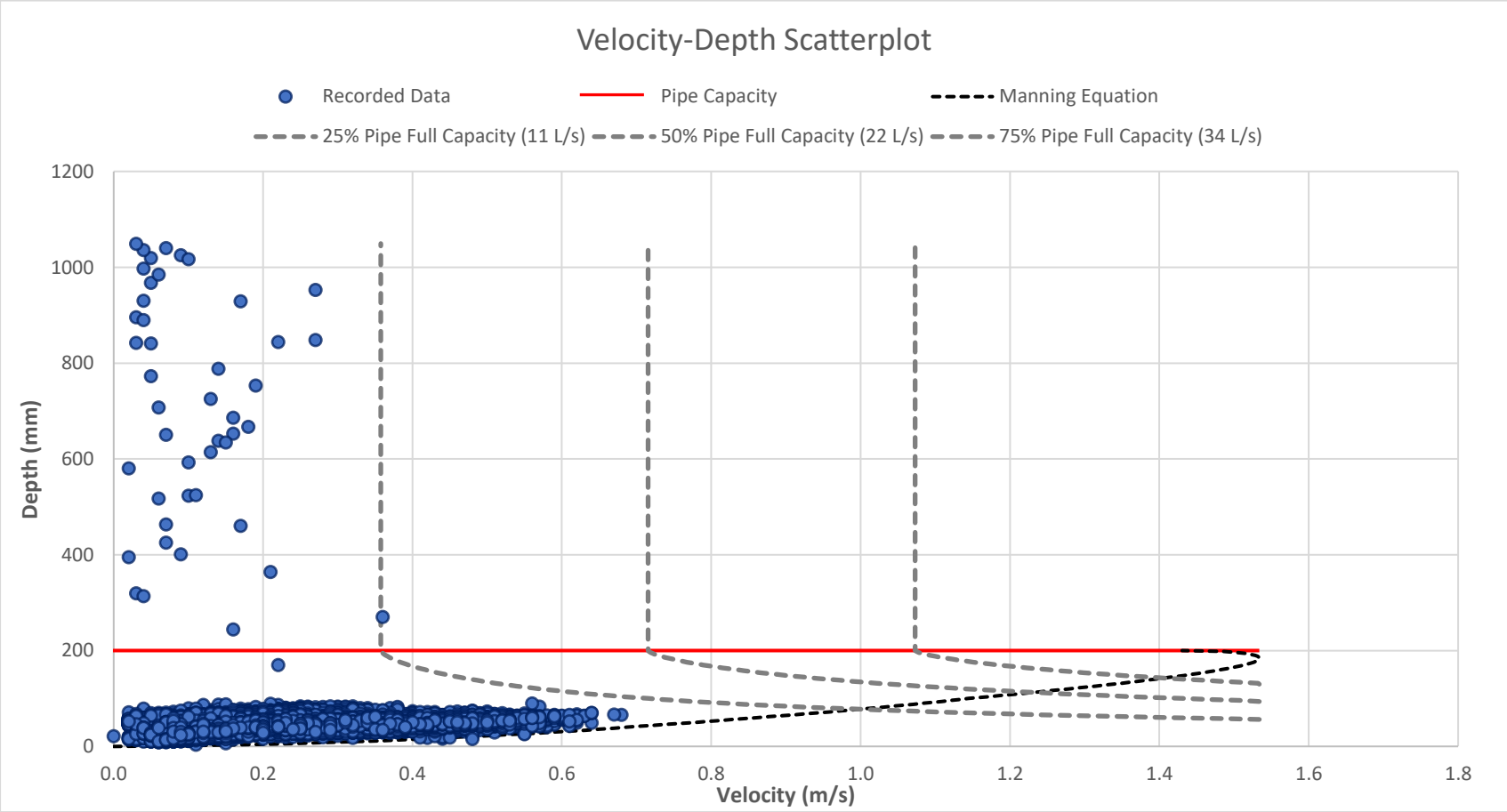
Analysis Period: July 01, 2022 - July 31, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028

From: March 01, 2022 To: June 16, 2022



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.004
Roughness Coefficient	0.006

Commentary

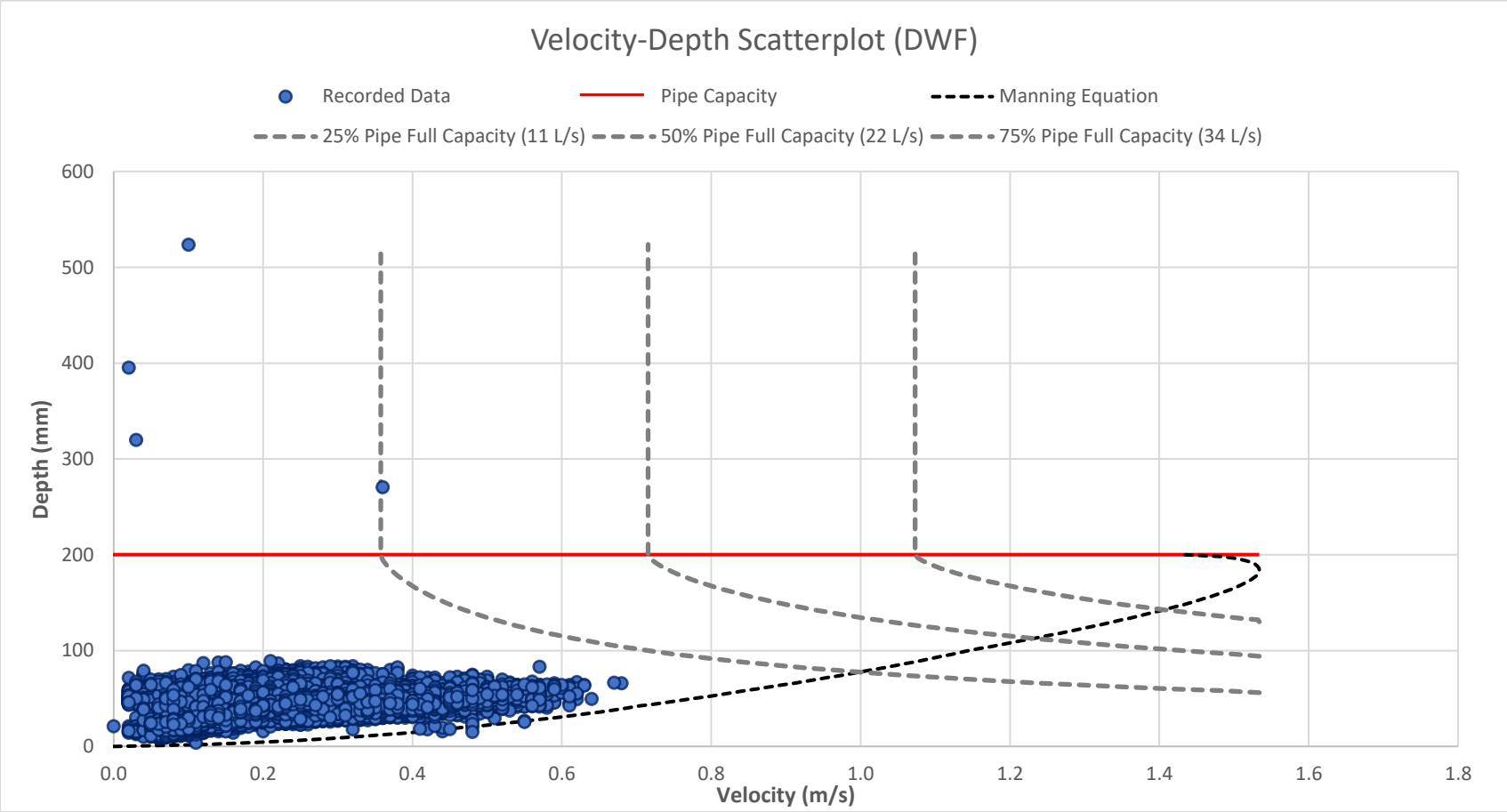
Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028

From: March 01, 2022 To: June 15, 2022



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.004
Roughness Coefficient	0.006

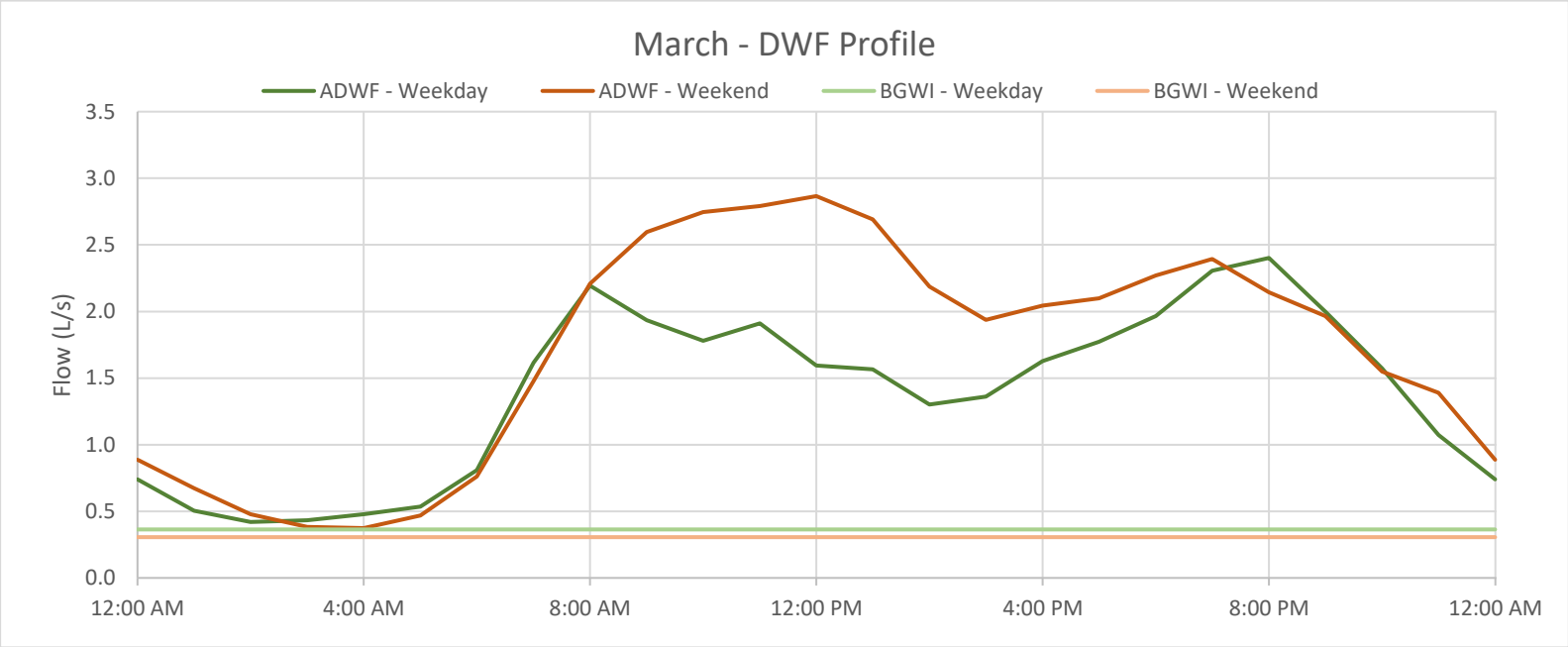
Commentary

Analysis Period: March 01, 2022 - June 15, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028 — March 2022



Dry Weather Flow Statistics			
Variable	Weekday	Weekend	Units
ADWF	1.4	1.7	L/s
MDWF	0.4	0.4	L/s
BGWI	0.4	0.3	L/s
Unit BGWI	0.03	0.02	L/s/ha
Unit BGWI			L/s/km^2
Sanitary Flow	1.0	1.4	L/s
Per Capita Sanitary Flow (model)			L/cap/day
Per Capita Sanitary Flow (DC)			L/cap/day
PDWF	2.4	2.9	L/s
BGWI/ADWF	25.77	17.75	%
Average d/D	20.68	22.56	%

Catchment Specifications

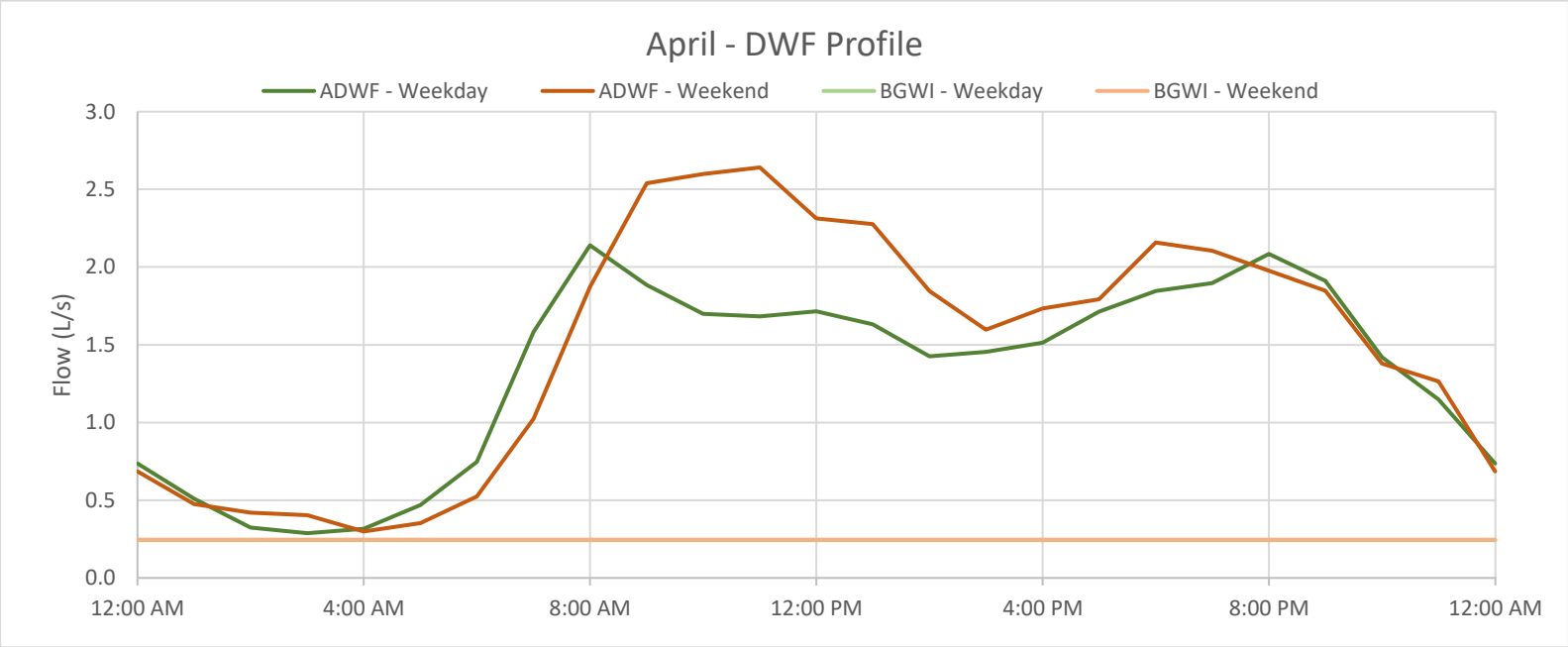
Catchment Area (ha)	12.3
Total Pipe Surface Area (m^2)	1,344
Population	605

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028 — April 2022



Dry Weather Flow Statistics			
Variable	Weekday	Weekend	Units
ADWF	1.3	1.5	L/s
MDWF	0.3	0.3	L/s
BGWI	0.2	0.2	L/s
Unit BGWI	0.02	0.02	L/s/ha
Unit BGWI			$L/s/km^2$
Sanitary Flow	1.1	1.3	L/s
Per Capita Sanitary Flow (model)			L/cap/day
Per Capita Sanitary Flow (DC)			L/cap/day
PDWF	2.1	2.6	L/s
BGWI/ADWF	18.14	16.36	%
Average d/D	26.94	25.79	%

Catchment Specifications

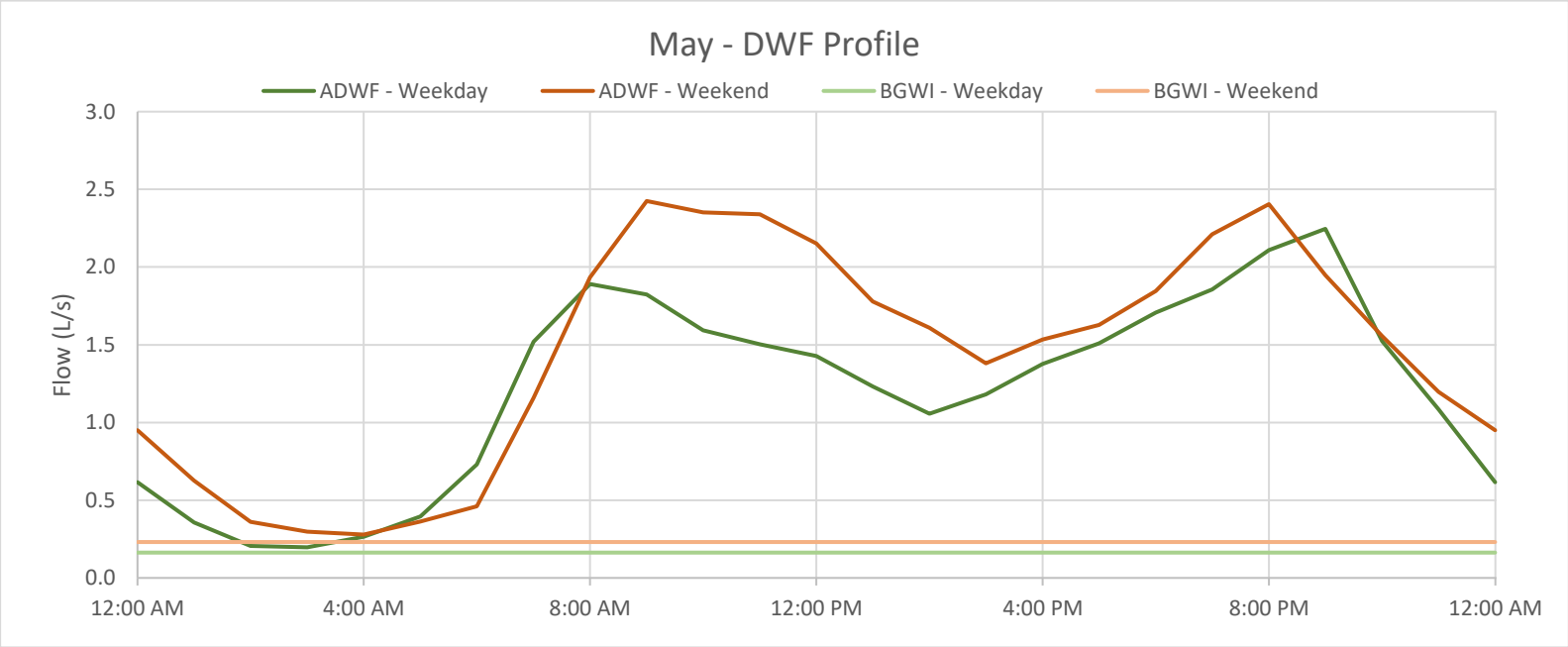
Catchment Area (ha)	12.3
Total Pipe Surface Area (m^2)	1,344
Population	605

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028 — May 2022



Dry Weather Flow Statistics			
Variable	Weekday	Weekend	Units
ADWF	1.2	1.5	L/s
MDWF	0.2	0.3	L/s
BGWI	0.2	0.2	L/s
Unit BGWI	0.01	0.02	L/s/ha
Unit BGWI			$L/s/km^2$
Sanitary Flow	1.1	1.2	L/s
Per Capita Sanitary Flow (model)			L/cap/day
Per Capita Sanitary Flow (DC)			L/cap/day
PDWF	2.2	2.4	L/s
BGWI/ADWF	13.33	15.90	%
Average d/D	18.75	19.03	%

Catchment Specifications

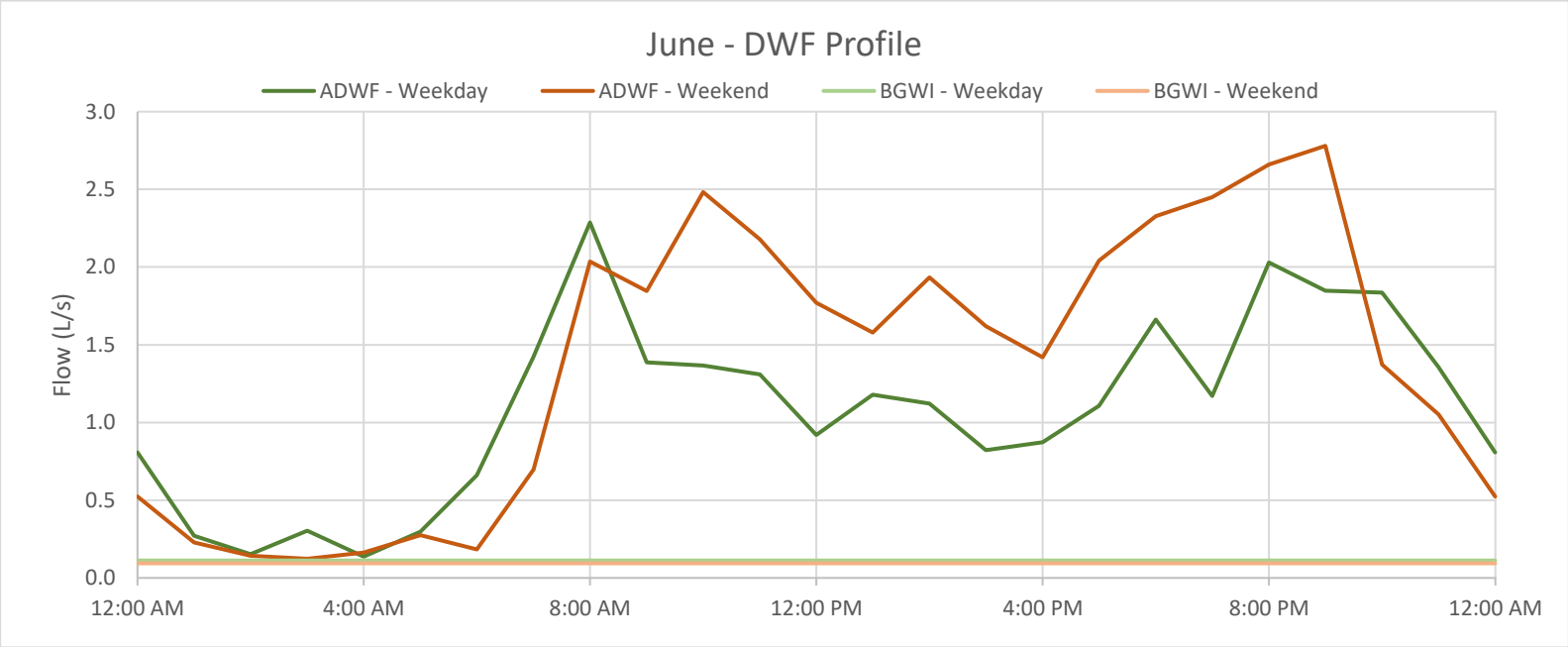
Catchment Area (ha)	12.3
Total Pipe Surface Area (m^2)	1,344
Population	605

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028 — June 2022



Dry Weather Flow Statistics			
Variable	Weekday	Weekend	Units
ADWF	1.1	1.4	L/s
MDWF	0.1	0.1	L/s
BGWI	0.1	0.1	L/s
Unit BGWI	0.01	0.01	L/s/ha
Unit BGWI			$L/s/km^2$
Sanitary Flow	1.0	1.3	L/s
Per Capita Sanitary Flow (model)			L/cap/day
Per Capita Sanitary Flow (DC)			L/cap/day
PDWF	2.3	2.8	L/s
BGWI/ADWF	10.23	6.69	%
Average d/D	18.67	19.90	%

Catchment Specifications

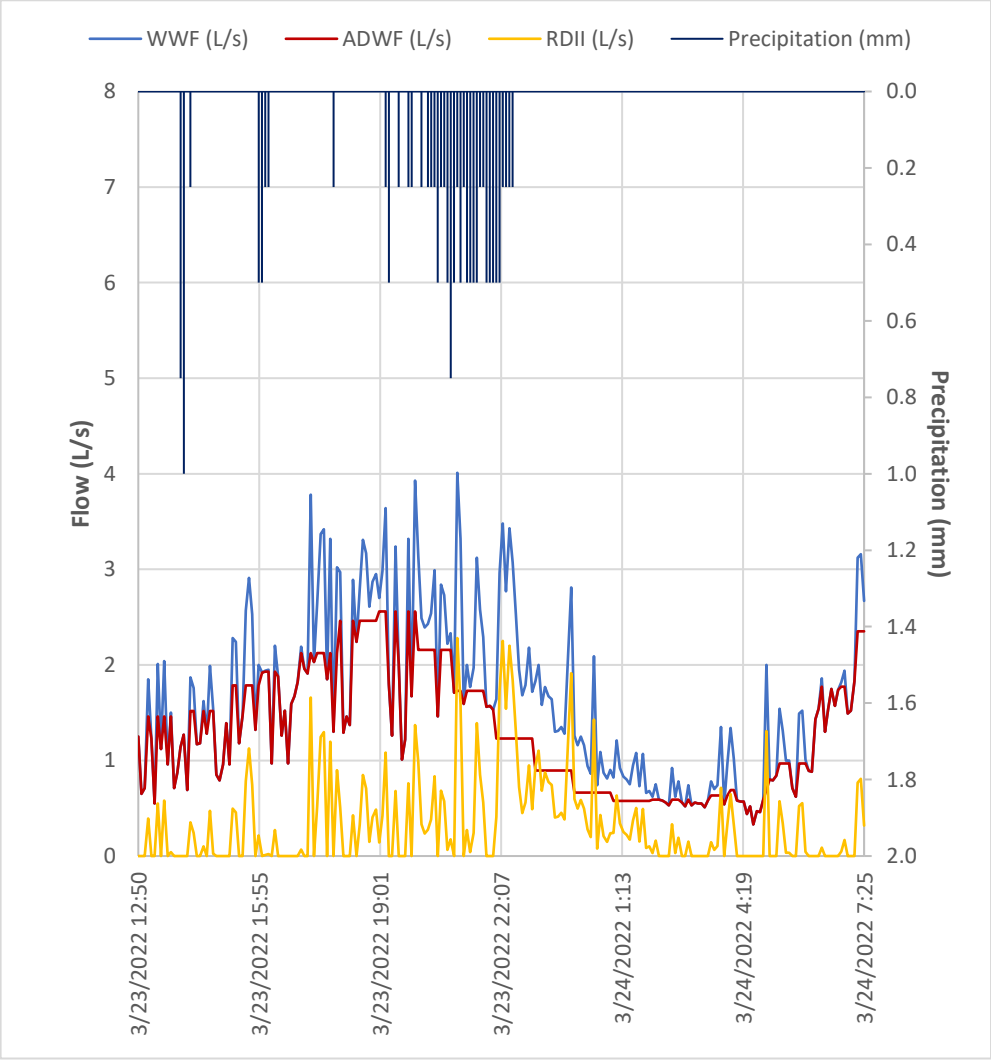
Catchment Area (ha)	12.3
Total Pipe Surface Area (m^2)	1,344
Population	605

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028 — 2022-03-23



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	16	mm
Rainfall Duration	9	hr
Peak 1-hr Intensity	5	mm/hr
Peak 5-min Intensity	12	mm/hr

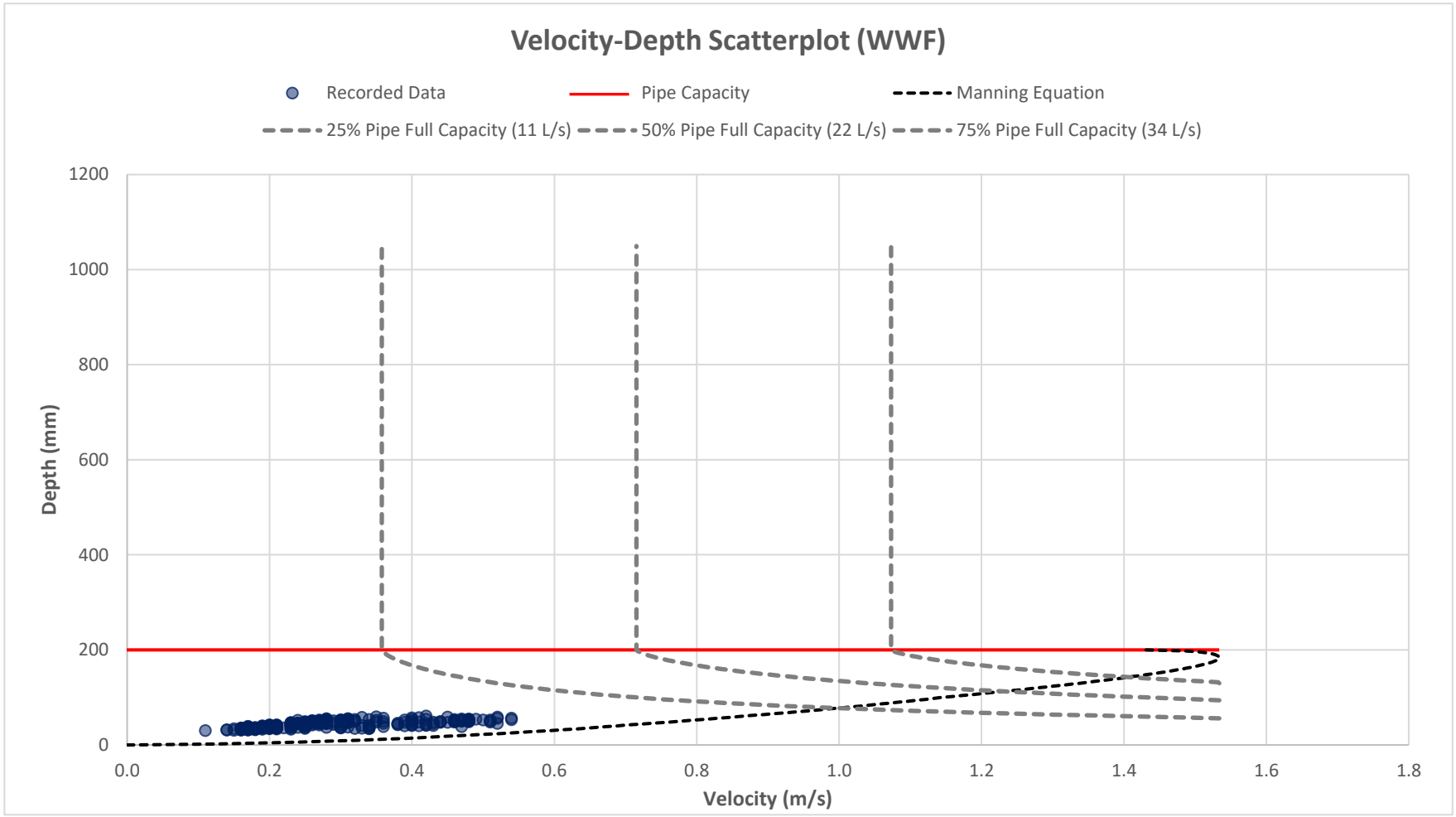
Monitored Area Statistics		
Catchment Area (ha)	12.3	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	3/23/2022 12:50	
End of Analysis	3/24/2022 7:25	
Peak Flow (PF)	4.010	L/s
Time of PF	3/23/2022 21:00	
DWF at Time of PF	1.729	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	2.281	L/s
Volume of RDII	23	m^3
Peak Unit RDII	0.19	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	1.16	%
WWF Vol./DWF Vol.	1.3	
PWWF/ADWF	3.1	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM028 — 2022-03-23



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.004
Roughness Coefficient	0.006

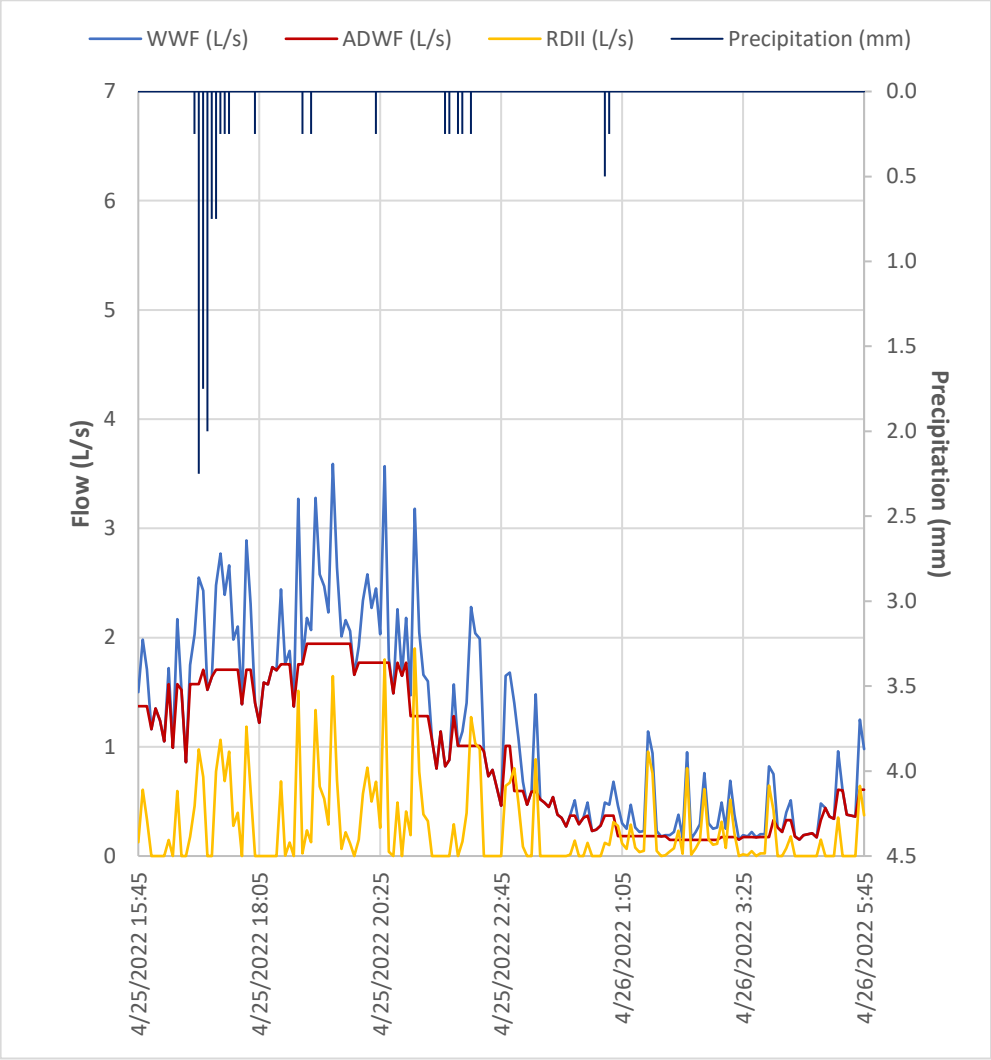
Analysis Period: March 01, 2022 - June 16, 2022

BluePlan ENGINEERING

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028 — 2022-04-25



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	12	mm
Rainfall Duration	8	hr
Peak 1-hr Intensity	9	mm/hr
Peak 5-min Intensity	27	mm/hr

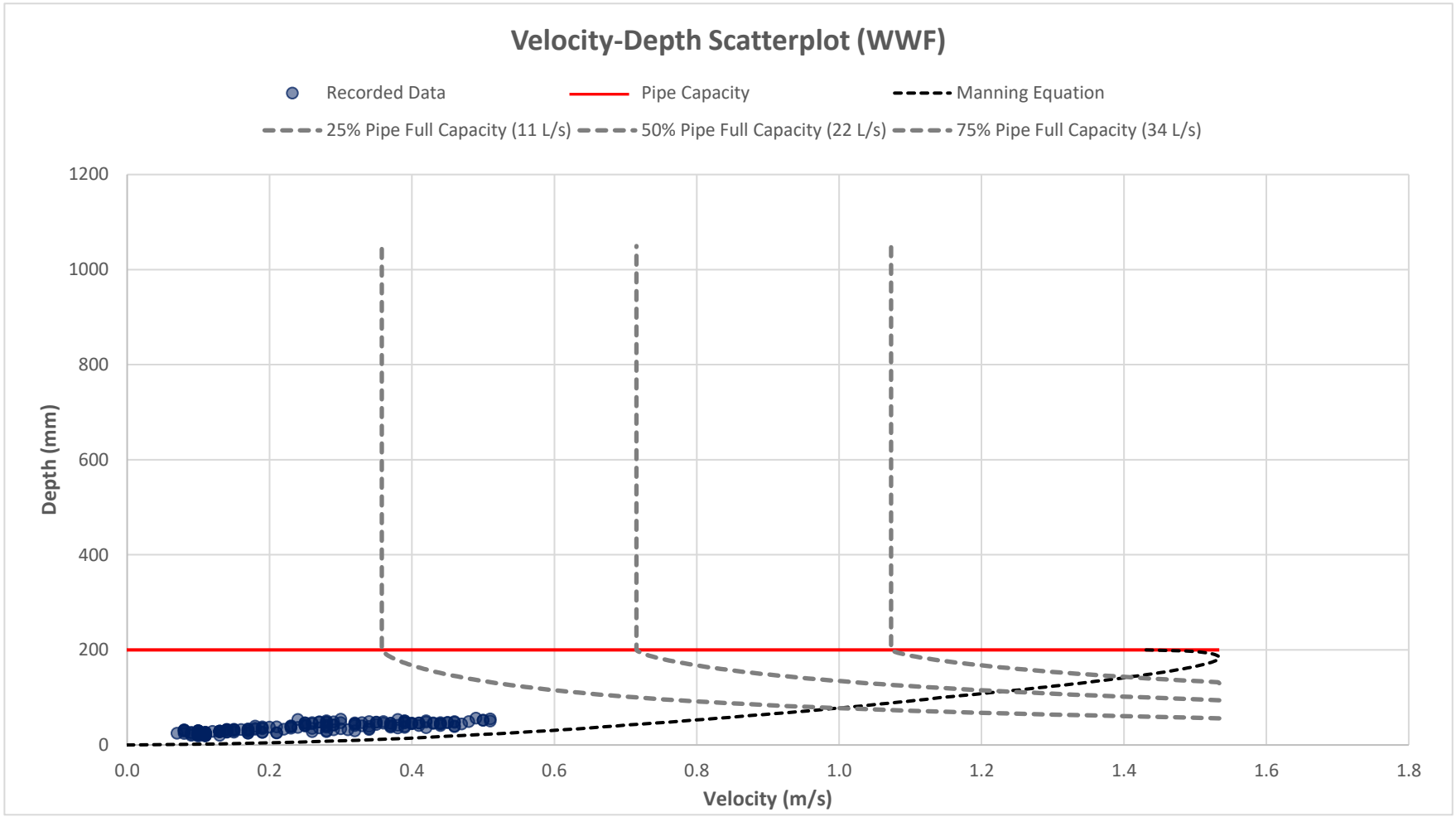
Monitored Area Statistics		
Catchment Area (ha)	12.3	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	4/25/2022 15:45	
End of Analysis	4/26/2022 5:45	
Peak Flow (PF)	3.590	L/s
Time of PF	4/25/2022 19:30	
DWF at Time of PF	1.944	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	1.900	L/s
Volume of RDII	14	m^3
Peak Unit RDII	0.15	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	0.96	%
WWF Vol./DWF Vol.	1.3	
PWWF/ADWF	4.0	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM028 2022-04-25



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.004
Roughness Coefficient	0.006

Analysis Period: March 01, 2022 - June 16, 2022

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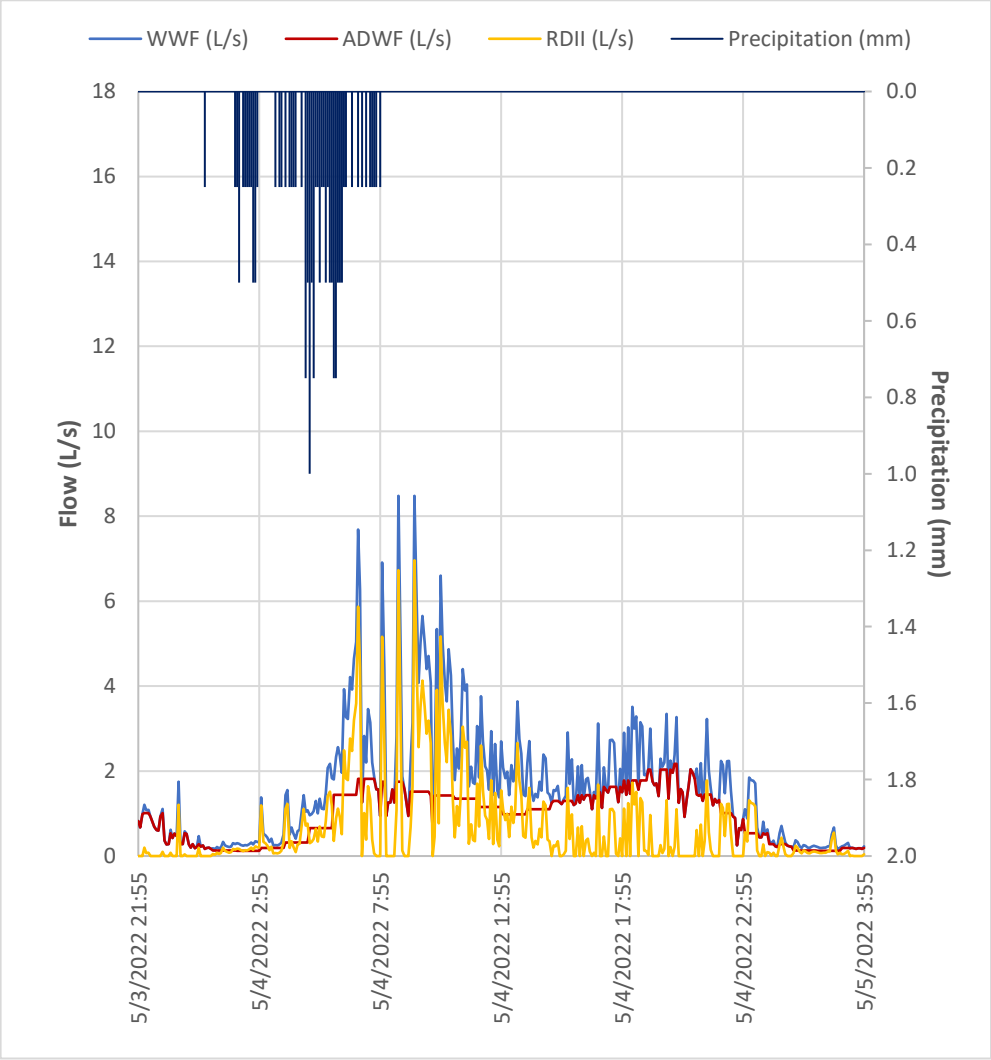
Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028 — 2022-05-03



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	19	mm
Rainfall Duration	7	hr
Peak 1-hr Intensity	6	mm/hr
Peak 5-min Intensity	12	mm/hr

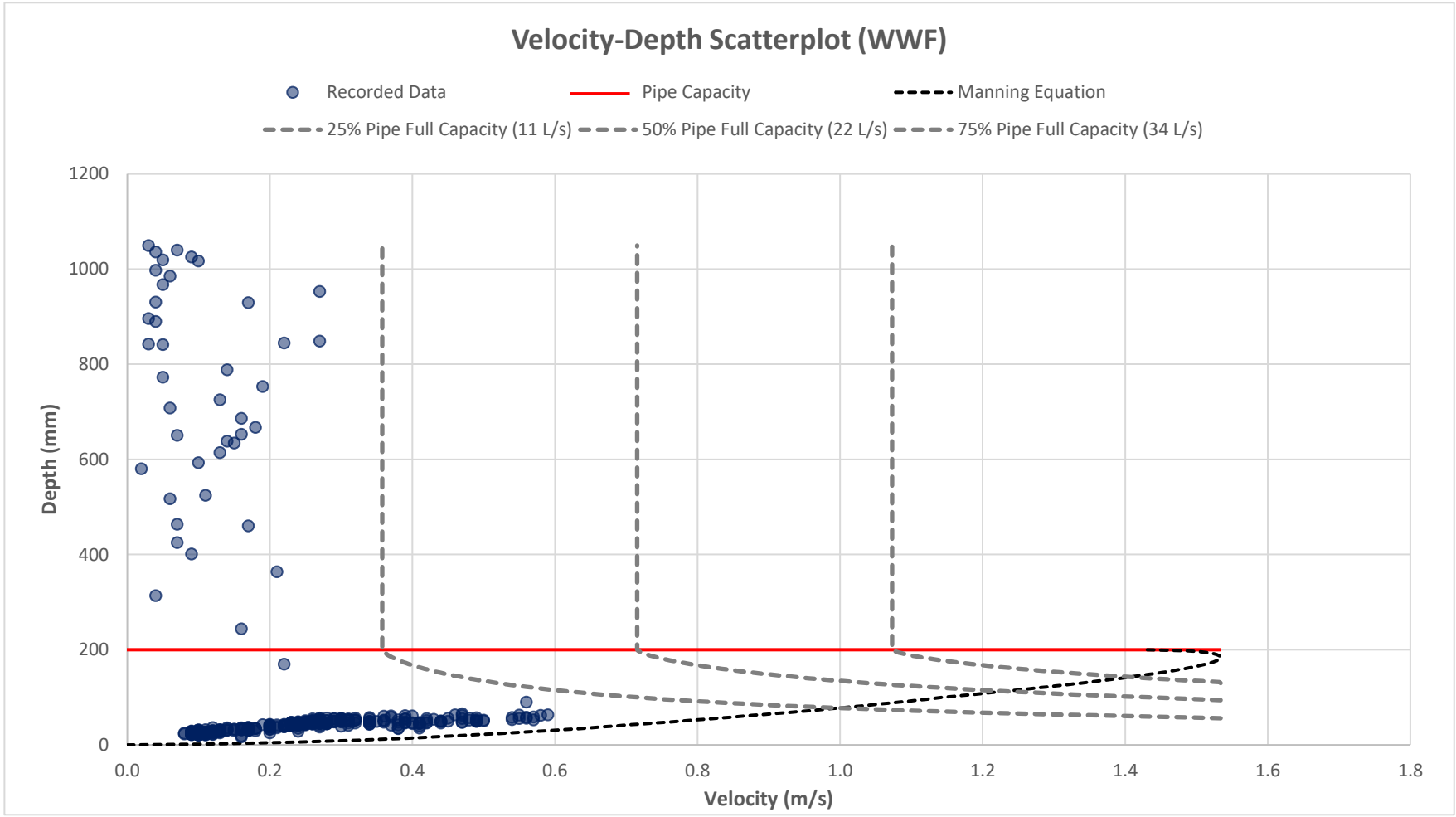
Monitored Area Statistics		
Catchment Area (ha)	12.3	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	5/3/2022 21:55	
End of Analysis	5/5/2022 3:55	
Peak Flow (PF)	8.480	L/s
Time of PF	5/4/2022 8:40	
DWF at Time of PF	1.749	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	6.962	L/s
Volume of RDII	72	m^3
Peak Unit RDII	0.57	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	3.17	%
WWF Vol./DWF Vol.	1.7	
PWWF/ADWF	9.2	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM028 — 2022-05-03



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.004
Roughness Coefficient	0.006

Analysis Period: March 01, 2022 - June 16, 2022

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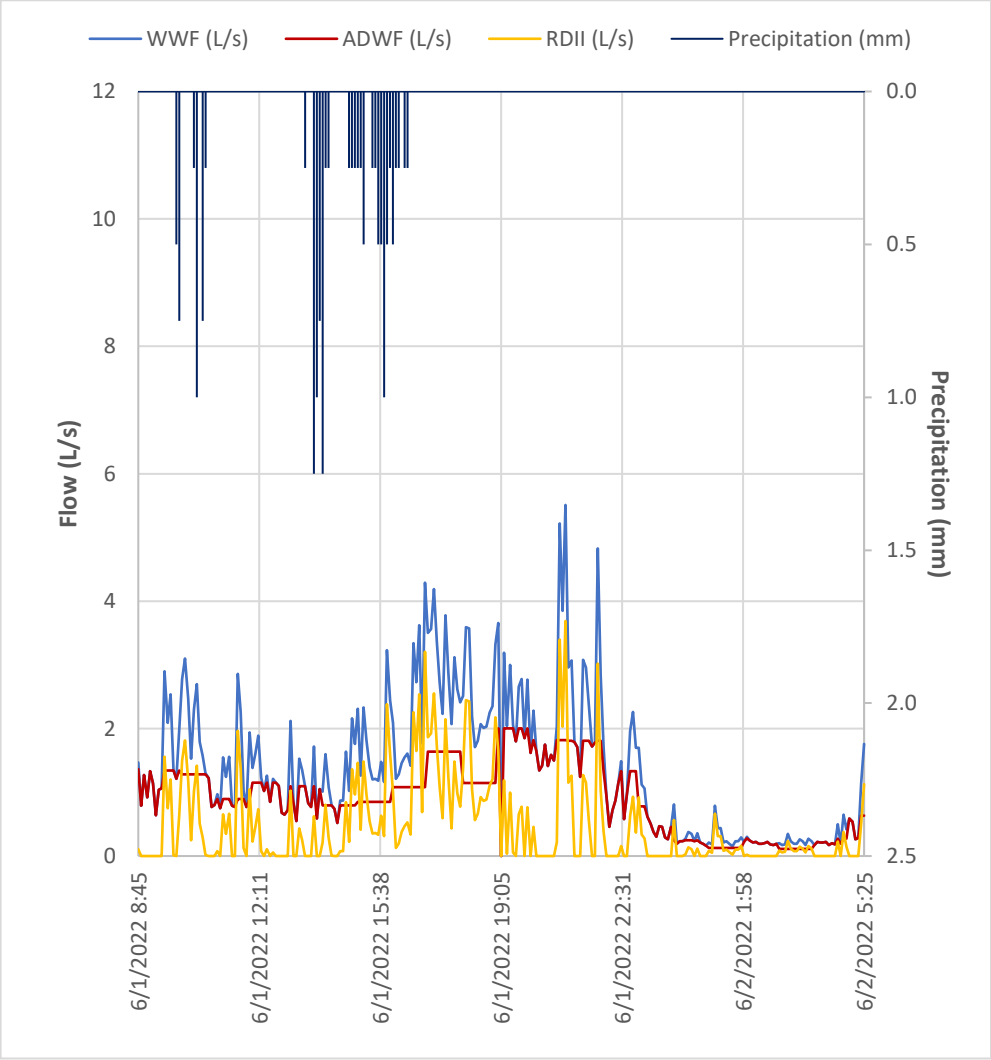
Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028 — 2022-06-01



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	15	mm
Rainfall Duration	7	hr
Peak 1-hr Intensity	5	mm/hr
Peak 5-min Intensity	15	mm/hr

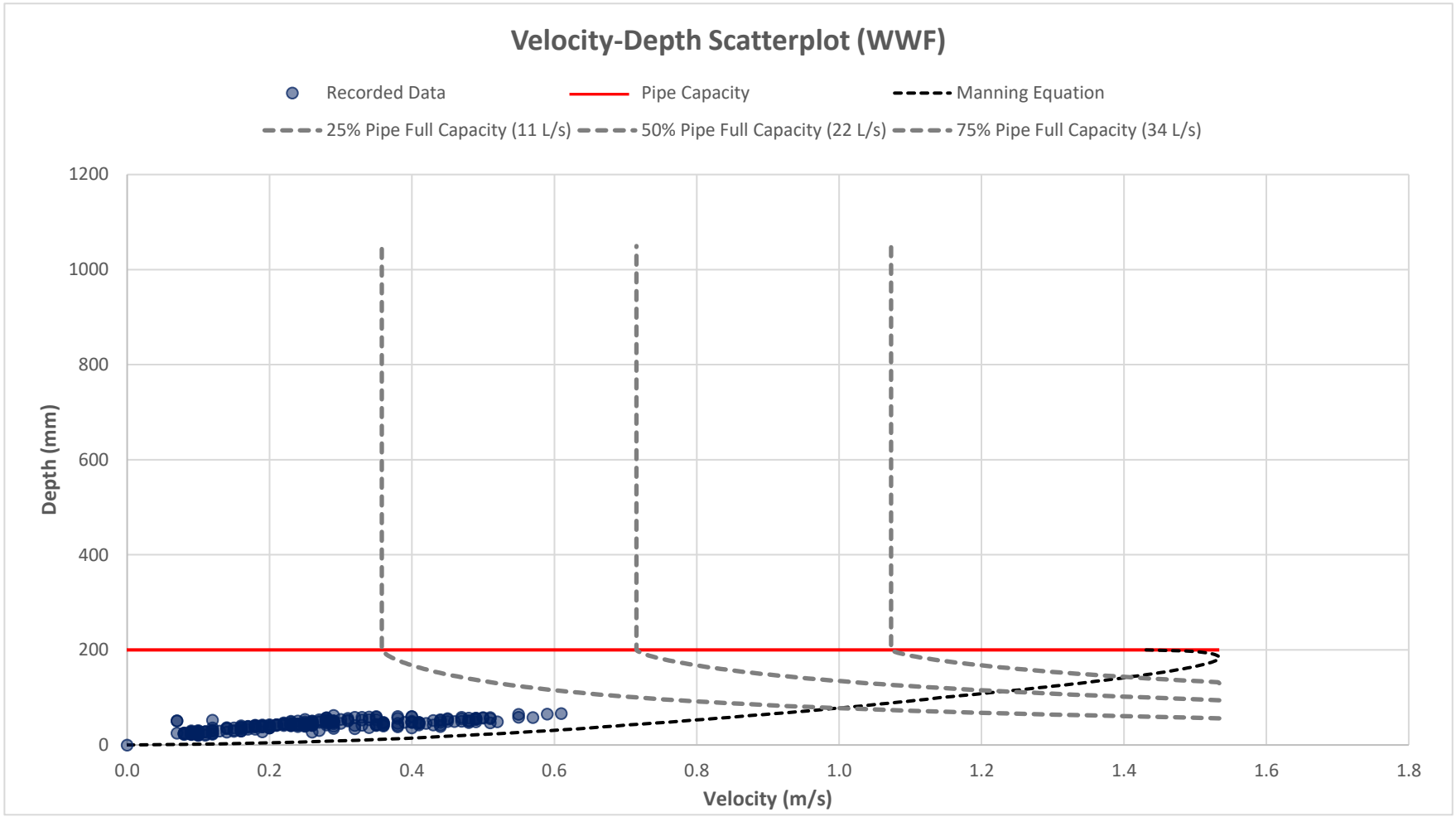
Monitored Area Statistics		
Catchment Area (ha)	12.3	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	6/1/2022 8:45	
End of Analysis	6/2/2022 5:25	
Peak Flow (PF)	5.510	L/s
Time of PF	6/1/2022 20:55	
DWF at Time of PF	1.821	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	3.689	L/s
Volume of RDII	36	m^3
Peak Unit RDII	0.30	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	1.96	%
WWF Vol./DWF Vol.	1.5	
PWWF/ADWF	6.1	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM028 — 2022-06-01



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.004
Roughness Coefficient	0.006

Analysis Period: March 01, 2022 - June 16, 2022

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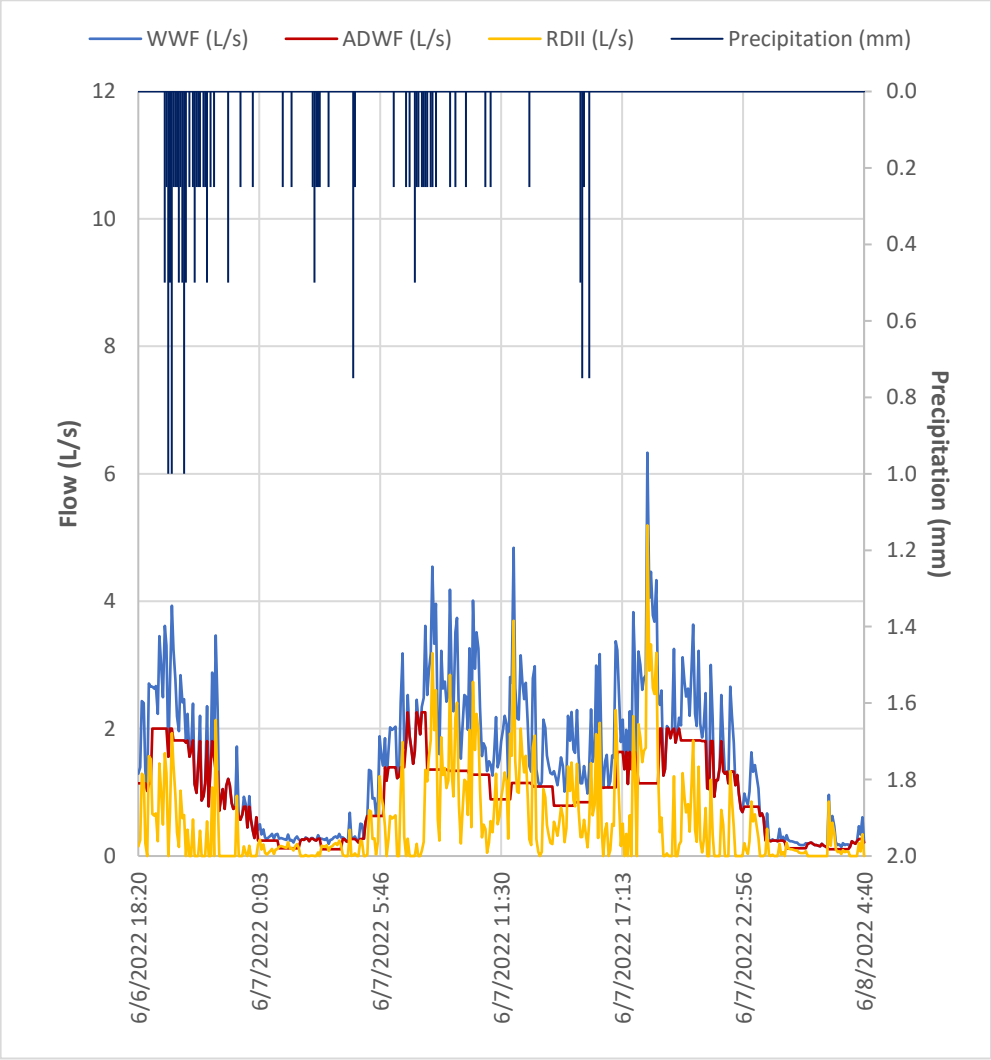
Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028 — 2022-06-06



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	22	mm
Rainfall Duration	20	hr
Peak 1-hr Intensity	6	mm/hr
Peak 5-min Intensity	12	mm/hr

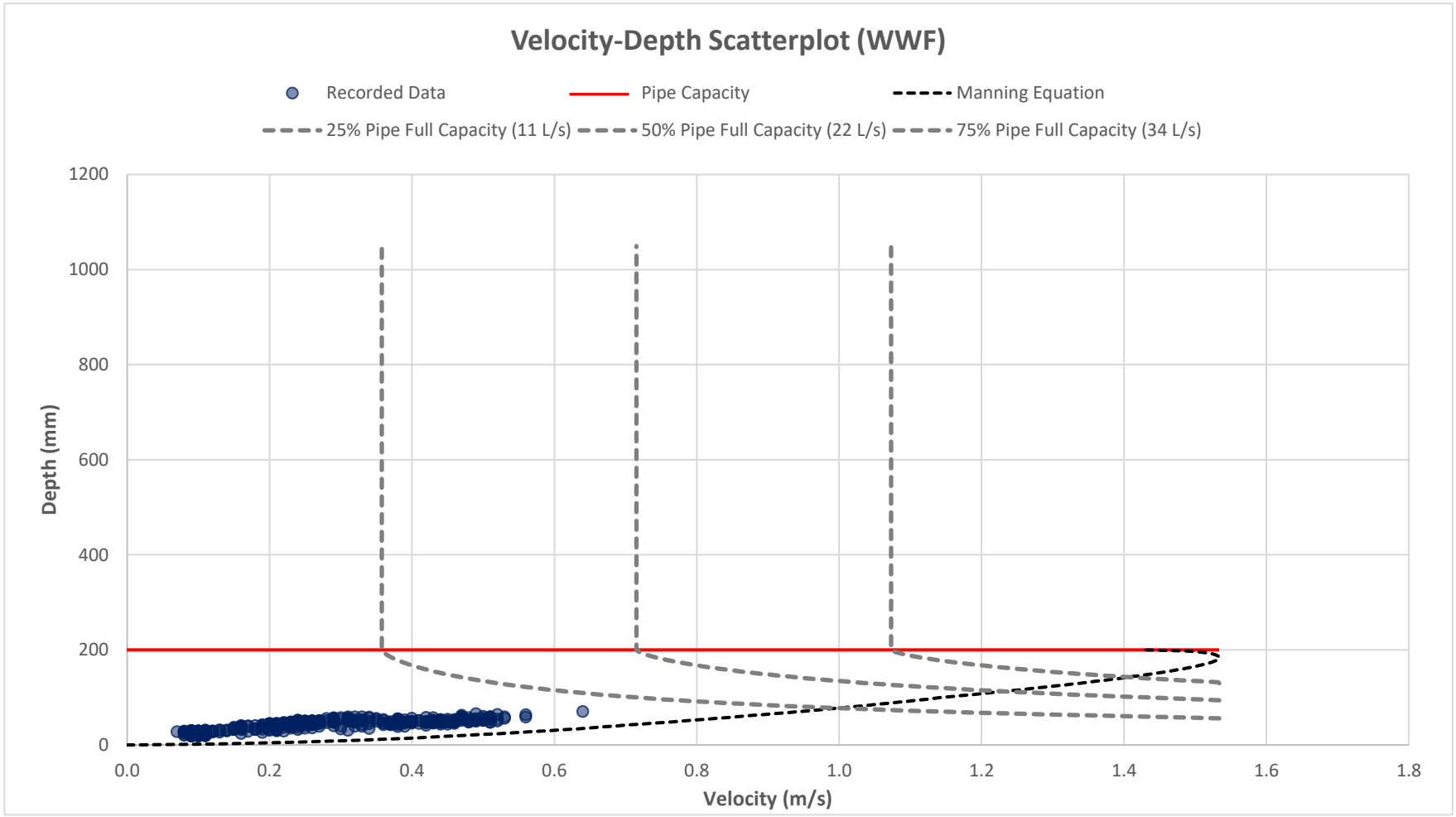
Monitored Area Statistics		
Catchment Area (ha)	12.3	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	6/6/2022 18:20	
End of Analysis	6/8/2022 4:40	
Peak Flow (PF)	6.330	L/s
Time of PF	6/7/2022 18:25	
DWF at Time of PF	1.139	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	5.191	L/s
Volume of RDII	66	m^3
Peak Unit RDII	0.42	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	2.52	%
WWF Vol./DWF Vol.	1.6	
PWWF/ADWF	6.7	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM028 — 2022-06-06



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.004
Roughness Coefficient	0.006

Analysis Period: March 01, 2022 - June 16, 2022

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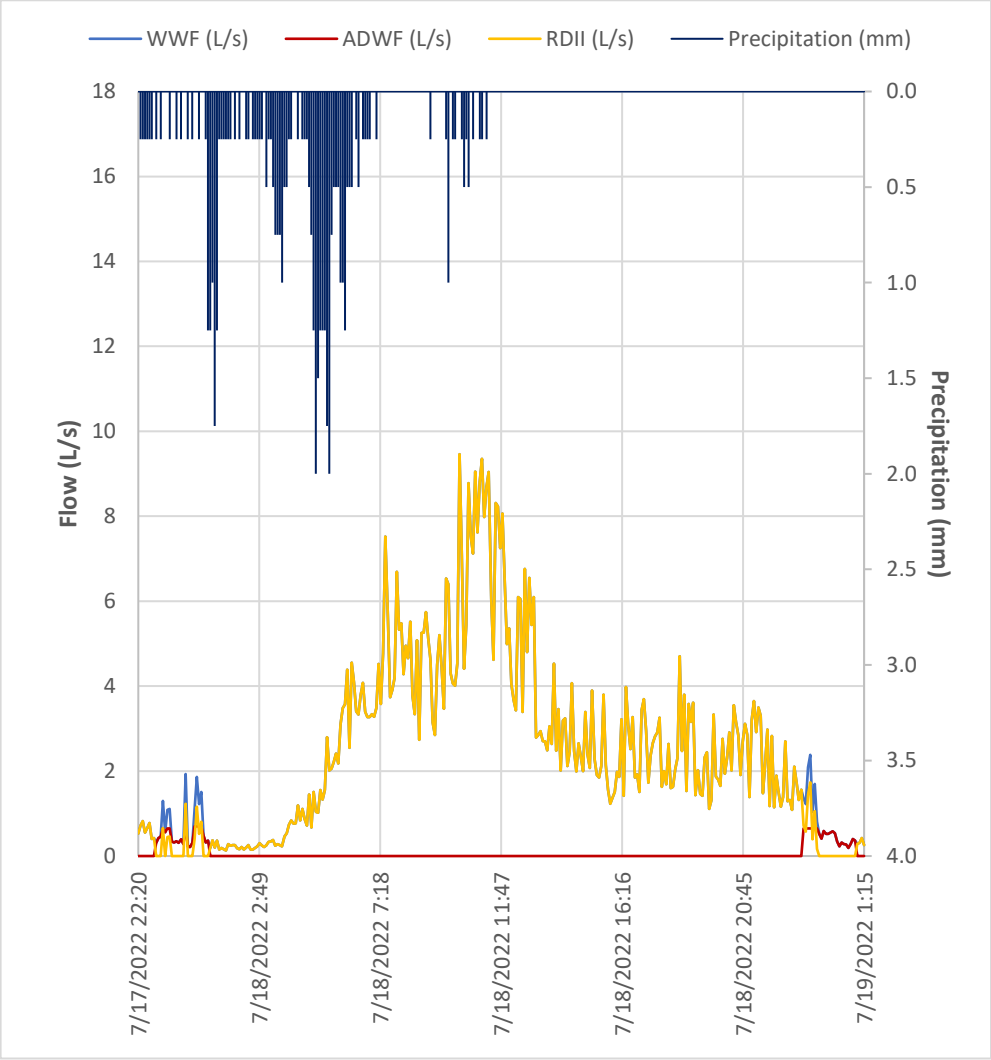
Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028 — 2022-07-17



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	48	mm
Rainfall Duration	13	hr
Peak 1-hr Intensity	15	mm/hr
Peak 5-min Intensity	24	mm/hr

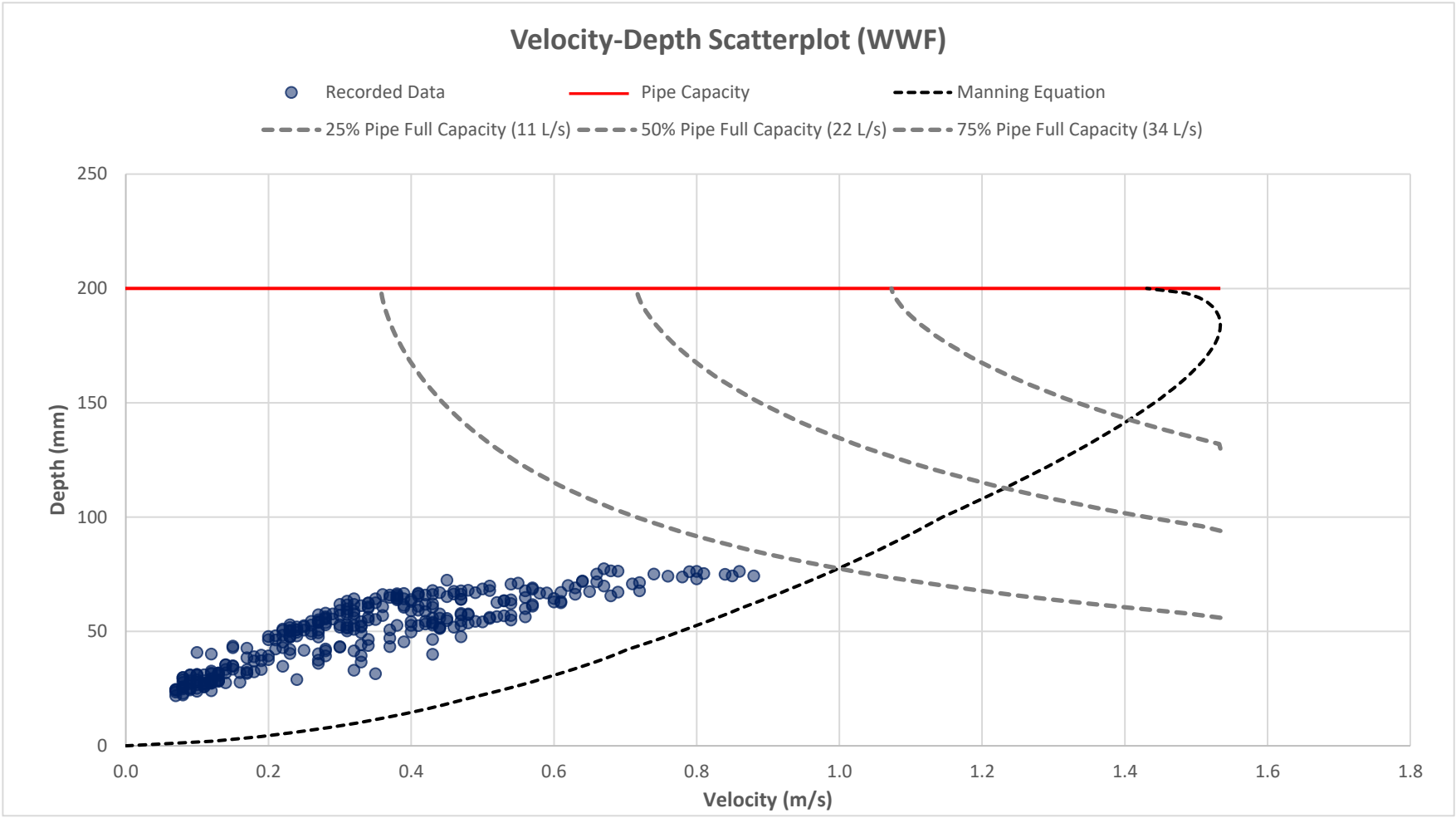
Monitored Area Statistics		
Catchment Area (ha)	12.3	ha
Total Pipe Surface Area (m^2)	1,344	m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	7/17/2022 22:20	
End of Analysis	7/19/2022 1:15	
Peak Flow (PF)	9.460	L/s
Time of PF	7/18/2022 10:15	
DWF at Time of PF	1.641	L/s
DWF Approach	ADWF Analysis	
Peak RDII	7.842	L/s
Volume of RDII	145	m^3
Peak Unit RDII	0.64	L/s/ha
Peak Unit RDII	5834.4959	$L/s/km^2$
Volumetric Coefficient	2.44	%
WWF Vol./DWF Vol.	2.4	
PWWF/ADWF	9.0	
Return Period at Tc		

Commentary:

Analysis Period: July 01, 2022 - July 31, 2022

Flow Monitor: FM028 — 2022-07-17



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.004
Roughness Coefficient	0.006

Analysis Period: July 01, 2022 - July 31, 2022

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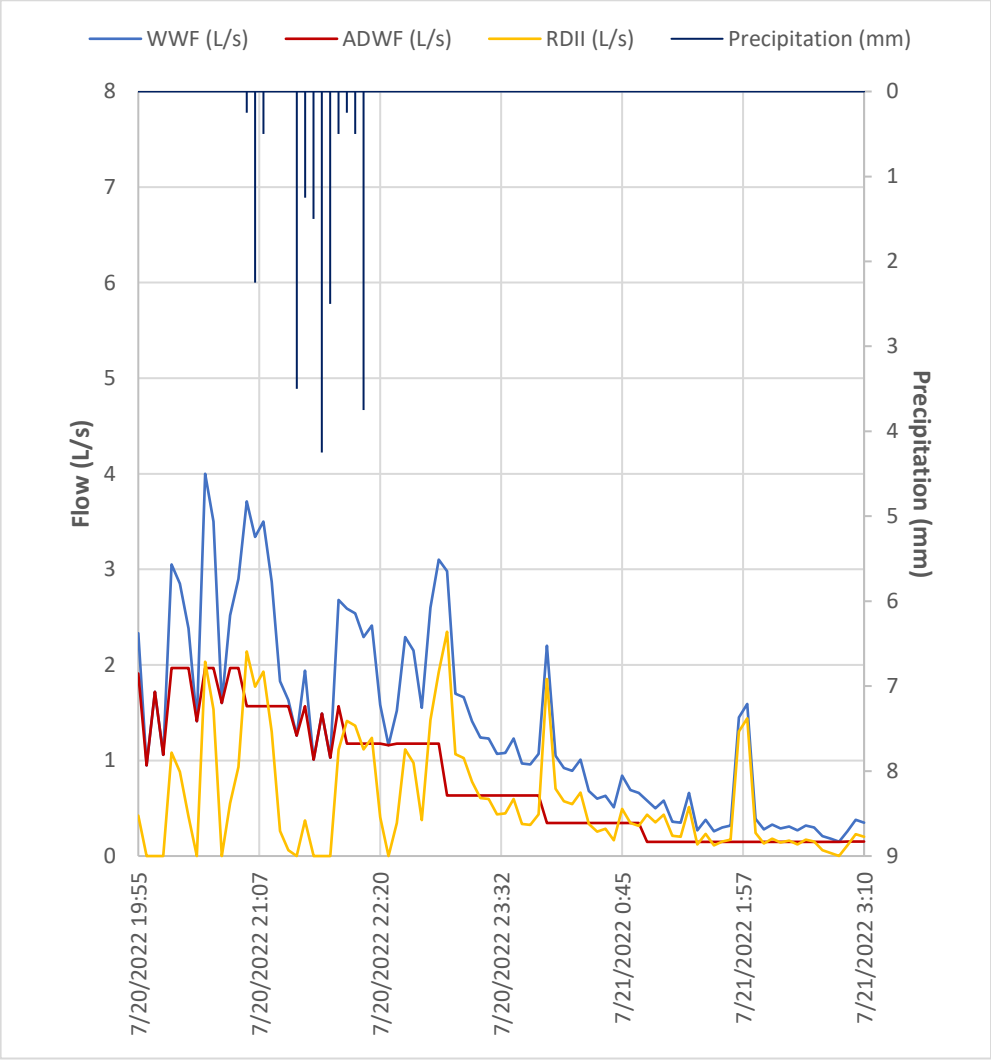
Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM028 — 2022-07-20



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	21	mm
Rainfall Duration	1	hr
Peak 1-hr Intensity	18	mm/hr
Peak 5-min Intensity	51	mm/hr

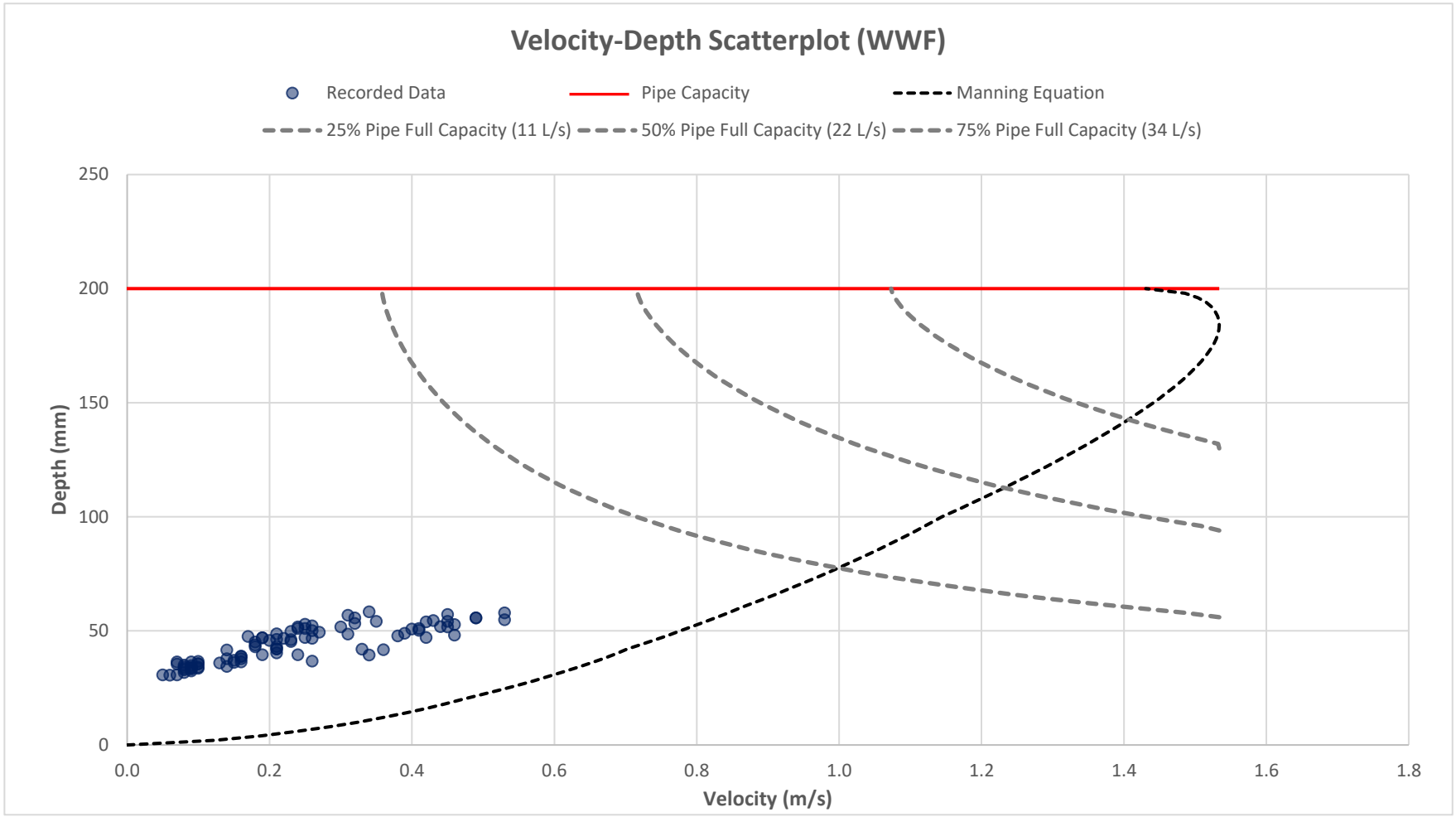
Monitored Area Statistics		
Catchment Area (ha)	12.3	ha
Total Pipe Surface Area (m^2)	1,344	m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	7/20/2022 19:55	
End of Analysis	7/21/2022 3:10	
Peak Flow (PF)	4.000	L/s
Time of PF	7/20/2022 20:35	
DWF at Time of PF	1.968	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	2.346	L/s
Volume of RDII	15	m^3
Peak Unit RDII	0.19	L/s/ha
Peak Unit RDII	1745.5768	$L/s/km^2$
Volumetric Coefficient	0.60	%
WWF Vol./DWF Vol.	1.7	
PWWF/ADWF	5.1	
Return Period at Tc		

Commentary:

Analysis Period: July 01, 2022 - July 31, 2022

Flow Monitor: FM028 — 2022-07-20



Manning Equation Variables

Diameter (mm)	200
Slope (m/m)	0.004
Roughness Coefficient	0.006

Analysis Period: July 01, 2022 - July 31, 2022

BluePlan ENGINEERING

Flow Monitor IDs

Name	Alias
FM032	Four Mile Creek Rd

Install Pipe Specifications

Sewer System	Measured Pipe Size (mm)	GIS Pipe Size (mm)	Associated Rain Gauge
Sanitary	300	300	RoN_RG16

Catchment Specifications

Catchment Area (ha)	Pipe Surface Area (m^2)	Population	Catchment Tc
130.8	8,198	1,953	

SSEA Specifications

SSEA Area (ha)

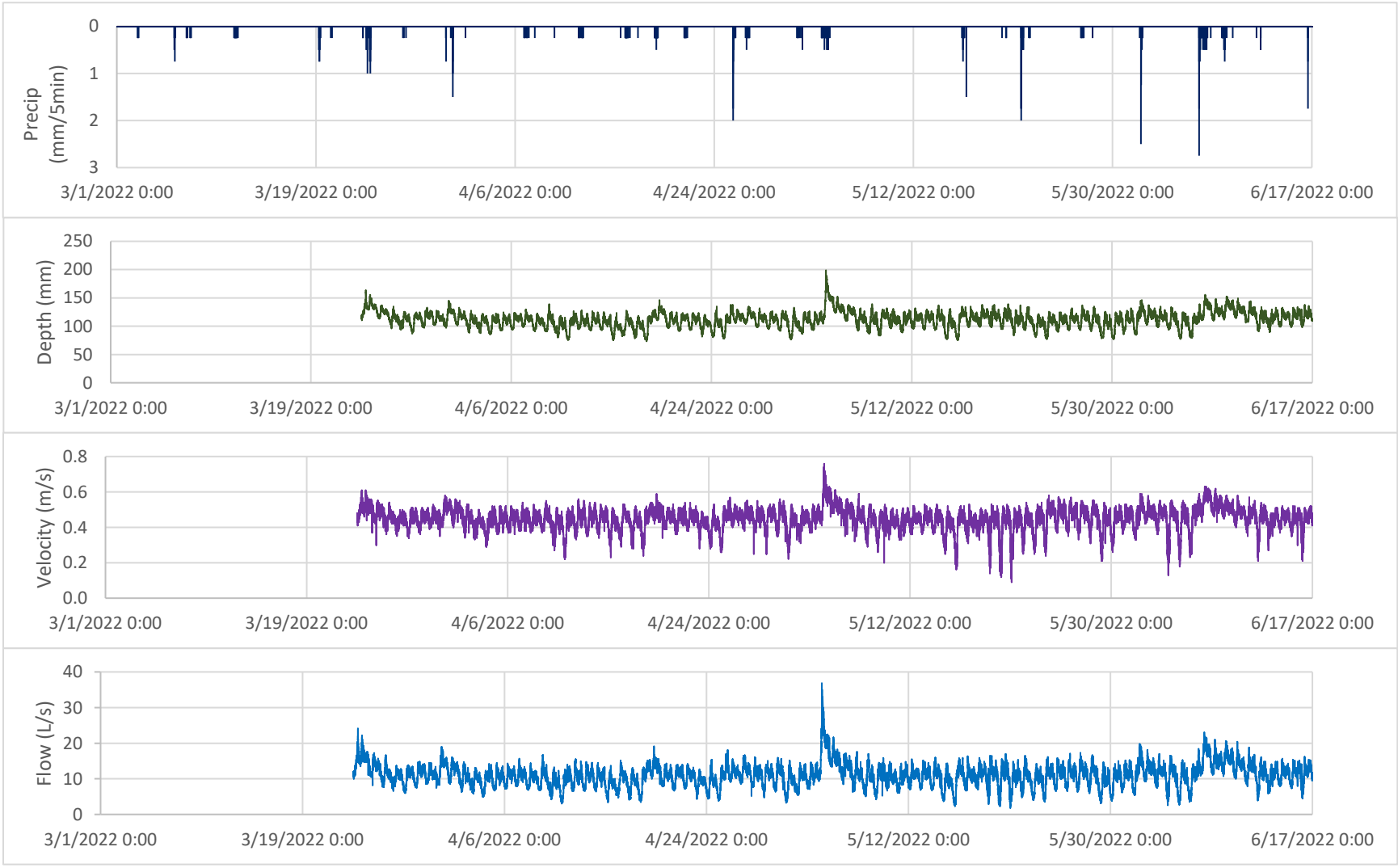
This report summarizes the flow analysis outputs for the following reporting period:
Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032

From: March 01, 2022 To: June 16, 2022



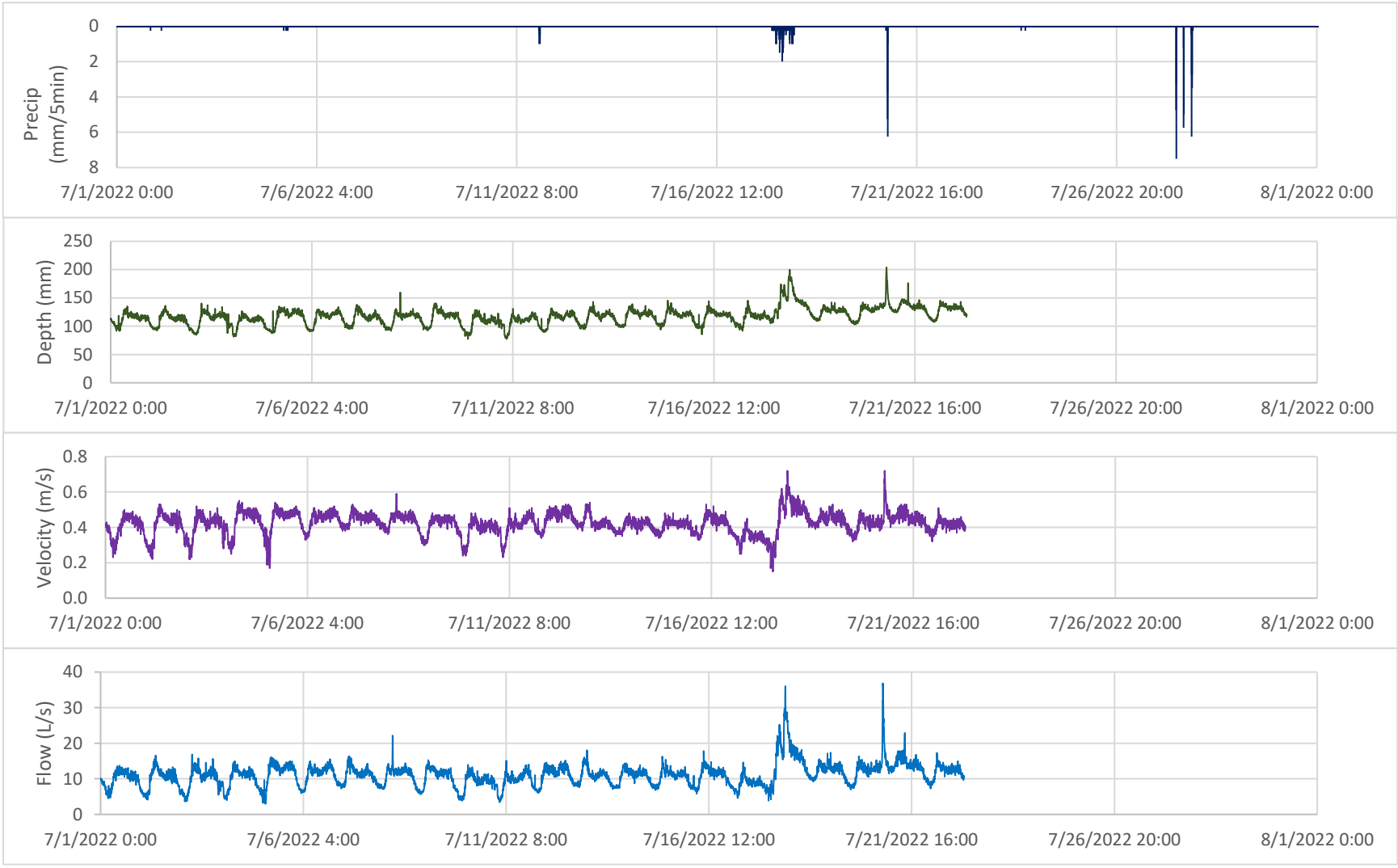
Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032

From: July 01, 2022 To: July 31, 2022



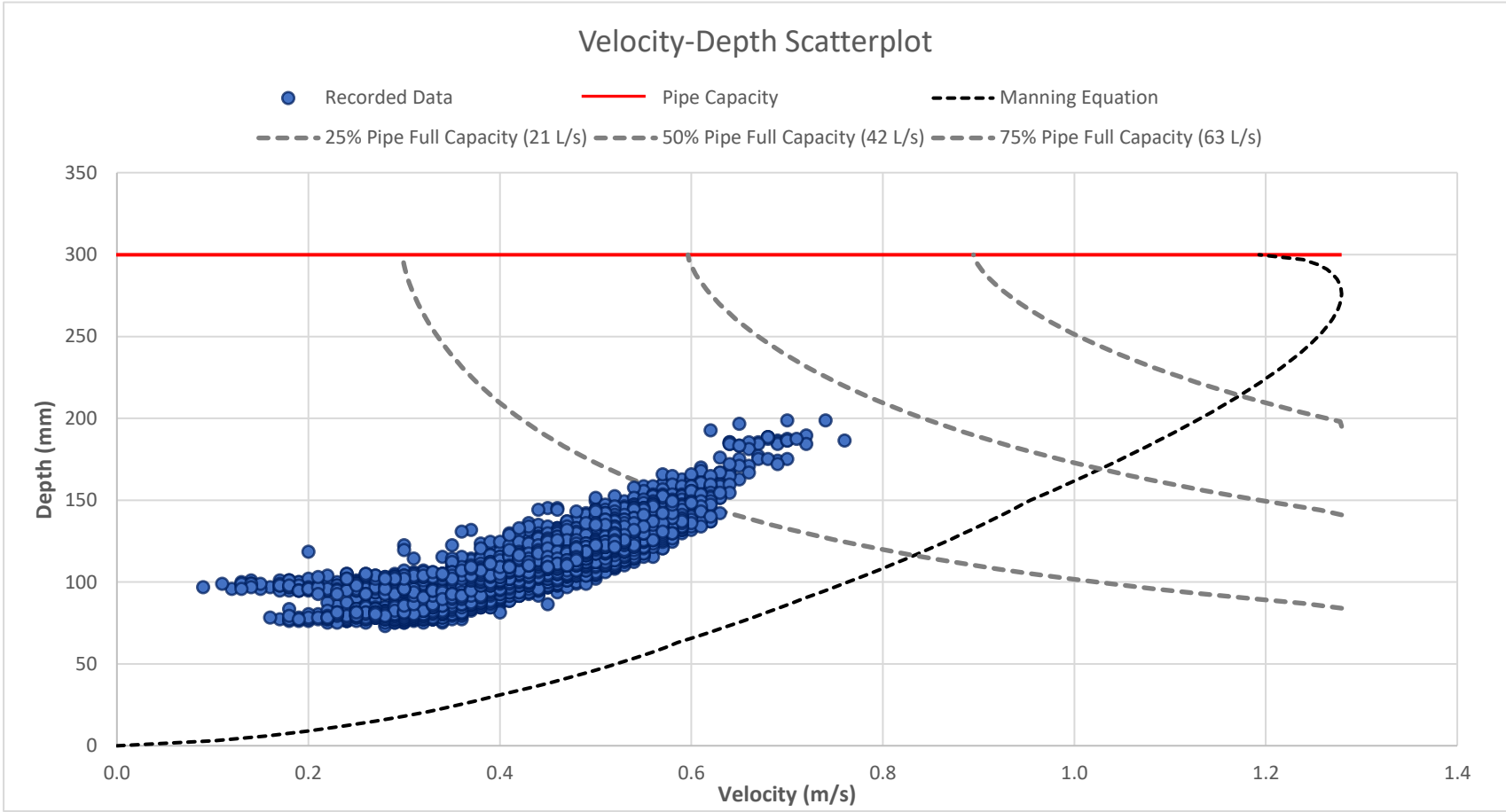
Analysis Period: July 01, 2022 - July 31, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032

From: March 01, 2022 To: June 16, 2022



Manning Equation Variables

Diameter (mm)	300
Slope (m/m)	0.0045
Roughness Coefficient	0.01

Commentary

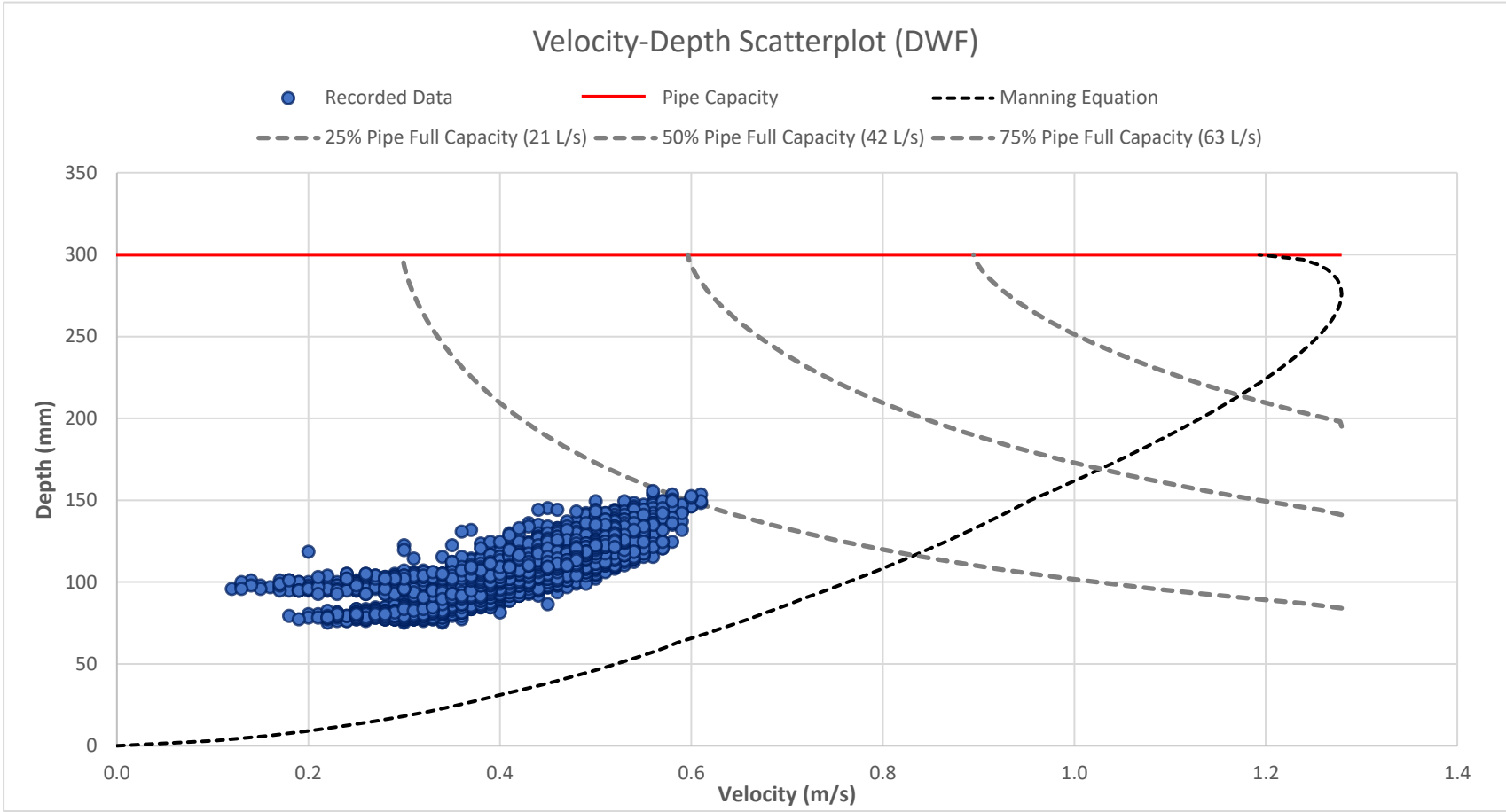
Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032

From: March 01, 2022 To: June 16, 2022



Manning Equation Variables

Diameter (mm)	300
Slope (m/m)	0.0045
Roughness Coefficient	0.01

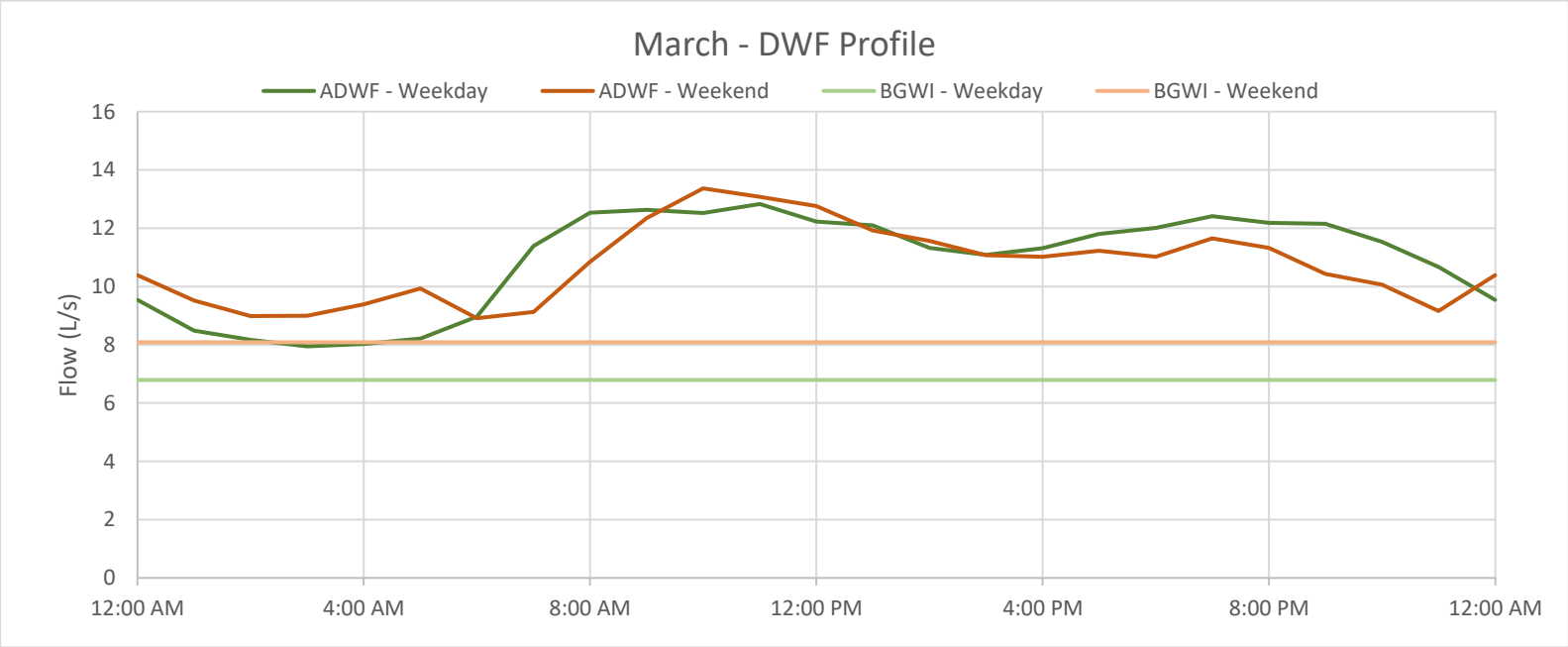
Commentary

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032 — March 2022



Dry Weather Flow Statistics			
Variable	Weekday	Weekend	Units
ADWF	10.9	10.8	L/s
MDWF	7.9	8.9	L/s
BGWI	6.8	8.1	L/s
Unit BGWI	0.05	0.06	L/s/ha
Unit BGWI			$L/s/km^2$
Sanitary Flow	4.1	2.7	L/s
Per Capita Sanitary Flow (model)			L/cap/day
Per Capita Sanitary Flow (DC)			L/cap/day
PDWF	12.8	13.4	L/s
BGWI/ADWF	62.21	75.20	%
Average d/D	37.50	37.27	%

Catchment Specifications

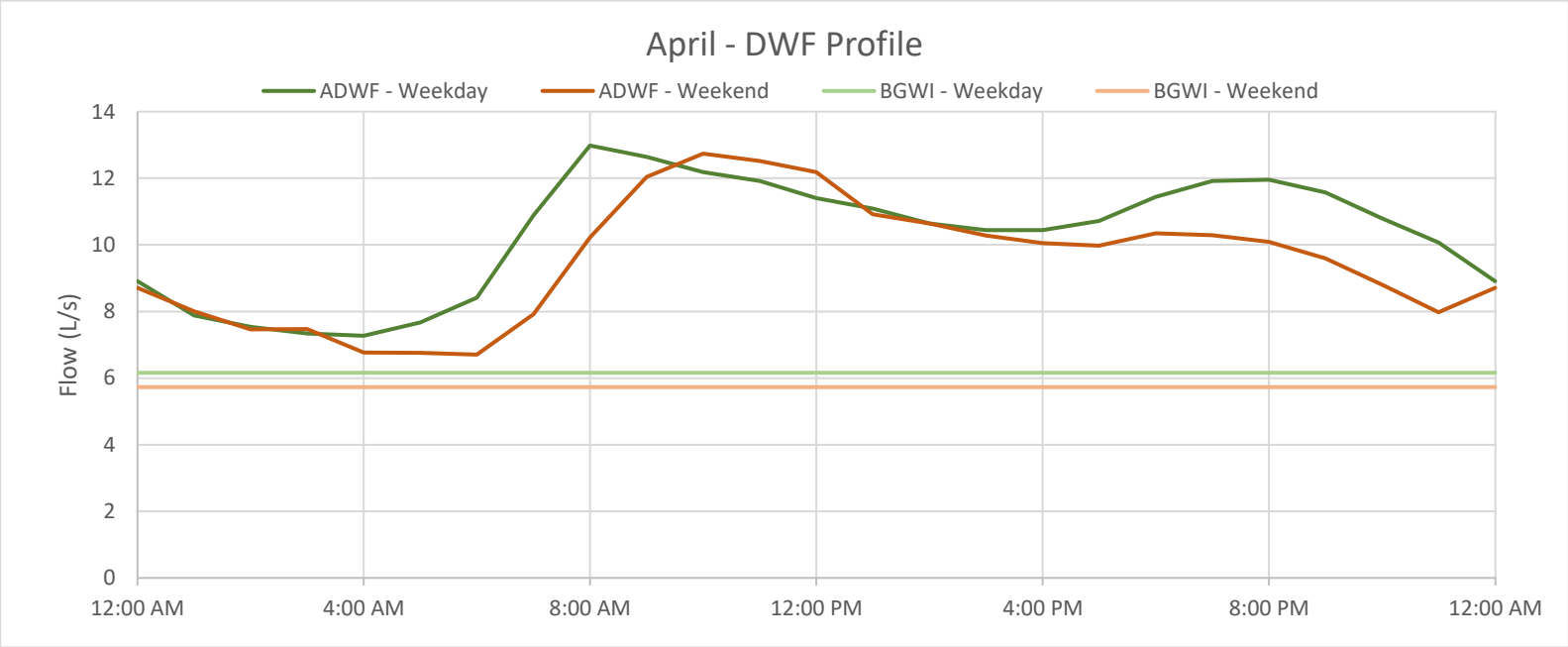
Catchment Area (ha)	130.8
Total Pipe Surface Area (m^2)	8,198
Population	1,953

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032 — April 2022



Dry Weather Flow Statistics			
Variable	Weekday	Weekend	Units
ADWF	10.3	9.5	L/s
MDWF	7.3	6.7	L/s
BGWI	6.2	5.7	L/s
Unit BGWI	0.05	0.04	L/s/ha
Unit BGWI			$L/s/km^2$
Sanitary Flow	4.2	3.8	L/s
Per Capita Sanitary Flow (model)			L/cap/day
Per Capita Sanitary Flow (DC)			L/cap/day
PDWF	13.0	12.7	L/s
BGWI/ADWF	59.57	60.19	%
Average d/D	36.10	34.86	%

Catchment Specifications

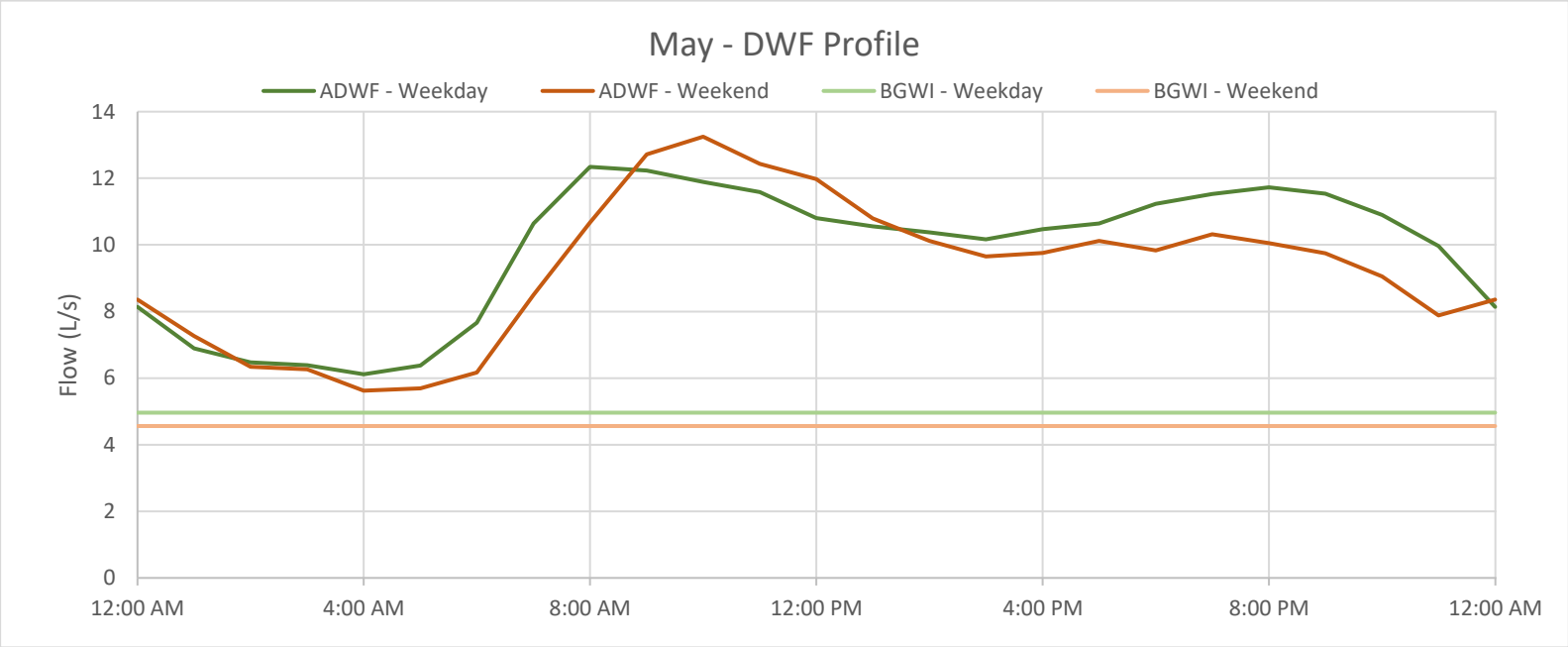
Catchment Area (ha)	130.8
Total Pipe Surface Area (m^2)	8,198
Population	1,953

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032 — May 2022



Dry Weather Flow Statistics			
Variable	Weekday	Weekend	Units
ADWF	9.9	9.3	L/s
MDWF	6.1	5.6	L/s
BGWI	5.0	4.6	L/s
Unit BGWI	0.04	0.03	L/s/ha
Unit BGWI			$L/s/km^2$
Sanitary Flow	4.9	4.7	L/s
Per Capita Sanitary Flow (model)			L/cap/day
Per Capita Sanitary Flow (DC)			L/cap/day
PDWF	12.3	13.2	L/s
BGWI/ADWF	50.32	49.17	%
Average d/D	36.27	35.08	%

Catchment Specifications

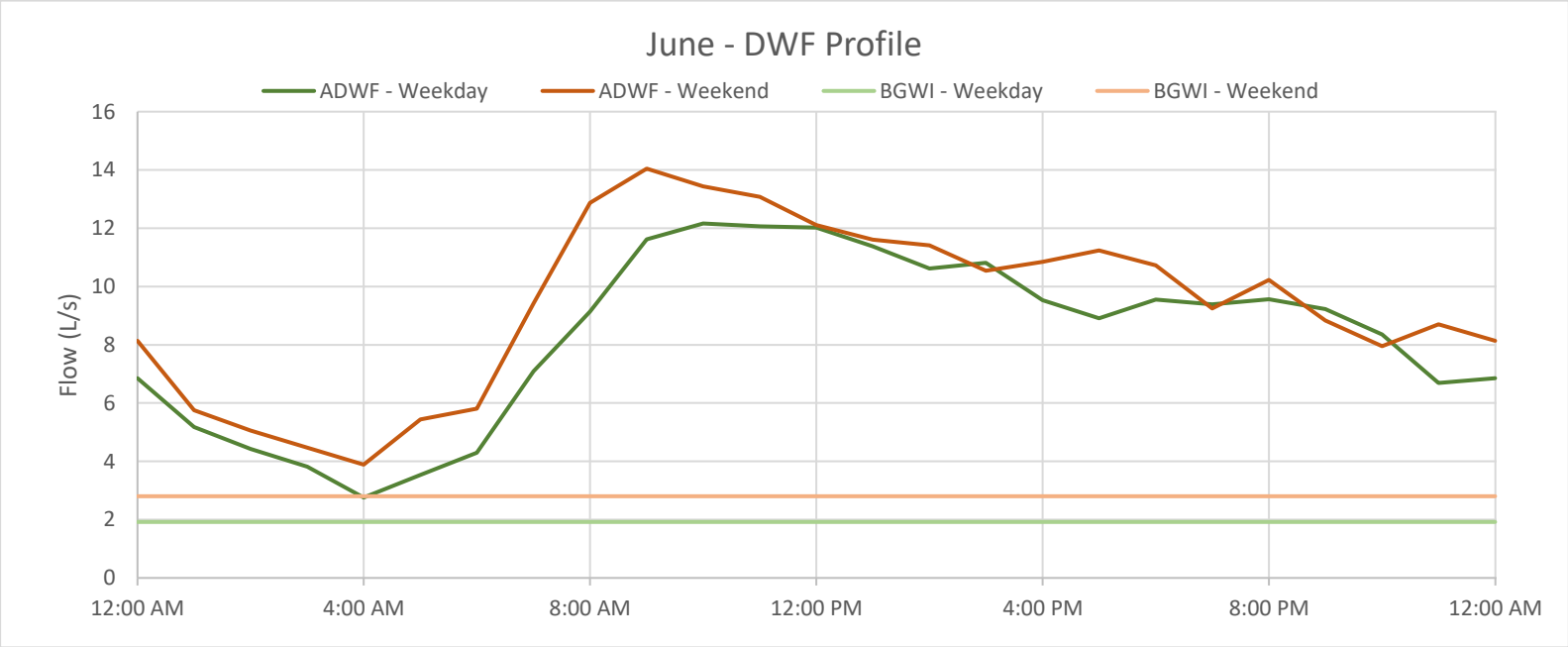
Catchment Area (ha)	130.8
Total Pipe Surface Area (m^2)	8,198
Population	1,953

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032 — June 2022



Dry Weather Flow Statistics			
Variable	Weekday	Weekend	Units
ADWF	8.3	9.4	L/s
MDWF	2.8	3.9	L/s
BGWI	1.9	2.8	L/s
Unit BGWI	0.01	0.02	L/s/ha
Unit BGWI			$L/s/km^2$
Sanitary Flow	6.4	6.6	L/s
Per Capita Sanitary Flow (model)			L/cap/day
Per Capita Sanitary Flow (DC)			L/cap/day
PDWF	12.2	14.0	L/s
BGWI/ADWF	23.16	29.92	%
Average d/D	33.85	36.55	%

Catchment Specifications

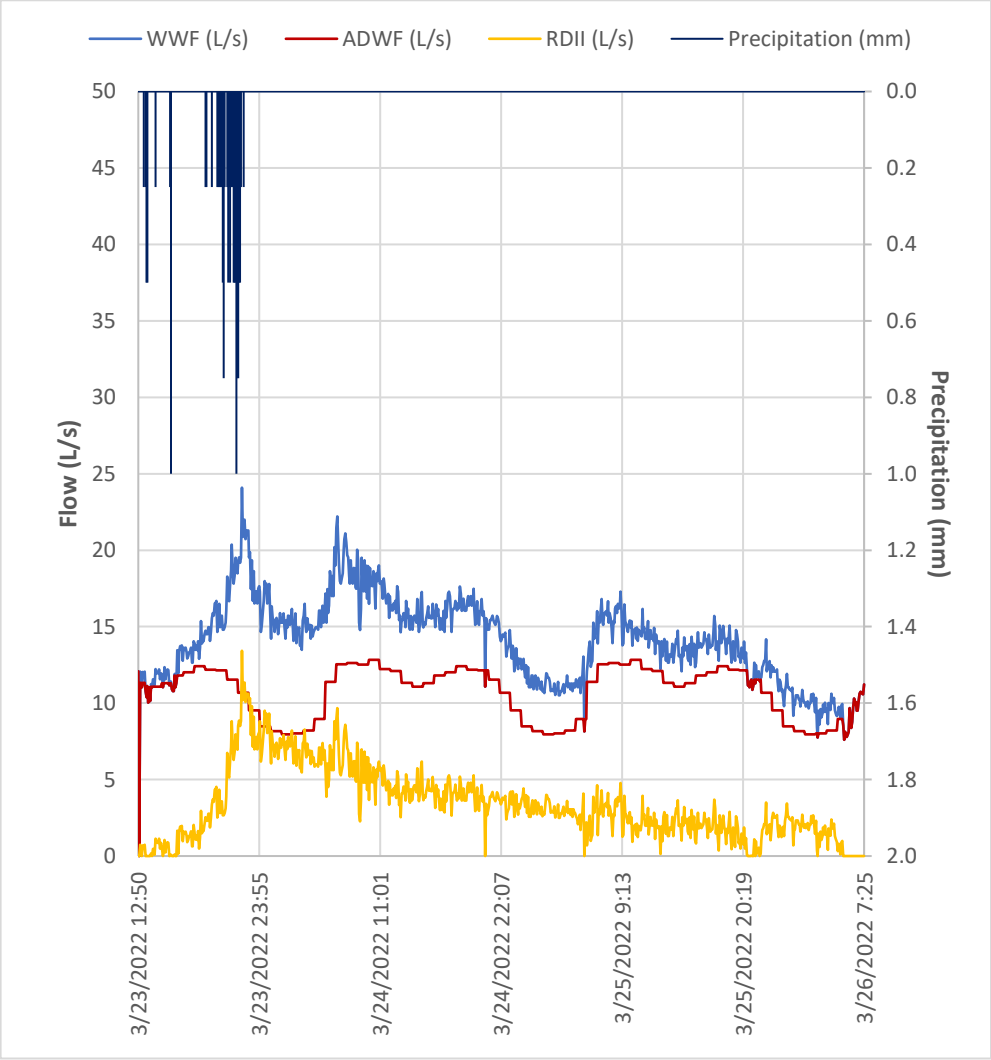
Catchment Area (ha)	130.8
Total Pipe Surface Area (m^2)	8,198
Population	1,953

Analysis Period: March 01, 2022 - June 16, 2022

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032 — 2022-03-23



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	16	mm
Rainfall Duration	9	hr
Peak 1-hr Intensity	5	mm/hr
Peak 5-min Intensity	12	mm/hr

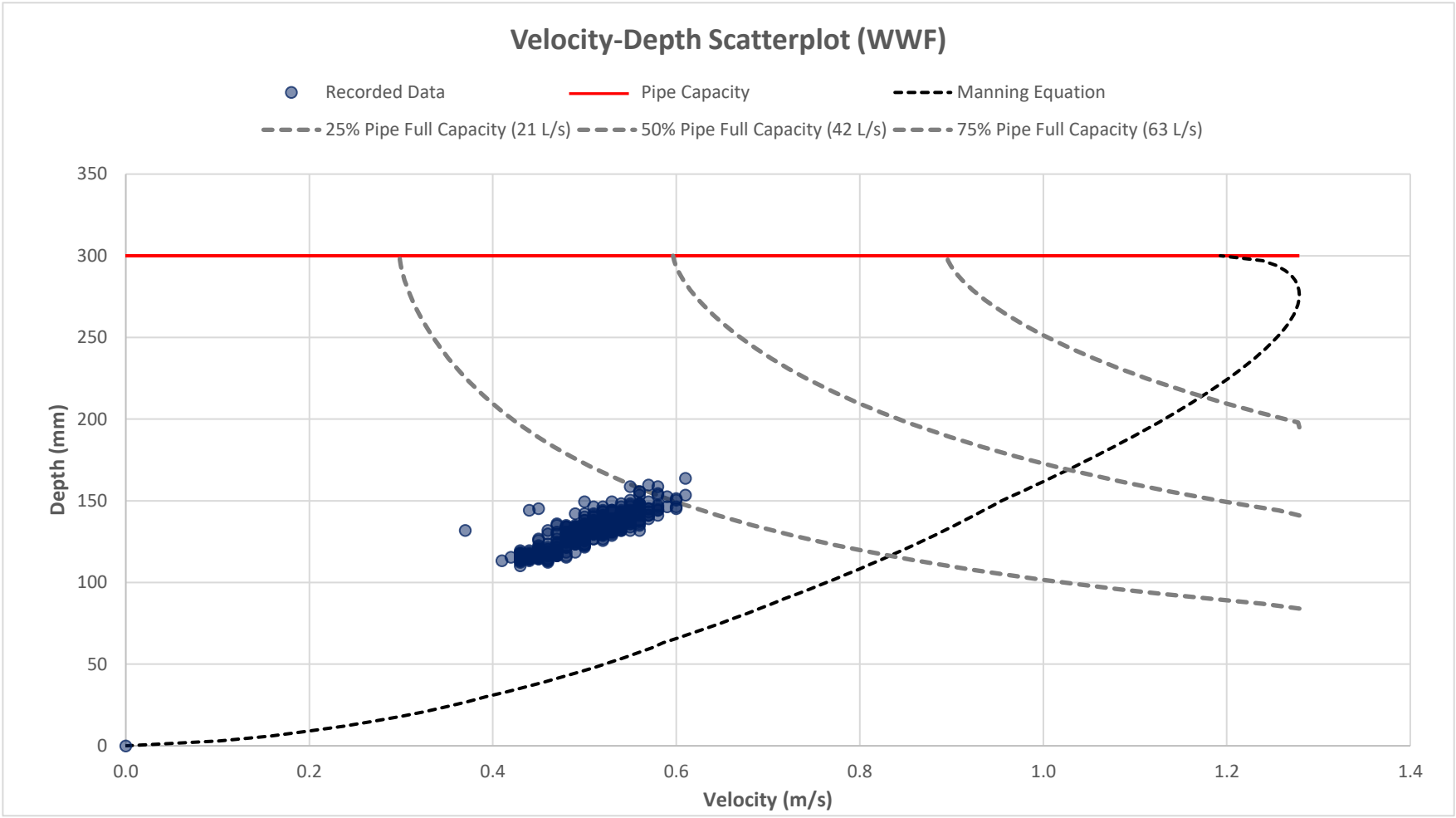
Monitored Area Statistics		
Catchment Area (ha)	130.8	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	3/23/2022 12:50	
End of Analysis	3/26/2022 7:25	
Peak Flow (PF)	24.090	L/s
Time of PF	3/23/2022 22:20	
DWF at Time of PF	10.668	L/s
DWF Approach	ADWF Analysis	
Peak RDII	13.422	L/s
Volume of RDII	791	m^3
Peak Unit RDII	0.10	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	3.78	%
WWF Vol./DWF Vol.	1.3	
PWWF/ADWF	2.2	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM032 — 2022-03-23



Manning Equation Variables

Diameter (mm)	300
Slope (m/m)	0.0045
Roughness Coefficient	0.01

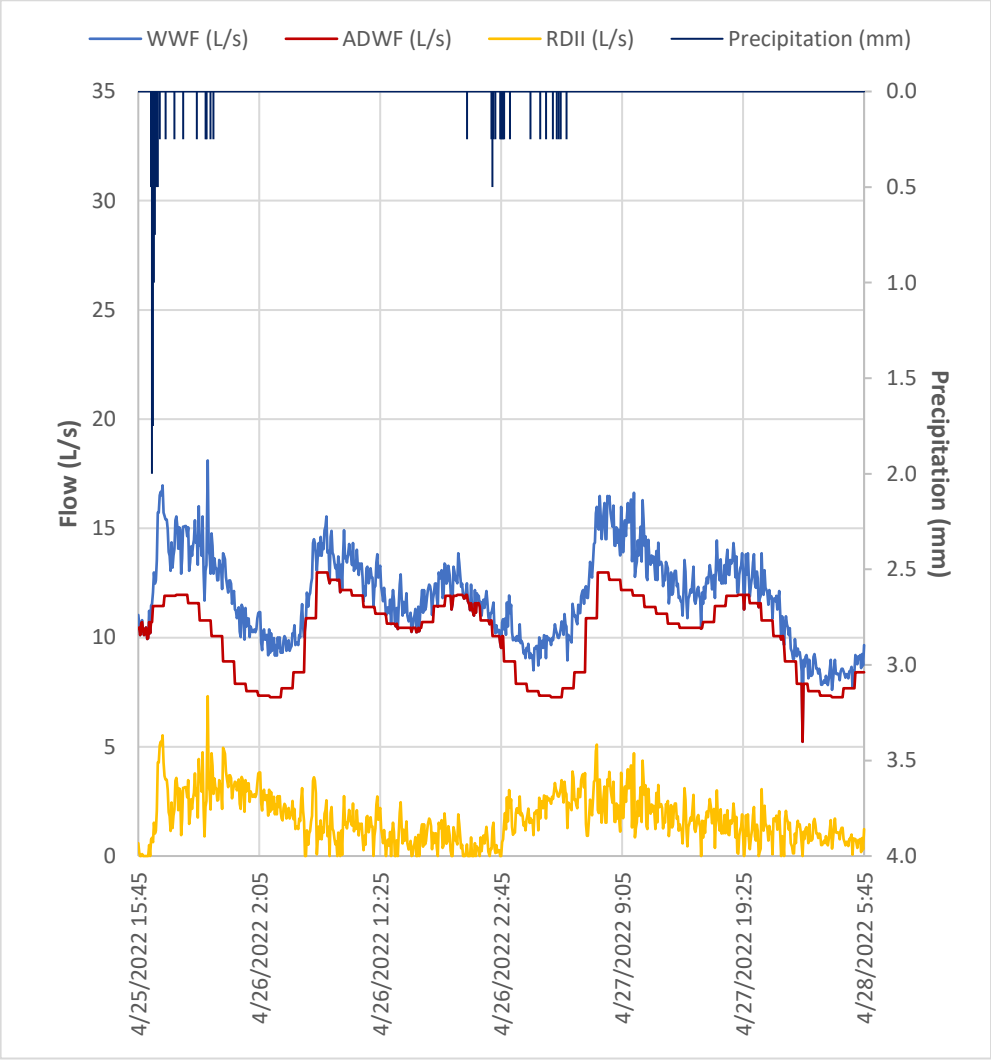
Analysis Period: March 01, 2022 - June 16, 2022

BluePlan ENGINEERING

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032 — 2022-04-25



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	15	mm
Rainfall Duration	36	hr
Peak 1-hr Intensity	9	mm/hr
Peak 5-min Intensity	27	mm/hr

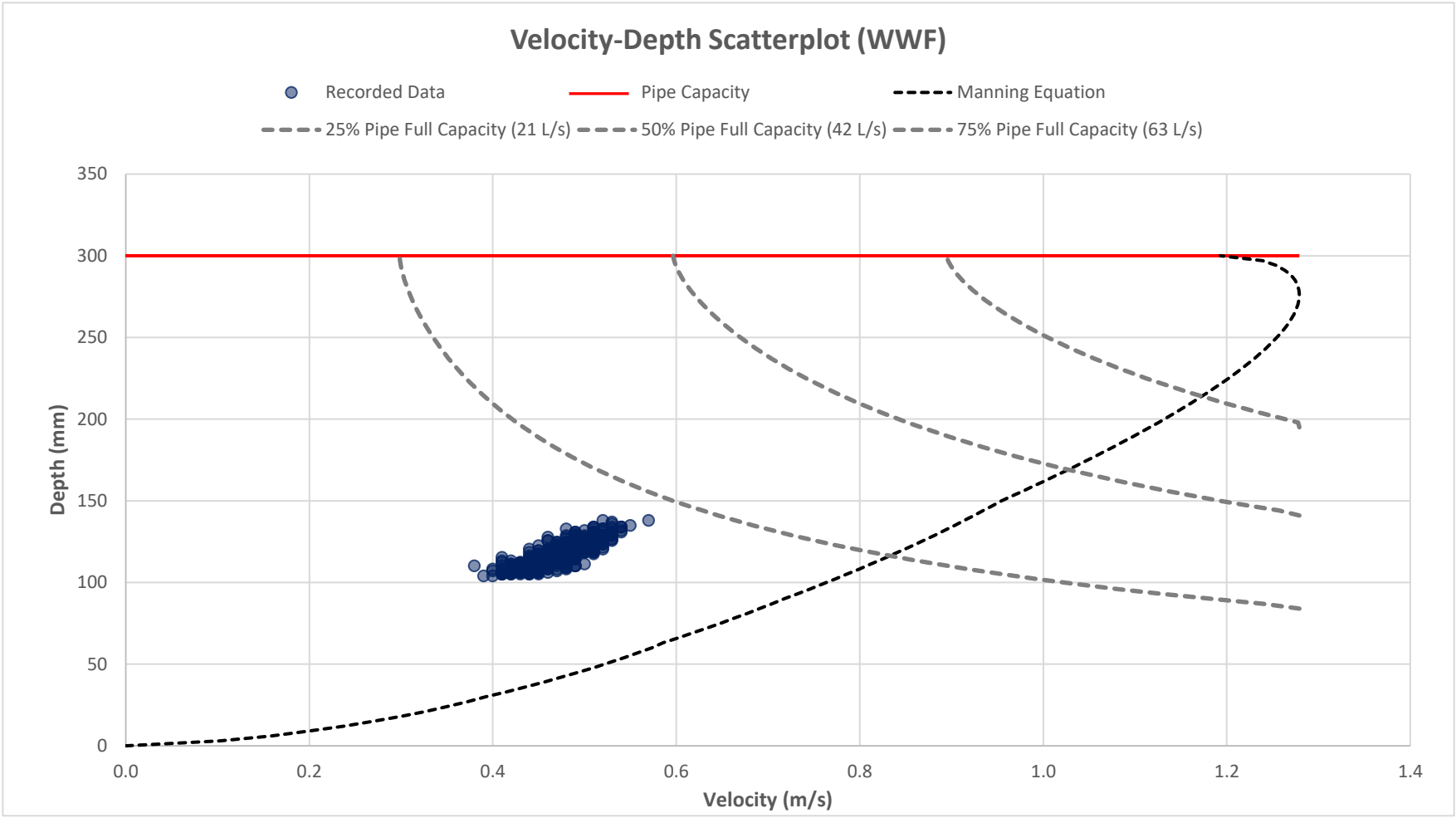
Monitored Area Statistics		
Catchment Area (ha)	130.8	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	4/25/2022 15:45	
End of Analysis	4/28/2022 5:45	
Peak Flow (PF)	18.110	L/s
Time of PF	4/25/2022 21:40	
DWF at Time of PF	10.792	L/s
DWF Approach	ADWF Analysis	
Peak RDII	7.318	L/s
Volume of RDII	384	m^3
Peak Unit RDII	0.06	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	2.03	%
WWF Vol./DWF Vol.	1.2	
PWWF/ADWF	1.8	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM032 — 2022-04-25



Manning Equation Variables

Diameter (mm)	300
Slope (m/m)	0.0045
Roughness Coefficient	0.01

Analysis Period: March 01, 2022 - June 16, 2022

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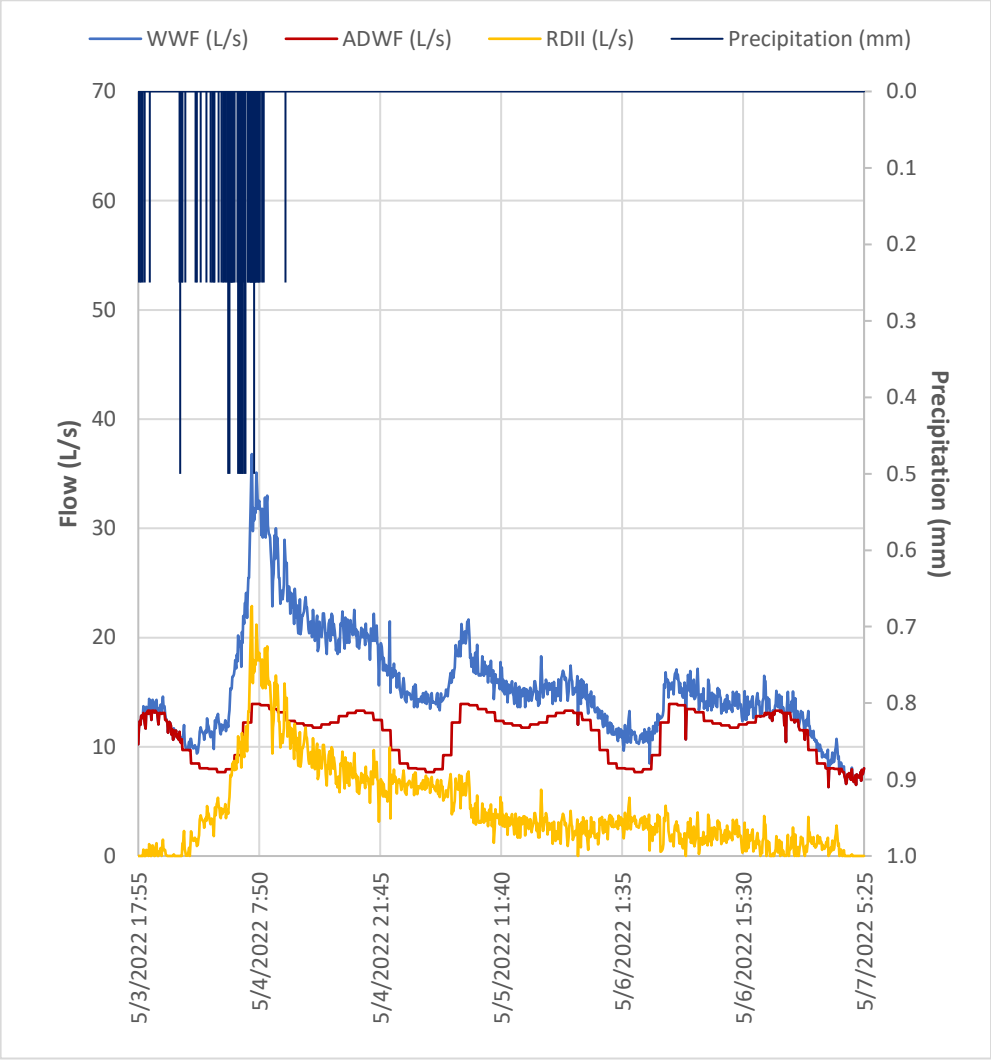
Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032 — 2022-05-03



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	20	mm
Rainfall Duration	14	hr
Peak 1-hr Intensity	6	mm/hr
Peak 5-min Intensity	12	mm/hr

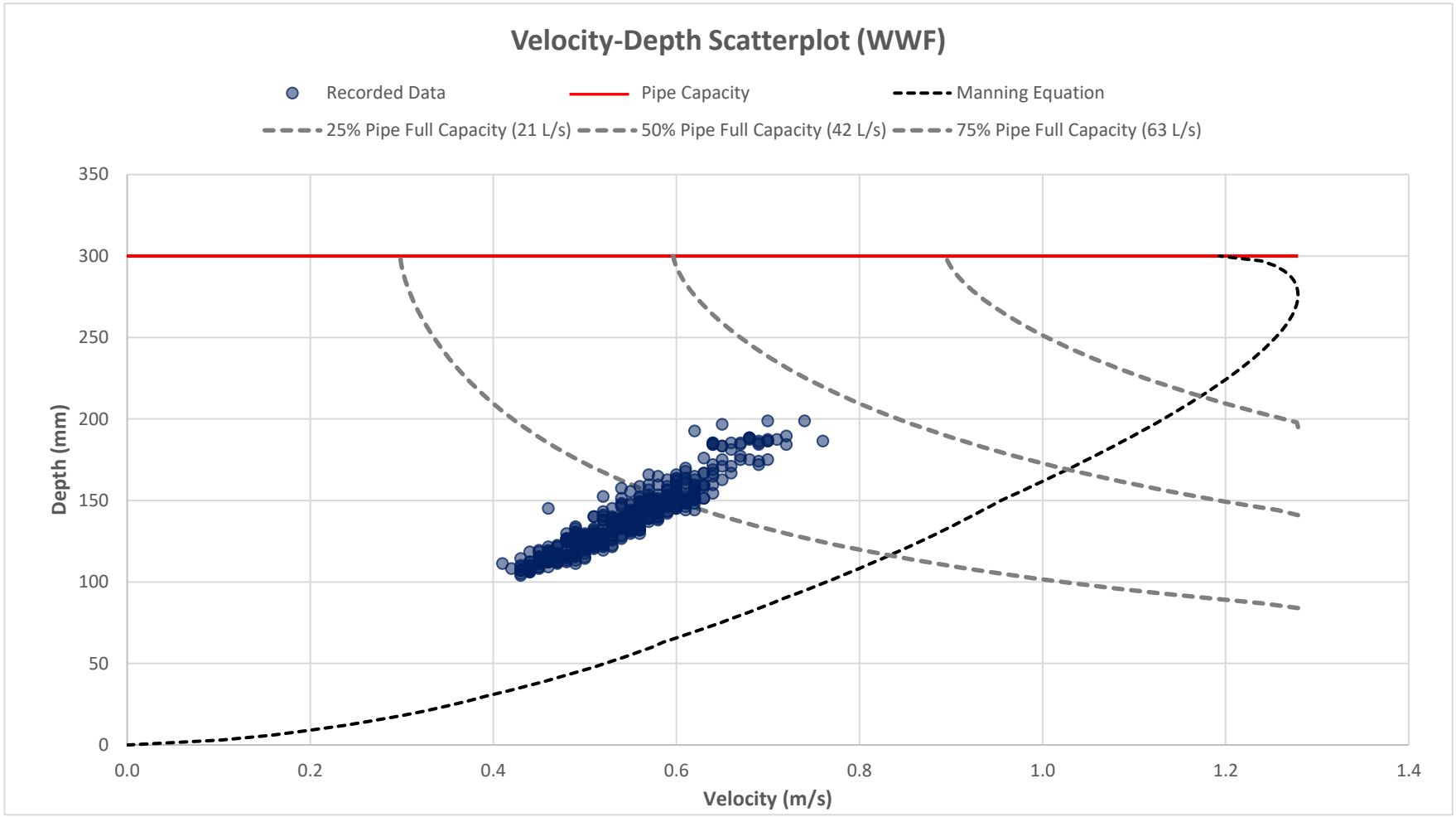
Monitored Area Statistics		
Catchment Area (ha)	130.8	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	5/3/2022 17:55	
End of Analysis	5/7/2022 5:25	
Peak Flow (PF)	36.800	L/s
Time of PF	5/4/2022 7:00	
DWF at Time of PF	13.914	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	22.886	L/s
Volume of RDII	1279	m^3
Peak Unit RDII	0.17	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	4.89	%
WWF Vol./DWF Vol.	1.4	
PWWF/ADWF	3.3	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM032 — 2022-05-03



Manning Equation Variables

Diameter (mm)	300
Slope (m/m)	0.0045
Roughness Coefficient	0.01

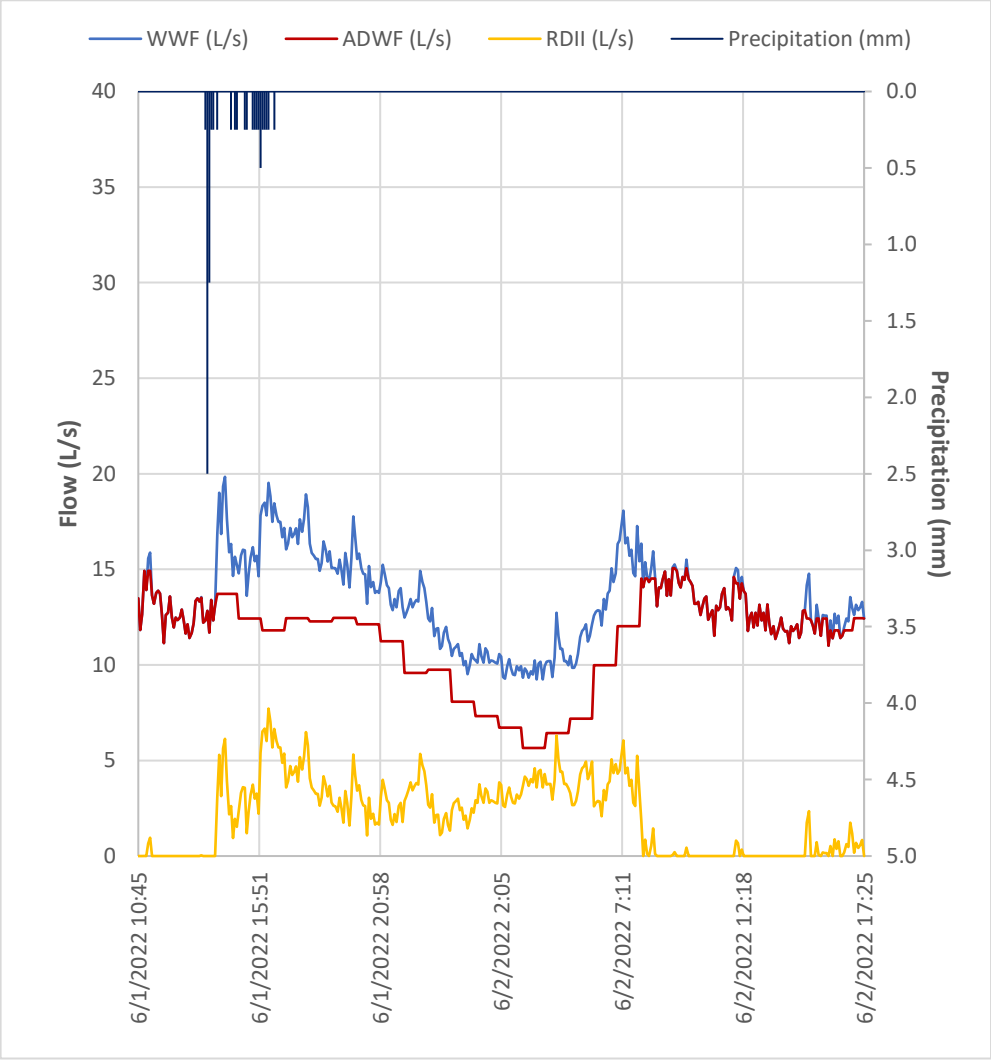
Analysis Period: March 01, 2022 - June 16, 2022

BluePlan ENGINEERING

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032 — 2022-06-01



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	12	mm
Rainfall Duration	3	hr
Peak 1-hr Intensity	5	mm/hr
Peak 5-min Intensity	15	mm/hr

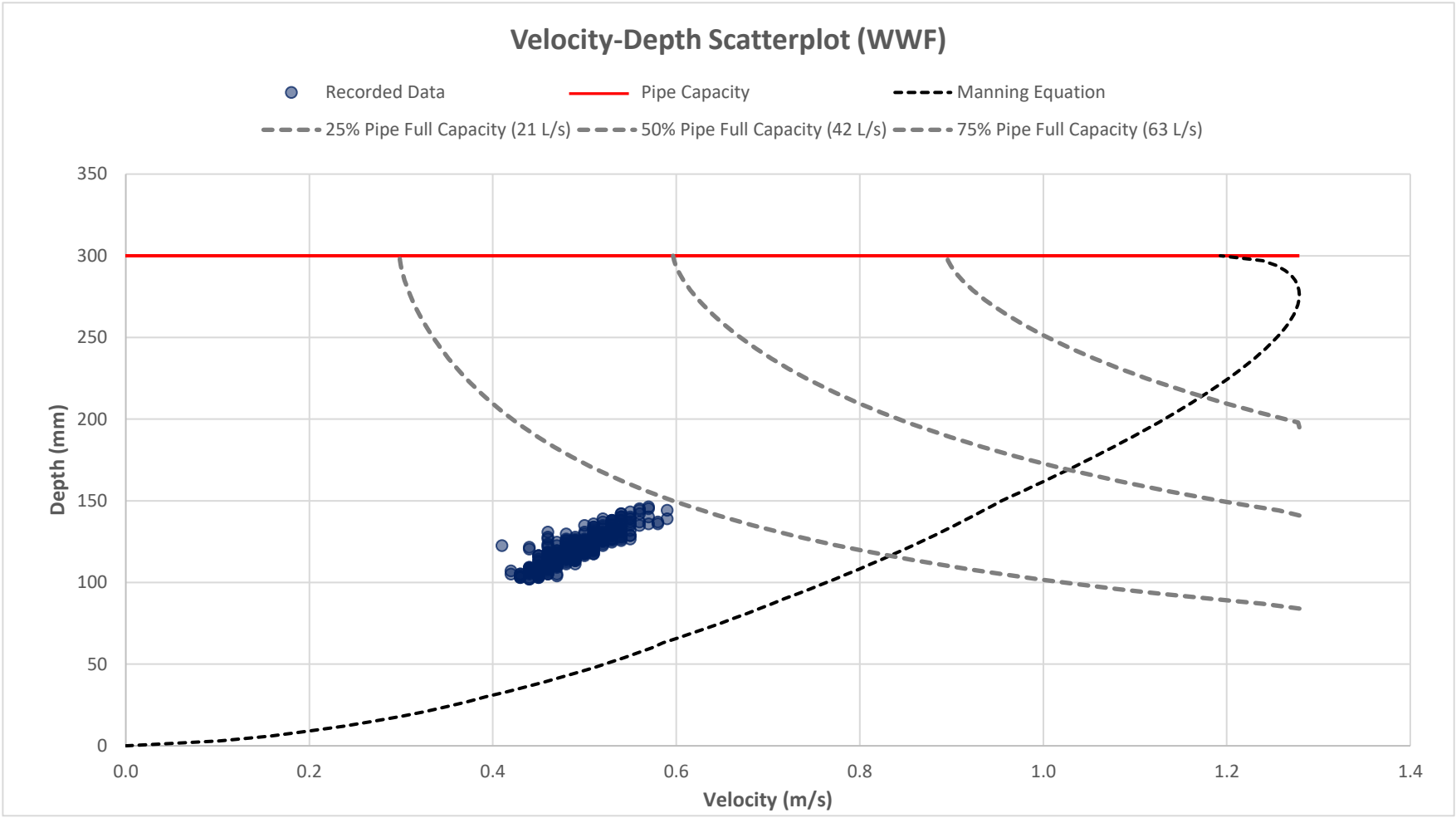
Monitored Area Statistics		
Catchment Area (ha)	130.8	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	6/1/2022 10:45	
End of Analysis	6/2/2022 17:25	
Peak Flow (PF)	18.490	L/s
Time of PF	6/1/2022 14:25	
DWF at Time of PF	13.180	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	6.876	L/s
Volume of RDII	192	m^3
Peak Unit RDII	0.05	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	1.28	%
WWF Vol./DWF Vol.	1.2	
PWWF/ADWF	1.8	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM032 — 2022-06-01



Manning Equation Variables

Diameter (mm)	300
Slope (m/m)	0.0045
Roughness Coefficient	0.01

Analysis Period: March 01, 2022 - June 16, 2022

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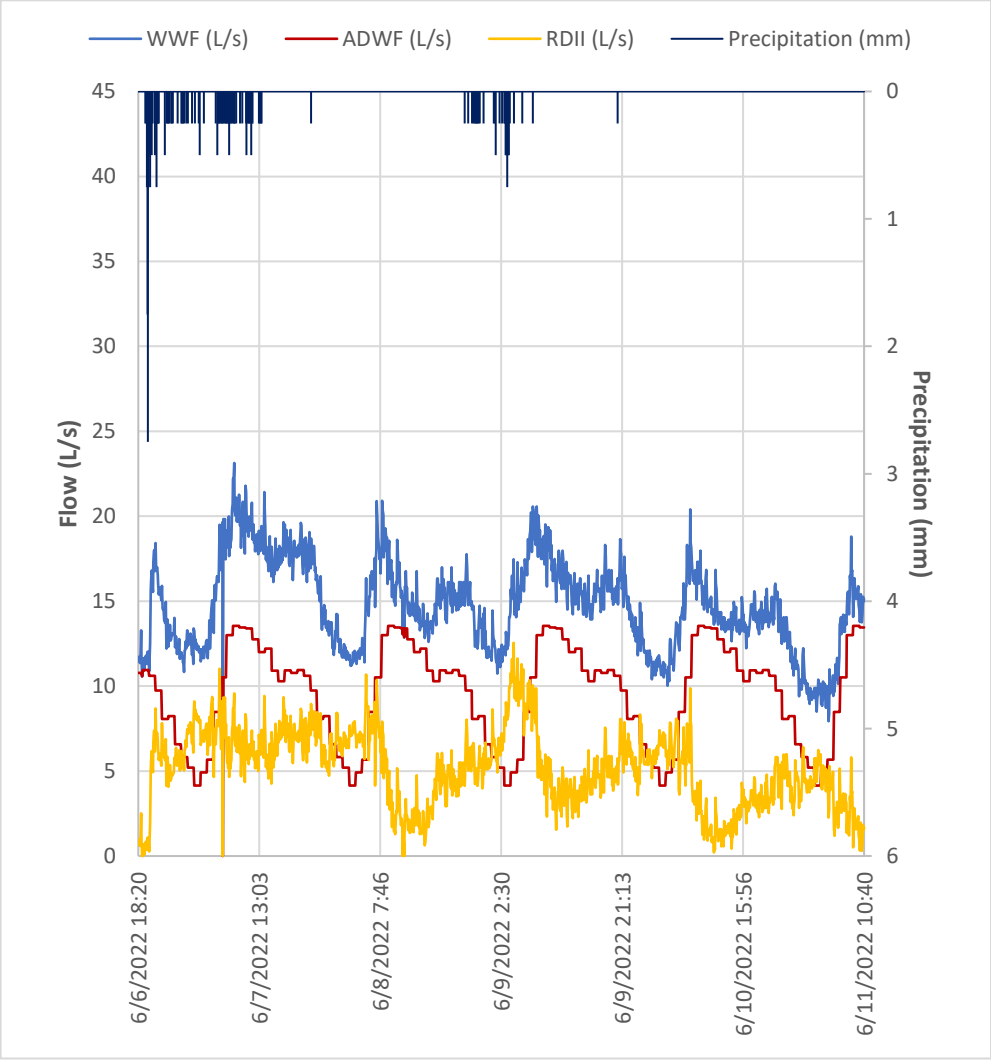
Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032 — 2022-06-06



Storm Statistics		
Rain Gauge ID	RoN_RG14	
Total Rainfall	32	mm
Rainfall Duration	60	hr
Peak 1-hr Intensity	6	mm/hr
Peak 5-min Intensity	12	mm/hr

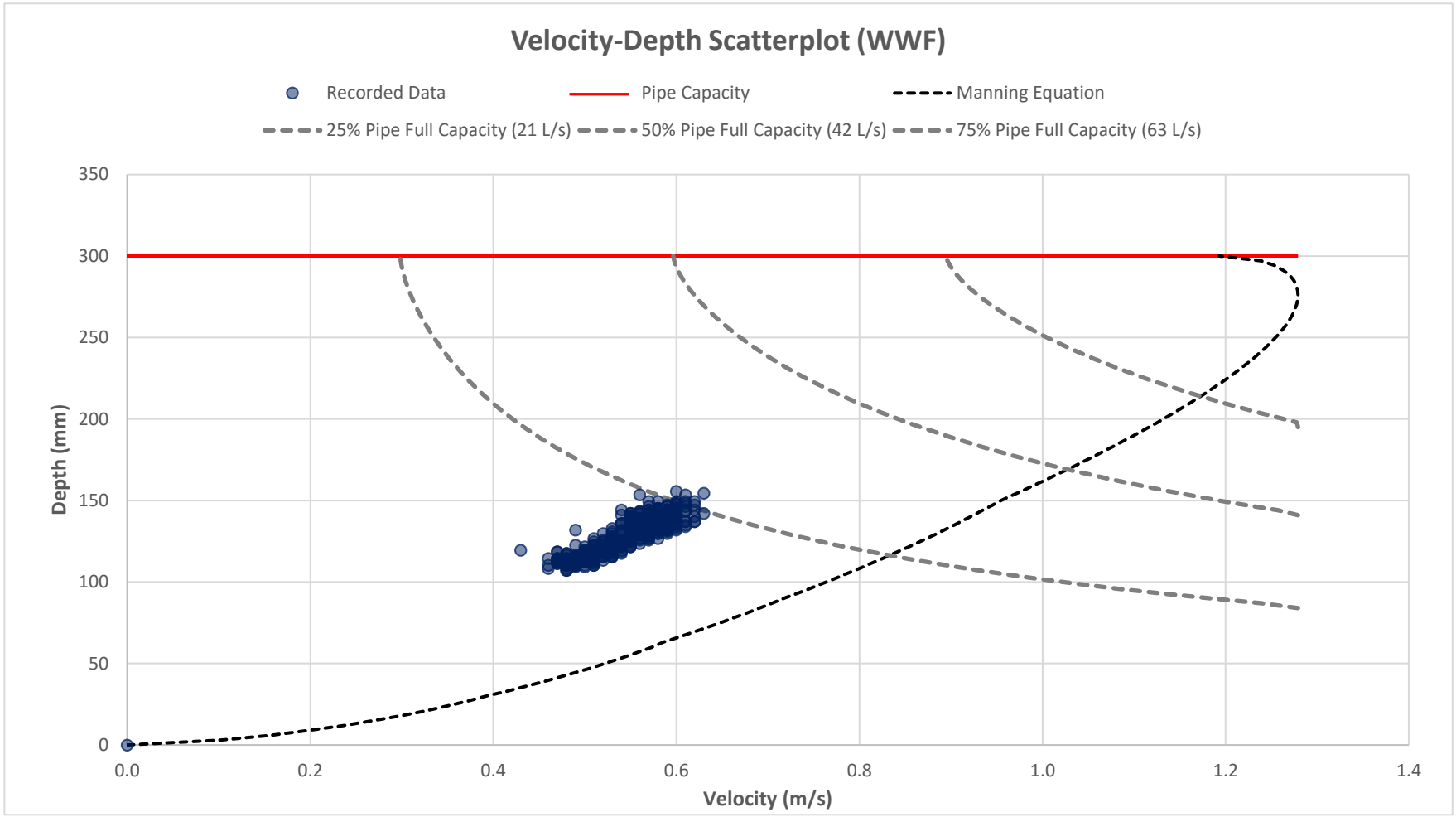
Monitored Area Statistics		
Catchment Area (ha)	130.8	ha
Total Pipe Surface Area (m^2)		m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	6/6/2022 18:20	
End of Analysis	6/11/2022 10:40	
Peak Flow (PF)	21.660	L/s
Time of PF	6/7/2022 9:10	
DWF at Time of PF	13.074	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	11.757	L/s
Volume of RDII	1801	m^3
Peak Unit RDII	0.09	L/s/ha
Peak Unit RDII		$L/s/km^2$
Volumetric Coefficient	4.30	%
WWF Vol./DWF Vol.	1.5	
PWWF/ADWF	2.4	
Return Period at Tc		

Commentary:

Analysis Period: March 01, 2022 - June 16, 2022

Flow Monitor: FM032 — 2022-06-06



Manning Equation Variables

Diameter (mm)	300
Slope (m/m)	0.0045
Roughness Coefficient	0.01

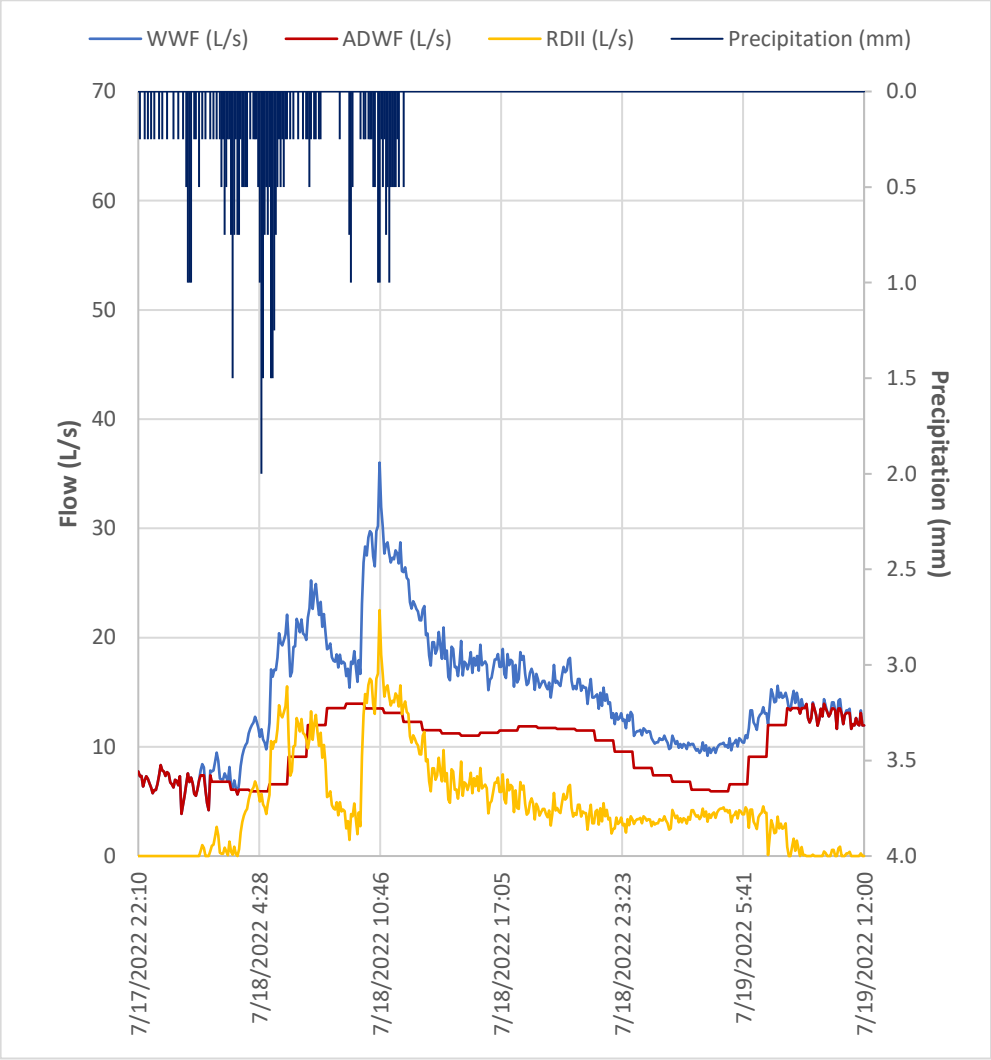
Analysis Period: March 01, 2022 - June 16, 2022

BluePlan ENGINEERING

Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032 — 2022-07-17



Storm Statistics		
Rain Gauge ID	RoN_RG16	
Total Rainfall	51	mm
Rainfall Duration	14	hr
Peak 1-hr Intensity	13	mm/hr
Peak 5-min Intensity	24	mm/hr

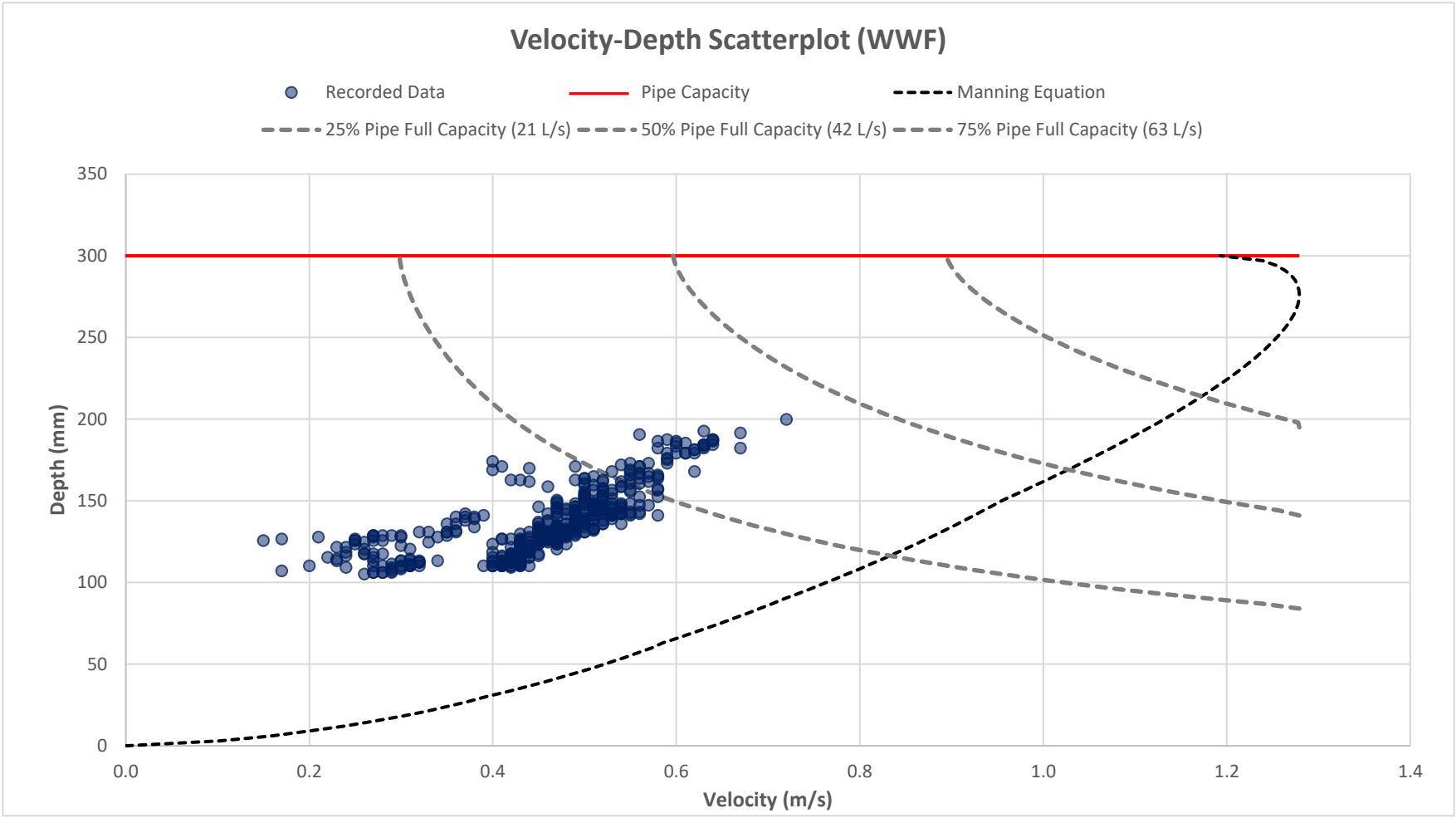
Monitored Area Statistics		
Catchment Area (ha)	130.8	ha
Total Pipe Surface Area (m^2)	8,198	m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	7/17/2022 22:10	
End of Analysis	7/19/2022 12:00	
Peak Flow (PF)	36.020	L/s
Time of PF	7/18/2022 10:45	
DWF at Time of PF	12.083	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	23.937	L/s
Volume of RDII	711	m^3
Peak Unit RDII	0.18	L/s/ha
Peak Unit RDII	2919.8976	$L/s/km^2$
Volumetric Coefficient	1.07	%
WWF Vol./DWF Vol.	1.6	
PWWF/ADWF	3.8	
Return Period at Tc		

Commentary:

Analysis Period: July 01, 2022 - July 31, 2022

Flow Monitor: FM032 — 2022-07-17



Manning Equation Variables

Diameter (mm)	300
Slope (m/m)	0.0045
Roughness Coefficient	0.01

Analysis Period: July 01, 2022 - July 31, 2022

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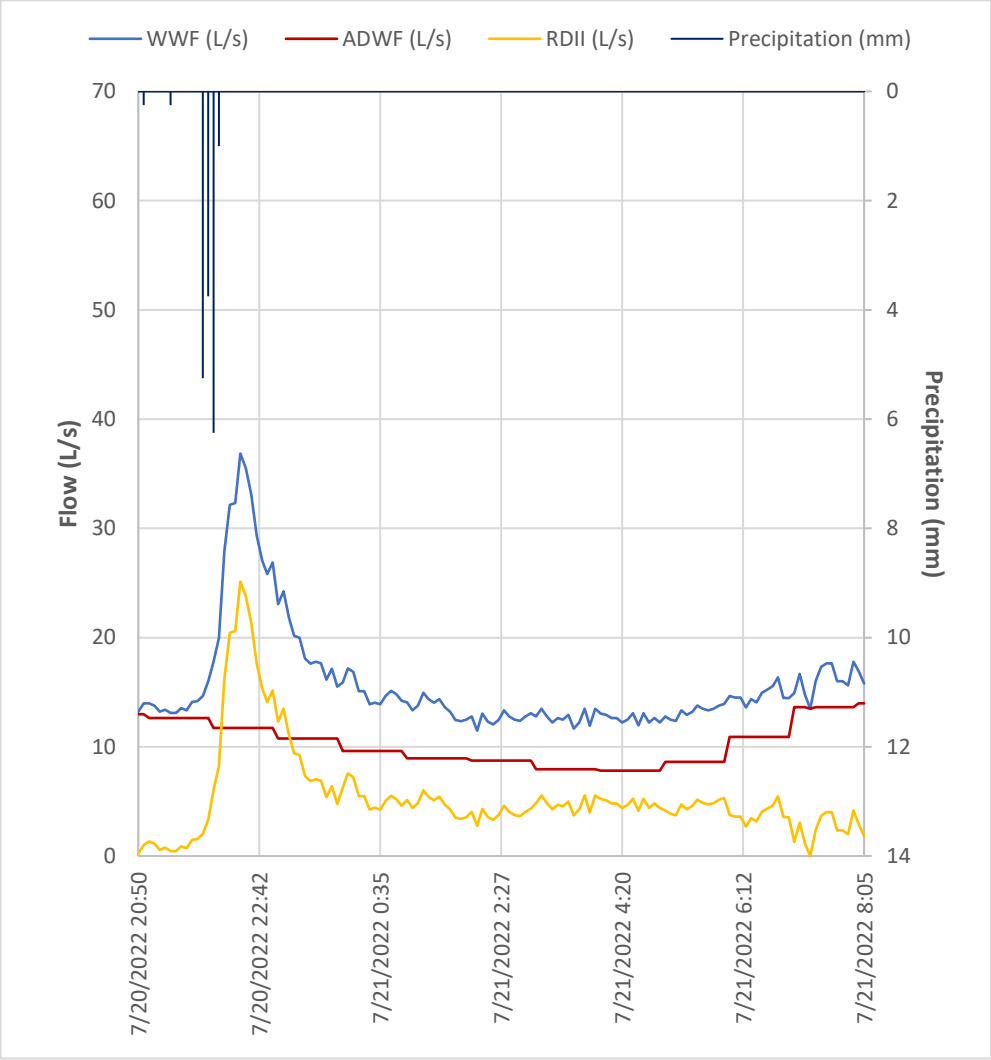
Niagara- On- The- Lake

Flow Analysis Report

Flow Monitor: FM032 — 2022-07-20



Storm Statistics		
Rain Gauge ID	RoN_RG16	
Total Rainfall	17	mm
Rainfall Duration	1	hr
Peak 1-hr Intensity	17	mm/hr
Peak 5-min Intensity	75	mm/hr

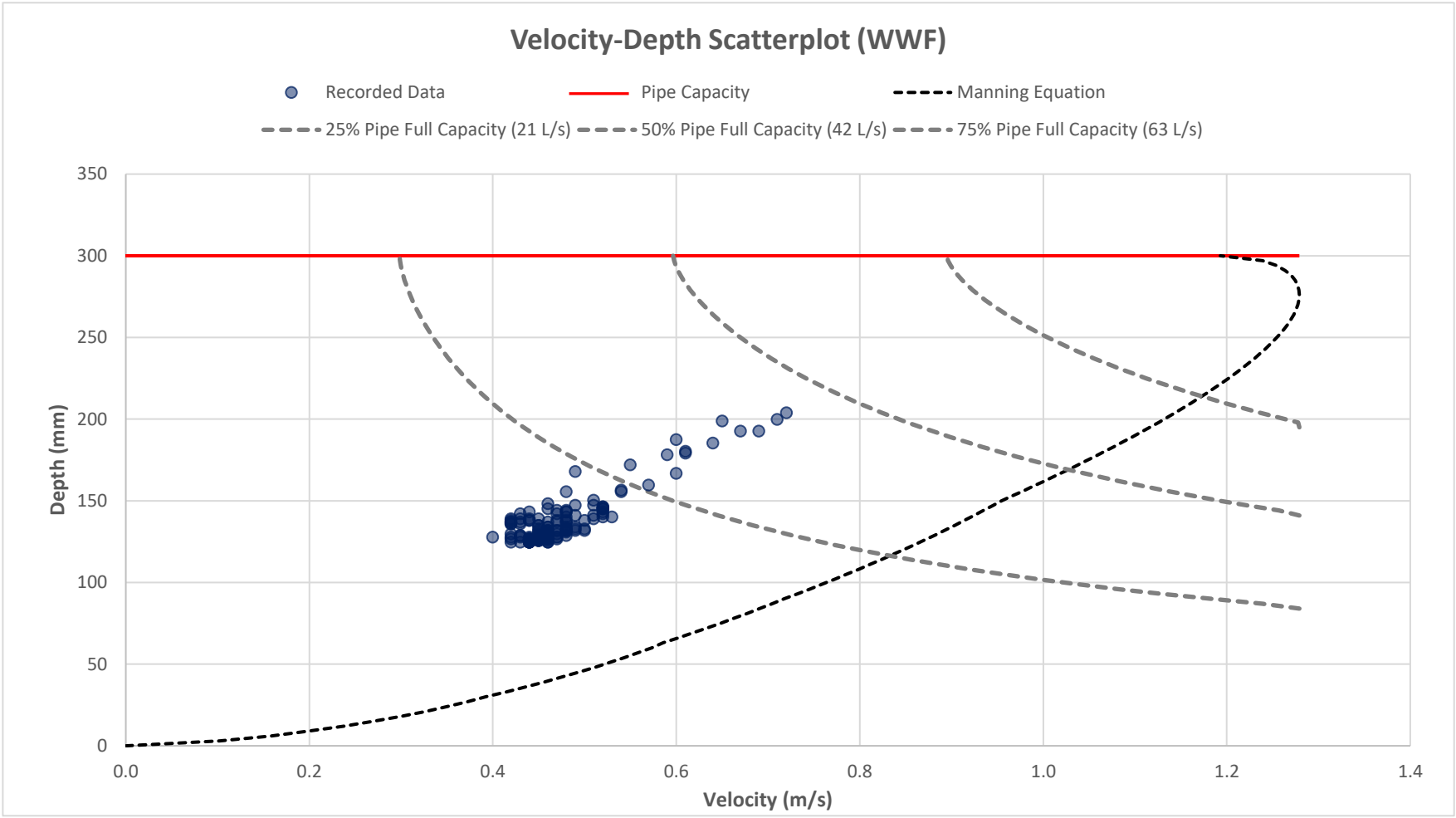
Monitored Area Statistics		
Catchment Area (ha)	130.8	ha
Total Pipe Surface Area (m^2)	8,198	m^2
Catchment Tc		min

I&I Event Statistics		
Start of Analysis	7/20/2022 20:50	
End of Analysis	7/21/2022 8:05	
Peak Flow (PF)	36.850	L/s
Time of PF	7/20/2022 22:25	
DWF at Time of PF	11.724	L/s
DWF Approach	Preceding 24-hour	
Peak RDII	25.126	L/s
Volume of RDII	221	m^3
Peak Unit RDII	0.19	L/s/ha
Peak Unit RDII	3064.8392	$L/s/km^2$
Volumetric Coefficient	1.01	%
WWF Vol./DWF Vol.	1.5	
PWWF/ADWF	3.6	
Return Period at Tc		

Commentary:

Analysis Period: July 01, 2022 - July 31, 2022

Flow Monitor: FM032 — 2022-07-20



Manning Equation Variables

Diameter (mm)	300
Slope (m/m)	0.0045
Roughness Coefficient	0.01

Analysis Period: July 01, 2022 - July 31, 2022

BluePlan ENGINEERING

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

APPENDIX D

Tawny Ridge Estates (Phase 2) – Stormwater Management Plan

STORMWATER MANAGEMENT PLAN

TAWNY RIDGE ESTATES (PHASE 2)

TOWN OF NIAGARA-ON-THE-LAKE

Prepared for:

ST. DAVIDS RIVERVIEW ESTATES INC
1755 STEVENSVILLE ROAD
FORT ERIE, ON
L0S 1N0

Prepared by:

Upper Canada Consultants
3-30 Hannover Drive
St. Catharines, Ontario
L2W 1A3

Revised May 2025

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

Appendix A	Vineyard Creek Estates Stormwater Management Plan Kerry T. Howe Engineering Limited (June 2005)
Appendix B	Tanbark Road Reconstruction Storm Drainage Areas
Appendix C	Stage Storage Discharge Calculation Sheet
Appendix D	MIDUSS Output Files (5 Year Design Storm)
Appendix E	MIDUSS Output Files (100 Year Design Storm)

REFERENCES

1. Stormwater Management Planning and Design Manual
   Ontario Ministry of Environment (March 2003)

2. Vineyard Creek Estates Stormwater Management Plan Kerry T. Howe Engineering Limited (June 2005)

STORMWATER MANAGEMENT PLAN

TAWNY RIDGE ESTATES (PHASE 2)

TOWN OF NIAGARA-ON-THE-LAKE

1.0 INTRODUCTION

1.1 Study Area

The proposed residential development of Tawny Ridge Estates (Phase 2) is located in the Village of St. Davids in the Town of Niagara-on-the-Lake. As shown on the enclosed Site Location Plan (Figure 1), the subject property is situated south of Warner Road, north of Tulip Tree Road and west of Tanbark Road. The proposed development will have two site entrances. The first one is located at the northwest limits of the site onto Warner Road and the second is located at the southeast limits of the site at the intersection of Tulip Tree Road and Chestnut Avenue.

Phase 1 of Tawny Ridge Estates is comprised of 12 single family residential lots fronting on Tanbark Road. The Phase 2 lands, which are the subject of the current submission for Conditions of Clearance of Draft Plan of Subdivision Approval, are located immediately west of the Phase 1 lands. Phase 2 consists of 20 single-family residential dwellings, 6 Blocks of townhouse dwellings and one medium density residential Block (Block 27).

A separate Functional Servicing Report was submitted for Phase 1 concluding that the municipal services for the Phase 1 lands would be independent from the Phase 2 lands. Therefore, for the purposes of this report, only the Phase 2 lands will be considered and will be referenced as the “Subject Lands” herein.

As part of the construction of Phase 2 of Tawny Ridge, Warner Road from Tanbark Road to the western limit of the site shall be reconstructed to an urban cross section with associated curb and gutter and sidewalk. The reconstruction of Warner Road will include the construction of catch basins and storm sewers that shall extend from the site entrance and outlet to the existing storm sewer on Tanbark Road.

The approximately 3.09 ha site will include associated asphalt road, concrete curb, catch basins, storm sewers, sanitary sewers and watermain. The drainage areas contributing to this stormwater management plan consist primarily of the subject lands and Warner Road from Tanbark Road to the future site entrance. All stormwater flows from the site will outlet to the Vineyard Creek Estates Stormwater Management Pond that ultimately outlets to Four Mile Creek.

1.2 Objectives

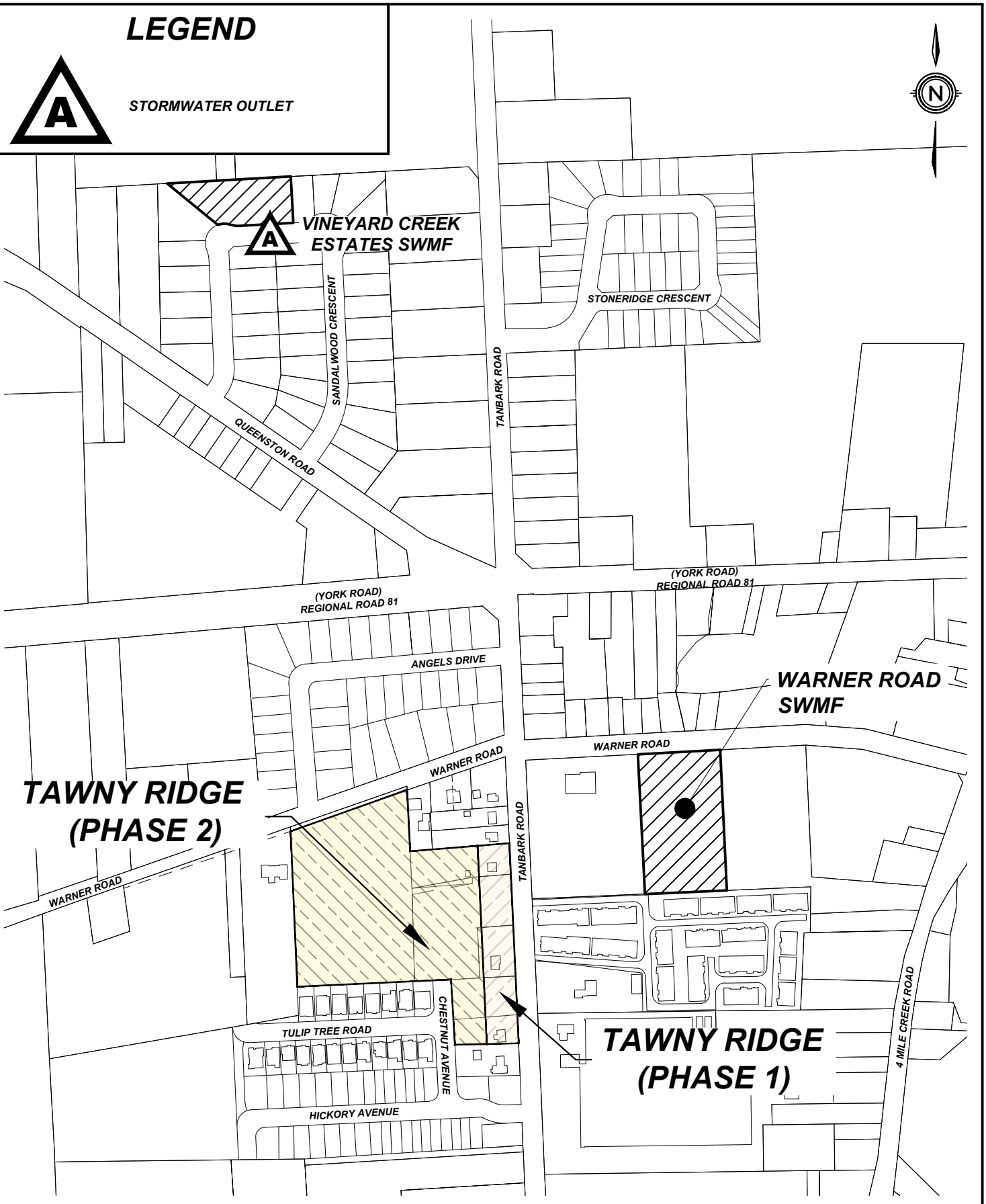
The objectives of this study are as follows:

1. Establish specific criteria for the management of stormwater from this site.

2. Determine the impact of development on the stormwater peak flow & volume from this site.

3. Investigate alternatives for controlling the quantity and quality of stormwater from this site.

4. Recommend a comprehensive plan for the management of stormwater during and after construction.



UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

TAWNY RIDGE ESTATES (PHASE 2)

TOWN OF NIAGRA-ON-THE-LAKE
SITE LOCATION PLAN

DATE	2024-12-11
SCALE	1:5000 m
REF No.	21178
DWG No.	FIGURE 1

DRAWING FILE: F:\21178\SWM\Old\Phase 2\21178 SWM Base.dwg PLOTTED: Dec 19, 2024 - 8:55am PLOTTED BY: zachb

1.3 Existing & Proposed Conditions

a) Existing Conditions

A Stormwater Management Report was prepared by Kerry T. Howe Engineering Limited and approved for the existing Vineyard Creek Estates stormwater management facility (SWMF), dated June 2005. As outlined within the approved Stormwater Management Report, the Vineyard Creek Estates Stormwater Management (SWM) Pond, which is located on Sandalwood Crescent as shown in Figure 1, was approved and constructed as a communal pond SWM facility to receive peak stormwater flows from the areas south of York Road and west of Tanbark Road. The communal facility was designed to provide stormwater quantity controls (storage) up to and including the 100 year design storm event and stormwater quality improvements to MECP Normal levels (70% TSS Removal) for the associated upstream drainage areas.

Upon review of existing topographical data, it has been determined that existing and future stormwater flows from the subject lands flow easterly to Tanbark Road. Overland Flows on Tanbark Road then flow northerly to Queenston Road, then northwesterly to Sandalwood Crescent and outlet to the Vineyard Creek Estates SWM Pond. The Vineyard Creek Estates Communal Pond Drainage Areas have been included in Appendix A. The subject lands are contained within Drainage Ares 1, 2, 3, 4, 5 and 202 in the enclosed Drainage Area Plan and were allocated capacity in the permanent pool and active storage volumes in the communal SWM facility at an overall imperviousness of 30% (0.40 Runoff Coefficient).

After the approval and construction of the Vineyard Creek Estates SWM Pond Tanbark Road was reconstructed from Pinecroft Drive to York Road. As part of the reconstruction, a 600mm diameter storm sewer was constructed that begins at the intersection of Warner Road and Tanbark Road and flows northerly to York Road. Flows from the reconstructed Tanbark Road ultimately outlet to the Vineyard Creek Estates SWM Pond. The existing storm sewer system was designed and constructed to convey the stormwater flows from the areas allocated to the Vineyard Creek Estates SWM pond, including the subject lands, at a runoff coefficient of 0.40. Drainage Areas for the storm sewer on Tanbark Road have been provided and have been included in Appendix B. As indicated on the Tanbark Road Storm Drainage Area Plan, Drainage Area 1 was assigned to the subject lands. The Drainage Area Plan shows flows from the subject lands are directed overland to Warner Road and outlets to the storm sewer on Tanbark Road at the intersection of Tanbark Road and Warner Road.

Historically, the site has been undeveloped open space. The majority of native soils within the study area have been determined to have poor draining and is part of Gleyed Brunisolic Gray Brown Luvisol soil group.

b) Proposed Conditions

The proposed development shall consist of the 20 single-family residential dwellings, 6 Blocks of townhouse dwellings and one medium density residential Block (Block 27). As part of the development Warner Road will be reconstructed to an urban cross section to include curb and gutters, and sidewalks. The reconstruction of Warner Road will also include the construction of new catch basins and new 600mm diameter storm sewers that will outlet to the existing 600mm diameter storm sewer on Tanbark Road.

The development will be constructed with asphalt pavement, concrete curbs and gutters, storm sewers, sanitary sewers and watermain.

2.0 STORMWATER MANAGEMENT CRITERIA

New developments are required to provide stormwater management in accordance with provincial and municipal policies including:

- Stormwater Quality Guidelines for New Development (MECP/MNRF, May 1991)

- Stormwater Management Planning and Design Manual (MECP, March 2003)

Based on the comments and outstanding policies from various agencies (Town of Niagara-on-the-Lake, Regional Municipality of Niagara, Niagara Peninsula Conservation Authority (NPCA), and the Ministry of the Environment, Conservation and Parks (MECP), and others) the following site specific considerations were identified:

- The existing downstream Vineyard Creek Estates Stormwater Management Facility provides stormwater quality improvements via a permanent pool volume to MECP Normal Levels (70% TSS Removal) for the entire Vineyard Creek Estates Communal Pond Drainage Areas, which included the subject lands at an overall imperviousness of 30% (equivalent runoff coefficient of 0.40) (See Appendix A).

- The Vineyard Creek Estates Stormwater Management Facility was designed to control future stormwater flows from the associated tributary drainage area (which includes the subject lands) to existing levels. This facility was designed using previous Town of Niagara-on-the-Lake Design Storm Events, which differ from the current standards which specify the use of the City of St. Catharines Design Storm Events.

- The existing 600mm diameter storm sewer flowing northerly on Warner Road was designed to receive peak 5 year flows from the subject lands at an overall runoff coefficient of 0.40. These sewers were designed using the City of St. Catharines 5 Year design storm, which aligns with current Town design standards.

Based on the above policies and site specific considerations, the following stormwater management criteria have been established for this site.

- Stormwater **quality** controls are required if the increased imperviousness within the subject lands requires more permanent pool volume in the existing Vineyard Creek Estates SWM Facility then what was approved in the SWM report to provide MECP Normal Protection (70% TSS Removal).

- Stormwater **quantity** controls are to be provided from the subject lands as follows:

  - The 5 year design storm event to the most restrictive of the following:
    - The available capacity of the existing 600mm diameter storm sewers on Tanbark Road; and,
    - Existing levels downstream of the existing Vineyard Creek Estates SWM Facility.
  - The 100 year design storm event to Existing levels downstream of the existing Vineyard Creek Estates SWM Facility which will be determined using the 100 year design storm specified in the Vineyard Creek Estates SWM Plan.

3.0 STORMWATER ANALYSIS

As identified in the Vineyard Creek Estates SWM Plan, stormwater modelling was conducted using MIDUSS for the design of the proposed SWM Facility within the subject lands to assess future conditions at the existing SWM facility including the proposed development. Therefore, it is proposed to also utilize MIDUSS with reference to the modelling and routing provided in the Vineyard Creek Estates SWM Plan.

3.1 Design Storms

The following design storm hyetographs were used for the proposed MIDUSS modelling:

i) 5 Year Design storm using a 4-hour Chicago distribution based on the City of St. Catharines IDF Curve, in accordance with the Tanbark Road Storm Sewer design for consistency in the storm sewer designs.

ii) 5 and 100 Year Design Storm using Chicago distribution based on the IDF parameters provided in the Vineyard Creek Estates SWM Plan for an “apples to apples” comparison of the pre to post development flow comparison.

Table 1. Rainfall Data			
Design Storm (Return Period)	**Chicago Distribution Parameters**		
	a	**b**	**c**
Tanbark Road Storm Sewers			
5 Year	664.00	4.700	0.744
Vineyard Creek Estates SWM Facility			
5 Year	996.92	4.233	0.826
100 Year	1815.30	3.090	0.847
$Intensity\ (mm/hr) = \frac{a}{(t_d + b)^c}$			

3.2 Existing/Allowable Conditions

Existing conditions within the subject lands were previously modelled as part of the Vineyard Creek Estates SWM Plan to establish the peak flow targets for the communal wet pond facility. The design of this facility allocated capacity to receive future peak stormwater flows from the subject lands up to the 100 year design storm event at an allowable imperviousness of 30% (runoff coefficient of 0.40).

Following the construction of the Vineyard Creek Estates SWM Facility, Tanbark Road was reconstructed with curb and gutter from Pinecroft Drive to York Road which also included the construction of 600mm diameter storm sewers to convey peak 5 year flows from upstream areas to ultimately outlet to the Vineyard Creek Estates SWM Facility.

Therefore, for the purposes of this Stormwater Management Plan, the peak flow targets for the subject lands will be to the allowable levels established in the Vineyard Creek Estates SWM Plan or the Tanbark Road Storm Sewer design, whichever is more restrictive.

Vineyard Creek Estates SWM Plan

The Vineyard Creek Estates SWM Plan included the subject lands as Drainage Areas 1, 2, 3, 4, 5 and 202 in the design of the Communal Wet Pond Facility at an imperviousness of 30% as shown in Appendix A. The wet pond facility provides stormwater management quantity controls for the tributary drainage areas up to the 100 year design storm event.

As shown in Table 6.0 of the Vineyard Creek Estates SWM Plan (see Appendix A), future peak flows from the facility are below existing levels by 0.040 m^3/s and 0.092 m^3/s in the 5 and 100 year design storm events respectively.

Therefore, future peak flows from the subject lands must be restricted to ensure that the future peak flow from the existing SWM Facility does not exceed existing levels.

Tanbark Road Storm Sewers

Tanbark Road was reconstructed with 600mm diameter storm sewers that were designed to receive 5 year stormwater flows from the subject lands at a runoff coefficient of 0.40 (equivalent imperviousness of 30%) as shown in Tanbark Road Storm Drainage Areas included in Appendix B.

3.3 Proposed Conditions

It is proposed to construct an internal storm sewer system within the subject lands to collect and convey stormwater flows up to and including the 5 year design storm event. As part of the construction of the proposed development a new storm sewer will be installed on Warner Road and outlet to the existing 600mm diameter storm sewer on Tanbark Road. The internal storm sewer system within the subject lands will outlet to the proposed storm sewer on Warner Road. Through the detailed storm sewer design, it was determined that the proposed Warner Road storm sewers will be installed at a slope of 0.15% slope, which has a full flow capacity of 248 L/s.

The future drainage areas for the proposed development, shown in Figure 2, were modelled to establish the stormwater peak flows and volumes once the development has been completed.

As shown in Figure 2, Drainage Area A10, A11 and A12 represent the portion of the proposed development, Warner Road and external lands west of the development which will convey future stormwater flows to the existing Vineyard Creek Estates SWM Facility.

Drainage Area A10 represents external lands to the west of the development. This area will outlet to the proposed SWM facility within the subject lands. Capacity within the proposed SWM facility was allocated for this external area with an imperviousness of 30% (Runoff Coefficient 0.40).

Drainage Areas B10, B11, B12 and C10 consist of the Approved Tawny Ridge Estates Phase 1 and the proposed rear yard areas of Lots 1 to 12 from Tawny Ridge Estates Phase 2, which ultimately outlet to the Lowry Drain. Proposed flows from these areas were included in the design of Tawny Ridge Estates Phase 1, where it was concluded that the existing SWM Facility on Warner Road, and associated storm sewers on Tanbark Road/Warner Road have adequate capacity to receive future flows from these areas. Therefore, future flows from Areas B10, B11, B12, and C10 will not drain to the Vineyard Creek Estates SWM Facility, and will not be considered further in the following analysis.

Major Overland flows from Drainage Areas A10, A11and A12 will be directed easterly to Tanbark Road, which has been confirmed to then convey overland flows northerly to the Vineyard Creek Estates SWM Facility.

Per the findings of the Vineyard Creek Estates SWM Plan, stormwater management quantity controls are required to ensure future stormwater flows discharging from the Vineyard Creek Estates SWM Facility are below existing levels. As the subject lands will convey future stormwater flows to this facility, it is required to ensure existing flows are maintained downstream of the receiving SWM Facility under future conditions.

The existing and future conditions model from the Vineyard Creek Estates SWM Plan were prepared in MIDUSS. Therefore, it is proposed to recreate the future conditions modelling in MIDUSS per the Drainage Area Plan and Hydrological Modelling Parameters provided in the Vineyard Creek Estates SWM Plan, which are provided in Appendix A for reference, for the purposes of the proposed analysis for the subject lands.

To account for the revised future stormwater drainage areas within the subject lands, Drainage Areas 1, 2, 3, 4, 5 and 202 from the Vineyard Creek Estates MIDUSS Modelling have been revised as Areas A10, A11 and A12 shown in Figure 2, and are summarized below in Table 2. The Hydrological Parameters for the proposed drainage areas reflect the parameters used in the Vineyard Creek Estates MIDUSS Modelling where appropriate.

Table 2. Hydrologic Parameters - Drainage Areas A10, A11, & A12

Area No.	Area (ha)	Length (m)	Slope (%)	SCS CN	Allocated Percent Impervious	Proposed Percent Impervious
A10	1.17	90	1.0	68	30%	30%
A11	2.64	135	1.0	68	30%	73%
A12	1.68	110	1.0	68	30%	35%

The governing allowable peak flow from the subject lands is the lesser of the capacity of the proposed 600mm diameter storm sewers on Warner Road (248 L/s) or the allocated peak 5 year flow from Drainage Areas A11, A11, and A12 at an imperviousness of 30% per the Vineyard Creek Estates SWM Plan.

To be consistent with the design of the existing 600mm diameter storm sewers on Tanbark Road and the proposed storm sewer system within the subject lands the City of St. Catharines 5 Year Design Storm Event was used for the allowable 5 year flow calculations. The 5 Year MIDUSS Modelling calculations are provided in Appendix D and are summarized in Table 3 below.

Table 3. Controlling Peak 5 Year Flows to Storm Sewers

Constraint	Flow (m^3/s)
Peak 5 Year at 30% Imperviousness	0.259
Capacity of 600mm Sewer @ 0.15%	0.248

As shown in Table 3, the future 5 year peak flow from Drainage Areas A10, A11 and A12 will be restricted to the governing 0.248 L/s. Since this peak flow is more restrictive than what was previously allocated for the subject lands in the Vineyard Creek Estates SWM Plan, a further analysis to the existing SWM Facility is not required for the 5 year design storm event and will only be provided for the 100 year event.

The Vineyard Creek Estates SWM Plan identified the existing and future peak flows within the existing ditch immediately downstream of the existing SWM Facility and at the existing roadside ditch along Tanbark Road, approximately 275m north east of the SWM Facility. As identified in Table 5.0 of the Vineyard Creek Estates SWM Plan (see Appendix A), the most restrictive location in the 100 year design storm event is immediately downstream of the existing SWM Facility (Node 104). Therefore, the revised MIDUSS Model has been prepared to identify the new future peak 100 year flow at this location and future 100 year peak flows will be controlled to the existing flow at this location (1.424 m^3/s).

To be consistent with the Vineyard Creek Estates SWM Plan, the 100 year Design Storm Parameters shown in Table 1 (see Appendix A) of the SWM Plan have been used for the proposed MIDUSS Model. The revised 100 Year Future Conditions MIDUSS model for the Vineyard Creek Estates SWM Facility is included in Appendix E.

LEGEND

A0 / 0.00 / 0% — DRAINAGE AREA ID #; AREA IN HECTARES; IMPERVIOUSNESS (%)

PHASE 2 PROPOSED STORMWATER DRAINAGE AREA

PHASE 1 STORMWATER DRAINAGE AREA

MAJOR OVERLAND FLOW

A — STORMWATER OUTLET

N

ANGELS DRIVE

WARNER ROAD

TANBARK ROAD

CHESTNUT AVENUE

HICKORY AVENUE

TO VINEYARD CREEK ESTATES SWM FACILITY

TO LOWRY DRAIN

AREA C10 OUTLETS TO THE LOWRY DRAIN

TO WARNER ROAD SWM FACILITY

AREAS B10, B11 AND B12 OUTLET TO THE WARNER ROAD SWM FACILITY AND DO NOT OUTLET TO THE VINEYARD CREEK ESTATES SWM FACILITY.

EX 600Ø STM

600Ø STM

600Ø STM @ 0.15%

450Ø STM

300Ø STM

EX 300Ø STM

1200Ø STM

1500Ø STM

1350Ø STM

EX. 1050Ø STM

3000 STM PH 1

STM

A12 — 1.68 / 35%

A11 — 2.64 / 73.0%

A10 — 1.17 / 30.0%

B10 — 0.17 / –

B11 — 0.50 / –

B12 — 0.28 / –

C10 — 0.06 / –

BLOCK 27

STORM MANHOLE '7' WITH 185Ø ORFICE PLATE INSTALLED ON DOWNSTREAM 450Ø STM

BLOCK 26 BLOCK 25 BLOCK 24

BLOCK 21 BLOCK 22 BLOCK 23

20 19 18 17 16 15 14 13

12 11 10 9 8 7 6 5 4 3 2 1

A B C

UPPER CANADA CONSULTANTS
ENGINEERS / PLANNERS

TAWNY RIDGE ESTATES PHASE 2

TOWN OF NIAGARA-ON-THE-LAKE

FUTURE STORM DRAINAGE AREAS

DATE	2025–05–30
SCALE	1:1500 m
REF No.	21178
DWG No.	FIGURE 2

4.0 STORMWATER MANAGEMENT ALTERNATIVES

4.1 Screening of Stormwater Management Alternatives

A variety of stormwater management alternatives are available to control the quality of stormwater, most of which are described in the Stormwater Management Planning and Design Manual (MECP, March 2003). Alternatives for the proposed and ultimate developments were considered in the following broad categories: lot level, vegetative, infiltration, and end-of-pipe controls. General comments on each category are provided below. Individual alternatives for the proposed development are listed in Table 4 with comments on their effectiveness and applicability to the proposed outlet.

a) Lot Level Controls

Lot level controls are not generally suitable as the primary control facility for quality control. They are generally used to enhance stormwater quality in conjunction with other types of control facilities.

b) Vegetative Alternatives

Vegetative stormwater management practices are not generally suitable as the primary control facility for quality control. They are generally used to enhance stormwater quality in conjunction with other types of control facilities.

c) Infiltration Alternatives

Where soils are suitable, infiltration techniques can be very effective in providing quantity and quality control. However, the very small amount of surface area on this site dedicated to permeable surfaces such as greenspace and landscaping make this an impractical option. Therefore, infiltration techniques will not be considered for this development.

d) End-of-Pipe Alternatives

Surface storage techniques can be very effective in providing both quality and quantity control. Surface storage is not space efficient for very small sites such as this. Underground storage facilities, such as tanks, super pipes, etc. are more effective for small developments.

Table 4. Evaluation of Stormwater Management Practices

Tawny Ridge Estates Phase 2	Criteria for Implementation of Stormwater Management Practices (SWMP)					Technical Effectiveness (10 high)	Recommend Implementation Yes / No	Comments
	Topography	**Soils**	**Bedrock**	**Groundwater**	**Area**			
Site Conditions	***Variable 1 to 3%***	***Beverly Loamy <12mm/hr***	***At Considerable Depth***	***At Considerable Depth***	***± 3.81ha***			
Lot Level Controls								
Lot Grading	<5%	nlc	nlc	nlc	nlc	2	Yes	Quality/quantity benefits
Roof Leaders to Surface	nlc	nlc	nlc	nlc	nlc	2	Yes	Quality/quantity benefits
Roof Ldrs.to Soakaway Pits	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 0.5 ha	6	No	Unsuitable site conditions
Sump Pump Fdtn. Drains	nlc	nlc	nlc	nlc	nlc	2	No	Unsuitable site conditions
Vegetative								
Grassed Swales	< 5 %	nlc	nlc	nlc	nlc	7	Yes	Quality/quantity benefits
Filter Strips(Veg. Buffer)	< 10 %	nlc	nlc	>.5m Below Bottom	< 2 ha	5	No	Unsuitable site conditions
Infiltration								
Infiltration Basins	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 5 ha	2	No	Unsuitable site conditions
Infiltration Trench	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 2 ha	4	No	Unsuitable site conditions
Rear Yard Infiltration	< 2.0 %	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	< 0.5 ha	7	No	Unsuitable site conditions
Perforated Pipes	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	nlc	4	No	Unsuitable site conditions
Pervious Catch basins	nlc	loam, infiltr. > 15 mm/hr	>1m Below Bottom	>1m Below Bottom	nlc	3	No	Unsuitable site conditions
Sand Filters	nlc	nlc	nlc	>.5m Below Bottom	< 5 ha	5	No	High maintenance/poor aesthetics
Surface Storage								
Dry Ponds	nlc	nlc	nlc	nlc	> 5 ha	7	No	Effective Quantity Control
Wet Ponds	nlc	nlc	nlc	nlc	> 5 ha	9	No	Unsuitable site conditions
Wetlands	nlc	nlc	nlc	nlc	> 5 ha	10	No	Very effective quality control
Other								
Underground storage	nlc	nlc	nlc	nlc	<5 ha	8	Yes	Quantity benefits only
Oil/Grit Separator	nlc	nlc	nlc	nlc	<5 ha	8	No	Effective quality control

Reference: Stormwater Management Practices Planning and Design Manual - 1994
nlc - No Limiting Criteria

4.2 Selection of Stormwater Management Alternatives

Stormwater management alternatives were screened based on technical effectiveness, physical suitability for this site, and their ability to meet the stormwater management criteria established for proposed and future development areas. The following stormwater management alternatives are recommended for implementation on the proposed development:

- **Lot grading** to be kept as flat as practical, while remaining consistent with municipal standards, in order to slow down stormwater and encourage infiltration.

- **Roof leaders to be discharged to the ground surface** in order to slow down stormwater and encourage infiltration.

- **Grassed swales** to be used to collect rear lot drainage. Grassed swales tend to filter sediments and slow down the rate of stormwater.

- **Underground Superpipe Storage** to provide stormwater quantity control for stormwater flows from the proposed development up to and including the 100 year storm event.

5.0 STORMWATER MANAGEMENT PLAN

A MIDUSS model was created to assess the allocated and future peak flows and stormwater volumes generated by the proposed residential development. The stormwater management facility was sized according to MECP Guidelines (MECP, March 2003) as follows:

5.1 Quantity Assessment

The proposed stormwater management plan is to capture and convey all stormwater from the development and control the flow to the allowable levels for the 5 and 100 year design storm events as follows:

a) To the capacity of the proposed receiving 600mm diameter storm sewers on Warner Road for the 5 year design storm.
b) To existing levels downstream of the existing Vineyard Creek Estates SWM Facility for the 100 year design storm.

To provide the required stormwater management quantity controls for the subject lands, it is proposed to construct oversized storm sewers within the site and a control outlet consisting of an orifice prior to discharging to the proposed storm sewers on Warner Road.

It is not proposed to provide stormwater storage within the proposed municipal storm sewers on Warner Road. Therefore, flows from Drainage Area A10 and A11 will be overcontrolled such that the combined peak flow from A10, A11 and A12 do not exceed allowable levels.

5.1.1 Stormwater Management Facility Configuration

A 185mm orifice plate will be installed at an elevation of 122.61m within Manhole 7. Storage will be provided by 168m of 1200mm diameter 74m of 1350mm diameter and 25m of 1500mm diameter internal storm sewer system, as shown in Figure 2, which will provide stormwater storage to a maximum elevation 125.80m (the lowest proposed catchbasin rim upstream of the proposed control orifice), corresponding to a total available storage volume of 426.8m³.

Table 5 below outlines the stormwater management characteristics for the proposed SWM facility during the 5 year design storm event. A Stage-Storage-Discharge Calculation sheet has been included within Appendix C for this facility. The MIDUSS output files for the 5 year analysis can be found in Appendix D.

Table 5. Proposed SWM Facility Characteristics (5 Year Storm)

Design Storm (Return Period)	Peak Inflow (L/s)	Controlled Discharge (L/s)	Maximum Volume (m^3)	Maximum Elevation (m)	Combined Discharge from (A10, A11 and A12)
5 Year	357	113	412	125.57	171

As outlined in Table 5 above, future 5 year stormwater flows will be controlled to a maximum outflow of 113 L/s when discharging to the proposed sewers on Warner Road. This corresponds to a maximum 5 year elevation of 125.57m, maximum storage of 412m^3, and a combined discharge of 172 L/s from drainage area A10, A11 and A12, which is below the allowable peak 5 year flow of 248 L/s.

The revised future conditions MIDUSS Model for the Vineyard Creek Estates SWM Facility includes the proposed SWM facility controlling flow from Drainage Area A10 and A11. Due to site topography, it is not feasible to provide substantial surface storage so it has been conservatively assumed that any stormwater flows above an elevation of 125.80m (lowest rim elevation of roadway catch basins in the subject lands) will be conveyed northerly to Warner Road as overland flow.

Table 6 summarizes the ultimate future peak flows from the existing Vineyard Creek Estates SWM facility following the development of the subject lands. The 100 year MIDUSS Modelling has been included in Appendix E for reference.

Table 6. Impact on Existing Vineyard Creek Estates SWM Pond – 100 Year Design Storm				
Peak Pond Volume (m^3)	**Peak Pond Elevation (m)**	**Peak Pond Discharge (m^3/s)**	**Peak Flow in Receiving Ditch (m^3/s)**	**Existing Peak Flow in Receiving Ditch (m^3/s)**
2886	118.22	1.260	1.328	1.424

As outlined in Table 6, by providing quantity controls within Tawny Ridge Estates Phase 2, the volume is contained within the pond and the future peak flows in the receiving existing downstream ditch are below existing levels. Therefore, the proposed stormwater quantity controls adequately reduce future peak flows from the subject lands to existing levels for the 5 Year and 100 Year design storm events.

5.2 Quality Assessment

The Vineyard Creek Estates SWM Facility treats stormwater to Normal Protection (70% Overall TSS Removal). The permanent pool of the SWM Facility has been designed to treat stormwater from the entire Vineyard Creek Estates Communal Pond Drainage Area assuming a storage requirement of $90m^3$/ha. Based on Table 3.2 of SWMP & Design Manual, the water quality storage requirement is approximately $90m^3$/ha for *Normal* protection for developments with 35% impervious areas. Therefore, there is available capacity within the permanent pool for the overall tributary drainage area to have an imperviousness of 35%.

The overall imperviousness of the entire drainage tributary area outletting to the Vineyard Creek Estates SWM Facility, as stated in the Vineyard Creek Estates SWM Report is, 27.03%. Following the construction of Tawny Ridge (Phase 2), the overall imperviousness of the drainage area outletting to the Vineyard Creek Estates SWM Facility is increased to 32.1% without additional onsite quantity controls. Therefore, the Vineyard Creek Estates SWM Pond will have sufficient capacity to treat stormwater runoff from the proposed development and no further quality controls are required.

6.0 SEDIMENT AND EROSION CONTROL

Sediment and erosion controls are required during all construction phases of this development to limit the transport of sediment into the Vineyard Creek Estates SWM pond.

The following additional erosion and sediment controls will also be implemented during construction:

- Install silt control fencing along the limits of construction where overland flows will flow beyond the limits of the development or into downstream watercourse.

- Re-vegetate disturbed areas as soon as possible after grading works have been completed.

- Lot grading and siltation controls plans will be provided with sediment and erosion control measures to the appropriate agencies for approval during the final design stage.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this study, the following conclusions are offered:

- Infiltration techniques are not suitable for this site as the primary control facility due to the low soil infiltration rates.
- A proposed stormwater management facility consisting of a 200mm diameter control orifice and oversized storm sewer storage pipes will provide the required quantity controls for the subject lands.
- Various lot level vegetative stormwater management practices can be implemented to enhance stormwater quality.
- This report was prepared in accordance with the provincial guidelines contained in "Stormwater Management Planning and Design Manual, March 2003".

The above conclusions lead to the following recommendations:

- That the stormwater management criteria established in this report be accepted.
- That the 185mm diameter control orifice and oversized storm sewer storage pipes be constructed as outlined in this Stormwater Management Plan.
- That additional lot level controls and vegetative stormwater management practices as described previously in this report be implemented.
- That the sediment and erosion control during construction as described in this report be implemented.

Prepared By:

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Reviewed By:

Brendan Kapteyn, P.Eng.

May 30, 2025

APPENDICES

APPENDIX A

Vineyard Creek Estates Stormwater Management Plan Kerry T. Howe Engineering Limited (June 2005)

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Vineyard Creek Estates

St. David's – Town of Niagara-on-the-Lake

STORM WATER MANAGEMENT REPORT

June 2005

Our File: 03-024-102

E-mail kthengineeringltd@cogeco.net

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF DRAWINGS

List of Tables	Description
03-024-00	Cover Sheet
03-024-GSP	General Servicing Plan
03-024-GP	General Grading Plan
03-024-C1	Sandalwood Crescent – STA. 0+000 to STA. 0+300
03-024-C2	Sandalwood Crescent – STA. 0+300 to STA. 0+512
03-024-C3	Queenston Road – Plan & Profile
03-024-C4	West Ditch – Queenston Road to Pond Outlet
03-024-P1	Pond Detail and Section A
03-024-P2	Pond and West Ditch Sections
03-024-P3	Pond and STMH. 15 Details
03-024-D1	Details and Cross-Sections
03-024-STM	Storm Drainage Plan
03-024-SAN	Sanitary Drainage Plan

1.0 INTRODUCTION

Vineyard Creek Estates is a draft plan approved proposed residential subdivision located in the St. David's Town Site within the Town of Niagara-on-the-Lake. The proposed development is located north of Queenston Road west of Tanbark Road being part of Township lot 96.

The site area totals 5.67 ha. The draft plan of subdivision is included in a reduced format as Figure No. 1. All figures are included in Appendix "A" bound at the back of the report. The Draft Plan includes a key plan showing the location of the site in St. David's.

This report was initially prepared to identify a storm water management system to be developed within Vineyard Creek Estates. The analysis was required to implement the objectives of the St. David's Master Servicing Plan requirements for storm water management for new development outletting to Four Mile Creek when the storm water control pond site known as Site "B1" was not available to the municipality. This report provided the Town with information to assess the practicality of installing a municipal facility in Vineyard Creek Estates to replace a major component of the MSP.

The information used for analysis of alternatives has been left in the storm water management report. The Town has opted to compensate the owner for additional land area and oversizing costs through the development charges. The Town will collect from upstream owners their share of the costs outlayed as those developments proceed in the future.

This report includes additional design information for the communal wet pond system in a new Section 7.0 to the report. The conclusions section of the original report was renumbered to Section 8.0 in this report. Cost sharing issues reported herein reflect only the common areas shared by upstream land owners and typically included in the municipal development charges computations.

2.0 EXISTING STORM DRAINAGE

The existing storm drainage plan surrounding Vineyard Creek Estates is shown in Figure No. 2.0. The existing storm drainage plan is used to establish existing flow rates in the tributary drainage area upstream and downstream of the proposed development. The existing drainage boundaries compare favourably to the drainage boundaries described in the St. David's Area Master Servicing Plan.

The rainfall data is listed in Table No. 1.0. All sotrm events are characterized by a Chicago format storm distribution with a 4 hour duration. The St. Catharines Airport AES rainfall data was used to establish the total rainfall for the study frequencies.

The existing drainage area hydrologic and hydraulic parameters are summarized in Table 2.0. The existing storm drainage area Figure No. 2.0 includes the MIDUSS Nodal Schematic and existing water course and piping layouts. Table No. 2.0 lists the hydraulic conditions for the MIDUSS input. The existing MIDUSS Data files are included in Appendix "D". Table No. 2.0 includes flows and hydrograph volumes for each storm event modeled at key locations for comparison of pre and post peak rates and volume of run-off. The MIDUSS output at various control locations is summarized in Table C1 included in Appendix "D".

3.0 ST. DAVID'S MASTER SERVICING PLAN

The St. David's Master Servicing Plan storm water management proposal was outlined as Concept "B" in Figure "B" included between page i) and iii) of the executive summary of the MSP. That figure is photocopied in black and white and included in Appendix A of this report.

Vineyard Creek Estates comprises a portion of Area A shown in Figure "B". This site was to be serviced easterly by a 750 dia. storm sewer to Tanbark Road through an easement between existing lots. At Tanbark the sewer went south 45 m to meet a storm sewer which would outlet easterly to Pond B1 through a proposed residential development.

The existing land south of York Road was to be serviced by storm sewers along Tanbark Road northerly to the proposed easterly storm sewer outletting to storm pond B-1. The Queenston Road future storm sewer was to outlet through the Vineyard Creek Estate storm sewers to Pond B1. The Master Servicing Plan provided for future residential developments. The commercial, industrial and institutional zoned lands were to provide on-site controls to maintain raw land discharge peak rates into the municipal system. The tributary commercial land south of Queenston Road were assessed on the same basis in our report.

Several factors have come to light since the acceptance of the MSP Concept "B" plan.

a) The existing lots abutting Vineyard Creek Estates east boundary and Tanbark Drive are not owned by Vineyard Creek Estates.
b) A storm sewer following the alignment shown in Concept "B" from Vineyard Creek Estates to Tanbark would be 7 m deep on Tanbark Drive and the suggested existing lot crossing. This depth would require an eight (8) metre R.O.W. for crossing the lot which would adversely impact house siting on the lot and possibly limit the building envelope.
c) The Pond B-1 location would fall within the steep slope section of the Lowrey Municipal Drain watercourse. Significant tree removal would be required to construct the facility.
d) Future development in Area B on the east side of the water course could not access the pond for storm water control without increased depth trunk storm sewers.
e) The northerly section of Vineyard Creek Estates would have to be raised to drain south to the proposed easterly storm sewer. The additional fill would create lots requiring structural fill or increased foundation depths or deeper storm sewers.
f) Major event overland flow from Area "A" and Area "D" would continue through Vineyard Creek Estates and exit along the northerly drainage ditch. Only flows up to the 5 year would be directed to Pond B-1. Flow conditions in the Lowrey Drain West Branch could increase for the less frequent storms beyond a 5 year return.
g) The secondary plan for Area "B" was not attainable in the immediate future since the land owner abutting Tanbark was not interested in a land use change. The lands on the east side of the water course fronting on Four Mile Creek Road were being converted to a vineyard with a winery operation attached. The availability of land to create Pond B-1 was suspect as well as the concern for final construction discussed earlier.

When the draft plan for Vineyard Creek was submitted for circulation these constraints were identified. A storm water proposal was included to ensure the Development of Vineyard Creek Estates would not adversely impact the existing conditions or those proposed in the MSP. This proposal is referred to as the "stand alone" system as described in the next section.

4.0 VINEYARD CREEK "STAND ALONE" STORM WATER MANAGEMENT PROPOSAL

The "Stand Alone" SWM proposal can be generally described as follows:

a) Divert existing storm drainage flows along Queenston Road westerly to the existing watercourse flowing northerly along the west boundary of Vineyard Creek Estates. Improve the Queenston Road north roadside ditch. Install culverts across Sandalwood Crescent. Re-locate westerly drain to Vineyard Creek side of west property line and provide easement for Town access to maintain drain.
b) The development lands south of Queenston and York Roads to be serviced by Pond B-1.
c) Storm sewer from Street A to Tanbark Road across existing lots is not required.
d) Install a 5 year storm sewer system on Sandalwood Crescent to service Vineyard Creek Estates and lands abutting east property line currently draining onto the site.
e) Construct storm water detention pond for the 6.72 ha of land tributary through Vineyard Creek Sandalwood Crescent Storm Sewer. Detain flows to existing northerly channel to pre-development peak rate or lower.

The "Stand Alone" Storm Drainage Plan and MIDUSS Nodal Schematic is shown in Figure No. 4.0. The design area, hydrologic, and hydraulic parameters are shown in Table No. 4.0. The peak flows and hydrograph volumes are referenced to locations in Table No. 2.0 for comparison. Table C2 in Appendix "D" summarizes the MIDUSS output file at various control locations in the watershed. The peak flow and hydrograph volumes are transferred to Table No. 4.0.

This proposal was made assuming pond B-1 could be constructed as detailed in Concept "B" of the MSP. An additional pond location resulted. However; the existing water course north of the site which lies within private property was now protected in all storm events to pre-development levels. This was a significant improvement to the MSP from Concept "B" which in our opinion outweighed the minor maintenance effort caused by the additional pond.

The lot grading plan for the "Stand Alone" plan is shown in Figure No. 4.1. The pond has been provided the 3.0 m perimeter buffer required by the MSP. The works required on Queenston Road are shown in Figure No. 4.2.

The "Stand Alone" Block 38 wet pond area is 0.1735 ha. The wet pond design is shown in Table No. 4.1. The statistics for the wet pond are shown in Table 4.2 compared to M.O.E. design requirements and the requirements of the MSP.

The estimated construction costs for the "Stand Alone" wet pond are included in Appendix C. The capital cost for construction is repeated here as $260,548.00. The cost includes works on Queenston Road, Street A and the pond site. The west ditch realignment construction cost is the same in all alternatives and would be completed by the developer in any scenario so the cost tehnically is not shared by lands to the south. Figure No. 4.3 shows the west ditch profile from Queenston Road to Block 38.

5.0 A COMMUNAL SWM PROPOSAL

The Town MSP included an alternative location for Pond B-1 on Line 9 Road at Four Mile Creek Road. This site was located outside the urban area boundary which may have created Regional or Provincial negative comment towards use of the site. However, the use of Alt. B-1 meant the water courses to the south had to be improved to accept the increased run-off from new development storm outlets or each site would have to have quality and quantity control facilities to maintain the existing flow regime in the water courses.

The Town does not have an easement over the major outlet water courses which inhibits entry to improve the water courses. As well the existing natural vegetation would be altered during and after reconstruction work. The town had selected the MSP Concept "B" because it reduced the number of storm water facilities to be maintained in the future.

The Town's desire to reduce the number of facilities and the lack of easements or R.O.W.'s along the water courses across private property resulted in a request to provide a communal facility for storm water control within Vineyard Creek Estates for future development of the existing lands tributary from the south. The facility would maintain pre-development peak flow rates across the private property to the north of Vineyard Creek Estates.

The Town expressed a desire to pursue an easement agreement for the watercourse maintenance with the single owner affected before the watercourse reached the Municipal R.O.W. on Tanbark Drive north-east of Vineyard Creek Estates. To maintain the watercourse easement requirement to a single owner, the adjusted west swale from Queenston Road was diverted along the north boundary of Vineyard Creek Estates to outlet to the main water course channel.

A larger storm water management facility was to be provided within Vineyard Creek Estates to control quality and quantity of run-off to the main watercourse to pre-development levels. The Town and the NPCA both requested the quality control be provided by a wet pond facility with extended detention for quantity control as recommended in the M.S.P.

Figure No. 5.0 shows the post storm drainage conditions for the communal wet pond proposal. The future development south of York Road will be intercepted on the east leg of Sandalwood Crescent at Queenston Road. The future commercial lands between York Road and Queenston Road will be collected in the west leg of Street A at Queenston Road at pre-development levels. The storm sewer on Street A will be oversized to accommodate the 5 year peak flow rate from the south. Overland flow along the streets will direct the less frequent storm run-off to the pond site for control before discharge to the existing northerly watercourse.

Table No. 5.0 summarizes the commercial post area hydrologic and hydraulic parameters. Figure No. 5.0 includes the MIDUSS schematic. Table No. C3 in Appendix "D" summarizes the MIDUSS output for the communal model at various control points for comparison with the present condition model. Table No. 5.0 summarizes the MIDUSS peak storm flows at the same locations noted in Table 2.0 for pre and post development comparison.

Table No. 5.0 summarizes the land use and ownership for cost sharing of the permanent communal facility. All lands without current plans by land owners have been included as existing residential at this time.

The communal pond stage storage discharge relationship is shown in Table No. 5.1. Table No. 5.2 compares the pond requirement to M.O.E. design guidelines and the MSP.

The commercial land on-site control was simulated as a storage pond for purposes of the MIDUSS model. The on-site storage may take the form of tanks or oversized piping and parking lot storage in the less frequent events. Table No. 5.0 shows the expected commercial on-site storage used in the model. We believe the on-site storage volumes are reasonable for development of the future commercial sites.

The communal pond grading and servicing plan is shown in Figure No. 5.1. The pond requires that 2 lots (15 & 16) be deleted to construct a pond with sufficient storage volume and the same physical set-backs as the "stand alone" pond. The Communal Wet Pond Area totals 0.3298 ha. The pond land area excludes the land required to construct the drainage ditch along the north property since that area is required in both alternatives. Works required on Queenston Road are shown in Figure No. 5.2.

The estimated construction cost estimate for the communal pond and oversize storm sewers on Sandalwood Crescent and Queenston Road is included in Appendix "C". The cost for this communal pond less land cost is $596,660.00.

6.0 COST SHARING

The MSP listed the works required for new development in the St. David's Area. Construction cost estimates were prepared for those projects and the Town generated development charges for the St. David's area based on those estimates. Table 6.0 summarizes the storm water management and storm sewer works required to create the new development on the west side of Four (4) Mile Creek outlined in the MSP Concept "B". Construction costs are taken from the Summary Table Pages viii) and ix) of the executive summary of the MSP.

Table No. 6.1 lists the estimated construction costs for the storm water works now proposed for the new development area. The MSP costs excluded land costs for the wet pond sites. The total present cost is less than the MSP costs. The modifications for Apricot Glen and Vineyard Creek Estates will not increase the capital cost of the MSP storm water works.

Table No. 6.0 and 6.1 include capital costs per ha. for the new development lands tributary to the Vineyard Creek pond. The cost per ha. includes the re-development of existing open space at York Road to commercial zoning. The MSP did not identify this growth area separately in the Concept "B" Map Figure "B". The cost share was dispersed to the new development residential lands.

The Town is asking the Vineyard Creek Estates owners to expend $596,600.00 in construction costs for storm water works. The works will eliminate 4 lots from the potential available had Concept "B" been in place. The expected revenue from the 4 lots was $445,338.00 (land cost shown for Communal Pond). The Town development charge is to generate $379,490.00 from lands south of Vineyard Creek Estates. The potential cost to Vineyard Creek Estates is $662,448.00. If they were to proceed on the "Stand Alone" system their cost would have been $494,841.00 less the revenues of two (2) lots $202,045.00 = $292,796.00.

The "Stand Alone" system would reduce their loss by $369,652.00. This assumes that the Town's development charges recovery is based on an area basis. The recovery may vary if an average unit per ha. figure was used.

7.0 FINAL DESIGN FEATURES FOR THE COMMUNAL POND

The Town accepted the use of the communal pond system within Vineyard Creek. The owner had a landscape plan prepared for the site by P.J. Smith and Associates. The proposed landscape plan is included in Appendix "B".

The landscape plan provided features which use up volume within the storage area. To off-set this volume loss some bio-engineered minimal retaining walls have been added to the pond design. The retaining areas will have a height of 0 m to 0.35 m maximum. The wall will be constructed using the Deltalock Patented Ecological Engineering System. The Deltalock sytem uses permeable non-woven geotextile bags filled with a permeable soil interlocked with plastic plates to create a vertical wall. The wall is hydro-seeded to create a natural vegetation cover to help maintain the wall integrity. The wall height will not exceed 0.35 m in height. The slope flattening for 3.0 m on the lower side will more than make-up for landscape volume losses. The low wall height will not require a railing.

A longitudinal section and pond cross sections are shown in Drawing P3. The pond outlet control structure is shown in Drawing D1. The overflow weir detail is shown in detail drawing D1.

The pond relief overland flow path to the existing ditch can be constructed of machine placed rip-rap 0.3 m minimum to 0.4 m maximum diameter stone. Alternatively the path can be constructed using Uni-lock Dura-mat a modular concrete paver system filled with topsoil and seeded to create a natural grassed outlet appearance.

A section through the proposed outlet structure piping has been included in detail drawing D1. The quality inlet will be by infiltration through a percolation trench from the outlet pool. The less frequent storm outflow will enter the control structure through the piping located above the permanent water level.

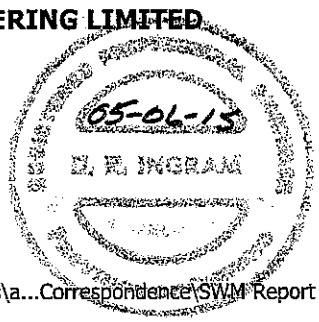
8.0 CONCLUSIONS

The proposed modified storm water management plan for the St. David's area west of Four Mile Creek will not adversely impact new or existing development. The creation of Pond B-1 is suspect due to the property ownership constraints. The proposed system will not increase storm water development charges proposed for construction of the works. However; cost adjustments are necessary to recover land costs for a new communal facility on lands that would have been available for development in Vineyard Creek Estates.

The owner had accepted the loss of two (2) lots to achieve an early start for construction. The oversizing of sewers and a larger pond to accommodate upstream development necessitate the owner request payment for the loss of revenue for two (2) additional lots.

The proposed system also provides protection to the west branch of the Lowrey Drain crossing in private property. This is an improvement to the requirements of the MSP which would not have controlled post development flows beyond the 5 year storm event. The new pond location also permits development upstream to proceed without on-site temporary controls once the wet pond in Vineyard Creek Estates is in place.

Prepared by:
KERRY T. HOWE ENGINEERING LIMITED



Doug Ingram, P. Eng.
Chief Municipal Engineer

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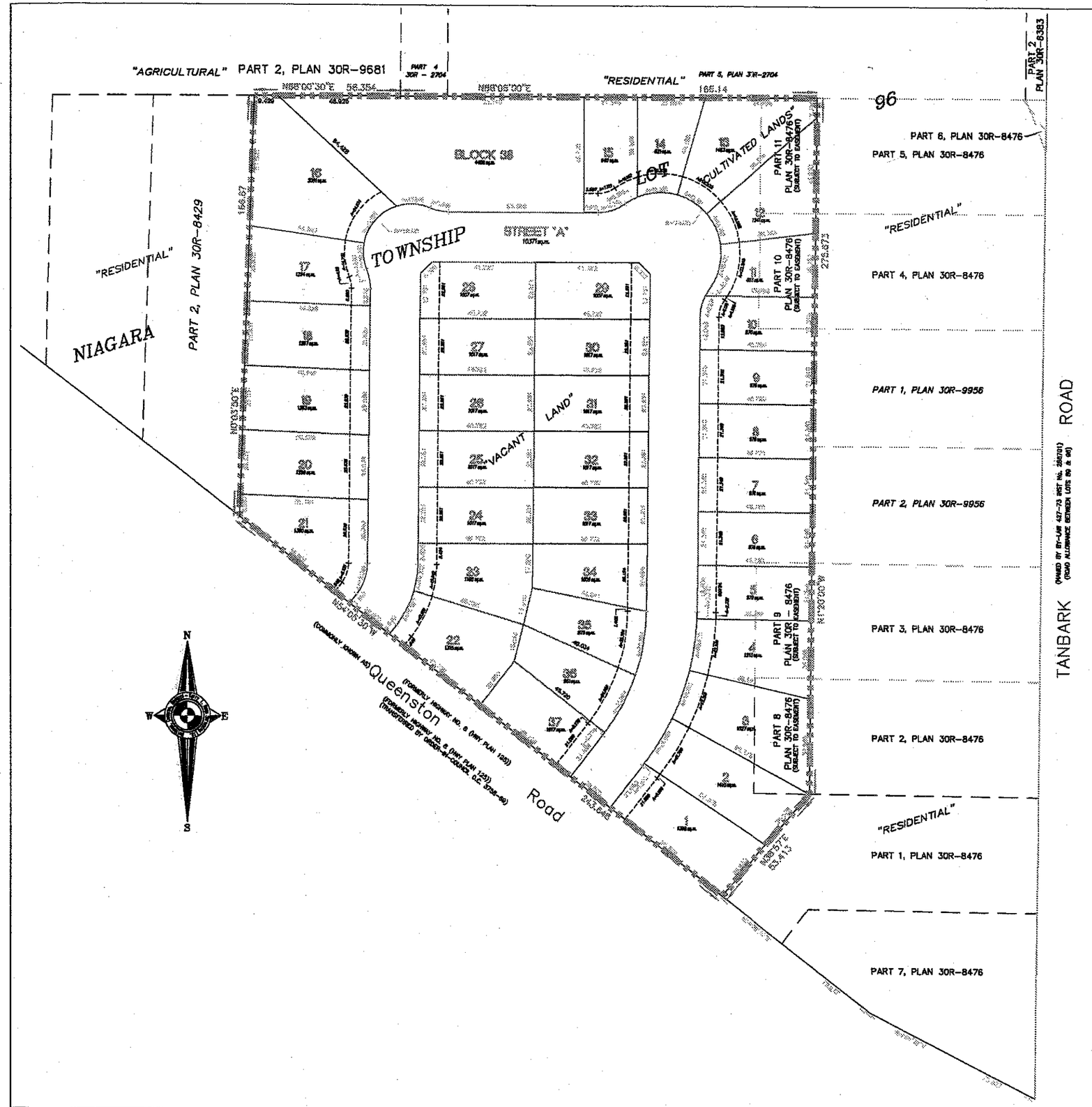
APPENDIX A – Figures



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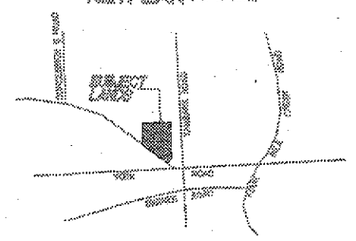


TOWN OF NIAGARA-ON-THE-LAKE (ST. DAVIDS)

DRAFT PLAN

OF SUBDIVISION

being

PART OF NIAGARA TOWNSHIP LOT 96

TOWN OF NIAGARA-ON-THE-LAKE

REGIONAL MUNICIPALITY OF NIAGARA

10 0 20 40 60 METRES 1 : 750

SCALE 1 : 750

Matthews, Cameron, Heywood – Kerry T. Howe SURVEYING LIMITED

LLN:36258

2004

ADDITIONAL INFORMATION REQUIRED UNDER SECTION 51 OF THE PLANNING ACT.

(A) – AS SHOWN ON DRAFT PLAN
(B) – AS SHOWN ON DRAFT PLAN
(C) – AS SHOWN ON DRAFT AND KEY PLANS
(D) – SINGLE FAMILY RESIDENTIAL LOTS 1 TO 37
(E) – AS SHOWN ON DRAFT PLAN
(F) – AS SHOWN ON DRAFT PLAN
(G) – AS SHOWN ON DRAFT PLAN
(H) – MUNICIPAL PIPED WATER
(I) – CLAY LOAM
(J) – AS SHOWN ON DRAFT PLAN
(K) – ALL MUNICIPAL SERVICES
(L) – AS SHOWN ON DRAFT PLAN

LAND USE ANALYSIS

NUMBER OF LOTS 37
NUMBER OF BLOCKS 1

AREA OF SINGLE FAMILY LOTS	6.162 ha (15.808 acres)
AREA OF ROAD	1.537 ha (3.800 acres)
AREA OF BLOCK 35	0.441 ha (1.088 acres)
TOTAL AREA OF SUBDIVISION =	8.57 ha (21.071 acres)

denotes boundary of subdivision

OWNER'S CERTIFICATE

I HEREBY AUTHORIZE MATTHEWS, CAMERON, HEYWOOD – KERRY T. HOWE SURVEYING LIMITED TO SUBMIT THIS PLAN TO THE TOWN OF NIAGARA-ON-THE-LAKE FOR THEIR APPROVAL.

Revised : January 6, 2005
March 2, 2004
Date

JODY RYLANDS
President
968571 Ontario Limited

SURVEYOR'S CERTIFICATE

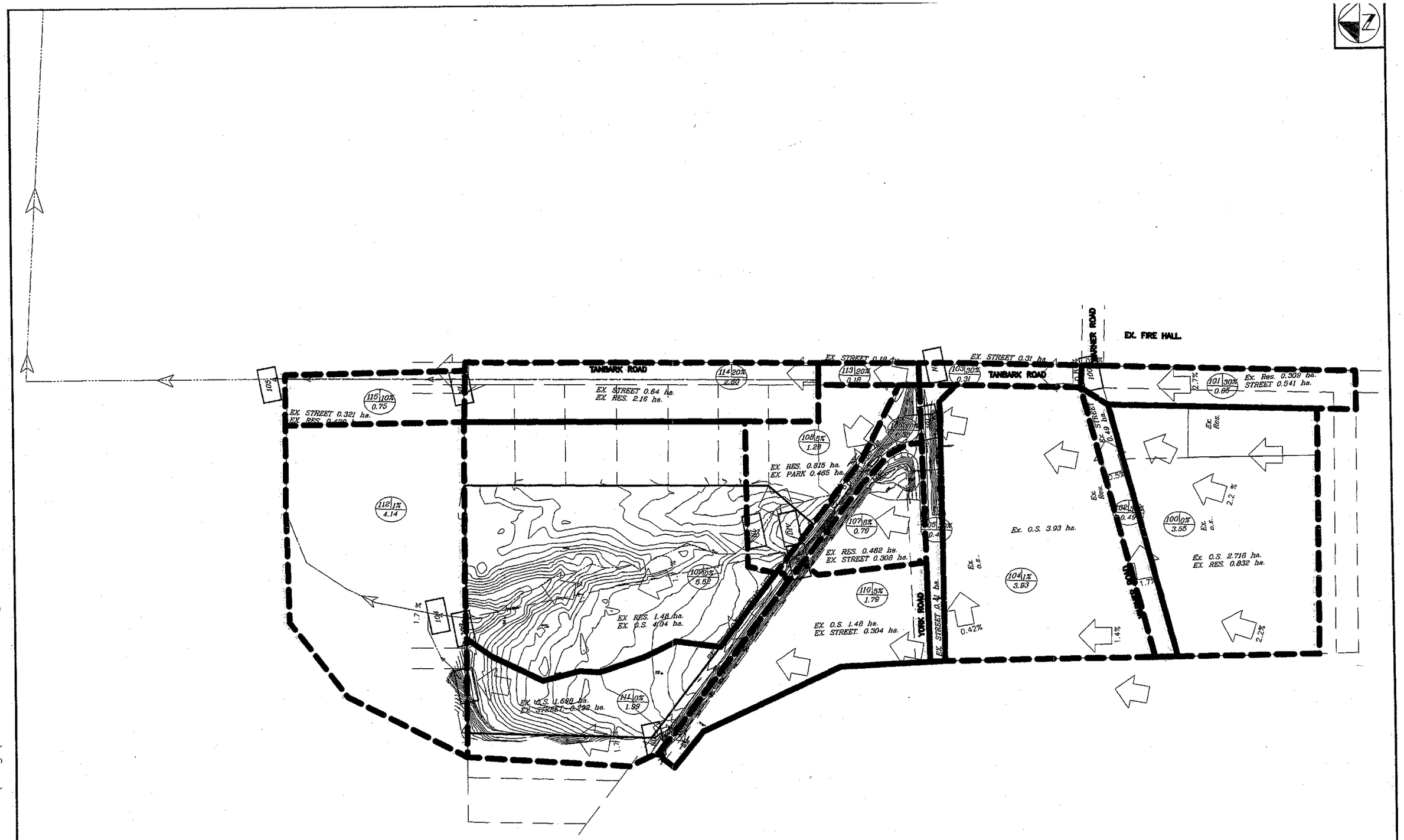
I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE SUBDIVIDED ARE CORRECTLY SHOWN.

Revised : January 6, 2005
March 2, 2004
Date

ALLAN J. HEYWOOD
Ontario Land Surveyor

MATTHEWS, CAMERON, HEYWOOD - KERRY T. HOWE SURVEYING LTD.
1823 Sheldon Avenue – Unit 21, Niagara Falls, Ontario L2E 7X2 Phone 295-1822 Fax 295-8234
99 Canal Bank St. S. Collingwood, Ontario L9Y 3Z9 Phone 607-1280
www.kenhowesurveyors.com

Drawn By: C. DOHERTY | Checked By: A. HEYWOOD



NOTES:
1) THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON TOP CONSTRUCTION DRAWINGS AND WHERE SHOWN THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED.
2) BEFORE STARTING THE WORK, THE CONTRACTOR SHALL INFORM HIMSELF AS TO THE EXACT LOCATION OF ALL UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.
3) METAL AND BELL POLES ARE TO BE ANCHORED TO THE GROUND WHERE REQUIRED SO AS TO ENSURE THE STABILITY OF THE POLE LINES.
4) THE CONTRACTOR IS TO CHECK WITH ALL THE UTILITIES INVOLVED.
5) ALL MANHOLE FRAMES, CATCH BASIN FRAMES, WATER VALVES AND GAS VALVES TO BE ADJUSTED TO FINISH GRADE.
6) EXISTING TREES AND VEGETATION OUTSIDE OF CONSTRUCTION AREAS TO REMAIN UNDISTURBED.

NO.	REVISION	DATE	INIT.
1	ISSUED FOR REVIEW	JUNE 13/05	R.B.

DRAFTING: J.H./R.B.
DESIGN: R.B.
CHECKED BY: D.Ingram P.Eng.
PROJ. SUPVR.: W.A.C.Mackay

KERRY T. HOWE ENGINEERING LTD.

KERRY T. HOWE ENGINEERING LTD.
CONSULTING ENGINEERS
98 Church Street
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(905) 688-6550

BENCH MARK DATUM
Control benchmark – Top of the north bore of the hydrant located on the S.E. corner of Tanbark & Regional Road 81 – York Road – Ele. 123.852.
Alternate Benchmark – Very top of the hydrant opposite House # 261 Tanbark. Ele. – 121.188

VINEYARD CREEK ESTATES AREA IN THE TOWN OF NIAGARA-ON-THE-LAKE

EXISTING STORM DRAINAGE PLAN AND MIDUSS SCHEMATIC

FIELD NOTES: Book No. 802
PLOT DATE: JUNE 13, 2005
SCALE: 1:1500
DWG. No. FIGURE NO. 2.0 REV. 1
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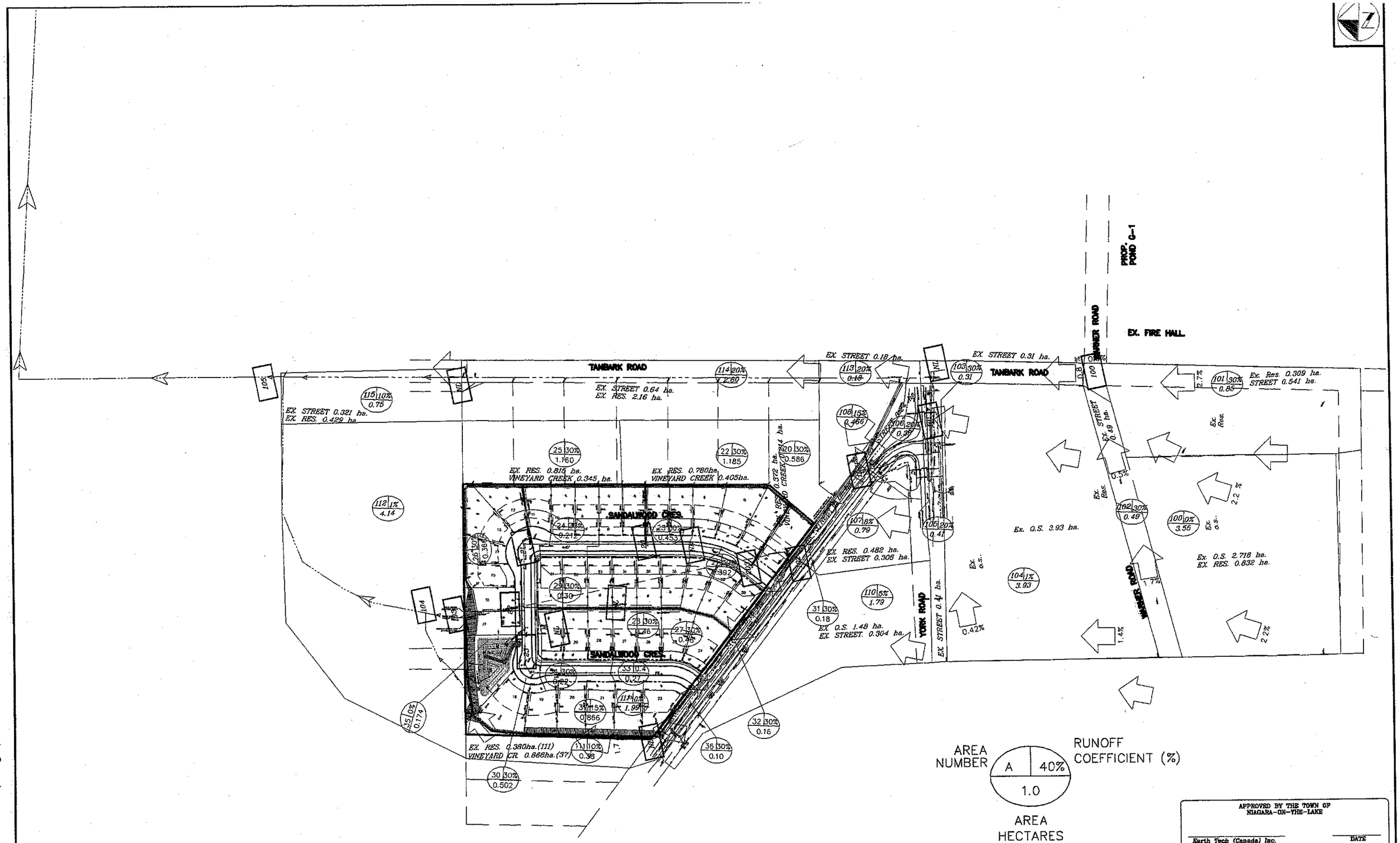

APPROVED BY THE TOWN OF NIAGARA-ON-THE-LAKE

Earth Tech (Canada) Inc. on Behalf of the Town of Niagara-On-The-Lake — DATE

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Alternate Benchmark – Very top of the hydrant opposite House # 281 Tanbark. Ele. – 121.168

VINEYARD CREEK ESTATES AREA IN THE TOWN OF NIAGARA-ON-THE-LAKE

STAND ALONE GRADING PLAN AND MIDUSS SCHEMATIC

FIELD NOTES: Book No. 802
PLOT DATE: JUNE 13, 2005
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SANDALWOOD CRES.

SANDALWOOD CRES.

QUEENSTON ROAD

APPROVED BY THE TOWN OF NIAGARA-ON-THE-LAKE

Earth Tech (Canada) Inc. on Behalf of the Town of Niagara-On-The-Lake — DATE

TYPICAL LOT

LOT SERVICING DETAIL
N.T.S.

TYPICAL ROAD CROSS-SECTION
SCALE 1:50

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Alternate Benchmark - Very top of the hydrant opposite House # 281 Tanbark. Ela. - 121.150

VINEYARD CREEK ESTATES IN THE TOWN OF NIAGARA-ON-THE-LAKE

GRADING PLAN
STAND ALONE POND

FIELD NOTES Book No. 802
PLOT DATE JUNE 13, 2005
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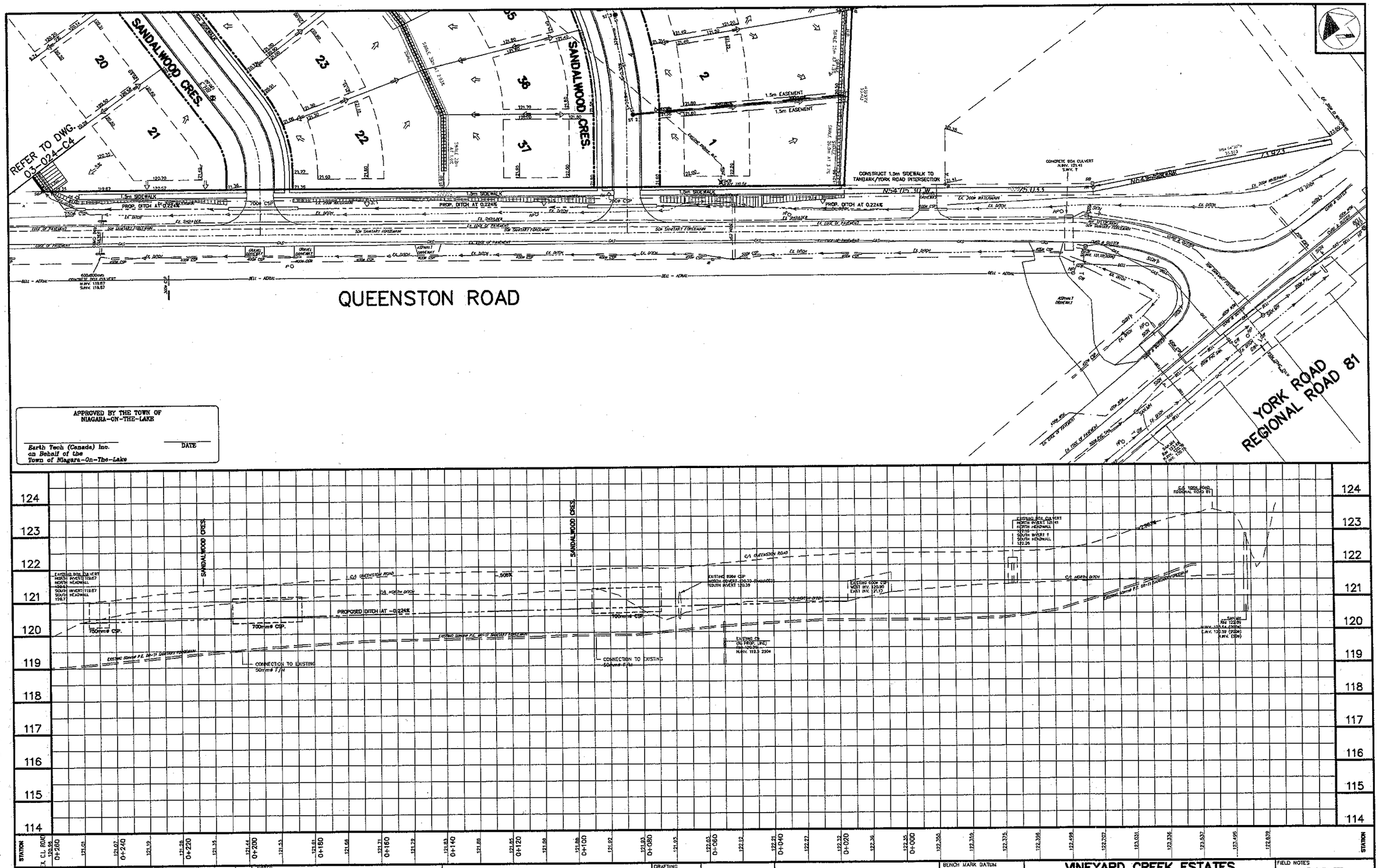

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Earth Tech (Canada) Inc.
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DRAFTING	JH
DESIGN	R.B.
CHECKED BY	D.Ingram P.Eng.
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VINEYARD CREEK ESTATES IN THE TOWN OF NIAGARA-ON-THE-LAKE

QUEENSTON ROAD COMMUNAL POND WORKS

FIELD NOTES: Book No. 802
PLOT DATE: JUNE 13, 2005
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QUEENSTON ROAD

SANDALWOOD CRES.

21 20 19 18 17 16

22 23 24 25 26 27 28

EXISTING BOX CULVERT QUEENSTON ROAD
NORTH INVERT 119.67
NORTH HEADWALL 120.67
SOUTH INVERT 119.57
SOUTH HEADWALL 120.77

MATCH DITCH AT CULV. 119.59

DITCH 82.9m AT -2.01%

DITCH 25.3m AT -2.17%

DITCH 28.0m AT -2.04%

DITCH 68.5m AT -0.39%

DITCH 25.1m AT -2.27%

DITCH 26.2m AT -0.5%

DITCH 21.3m AT -5.71%

PROPOSED DITCH

EXISTING DITCH

EX. GROUND AT P/L

EX. GROUND ON BASELINE 1m O/S RT P/L

EX. GROUND 3m RT BASELINE

DITCH O/S 0.92m EAST OF B/L

DITCH O/S 0.05m EAST OF B/L

DITCH O/S 2.9m EAST OF B/L MID LOT

DITCH O/S 5.6m SOUTH OF B/L LOT 18/ BLOCK 38

DITCH O/S 0.3m SOUTH OF B/L

DITCH ON B/L (604+395)

MATCH EXISTING DITCH GRADE

SOUTH P/L LOT 21

LOT 20/19

LOT 19/18

LOT 18/17

LOT 17/16

LOT 16

STATION

APPROVED BY THE TOWN OF NIAGARA-ON-THE-LAKE

Earth Tech (Canada) Inc. on Behalf of the Town of Niagara-On-The-Lake

DATE

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DRAFTING JH/RB
DESIGN R.B.
CHECKED BY D.Ingram P.Eng.
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VINEYARD CREEK ESTATES IN THE TOWN OF NIAGARA-ON-THE-LAKE

WEST DITCH
QUEENSTON RD. TO BLOCK 38

FIELD NOTES Book No. 802
PLOT DATE JUNE 13, 2005
SCALE HOR. 1:500 VERT. 1:50
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REV. 1
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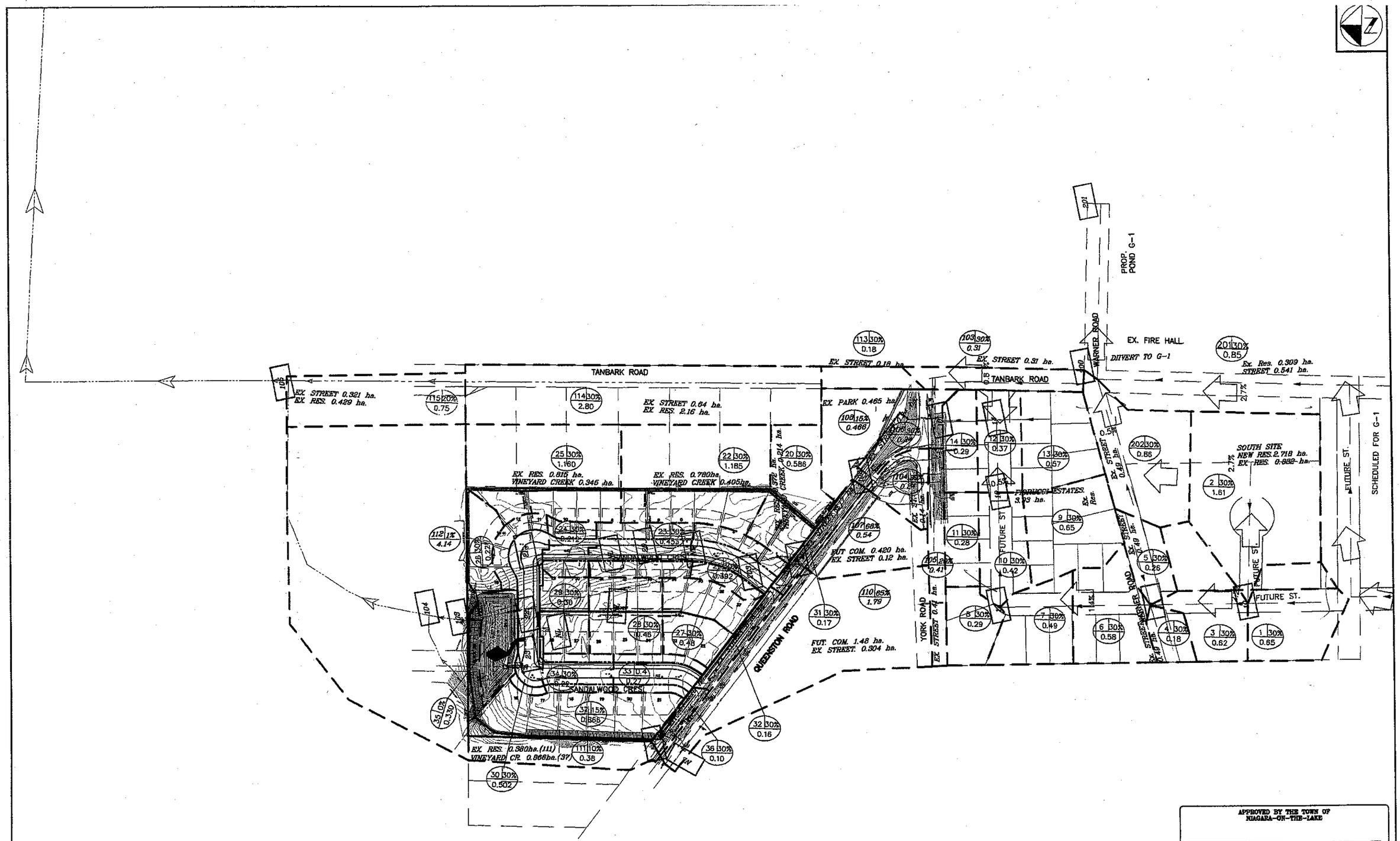

APPROVED BY THE TOWN OF NIAGARA-ON-THE-LAKE

Earth Tech (Canada) Inc. on Behalf of the Town of Niagara-On-The-Lake — DATE

NO.	REVISION	DATE	INIT.
1	ISSUED FOR REVIEW	JUNE 13/05	R.B.

NOTES:
1) THE PROVISION OF POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONSTRUCTION DRAWINGS, AND WHERE SHOWN THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED.
2) BEFORE STARTING THE WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL UTILITIES AND STRUCTURES AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.
3) HYDRO AND BELL POLES ARE TO BE ANCHORED TO THE GROUND WHERE REQUIRED SO AS TO ENSURE THE STABILITY OF THE POLE LINES.
4) THE CONTRACTOR IS TO CHECK WITH ALL THE UTILITIES INVOLVED.
5) ALL MANHOLE FRAMES, CATCH BASIN FRAMES, WATER VALVES AND GAS VALVES TO BE ADJUSTED TO FINISH GRADE.
6) EXISTING TREES AND VEGETATION OUTSIDE OF CONSTRUCTION AREAS TO REMAIN UNDISTURBED.

DRAFTING: J.H./R.B.
DESIGN: R.B.
CHECKED BY: D.Ingram P.Eng.
PROJ. SUPVR.: W.A.G.Mackay

KERRY T. HOWE ENGINEERING LTD.

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CONSULTING ENGINEERS
98 Church Street
St. Catharines ,Ontario
(905) 688-6550

BENCH MARK DATUM
Control benchmark - Top of the north bore of the hydrant located on the S.E. corner of Tanbark & Regional Road 81 - York Road - Ele. 123.652.
Alternate Benchmark - Very top of the hydrant opposite House # 281 Tanbark. Ele. - 121.185

VINEYARD CREEK ESTATES AREA IN THE TOWN OF NIAGARA-ON-THE-LAKE

COMMUNAL POND DRAINAGE AREAS AND MIDUSS SCHEMATIC

FIELD NOTES: Book No. 802
PLOT DATE: JUNE 13, 2005
SCALE: 1 : 1500
DWG. No. FIGURE NO. 5.0 REV. 1
CAD FILE: 03-024BASE.dwg

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SANDALWOOD CRES.

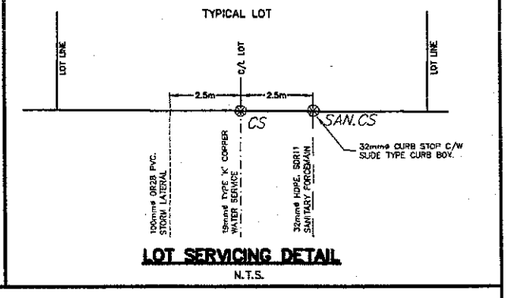
SANDALWOOD CRES.

QUEENSTON ROAD

APPROVED BY THE TOWN OF NIAGARA-ON-THE-LAKE

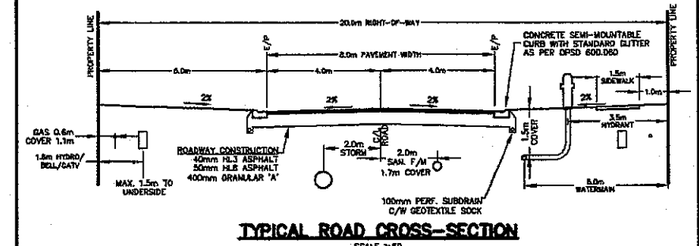
Earth Tech (Canada) Inc. on Behalf of the Town of Niagara-On-The-Lake — DATE

TYPICAL LOT



LOT SERVICING DETAIL

N.T.S.



TYPICAL ROAD CROSS-SECTION

SCALE 1:50

NO.	REVISION	DATE	INIT.
1.	ISSUED FOR REVIEW	JUNE 13/05	R.B.

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BENCH MARK DATUM

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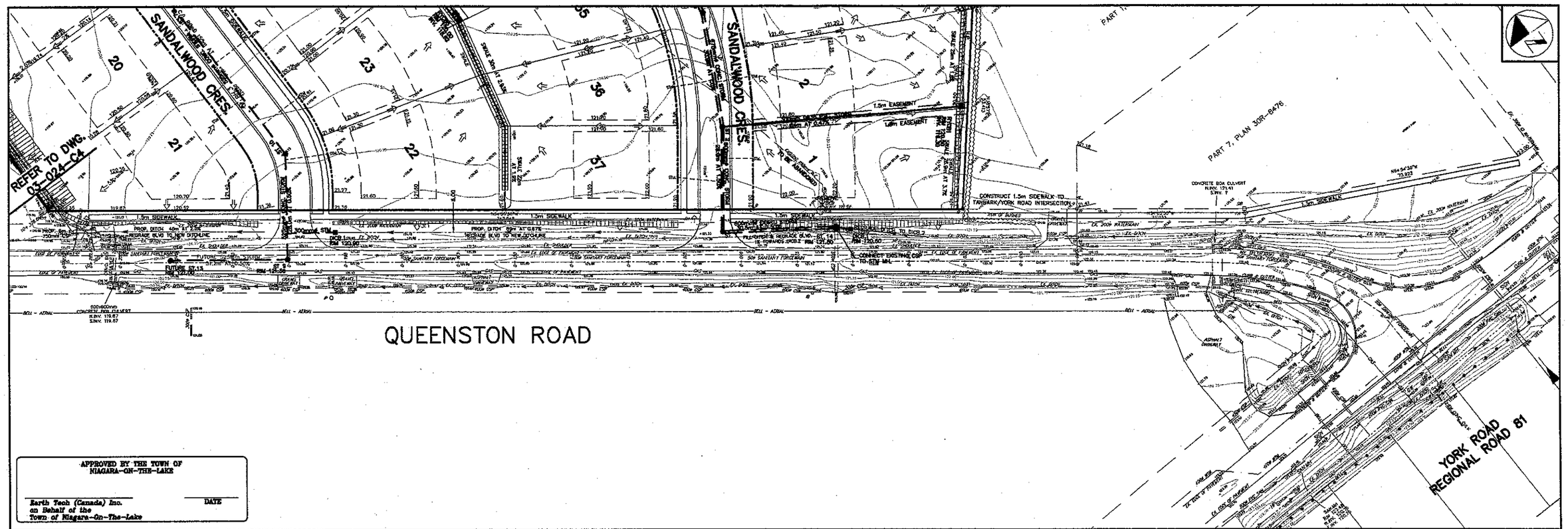
Alternate Benchmark - Very top of the hydrant opposite House # 281 Tanbark. Ele. - 121.188

VINEYARD CREEK ESTATES IN THE TOWN OF NIAGARA-ON-THE-LAKE

GRADING PLAN COMMUNAL POND

FIELD NOTES: Book No. 302
PLOT DATE: JUNE 13, 2005
SCALE: 1:500
DWG. No. FIGURE NO. 5.1
CAD. FILE: 03-024Base
REV. 1



APPROVED BY THE TOWN OF NIAGARA-ON-THE-LAKE

Earth Tech (Canada) Inc. on Behalf of the Town of Niagara-On-The-Lake — DATE

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3) MITRED END WALL BOLES ARE TO BE ANCHORED TO THE GROUND WHERE REQUIRED SO AS TO ENSURE THE STABILITY OF THE POLE UNIT.
4) THE CONTRACTOR IS TO CHECK WITH ALL THE UTILITIES INVOLVED.
5) ALL MANHOLE FRAMES, CATCH BASIN FRAMES, WATER VALVES AND GAS VALVES TO BE ADJUSTED TO FINISH GRADE.
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VINEYARD CREEK ESTATES

IN THE
TOWN OF NIAGARA-ON-THE-LAKE

QUEENSTON ROAD COMMUNAL POND WORKS

FIELD NOTES: Book No. 802
PLOT DATE: JUNE 13, 2005
SCALE: HOR. 1:500 VERT. 1:50
DWG. NO.: FIGURE NO. 5.2
REV.: 1
CAD FILE: 03-024BASE.dwg

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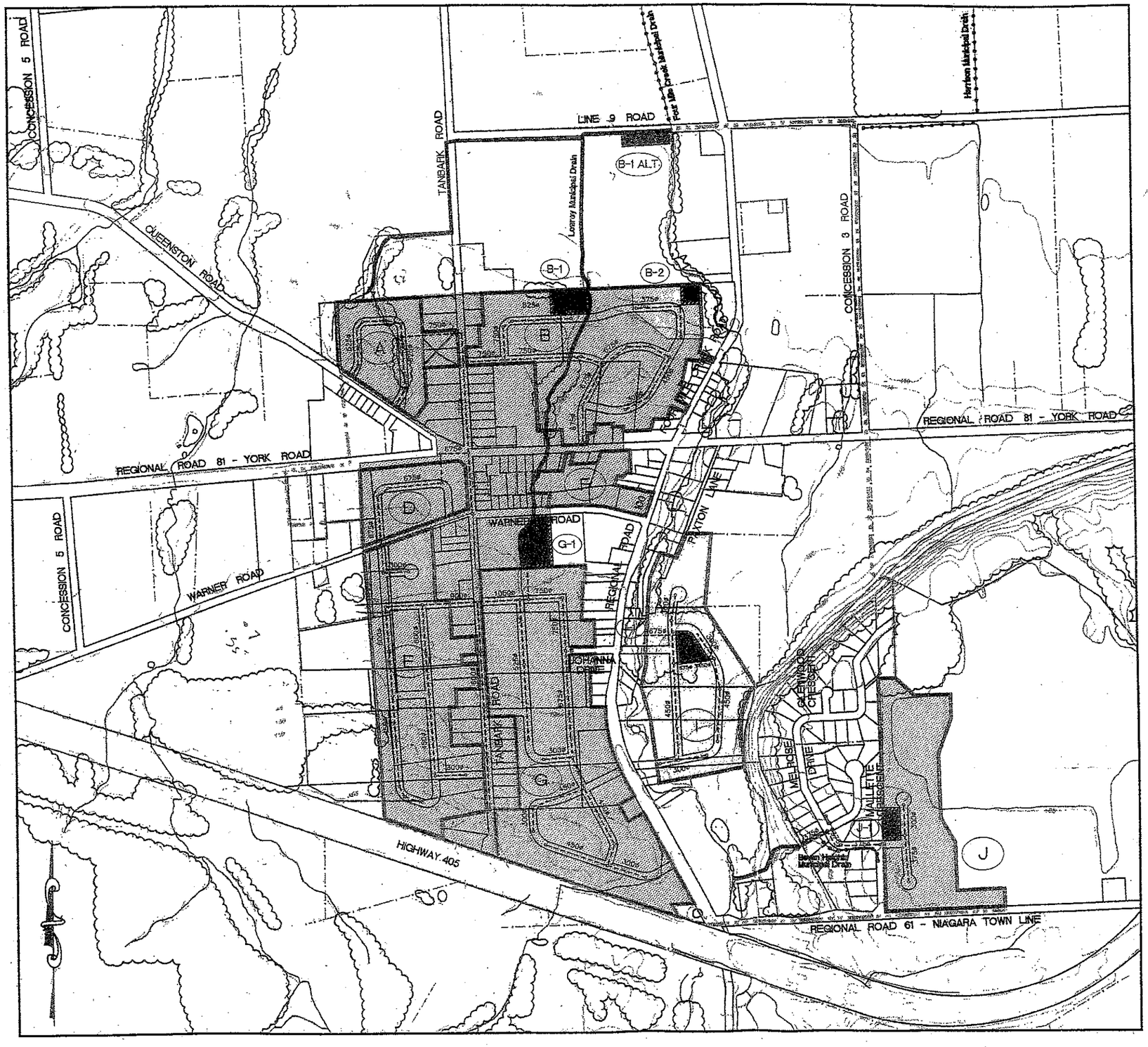

FIGURE B

Town of Niagara-On-The-Lake
ST. DAVID'S MASTER SERVICING STUDY

STORMWATER MANAGEMENT SYSTEM CONCEPT 'B'

0 150 300 450m

LEGEND

- URBAN BOUNDARY
- POTENTIAL DEVELOPMENT BOUNDARY
- POSSIBLE ROAD ALIGNMENT
- 1050ø PROPOSED STORMWATER COLLECTION SYSTEM
- STORMWATER MANAGEMENT FACILITY (APPROXIMATE TO SCALE)
- PROPOSED DITCH IMPROVEMENTS
- MUNICIPAL DRAIN
- B-1 POND NUMBER
- A AREA NUMBER

DRAINAGE AREA	DRAINAGE AREA (Ha)	POND STATISTICS POND	AREA m^2	VOLUME m^3
	26.3	B-1	6550	6450
	3	B-2	2250	960
	46.5	G-1	10450	14550
	12.8	I-1	5200	4700
	7.8	J-1	3900	2780

NOTE: B-1 ALT = ALTERNATIVE LOCATION FOR THIS POND

EARTH TECH

Earth Tech (Canada) Inc. St. Catharines, Ontario 905.688.4272

APPENDIX B – Tables

TABLE NO. 1 - RAINFALL DATA

STORM RETURN	DURATION 4 hrs DEPTH mm	CHICAGO PARAMETRES		
		a	b	c
QUALITY	25.04	512	6	0.800
2	32.55	719.65	5.849	0.813
5	42.50	996.92	4.233	0.826
10	47.76	1197.74	3.827	0.833
25	55.20	1460.25	3.560	0.841
50	61.74	1639.03	3.305	0.844
100	70.38	1815.30	3.090	0.847

Table No. 4.0 "Stand Alone "Post Hydrologic and Hydraulic Parameters and Miduss Output

VINEYARD CREEK ESTATES ST. DAVID'S IN THE TOWN OF N-O-T-L

AREA NO.	AREA EXIST. STREET	AREA EXIST. RES.	AREA EXIST. O.S. PARK	AREA EXIST. O.S.	AREA EXIST. O.S. FIORUCCI ESTATES	AREA EXIST. O.S. SOUTH SITE	AREA EXIST. O.S. VINEYARD CREEK ESTATES	AREA TOTAL	L	S	IMPERVIOUS %		SCS	PERVIOUS AREA	SCS AMC II	Ia	L	JCT	PIPE DIA	S	L	CONTROL LOCATION	MIDUSS OUTPUT 25 mm VoL.	25 mm Qp	2-YEAR VoL.	2-YEAR Qp	5-YEAR VoL.	5-YEAR Qp	100-YEAR VoL.	100-YEAR Qp
	ha.	ha.	ha.	ha.	ha.	ha.	ha.	ha.			IMP	ha.	CN.	ha.	CN.	mm	m	NO	m.	%	m.		cu.m./s.	cu.m.	cu.m./s.	cu.m.	cu.m./s.	cu.m.	cu.m./s.	cu.m.
ALTERNATIVE 1 - STANDALONE SYSTEM FOR VINEYARD CREEK ESTATES																													
VINEYARD CREEK ESTATES DIRECT RUNOFF CONTROLLED BY WET POND - SOUTHERLY PROPPERTIES DIVERTED AROUND SITE. - SOUTHERLY SITES CONTOLLED TO PRE																													
100		0.932				2.718		**3.650**	212.6	2.20%	3.0%	0.107	98	3.444	68.0	12.0	212.6	**100**	**ODR**	2.20%	270								
101	0.541	0.309						**0.850**	104.0	2.70%	30.0%	0.255	98	0.595	68.0	12.0	104.0	**100**	**ODR**	2.70%	189								
102	0.490							**0.490**	79.0	1.00%	30.0%	0.147	98	0.343	68.0	12.0	79.0	**100**	**ODR**	1.00%	237	TANBARK AT WARNER								
103	0.310							**0.310**	62.8	0.80%	30.0%	0.093	98	0.217	68.0	12.0	62.8	**NL**	**ODR**	0.80%	140								
																	0.0	**101**	**450**	1.00%	26								
104					3.930			**3.930**	223.7	1.00%	1.0%	0.039	98	3.891	68.0	12.0	223.7	**101**	**ODR**	1.00%	254	YORK RD 750 U.S.								
105	0.410							**0.410**	72.3	0.80%	20.0%	0.082	98	0.328	68.0	12.0	72.3	**101**	**ODR**	0.80%	235	YORK RD 750 U.S.								
																		NL	**750**	1.00%	30	YORK RD 750 D.S.								
106	0.372							**0.372**	68.8	0.80%	30.0%	0.112	98	0.260	68.0	12.0	68.8	**1021**	**ODR**	0.80%	50								
108			0.466					**0.466**	77.0	0.80%	0.0%	0.000	98	0.466	68.0	12.0	77.0	**1021**	**ODR**	0.80%	149								
																		102	**ODR**	0.80%	62								
107	0.338	0.452						**0.790**	100.3	0.80%	10.0%	0.079	98	0.711	70.0	10.9	100.3	**NL**	**ODR**	0.80%	150								
																		102	**750**	1.00%	12	QUEENSTON RD. AT VINEYARD ESTATES	406	0.056	575	0.186			2798	0.804
31	0.100							**0.100**	35.7	0.80%	30.0%	0.030	98	0.070	70.0	10.9	35.7	**NL**	**ODR**	0.20%	62								
																		NL	**750**	1.00%	20	QUEENSTON RD CULV. AT ST. A EAST								
32	0.100							**0.100**	35.7	0.80%	10.0%	0.010	98	0.090	70.0	10.9	35.7	**NL**	**ODR**	0.20%	88	QUEENSTON RD CULV. AT S.W. BR.								
																		NL	**750**	1.00%	20	QUEENSTON RD CULV. AT ST. A WEST								
36	0.100							**0.100**	35.7	0.80%	30.0%	0.030	98	0.070	70.0	10.9	35.7	**40**	**ODR**	0.20%	39	WEST LIMIT VINEYARD ESTATES								
110	0.304	1.486						**1.790**	151.0	0.80%	5.0%	0.090	98	1.701	70.0	10.9	151.0	**NL**	**ODR**	0.80%	140								
																		40	**750**	1.00%	12	QUEENSTON RD CULV. AT S.W. BR.								
111		0.380					0.866	**1.246**	126.0	1.70%	10.0%	0.125	98	1.121	70.0	10.9	126.0	**103**	**ODR**	1.70%	285	NORTH LIMIT VINEYARD ESTATES D.S. POND								
20		0.372					0.214	**0.586**	86.4	1.70%	30.0%	0.176	98	0.410	68.0	12.0	86.4	**NL**	**300**	0.80%	64								
																		NL	**375**	0.50%	30								
																		NL	**375**	0.50%	27								
21							0.392	**0.392**	70.6	1.70%	30.0%	0.118	98	0.274	68.0	12.0	70.6	**20**	**450**	0.50%	42								
22		0.780					0.405	**1.185**	122.8	1.70%	30.0%	0.356	98	0.830	68.0	12.0	122.8	**20**	**375**	1.00%	53								
23							0.453	**0.453**	75.9	1.70%	30.0%	0.136	98	0.317	68.0	12.0	75.9	**NL**	**600**	0.60%	42								
24							0.223	**0.223**	53.3	1.70%	30.0%	0.067	98	0.156	68.0	12.0	53.3	**21**	**600**	0.60%	67								
25		0.830					0.345	**1.175**	122.3	1.70%	30.0%	0.353	98	0.823	68.0	12.0	122.3	**21**	**375**	1.00%	56								
																		22	**675**	0.60%	56								
26							0.366	**0.366**	68.3	1.70%	30.0%	0.110	98	0.256	68.0	12.0	68.3	**22**	**300**	0.70%	42								
27							0.480	**0.480**	78.2	1.70%	30.0%	0.144	98	0.336	68.0	12.0	78.2	**NL**	**300**	0.70%	40								
28							0.460	**0.460**	76.5	1.70%	30.0%	0.138	98	0.322	68.0	12.0	76.5	**NL**	**375**	2.00%	45								
29							0.300	**0.300**	61.8	1.70%	30.0%	0.090	98	0.210	68.0	12.0	61.8	**22**	**450**	0.70%	34								
																		23	**675**	0.50%	20								
33							0.270	**0.270**	58.6	1.70%	30.0%	0.081	98	0.189	68.0	12.0	58.6	**NL**	**300**	1.00%	72								
34							0.220	**0.220**	52.9	1.70%	30.0%	0.066	98	0.154	68.0	12.0	52.9	**NL**	**300**	1.00%	9								
30							0.502	**0.502**	79.9	1.70%	30.0%	0.151	98	0.351	68.0	12.0	79.9	**23**	**450**	0.50%	32								
35							0.174	**0.174**	47.1	1.70%	0.0%	0.000	98	0.174	68.0	12.0	47.1	**NL**	**750**	0.60%	22	INTLET TO SWM POND								
																			POND			**POND MAX. STORAGE / ELEV.**	418	117.415	576	117.809	786	117.811	1201	118.210
																		103	**300**	0.80%	40	**OUTFLOW FROM POND**		0.009		0.021		0.074		0.384
																		NL	**ODR**	1.70%	53	**FLOW U.S. OLD 104**	897	0.078	1494	0.194	2541	0.373	5813	1.434
																							431	0.015	410	0.007	783	0.007	3648	0.010
112				4.140				**4.140**	229.6	2.00%	1.0%	0.041	98	4.099	70.0	10.9	229.6	**105**	**ODR**	2.00%	290	**MD. WEST BR TO TANBARK RD.**	1016	0.075	1710	0.177	2799	0.366	6636	1.613
																							388	0.007	495	0.015	934	0.044	973	0.027
113	0.180							**0.180**	47.9	1.00%	30.0%	0.054	98	0.126	70.0	10.9	47.9	**NL**	**ODR**	1.00%	86	TANBARK RD								
114	0.640	2.160						**2.800**	188.8	1.00%	30.0%	0.840	98	1.960	70.0	10.9	188.8	**NL**	**ODR**	1.00%	313	TANBARK RD								
115	0.321	0.429						**0.750**	97.7	3.00%	20.0%	0.150	98	0.600	70.0	10.9	97.7	**105**	**ODR**	3.00%	150	TANBARK RD AT MD. WEST BR								
																	0.0	**NL**	**ODR**	2.00%	150	**TANBARK RD NORTH W. RD. DITCH**	1270	0.112	2098	0.299	3390	0.492	8079	1.988
																						DIFFERENCE TANBARK RD N. FROM PRESENT	385	0.009	494	0.016	624	0.012	972	0.031
Totals	4.206	8.030	0.466	4.140	3.930	2.718	5.670	**29.160**	609.3	4.27%	14.6%	4.267	98	24.894																

TABLE NO. 4.1 - DESIGN STAND ALONE WET POND

ALTERNATIVE 1- STAND ALONE POND DESIGN

Level m.	Surface Area sm.	Avg. Area sm.	Incr Vol cu.m.	Volume cu.m.	Discharge cu.m./s.	Avg. Drain Rate cu.m./s.	Avg. Drain Rate cu.m./hr..	Incr Drain Time hrs	Accum Drain Time For Ext. Det. hrs	Accum Drain 100 yr. To Ext. Det. hrs	
114.50	0.0										
114.75	4.0										
115.00	29.4	16.7	4.2	4.2	0.000						
115.25	65.0	47.2	11.8	16.0	0.000						
115.50	110.4	87.7	21.9	37.9	0.000						
115.75	165.3	137.9	34.5	72.4	0.000						
116.00	229.7	197.5	49.4	121.7	0.000						
116.25	303.7	266.7	66.7	188.4	0.000						
116.50	387.3	345.5	86.4	274.8	0.000						
116.75	480.1	433.7	108.4	383.2	0.000	STATIC WATER LEVEL					PERMANENT POOL
116.75	480.1			0.0	0.000				22.1		EXTENDED POOL POOL
117.00	582.4	531.3	132.8	132.8	0.005	0.003	9.0	14.8	7.4		
117.25	694.0	638.2	159.6	292.4	0.007	0.006	21.6	7.4	0.0		
117.415				**418.8**	**0.009**	0.008	28.8	0.0		8.4	25 mm QUALITY
117.50	814.9	754.5	188.6	481.0	0.009	0.009	32.4	5.8		8.4	
117.705				**576.1**	**0.021**	0.015	54.0	0.0		2.6	2 YEAR
117.75	944.1	879.5	219.9	700.9	0.038	0.030	106.2	2.1		2.6	
117.811				**765.4**	**0.074**	0.056	201.6	0.0		0.5	5 YEAR
118.00	1080.0	1012.1	253.0	953.9	0.201	0.138	495.0	0.5		0.5	
118.210				**1201.3**	**0.394**	0.298	1071.0	0.0		0.0	100 YEAR
118.25	1223.0	1151.5	287.9	1241.7	0.431	0.413	1485.0	0.2			

TABLE NO. 4.2 - SUMMARY STAND ALONE WET POND SYSTEM DESIGN PARAMETERS

VINEYARD CREEK ESTATES - ST. DAVID'S TOWN OF N-O-T-L

MUNICIPAL STORM WATER MANAGEMENT REVIEW SUMMARY
MUNICIPAL SITE FOR UPSTREAM DEVELOPMENTS WET POND + EXTENDED STORAGE

RAW LAND AREA CONNECTED VINEYARD CREEK ESTATES POND =	6.786	ha.		
PRESENT RUNOFF % IMPERVIOUS	0.00%	%		
FUTURE RUNOFF % IMPERVIOUS	30	%		
PROTECTION LEVEL TSS REMOVAL	70	%		
STORM WATER WET POND CRITERIA TAB 3.2 2003	90	cu.m./ha.	610.74	cu.m.
PERMANENT POOL	50	cu.m./ha.	339.3	cu.m.
EXTENDED DETENTION	40	cu.m./ha.	271.44	cu.m.
PERMANENT POOL	383.2	cu.m./ha.	418.8	cu.m.
25 mm STORM EXT. POND STORAGE VOL.	61.7	cu.m./ha.	418.8	cu.m.
25 mm STORM EXT. POND STORAGE PEAK OUTFLOW	9	lps		
25 mm STORM EXT. POND STORAGE DRAINTIME	22.1	hrs		
25 mm STORM EXT. POND STORAGE LEVEL EXTENDED DETENTION	117.415	m.		
2 YEAR STORM STORAGE VOLUME			576.1	cu.m.
2 YEAR STORM EXT. POND STORAGE PEAK OUTFLOW	21	lps		
2 YEAR STORM POND STORAGE LEVEL	117.705	m.		
5 YEAR STORM STORAGE VOLUME			765.4	cu.m.
5 YEAR STORM EXT. POND STORAGE PEAK OUTFLOW	74	lps		
5 YEAR STORM POND STORAGE LEVEL	117.811	m.		
100 YEAR STORM STORAGE VOLUME			1201.3	cu.m.
100 YEAR STORM POND STORAGE PEAK OUTFLOW	394	lps		
100 YEAR STORM POND STORAGE DRAIN TIME TO EXT. STORAGE			8.4	hrs
100 YEAR STORM POND STORAGE LEVEL	118.21	m.		
POND SIDE SLOPES 4:1 ASPECT RATIO 2:1		**PROVIDED**		
POND TO PERMANENT POOL INV. - WSEL	114.50	m.	116.75	m.
POND MAX. WATER LEVEL	118.25	m.		
MOE 2003 GUIDELINES TABLE 4.6 WET POND CITERIA				
BUFFERS - 7.5 m. FROM 25 mm WSEL. OR 3.0 m. FROM 100 YR QUANTUTY WSEL		**PROVIDED**		
BUFFERS - 3.0 m. FROM TOP BANK NOTL MSP		**PROVIDED**		
MIN. 5.0 ha. DRAINAGE AREA PREFERRED GRAEATER THAN 10 ha.		**PROVIDED**		
ANNUAL SEDIMENT YIELD 35% IMP	0.60	cu.m./ha./yr		
TOTAL EXPECTED ANNUAL SEDIMENT	4.07	cu.m./yr		
WET POND CLEANOUT 10 YEAR INTERVAL VOL.	40.72	cu.m.	**PROVIDED**	

Vineyard Creek Estates - Stand Alone Storm Computation Sheet KERRY T. HOWE ENGINEERING LIMITED

Town of Niagara-On-The-Lake

PROJECT No. : 03 - 024

DATE: Feb 3, 2005

DESIGN: R. Beaulieu

CHECKED: D. Ingram

n = 0.013

i = 996.916 / (t+4.233) ^ 0.826

Figure No. 4.3

Town of Niagara-On-The-Lake 5-Year Storm

STORM SEWER DESIGN (Metric)

			RAINFALL DESIGN								PIPE DESIGN					TIME OF CON.	
STREET	FROM	TO	AREA NO.	AREA (ha.)	R	A * R	SEC A*R	SEW A*R	I mm/hr	Q cms	LENGTH m	DIA mm	SLOPE %	Q cms	VEL m/sec	SECT min	CUM min
																START	10.00
REAR LOT 1&2	RYCB.1	ST 2	20	0.586	0.40	0.234	0.234	0.234	111.18	0.072	64.4	300	0.800	0.086	1.224	0.88	10.88
Sandalwood Crescent east N/S	ST 2	ST 3			0.40	0.000	0.000	0.234	105.82	0.069	30.9	375	0.300	0.096	0.869	0.59	11.47
Sandalwood Crescent east N/S	ST 3	ST 4			0.40	0.000	0.000	0.234	102.52	0.067	26.8	375	0.300	0.096	0.869	0.51	11.98
Sandalwood Crescent east N/S	ST 4	ST 5	21	0.392	0.40	0.157	0.157	0.391	99.83	0.108	26.8	375	0.500	0.124	1.123	0.40	12.38
																START	10.00
REAR LOTS 2 - 5	RYCB 2	ST 5	22	1.185	0.40	0.474	0.474	0.474	111.18	0.146	52.1	375	1.000	0.175	1.587	0.55	10.55
Sandalwood Crescent east N/S	ST 5	ST 6	23,24	0.665	0.40	0.266	0.266	1.131	97.85	0.307	109.8	600	0.300	0.336	1.189	1.54	13.92
																START	10.00
REAR LOTS 3 - 7	RYCB 3	ST 6	25	1.160	0.40	0.464	0.464	0.464	111.18	0.143	51.7	375	1.000	0.175	1.587	0.54	10.54
Sandalwood Crescent east N/S	ST 6	ST 7			0.40	0.000	0.000	1.595	90.94	0.403	56.9	600	0.500	0.434	1.536	0.62	14.54
																START	10.00
REAR LOTS 8 -12	RYCB 4	ST 7	26	0.366	0.40	0.146	0.146	0.146	111.18	0.045	51.7	300	1.000	0.097	1.368	0.63	10.63
																START	10.00
REAR LOTS 22-23, 34-37	RYCB 5	RYCB 6	27	0.480	0.40	0.192	0.192	0.338	111.18	0.105	62.1	300	1.500	0.118	1.675	0.62	10.62
REAR LOTS 24-26, 31-33	RYCB 6	RYCB 7	28	0.460	0.40	0.184	0.184	0.522	107.35	0.156	44.5	375	2.000	0.248	2.245	0.33	10.95
REAR LOTS 27-30	RYCB 7	ST 7	29	0.300	0.40	0.120	0.120	0.642	105.41	0.188	34.2	450	0.700	0.239	1.500	0.38	11.33
Sandalwood Crescent east E/W	ST 7	ST 8			0.40	0.000	0.000	2.722	88.47	0.669	19.5	750	0.400	0.704	1.594	0.20	14.74
																START	10.00
Sandalwood Crescent west N/S	ST 11	ST 12	33	0.270	0.40	0.108	0.108	0.108	111.18	0.033	71.7	300	1.000	0.097	1.368	0.87	10.87
Sandalwood Crescent west N/S	ST 12	ST 13	34	0.220	0.40	0.088	0.088	0.196	105.84	0.058	9.1	300	1.000	0.097	1.368	0.11	10.98
Sandalwood Crescent west N/S	ST 13	ST 8	30	0.502	0.40	0.201	0.201	0.397	105.21	0.116	31.4	450	0.400	0.180	1.134	0.46	11.45
OUTLET TO POND BLK 38	ST 8	OUTLET	35	0.330	0.40	0.132	0.132	3.251	87.68	0.792	22.4	750	0.540	0.818	1.852	0.20	14.94

VINEYARD CREEK ESTATES ST. D

AREA NO.	AREA EXIST. STREET ha.	AREA EXIST. RES. ha.	AREA EXIST. O.S. PARK ha.	AREA FUT COM. ha.	AREA FUT RES FIORUCCI ESTATES ha.	AREA FUT RES SOUTH SITE ha.
ALTERNATE 2 - FUTURE DEVELOPMENT SOUTH DEVELOPMENTS TO						
201	0.541	0.309				
202	0.221	0.519				
Totals	0.762	0.628				
103	0.310					
1						
2		0.312				0.538
3	0.013					1.290
4	0.097					0.615
5	0.159					0.075
						0.100
6					0.580	
7					0.490	
8					0.280	
9					0.650	
10					0.420	
11					0.280	
12					0.370	
13					0.570	
14					0.290	
106	0.250					
108			0.466			
105	0.410					
104	0.140			0.100		
31	0.180					
107	0.090			0.450		

...ers and Miduss Output

AREA	DA	S	L	CONTROL LOCATION	25 mm		2-YEAR		5-YEAR		100-YEAR	
					VoL.	Qp	VoL.	Qp	VoL.	Qp	VoL.	Qp
		%	m.		cu.m./s.	cu.m.	cu.m./s.	cu.m.	cu.m./s.	cu.m.	cu.m./s.	cu.m.
		2.70%	189	TANBARK	61	0.013	85	0.045			271	0.189
		0.50%	189	WARNER RD. W.	53	0.011	74	0.048			236	0.171
				...TERLY DITCH AFTER MINOR EVENT MATCHING PRE FLOWS TO 100 YEA								
		0.80%	140	TANBARK RD. N. WARNER								
		1.00%	28	YORK RD 750 U.S.								
				LANDS SOUTH OF FIORUCCI ESTATES								
		0.80%	66	S. WARNER FUT. ST.								
		1.00%	127	S. WARNER FUT. ST.								
		2.00%	88	S. WARNER FUT. ST.								
		2.00%	53	WARNER RD. W.								
		0.50%	86	WARNER RD. W.								
				FIORUCCI ESTATES SITE								
		2.00%	50	N. WARNER FUT ST.								
		1.00%	66	N. WARNER FUT ST.								
		0.50%	41	N. WARNER FUT RYCB								
		0.50%	41	N. WARNER FUT RYCB								
		0.50%	104	N. WARNER FUT ST.								
		0.50%	41	N. WARNER FUT RYCB								
		0.50%	61	N. WARNER FUT ST.								
		0.50%	41	N. WARNER FUT RYCB								
		0.50%	41	N. WARNER FUT EASEMENT								
		0.50%	6	YORK RD 750 U.S.								
		1.00%	26	YORK RD 750 D.S.								
		0.80%	50	QUEENSTON RD CULV. D.S.								
		0.80%	62	QUEENSTON RD CULV. D.S.								
		0.80%	190									
		1.00%	16	YORK RD 450 D.S.								
		0.80%	60									
		1.00%	16	QUEENSTON RD 750 D.S.								
		0.80%	100.0	QUEENSTON RD. AT ST. A E.								
		0.80%	60.0									
		1.00%	19.0	QUEENSTON RD 600 D.S.								
		0.80%	30.5	QUEENSTON RD. AT ST. A E.								
		1.00%	28.8									

Table No. 5.0 Hydrologic and Hydraulic Parameters and Miduss Output

VINEYARD CREEK ESTATES ST. DAVID'S IN THE TOWN OF N-O-T-L

AREA NO.	AREA EXIST. STREET	AREA EXIST. RES.	AREA EXIST. O.S. PARK	AREA FUT COM.	AREA FUT RES FIORUCCI ESTATES	AREA FUT RES SOUTH SITE	AREA NOW RES VINEYARD CREEK ESTATES	AREA TOTAL	L	S	IMPERVIOUS %	IMP	SCS	PERVIOUS AREA	SCS AMC II	Ia	L	JCT NO	DIA m.	S %	L m.	CONTROL LOCATION	25 mm VoL. cu.m./s.	25 mm Qp cu.m.	2-YEAR VoL. cu.m./s.	2-YEAR Qp cu.m.	5-YEAR VoL. cu.m./s.	5-YEAR Qp cu.m.	100-YEAR VoL. cu.m./s.	100-YEAR Qp cu.m.
	ha.	ha.	ha.	ha.	ha.	ha.	ha.	ha.				ha.		ha.	CN.	mm	m		m.	%	m.									
ALTERNATE 2 - FUTURE DEVELOPMENT CONDITION - VINEYARD CREEK AREA																														
SOUTH DEVELOPMENT TO POND G-1																														
201	0.541	0.309						**0.850**	104.0	2.70%	30.0%	0.255	98	0.595	68.0	12.0	104.0	**100**	**450**	2.70%	189	TANBARK	61	0.013	85	0.045			271	0.189
202	0.221	0.519						**0.740**	97.1	100.00%	30.0%	0.222	98	0.518	68.0	12.0	97.1	**100**	**525**	0.50%	189	WARNER RD. W.	53	0.011	74	0.048			236	0.171
Totals	0.762	0.828						**1.590**				0.477		1.113																
SOUTH DEVELOPMENTS TO VINEYARD CREEK ESTATES POND																		OVER CONTROL POND TO ALLOW DIVERSION TO WESTERLY DITCH AFTER MINOR EVENT MATCHING PRE FLOWS TO 100 YEA												
103	0.310							**0.310**	62.8	0.80%	30.0%	0.093	98	0.217	68.0	12.0	62.8	**NL**	**ODR**	0.80%	140	TANBARK RD. N. WARNER								
																		101	**450**	1.00%	28	YORK RD 750 U.S.								
																						LANDS SOUTH OF FIORUCCI ESTATES								
1						0.638		**0.638**	90.1	2.00%	30.0%	0.191	98	0.447	68.0	12.0	90.1	**10**	**375**	0.80%	66	S. WARNER FUT. ST.								
2		0.312				1.290		**1.602**	142.8	1.00%	30.0%	0.481	98	1.121	68.0	12.0	142.8	**10**	**450**	1.00%	127	S. WARNER FUT. ST.								
3	0.013					0.615		**0.628**	89.4	2.70%	30.0%	0.188	98	0.440	68.0	12.0	89.4	**11**	**450**	2.00%	88	S. WARNER FUT. ST.								
4	0.097					0.075		**0.172**	46.8	1.00%	30.0%	0.052	98	0.120	68.0	12.0	46.8	**11**	**300**	2.00%	53	WARNER RD. W.								
5	0.159					0.100		**0.259**	57.4	1.00%	30.0%	0.078	98	0.181	68.0	12.0	57.4	**11**	**375**	0.50%	86	WARNER RD. W.								
									0.0								0.0					FIORUCCI ESTATES SITE								
6					0.580			**0.580**	85.9	1.00%	30.0%	0.174	98	0.406	68.0	12.0	85.9	**NL**	**450**	2.00%	50	N. WARNER FUT ST.								
7					0.490			**0.490**	79.0	1.00%	30.0%	0.147	98	0.343	68.0	12.0	79.0	**12**	**525**	1.00%	66	N. WARNER FUT ST.								
8					0.280			**0.280**	59.7	1.00%	30.0%	0.084	98	0.196	68.0	12.0	59.7	**12**	**300**	0.50%	41	N. WARNER FUT RYCB								
9					0.650			**0.650**	91.0	1.00%	30.0%	0.195	98	0.455	68.0	12.0	91.0	**12**	**300**	0.50%	41	N. WARNER FUT RYCB								
10					0.420			**0.420**	73.1	0.01	30.0%	0.126	98	0.294	68.0	12.0	73.1	**13**	**525**	0.50%	104	N. WARNER FUT ST.								
11					0.280			**0.280**	59.7	1.00%	30.0%	0.084	98	0.196	68.0	12.0	59.7	**13**	**300**	0.50%	41	N. WARNER FUT RYCB								
12					0.370			**0.370**	68.6	1.00%	30.0%	0.111	98	0.259	68.0	12.0	68.6	**14**	**600**	0.50%	61	N. WARNER FUT ST.								
13					0.570			**0.570**	85.2	1.00%	30.0%	0.171	98	0.399	68.0	12.0	85.2	**14**	**300**	0.50%	41	N. WARNER FUT RYCB								
																		NL	**600**	0.50%	41	N. WARNER FUT EASEMENT								
14					0.290			**0.290**	60.8	1.00%	30.0%	0.087	98	0.203	68.0	12.0	60.8	**101**	**600**	0.50%	6	YORK RD 750 U.S.								
																		NL	**750**	1.00%	26	YORK RD 750 D.S.								
106	0.250							**0.250**	56.4	0.80%	30.0%	0.075	98	0.175	68.0	12.0	56.4	**1021**	**ODR**	0.80%	50	QUEENSTON RD CULV. D.S.								
108			0.466					**0.466**	77.0	0.80%	0.0%	0.000	98	0.466	68.0	12.0	77.0	**1021**	**ODR**	0.80%	62	QUEENSTON RD CULV. D.S.								
105	0.410							**0.410**	72.3	0.80%	30.0%	0.123	98	0.287	68.0	12.0	72.3	**NL**	**ODR**	0.80%	190									
104	0.140			0.100				**0.240**	55.3	0.80%	30.0%	0.072	98	0.168	68.0	12.0	55.3	**NL**	**450**	1.00%	16	YORK RD 450 D.S.								
																		NL	**ODR**	0.80%	60									
31	0.180							**0.180**	47.9	0.80%	30.0%	0.054	98	0.126	70.0	10.9	47.9	**1021**	**CULV**	1.00%	16	QUEENSTON RD 750 D.S.								
107	0.090			0.450				**0.540**	82.9	0.80%	65.0%	0.351	98	0.189	68.0	12.0	82.9	**102**	**ODR**	0.80%	100.0	QUEENSTON RD. AT ST. A E.								
																		NL	**ODR**	0.80%	60.0									
																		102	**600**	1.00%	19.0	QUEENSTON RD 600 D.S.								
																		NL	**600**	0.80%	30.5	QUEENSTON RD. AT ST. A E.								
																		203	**600**	1.00%	28.8									

Table No. 6.0 Hydrologic and Hydraulic Parameters and Midúss Output

VINEYARD CREEK ESTATES ST. DAVID'S IN THE TOWN OF N-O-T-L

AREA NO.	AREA EXIST. STREET	AREA EXIST. RES.	AREA EXIST. O.S. PARK	AREA FUT COM.	AREA FUT RES FIORUCCI ESTATES	AREA FUT RES SOUTH SITE	AREA NOW RES VINEYARD CREEK ESTATES	AREA TOTAL	L	S	IMPERVIOUS %	IMP	SCS	PERVIOUS AREA	SCS AMC II	Ia	L	JCT	DIA	S	L	CONTROL LOCATION	25 mm VoL.	25 mm Qp	2-YEAR VoL.	2-YEAR Qp	5-YEAR VoL.	5-YEAR Qp	100-YEAR VoL.	100-YEAR Qp
	ha.	ha.	ha.	ha.	ha.	ha.	ha.	ha.			IMP	ha.	CN.	ha.	CN.	mm	m	NO	m.	%	m.		cu.m./s.	cu.m.	cu.m./s.	cu.m.	cu.m./s.	cu.m.	cu.m./s.	cu.m.
VINEYARD ESTATES STORM SEWERS																						OFFSITE FROM SOUTH	698	0.134	1057	0.485	1568	0.760	3308	1.767
20		0.372					0.214	**0.586**	86.4	1.70%	30.0%	0.176	98	0.410	68.0	12.0	86.4	**203**	**375**	0.80%	64.1	RYCB TO MH 1								
																		NL	**675**	0.50%	30.0									
																		NL	**675**	0.50%	26.8									
21							0.392	**0.392**	70.6	1.70%	30.0%	0.118	98	0.274	68.0	12.0	70.6	**20**	**675**	0.50%	44.0	RYCB TO MH 3								
22		0.780					0.405	**1.185**	122.8	1.70%	30.0%	0.356	98	0.830	68.0	12.0	122.8	**20**	**375**	1.00%	52.1									
																		NL	**675**	0.50%	42.2									
23							0.453	**0.453**	75.9	1.70%	30.0%	0.136	98	0.317	68.0	12.0	75.9	**NL**	**900**	0.50%	28.8	RYCB TO MH 4								
24							0.212	**0.212**	52.0	1.70%	30.0%	0.064	98	0.148	68.0	12.0	52.0	**21**	**900**	0.60%	79.3									
25		0.815					0.345	**1.160**	121.5	1.70%	30.0%	0.348	98	0.812	68.0	12.0	121.5	**21**	**375**	0.70%	52.0									
26							0.221	**0.221**	53.0	1.70%	30.0%	0.066	98	0.155	68.0	12.0	53.0	**21**	**375**	0.50%	46.0	RYCB TO MH 6								
																		22	**1050**	1.00%	57.6									
27							0.480	**0.480**	78.2	1.70%	30.0%	0.144	98	0.336	68.0	12.0	78.2	**NL**	**300**	0.50%	62.0									
28							0.460	**0.460**	76.5	1.70%	30.0%	0.138	98	0.322	68.0	12.0	76.5	**NL**	**375**	0.50%	44.5									
29							0.300	**0.300**	61.8	1.70%	30.0%	0.090	98	0.210	68.0	12.0	61.8	**22**	**450**	0.50%	34.0									
30							0.502	**0.502**	79.9	1.70%	30.0%	0.151	98	0.351	68.0	12.0	79.9	**23**	**825**	0.50%	58.0									
110	0.394	0.396		1.008				**1.798**	151.3	0.80%	65.0%	1.169	98	0.629	70.0	10.9	151.3	**NL**	**ODR**	0.80%	140.0	**OFFSITE COMMERCIAL**								
																		NL	**600**	0.80%	31.0		250	0.054	348	0.135	492	0.297	893	0.604
																						OFF SITE CONTROL COMMERCIAL Q		0.026		0.042		0.069		0.085
																						OFF SITE CONTROL COMMERCIAL STORAGE	115		176		264		523	
32	0.160							**0.160**	45.1	0.80%	30.0%	0.048	98	0.112	70.0	10.9	45.1	**NL**	**375**	0.80%	28.0	QUEENSTON RD. MH 11								
																		NL	**375**	0.80%	63.7	OVERLAND TO MH 12FROM QUEENSTON RD.								
33							0.291	**0.291**	60.9	1.70%	30.0%	0.087	98	0.204	68.0	12.0	60.9	**NL**	**375**	0.80%	71.7									
34							0.220	**0.220**	52.9	1.70%	30.0%	0.066	98	0.154	68.0	12.0	52.9	**23**	**375**	0.80%	9.1									
35							0.330	**0.330**	64.8	1.70%	30.0%	0.099	98	0.231	68.0	12.0	64.8	**NL**	**1350**	0.80%	12.7		1450	0.262	2170	0.793	3191	1.269	6622	3.051
							0.000	**0.000**	0.0	1.70%	0.0%	0.000	98	0.000	68.0	12.0	0.0	**NL**	**POND**			**POND MAX. STORAGE / ELEV.**	969	117.223	1238	117.381	1824	117.709	2919	118.232
																		103	**300**	0.80%	40.0	**OUTFLOW FROM POND**		0.107		0.167		0.223		1.242
36	0.100							**0.100**	35.7	0.80%	10.0%	0.010	98	0.090	70.0	10.9	35.7	**NL**	**ODR**	0.80%	40.0	QUEENSTON RD N. RD. DITCH								
111		0.380					0.845	**1.225**	124.9	1.70%	13.5%	0.165	98	1.060	70.0	10.9	124.9	**103**	**ODR**	1.70%	265.0	NORTH LIMIT VINEYARD ESTATES	86	0.069	93	0.033	160	0.066	360	0.127
																						DIFFERENCE FROM PRESENT CONDITIONS	-22	0.000	-148	-0.085	-660	-0.186	-2447	-0.963
																		OLD 104	**ODR**	1.70%	35.0	MAIN DRAIN N. OF VINEYARD ESTATES OLD 104	1490	0.120	2253	0.166	3325	0.236	6952	1.346
																						DIFFERENCE FROM PRESENT CONDITIONS	934	0.069	1199	-0.012	1467	-0.130	4787	-0.075
112		4.140						**4.140**	229.6	2.00%	1.0%	0.041	98	4.099	70.0	10.9	229.6	**105**	**ODR**	2.00%	320.0	MD. WEST BR TO TANBARK RD.	1665	0.120	2414	0.181	3632	0.282	7641	1.648
																						DIFFERENCE FROM PRESENT CONDITIONS	935	0.082	1199	-0.011	1467	-0.128	1978	-0.092
113	0.180							**0.180**	47.9	1.00%	30.0%	0.054	98	0.126	70.0	10.9	47.9	**NL**	**ODR**	1.00%	86.0	TANBARK RD								
114	0.640	2.160						**2.800**	188.8	1.00%	30.0%	0.840	98	1.960	70.0	10.9	188.8	**NL**	**ODR**	1.00%	313.0	TANBARK RD								
115	0.321	0.429						**0.750**	97.7	3.00%	20.0%	0.150	98	0.600	70.0	10.9	97.7	**105**	**ODR**	3.00%	150.0	TANBARK RD AT MD. WEST BR								
																		NL	**ODR**	2.00%	150.0	TANBARK RD NORTH W. RD. DITCH	1820	0.142	2803	0.253	4213	0.455	9684	1.810
Totals	3.444	9.784	0.466	1.558	3.930	2.718	5.670	**27.570**	592.5	2.00%	27.0%	7.452	98	20.118	70.0	10.9	592.5					**DIFFERENCE FROM PRESENT CONDITIONS**	936	0.035	1199	0.002	1467	-0.040	1977	-0.109
Totals	4.206	10.612	0.466	1.558	3.930	2.718	5.670	**29.160**	609.3	2.00%	27.2%	7.929	98	21.231	70.0	10.9	609.3													

Vineyard Creek Estates - Communal Storm Sewer Design She

KERRY T. HOWE ENGINEERING LIMITED

Town of Niagara-On-The-Lake

PROJECT No. : 03 - 024
DATE: June 10, 2005
DESIGN: R. Beaulieu
CHECKED: D. Ingram

Figure No. 5.3

n = 0.013
i = 996.916 / (t+4.233) ^ 0.826
STORM DRAINAGE PLAN FIGURE NO. 5
Town of Niagara-On-The-Lake 5-Year Storm

STORM SEWER DESIGN (Metric)

			RAINFALL DESIGN								PIPE DESIGN					TIME OF CON.	
STREET	FROM	TO	AREA NO.	AREA (ha.)	R	A * R	SEC A*R	SEW A*R	I mm/hr	Q cms	LENGTH m	DIA mm	SLOPE %	Q cms	VEL m/sec	SECT min	CUM min
																START	*13.70*
Future Upstream draiinage	*Warner Rd*	*York Rd.*	*1-14*	*8.259*	*0.30*	*2.478*	*2.478*	*2.478*	*91.86*	*0.632*	*500.0*	*600*	*1.200*	*0.673*	*2.379*	*3.50*	*17.20*
Queenston Road	*York Rd.*	ST. 14	*104-106,31*	*1.546*	*0.30*	*0.464*	*0.464*	*2.942*	*79.27*	*0.648*	*180.0*	*600*	*1.200*	*0.673*	*2.379*	*1.26*	*18.46*
Queenston Road	ST. 14	ST 1	107	0.540	0.30	0.162	0.626	3.567	75.62	0.749	30.5	600	1.500	0.752	2.660	0.19	18.66
Sandalwood Cres (east end)	ST 1	ST 2		0.000	0.30	0.000	0.000	3.567	75.10	0.744	28.0	600	1.500	0.752	2.660	0.18	18.83
																START	**10.00**
REAR LOT 1 & 2	RYCB.1	ST 2	20	0.586	0.30	0.176	0.176	0.176	111.18	0.054	64.0	300	0.470	0.066	0.938	1.14	11.14
Sandalwood Cres (east end)	ST 2	ST 3		0.000	0.30	0.000	0.000	3.743	74.62	0.776	28.0	675	1.000	0.841	2.349	0.20	19.03
Sandalwood Cres (east end)	ST 3	ST 4		0.000	0.30	0.000	0.000	3.743	74.10	0.770	30.9	675	1.000	0.841	2.349	0.22	19.25
Sandalwood Cres. (east end)	ST 4	ST 5	21	0.392	0.30	0.118	0.118	3.861	73.53	0.788	26.8	675	1.000	0.841	2.349	0.19	19.44
																START	**10.00**
REAR LOTS 3 - 5	RYCB 2	ST 5	22	1.185	0.30	0.356	0.356	0.356	111.18	0.110	52.0	375	1.500	0.215	1.944	0.45	19.88
Sandalwood Cres. (east end)	ST 5	ST 6	23,24	0.665	0.30	0.200	0.200	4.416	73.04	0.896	109.8	914	0.250	0.944	1.438	1.27	20.71
																START	**10.00**
REAR LOTS 8 - 12	RYCB 3	ST 6	25	1.160	0.30	0.348	0.348	0.348	111.18	0.107	51.5	375	1.000	0.175	1.587	0.54	10.54
																START	**10.00**
REAR LOTS 13 - 15	RYCB 4	ST 6	26	0.221	0.30	0.066	0.066	0.066	91.86	0.017	46.9	300	0.300	0.053	0.749	1.04	11.04
Sandalwood Cres. (north end)	ST 6	ST 7		0.000	0.30	0.000	0.000	4.830	69.95	0.938	56.8	1050	0.150	1.058	1.221	0.78	21.49
												(HE 865x1345)				**START**	**10.00**

TABLE NO.5.1 - DESIGN COMMUNAL WET POND

Level m.	Surface Area sm.	Avg. Area sm.	Incr Vol cu.m.	Volume cu.m.	Discharge cu.m./s.	Avg. Drain Rate cu.m./s.	Avg. Drain Rate cu.m./hr..	Incr Drain Time hrs	Accum Drain Time For Ext. Det. hrs	Accum Drain 100 yr. To Ext. Det. hrs	
113.50	0.0										
113.75	3.0										
114.00	38.3	20.7	5.2	5.2							
114.25	111.4	74.9	18.7	23.9							
114.50	196.4	153.9	38.5	62.4							
114.75	287.1	241.8	60.4	122.8							
115.00	383.1	335.1	83.8	206.6							
115.25	484.6	433.9	108.5	315.0							
115.50	591.5	538.1	134.5	449.5							
115.75	703.9	647.7	161.9	611.5							
116.00	821.3	762.6	190.7	802.1							
116.25	944.3	882.8	220.7	1022.8							
116.50	1072.6	1008.5	252.1	1274.9							
116.59	1143.0	1107.8	103.0	**1378.0**	STATIC WATER LEVEL						PERMANENT POOL
116.59	1143.0				0.000	0.000			**35.8**		EXTENDED POOL
116.75	1252.0	1197.5	303.0	303.0	0.006	0.003	10.8	28.1	7.8		
117.00	1441.0	1346.5	340.0	643.0	0.024	0.015	54.0	6.3	1.5		
117.223			346.0	**989.0**	**0.107**	0.066	235.8	1.5			25 mm QUALITY
117.25	1639.6	1540.3	379.0	1022.0	0.120	0.072	259.2	1.5		1.8	
117.381			214.0	**1236.0**	**0.157**	0.139	498.6	0.4		1.3	2 YEAR
117.50	1847.7	1743.7	204.0	1440.0	0.184	0.170	612.0	0.3		1.0	
117.709			384.0	**1824.0**	**0.245**	0.245	882.0	0.4		0.6	5 YEAR
117.75	2064.0	1955.9	78.0	1902.0	0.230	0.238	855.0	0.1		0.5	
118.00	2286.3	2175.2	505.0	2407.0	0.611	0.421	1513.8	0.3		0.1	
118.218			480.0	**2887.0**	**1.262**	0.937	3371.4	0.1			100 YEAR
118.25	2515.0	2400.7	73.0	2960.0	1.372	1.317	4741.2	0.0			

TABLE NO. 5.2 - SUMMARY COMMUNAL WET POND SYSTEM DESIGN PARAMETERS

VINEYARD CREEK ESTATES - ST. DAVID'S TOWN OF N-O-T-L

MUNICIPAL STORM WATER MANAGEMENT REVIEW SUMMARY
MUNICIPAL SITE FOR UPSTREAM DEVELOPMENTS WET POND + EXTENDED STORAGE

RAW LAND AREA CONNECTED VINEYARD CREEK ESTATES POND =	27.57	ha.		
PRESENT RUNOFF % IMPERVIOUS	7.61%	%		
FUTURE RUNOFF % IMPERVIOUS	27.03%	%		
PROTECTION LEVEL TSS REMOVAL	70	%		
STORM WATER WET POND CRITERIA TAB 3.2 2003	90	cu.m./ha.	2481.3	cu.m.
PERMANENT POOL	50	cu.m./ha.	1378.5	cu.m.
EXTENDED DETENTION	40	cu.m./ha.	1102.8	cu.m.
PERMANENT POOL	50.0	cu.m./ha.	1378.0	cu.m.
25 mm STORM EXT. POND STORAGE VOL.	35.9	cu.m./ha.	989.0	cu.m.
25 mm STORM EXT. POND STORAGE PEAK OUTFLOW	107	lps		
25 mm STORM EXT. POND STORAGE DRAINTIME	35.8	hrs		
25 mm STORM EXT. POND STORAGE LEVEL EXTENDED DETENTION	117.381	m.		
2 YEAR STORM STORAGE VOLUME			1236	cu.m.
2 YEAR STORM EXT. POND STORAGE PEAK OUTFLOW	157	lps		
2 YEAR STORM POND STORAGE LEVEL	117.381	m.		
5 YEAR STORM STORAGE VOLUME			1824	cu.m.
5 YEAR STORM EXT. POND STORAGE PEAK OUTFLOW	245	lps		
5 YEAR STORM POND STORAGE LEVEL	117.709	m.		
100 YEAR STORM STORAGE VOLUME			2887	cu.m.
100 YEAR STORM POND STORAGE PEAK OUTFLOW	1262	lps		
100 YEAR STORM POND STORAGE DRAIN TIME TO EXT. STORAGE			1.3	hrs
100 YEAR STORM POND STORAGE LEVEL	118.218	m.		
POND SIDE SLOPES 4:1 ASPECT RATIO 2:1		**PROVIDED**		
POND TO PERMANENT POOL INV. - WSEL	113.50	m.	116.59	m.
POND MAX. WATER LEVEL	118.25	m.		
MOE 2003 GUIDELINES TABLE 4.6 WET POND CITERIA				
BUFFERS - 7.5 m. FROM 25 mm WSEL. OR 3.0 m. FROM 100 YR QUANTUTY WSEL		**PROVIDED**		
BUFFERS - 3.0 m. FROM TOP BANK NOTL MSP		**PROVIDED**		
MIN. 5.0 ha. DRAINAGE AREA PREFERRED GRAEATER THAN 10 ha.		**PROVIDED**		
ANNUAL SEDIMENT YIELD 35% IMP	0.60	cu.m./ha./yr		
TOTAL EXPECTED ANNUAL SEDIMENT	16.54	cu.m./yr		
WET POND CLEANOUT 10 YEAR INTERVAL VOL.	165.42	cu.m.	**PROVIDED**	

Vineyard Creek Estates - Communal Storm Sewer Design She

KERRY T. HOWE ENGINEERING LIMITED

Town of Niagara-On-The-Lake

PROJECT No. : 03 - 024
DATE: June 10, 2005
DESIGN: R. Beaulieu
CHECKED: D. Ingram

n = 0.013
i = 996.916 / (t+4.233) ^ 0.826
STORM DRAINAGE PLAN FIGURE NO. 5
Town of Niagara-On-The-Lake 5-Year Storm

Figure No. 5.3

STORM SEWER DESIGN (Metric)

			RAINFALL DESIGN								PIPE DESIGN					TIME OF CON.	
STREET	FROM	TO	AREA NO.	AREA (ha.)	R	A * R	SEC A*R	SEW A*R	I mm/hr	Q cms	LENGTH m	DIA mm	SLOPE %	Q cms	VEL m/sec	SECT min	CUM min
REAR LOTS 22-23, 34-37	RYCB 5	RYCB 6	27	0.480	0.30	0.144	0.144	0.144	91.86	0.037	61.0	300	1.000	0.097	1.368	0.74	10.74
REAR LOTS 24-26, 31-33	RYCB 6	RYCB 7	28	0.460	0.30	0.138	0.138	0.282	106.61	0.084	45.0	375	2.000	0.248	2.245	0.33	11.08
REAR LOTS 27-30	RYCB 7	ST 7	29	0.300	0.30	0.090	0.090	0.372	104.68	0.108	34.0	450	0.710	0.240	1.511	0.38	11.45
Sandalwood Cres. (north end)	ST 7	ST 8	30	0.502	0.30	0.151	0.151	5.353	68.20	1.014	50.8	1050	0.300	1.496	1.727	0.49	21.98
												(HE 865x1345)				*START*	*10.00*
Future Commercial site	Site	*ST. 13*	*Pt 110*	*1.480*	*0.30*	*0.444*	*0.444*	*0.444*	*111.18*	*0.137*	*100.0*	*450*	*0.500*	*0.202*	*1.268*	*1.31*	*11.31*
			Commercial Lands controlled To Residential Runnoff using On Site Stoarge														
Queenston Road (Future)	*ST. 13*	*ST 9*	*32,36,pt 110*	*0.578*	*0.30*	*0.173*	*0.173*	*0.617*	*103.36*	*0.177*	*31.2*	*525*	*0.500*	*0.304*	*1.405*	*0.37*	*11.69*
Sandalwood Cres (west end)	ST 9	ST 10		0.000	0.30	0.000	0.000	0.617	101.37	0.174	28.0	525	0.500	0.304	1.405	0.33	12.02
Sandalwood Cres (west end)	ST 10	ST 11		0.000	0.30	0.000	0.000	0.617	99.65	0.171	63.7	525	0.500	0.304	1.405	0.76	12.77
Sandalwood Cres. (west end)	ST 11	ST 12	33	0.270	0.30	0.081	0.081	0.698	95.98	0.186	71.7	525	1.000	0.430	1.987	0.60	13.37
Sandalwood Cres. (west end)	ST 12	ST 8	34	**0.220**	0.30	0.066	0.066	0.764	93.26	0.198	9.1	525	1.000	0.430	1.987	0.08	13.45
OUTLET TO POND (Block 38)	ST 8	OUTLET	35	0.330	0.20	0.066	0.066	6.183	67.14	1.153	20.1	1200	0.150	1.510	1.335	0.25	22.23
												(HE 965x1525)					

Table No. 6.0
Lands Tributary to The Lowery Drain
Master Servicing Plan Storm Water Projects only
Costs Taken from St. David's MSP Summary Pages viii&ix
Excluded storm water pond land costs in MSP

Location	Rationale	Length m.	Size	Unit	Unit Price	Estimated Cost	Service Area ha.	Cost/ha.
Pond B-1	New wet pond		6444	cu.m.	$22.35	$144,000	26.300	$5,475
Pond B-2	New wet pond		958	cu.m.	$56.37	$54,000	3.000	$18,000
Pond G-2	New wet pond		14527	cu.m.	$16.87	$245,000	46.500	$5,269
West Branch Lowery Drain	Ditch to Post development standards	850		m.	$49.41	$42,000	75.800	$554
Lowery Municipal Drain	Ditch to Post development standards	1330		m.	$233.83	$311,000	75.800	$4,103
Extend Lowery Municipal Drain	Ditch to Post development standards	300		m.	$660.00	$198,000	75.800	$2,612
4 Mile Creek	Ditch to Post development standards	70		m.	$214.29	$15,000	75.800	$198
Area A (VCE)	New Storm sewers For Dev.& Queenston Rd.	450	525	m.	$600.00	$270,000	7.228	$37,355
Area A (VCE)	New Storm sewers For Dev.& Queenston Rd.	475	750	m.	$800.00	$380,000	13.876	$27,385
Area B-1	New Storm sewers For Dev.& Upstream lands.	450	750	m.	$800.00	$360,000	20.524	$17,540
Area B-1	New Storm sewers For Dev.& Upstream lands.	160	825	m.	$875.00	$140,000	26.300	$5,323
Area B-1	New Storm sewers For Dev.	70	300	m.	$450.00	$31,500	5.776	$5,454
Area B-1	New Storm sewers For Dev.	110	450	m.	$525.00	$57,750	5.776	$9,998
Area B-1	New Storm sewers For Dev.	400	675	m.	$725.00	$290,000	5.776	$50,208
Area B-2	New Storm sewers For Dev.	190	375	m.	$475.00	$90,250	3.000	$30,083
Area D (Fiorucci)&part Area E	New Storm sewers For Dev.& Part Area E S. of Warner Rd	350	675	m.	$725.00	$253,750	6.648	$38,169
						$2,882,250		
Area D (Fiorucci)	Estimated cost from above					$398,341	3.930	**$101,359**
Area A (VCE)	Estimated cost from above					$532,016	5.670	**$93,830**
Area E. S. Warner	Estimated cost from above					$201,061	2.718	**$73,974**
Fut Commercial Area York Rd.. Warner	Estimated cost from above					$156,649	1.558	**$100,545**

Table No. 6.1
Lands Tributary to The Lowery Drain
Revised for Relocated B-1
Excludes storm water pond land costs as in MSP

Location	Rationale	Length m.	Size	Unit	Unit Price	Estimated Cost	Service Area ha.	Cost/ha.
Pond B-1 relocated to G-1?	Balance of storm control to G-1 ?		(3499)	cu.m.			(12.424)	
Vineyard Creek Estates	New wet pond		2945	cu.m.	$58.09	$171,089	13.876	$12,330
Pond B-2	New wet pond		958	cu.m.	$56.37	$54,000	3.000	$18,000
Pond G-2 Apricot Glen	New wet pond		5000	cu.m.	$54.00	$270,000	14.000	$19,286
Pond G-1	New wet pond reduced by Apricot Glen (5000cu.m.) add B-1 overcontrol ?		13,026	cu.m.	$16.87	$219,749	44.924	$4,892
West Branch Lowery Drain	Ditch to Post development standards	850		m.	$49.41	$42,000	75.800	$554
Lowery Municipal Drain	Ditch to Post development standards	1330		m.	$233.83	$311,000	75.800	$4,103
Extend Lowery Municipal Drain	Ditch to Post development standards	300		m.	$660.00	$198,000	75.800	$2,612
4 Mile Creek	Ditch to Post development standards	70		m.	$214.29	$15,000	75.800	$198
Area A (VCE)	New Storm sewers For Dev.& fut. Commercial	204	525	m.	$283.54	$57,843	4.393	$13,167
Area A (VCE)	New Storm sewers For Dev.& Area D & part Area E	400	varies	m.	$919.33	$367,730	9.483	$38,778
Area B-1	New Storm sewers For Dev.& Upstream lands.	450	450	m.	$525.00	$236,250	16.131	$14,646
Area B-1	New Storm sewers For Dev.	70	300	m.	$450.00	$31,500	16.131	$1,953
Area B-1	New Storm sewers For Dev.	110	450	m.	$525.00	$57,750	16.131	$3,580
Area B-1	New Storm sewers For Dev.	400	675	m.	$725.00	$290,000	16.131	$17,978
Area B-2	New Storm sewers For Dev.	190	375	m.	$475.00	$90,250	3.000	$30,083
Area D (Fiorucci)&part Area E	New Storm sewers For Dev.& Part Area E S. of Warner Rd	540	600	m.	$650.00	$351,000	6.648	$52,798
						$2,763,161		
Area D (Fiorucci)	Estimated cost from above					$437,696	3.930	**$111,373**
Area A (VCE)	Estimated cost from above					$406,777	5.670	**$71,742**
Area E. S. Warner	Estimated cost from above					$197,313	2.718	**$72,595**
Fut Commercial Area York Rd.. Warner	Estimated cost from above					$51,358	1.558	**$32,964**
Adjust cost with VCE pond increased land cost								**$445,338**
Area D (Fiorucci)	Add land costs for Area A (VCE) pond					$563,826	3.930	**$143,467**
Area A (VCE)	Add land costs for Area A (VCE) pond					$586,751	5.670	**$103,836**
Area E. S. Warner	Add land costs for Area A (VCE) pond					$284,545	2.718	**$104,689**
Fut Commercial Area York Rd.. Warner	Add land costs for Area A (VCE) pond					$101,361	1.558	**$65,058**

Table No. 6.2

Lands Tributary to The Lowery Drain

Master Servicing Plan Storm Water Projects only

Costs Taken from St. David's MSP Summary Pages viii&ix

Excluded storm water pond land costs in MSP

Location	Rationale	Length m.	Size	Unit	Unit Price	Estimated Cost	Service Area ha.	Cost/ha.
Pond B-1	New wet pond		6444	cu.m.	$22.35	$144,000	26.300	$5,475
Pond B-2	New wet pond		958	cu.m.	$56.37	$54,000	3.000	$18,000
Pond G-2	New wet pond		14527	cu.m.	$16.87	$245,000	46.500	$5,269
West Branch Lowery Drain	Ditch to Post development standards	850		m.	$49.41	$42,000	75.800	$554
Lowery Municipal Drain	Ditch to Post development standards	1330		m.	$233.83	$311,000	75.800	$4,103
Extend Lowery Municipal Drain	Ditch to Post development standards	300		m.	$660.00	$198,000	75.800	$2,612
4 Mile Creek	Ditch to Post development standards	70		m.	$214.29	$15,000	75.800	$198
Area A (VCE)	New Storm sewers For Dev.& Queenston Rd.	450	525	m.	$600.00	$270,000	7.228	$37,355
Area A (VCE)	New Storm sewers For Dev.& Queenston Rd.	475	750	m.	$800.00	$380,000	13.876	$27,385
Area B-1	New Storm sewers For Dev.& Upstream lands.	450	750	m.	$800.00	$360,000	20.524	$17,540
Area B-1	New Storm sewers For Dev.& Upstream lands.	160	825	m.	$875.00	$140,000	26.300	$5,323
Area B-1	New Storm sewers For Dev.	70	300	m.	$450.00	$31,500	5.776	$5,454
Area B-1	New Storm sewers For Dev.	110	450	m.	$525.00	$57,750	5.776	$9,998
Area B-1	New Storm sewers For Dev.	400	675	m.	$725.00	$290,000	5.776	$50,208
Area B-2	New Storm sewers For Dev.	190	375	m.	$475.00	$90,250	3.000	$30,083
Area D (Fiorucci)&part Area E	New Storm sewers For Dev.& Part Area E S. of Warner Rd	350	675	m.	$725.00	$253,750	6.648	$38,169
						$2,882,250		
Area D (Fiorucci)	Estimated cost from above					$398,341	3.930	**$101,359**
Area A (VCE)	Estimated cost from above					$532,016	5.670	**$93,830**
Area E. S. Warner	Estimated cost from above					$201,061	2.718	**$73,974**
Fut Commercial Area York Rd.. Warner	Estimated cost from above					$156,649	1.558	**$100,546**

Table No. 6.3

Lands Tributary to The Lowery Drain

Revised for Relocated B-1

Excludes storm water pond land costs as in MSP

Location	Rationale	Length m.	Size	Unit	Unit Price	Estimated Cost	Service Area ha.	Cost/ha.
Pond B-1 relocated to G-1?	Balance of storm control to G-1 ?		(3499)	cu.m.			(12.424)	
Vineyard Creek Estates	New wet pond		2945	cu.m.	$58.09	$171,089	13.876	$12,330
Pond B-2	New wet pond		958	cu.m.	$56.37	$54,000	3.000	$18,000
Pond G-2 Apricot Glen	New wet pond		5000	cu.m.	$54.00	$270,000	14.000	$19,286
Pond G-1	New wet pond reduced by Apricot Glen (5000cu.m.) add B-1 overcontrol ?		13,026	cu.m.	$16.87	$219,749	44.924	$4,892
West Branch Lowery Drain	Ditch to Post development standards	850		m.	$49.41	$42,000	75.800	$554
Lowery Municipal Drain	Ditch to Post development standards	1330		m.	$233.83	$311,000	75.800	$4,103
Extend Lowery Municipal Drain	Ditch to Post development standards	300		m.	$660.00	$198,000	75.800	$2,612
4 Mile Creek	Ditch to Post development standards	70		m.	$214.29	$15,000	75.800	$198
Area A (VCE)	New Storm sewers For Dev.& fut. Commercial	204	525	m.	$263.54	$57,843	4.393	$13,167
Area A (VCE)	New Storm sewers For Dev.& Area D & part Area E	400	varies	m.	$919.33	$367,730	9.483	$38,778
Area B-1	New Storm sewers For Dev.& Upstream lands.	450	450	m.	$525.00	$236,250	16.131	$14,646
Area B-1	New Storm sewers For Dev.	70	300	m.	$450.00	$31,500	16.131	$1,953
Area B-1	New Storm sewers For Dev.	110	450	m.	$525.00	$57,750	16.131	$3,580
Area B-1	New Storm sewers For Dev.	400	675	m.	$725.00	$290,000	16.131	$17,978
Area B-2	New Storm sewers For Dev.	190	375	m.	$475.00	$90,250	3.000	$30,083
Area D (Fiorucci)&part Area E	New Storm sewers For Dev.& Part Area E S. of Warner Rd	540	600	m.	$650.00	$351,000	6.648	$52,798
						$2,763,161		
Area D (Fiorucci)	Estimated cost from above					$437,696	3.930	**$111,373**
Area A (VCE)	Estimated cost from above					$406,777	5.670	**$71,742**
Area E. S. Warner	Estimated cost from above					$197,313	2.718	**$72,595**
Fut Commercial Area York Rd.. Warner	Estimated cost from above					$51,358	1.558	**$32,964**
Adjust cost with VCE pond increased land cost								**$445,338**
Area D (Fiorucci)	Add land costs for Area A (VCE) pond					$563,826	3.930	**$143,467**
Area A (VCE)	Add land costs for Area A (VCE) pond					$588,751	5.670	**$103,836**
Area E. S. Warner	Add land costs for Area A (VCE) pond					$284,545	2.718	**$104,689**
Fut Commercial Area York Rd.. Warner	Add land costs for Area A (VCE) pond					$101,361	1.558	**$65,058**

APPENDIX C – Cost Estimates

Contract No.: 03-024
Title: Vineyard Creek Estates
Location: The Town of Niagara on the Lake

SCHEDULE OF ESTIMATE UNIT PRICES

Item No.	Spec No.	Description	Quantity	Unit	Unit Price	Amount
		A - STAND ALONE SWM System				
		SECTION 3 - Storm Sewers				
3.1	SPC-B3	**Granular Material**				
		Granular "A" limestone material (100% passing 19.0mm sieve). Supply, place and compact for all storm requirements.	675	t	$12.00	$8,100.00
3.2	SPC-C1	**Storm Sewer**				
		DR35 PVC./ Ulta Rib storm pipe (smooth wall), granular 'A' bedding and cover (OPSD 802.010) and c/w backfill as specified including connection				
		a) 450mm dia.				
		i) ST. 13 to ST. 8	31.4	m	$155.00	$4,867.00
		b) 375mm dia.				
		i) ST. 2 to ST. 3	30.9	m	$125.00	$3,862.50
		ii) ST. 3 to ST. 4	26.8	m	$125.00	$3,350.00
		c) 300mm dia.				
		i) ST. 11 to ST. 12	31.4	m	$95.00	$2,983.00
		ii) ST. 12 to ST. 13	9.1	m	$95.00	$864.50
	SPC-C1	**Storm Sewer**				
		Conc. storm pipe , granular 'A' bedding (OPSD 802.011) and c/w native cover and backfill connections				
		a) 750mm dia.				
		i) ST. 8 to ST. INLET - 140 D	22.4	m	$500.00	$11,200.00
		ii) ST. 7 to ST.8 140 D	19.5	m	$500.00	$9,750.00
		c)600mm dia.				
		i) ST. 5 to ST. 6 - 100 D	109.8	m	$266.00	$29,206.80
		ii) ST.4 to ST. 5 140 D	19.5	m	$266.00	$5,187.00
3.3	SPC-C6	**Storm Maintenance Hole**				
		(1200mm dia. precast concrete including flat cap and frame & cover (OPSD401.010)				
		a) ST. 2	1	each	$2,800.00	$2,800.00
		b) ST.3	1	each	$2,800.00	$2,800.00
		c) ST.4	1	each	$2,800.00	$2,800.00
		d ST. 5	1	each	$2,800.00	$2,800.00
		e) ST.11	1	each	$2,800.00	$2,800.00
		f) ST.12	1	each	$2,800.00	$2,800.00
		g) ST.13	1	each	$2,800.00	$2,800.00
3.4	SPC-C6	**Storm Maintenance Hole**				
		(1500mm dia. precast concrete including flat cap and frame & cover (OPSD401.010)				
		a) ST.6	1	each	$3,500.00	$3,500.00
		b) ST.7	1	each	$3,500.00	$3,500.00

Contract No.: 03-024
Title: Vineyard Creek Estates
Location: The Town of Niagara on the Lake

SCHEDULE OF ESTIMATE UNIT PRICES

Item No.	Spec No.	Description	Quantity	Unit	Unit Price	Amount
		A - STAND ALONE SWM System				
3.5	SPC-C6	**Storm Maintenance Hole** (2400mm dia. precast concrete including flat cap and frame & cover (OPSD401.010)				
		a) ST.8	1	each	$5,500.00	$5,500.00
		b) Control MH. 1	1	each	$9,000.00	$9,000.00
3.6	SPC-C6	STORM OUTFALL C/W GATE - 750 Dia.	1	each	$15,000.00	$15,000.00
3.7	SPC-C6	700 Dia. CSP ON QUEENSTON RD.	42	m.	$600.00	$25,200.00
3.8		**Pond Works**				
		a) Excavation including shaping, access road, internal ditches and berm	1,242	cu.m.	$8.00	$9,936.00
		b) Supply and place Granular 'A' limestone for roadways	500	t	$15.00	$7,500.00
		c) 1.8m high chainlink fence (OPSD 972.13)	109	m	$45.00	$4,905.00
		d) RipRap including 270R geotextile OPSD 804.030)	30	sq.m.	$80.00	$2,400.00
		e) 300mm HDPE culvert pipe THRU berm	20	m	$110.00	$2,200.00
		f) Landscaping and plantings	1735.5	sm	$12.00	$20,826.00
		TOTAL SECTION 3 - Storm Sewer A				**$208,438**
		ENGINEERING & CONTINGENCIES				**$52,110**
		TOTAL SECTION 3 - Communal Pond				**$260,548.00**
3.8		POND LAND AREA	1735.5	sm	$135.00	**$234,293**
		TOTAL SECTION 3 - Storm Sewer A				**$494,841**
		Vineyard Creek Estates Service Area	5.67	ha.		

Contract No.: 03-024
Title: Vineyard Creek Estates
Location: The Town of Niagara on the Lake

SCHEDULE OF ESTIMATE UNIT PRICES

Item No.	Spec No.	Description	Quantity	Unit	Unit Price	Amount
		B - VINEYARD CREEK ESTATES - COMMUNAL POND				
		SECTION 3 - Storm Sewers				
3.1	SPC-B3	**Granular Material** Granular "A" limestone material (100% passing 19.0mm sieve). Supply, place and compact for all storm requirements.	1,108	t	$12.00	$13,296.00
3.2	SPC-C1	**Storm Sewer**				
		Conc. storm pipe , granular 'A' bedding (OPSD 802.011) and c/w native cover and backfill connections				
		a)965x1525 HE IV.				
		i) ST. 8 to inlet - 140 D	20.7	m	$1,300.00	$26,910.00
		b)865x1345 HE IV				
		i) ST. 6 to ST. 7 140 D	56.8	m	$1,050.00	$59,640.00
		ii) ST.7 to ST.8 140D	50.8	m	$1,050.00	$53,340.00
		c) 900mm dia.				
		i) ST. 5 to ST. 6 100 D	109.8	m	$560.00	$61,488.00
		d) 675mm dia.				
		i) ST. 2 to ST. 3 140 D	30.0	m	$360.00	$10,800.00
		ii) ST. 3 to ST. 4 100D	26.8	m	$360.00	$9,648.00
		iii) ST. 4 to ST.5 100D	42.2	m	$360.00	$15,192.00
		iv)Outlet from pond 100 D	35.0	m	$360.00	$12,600.00
		e)600mm dia.				
		i) ST. 0 to ST. 1 - 100 D	28.0	m	$220.00	$6,160.00
		ii) ST. 1 to ST. 2 - 100 D	30.5	m	$220.00	$6,710.00
		f) 525mm dia.				
		i) ST. 13 to ST. 9 - 100 D	31.2	m	$155.00	$4,836.00
		ii) ST. 9 to ST. 10 100D	28.0	m	$155.00	$4,340.00
		iii) ST. 10 to ST.11 100D	63.7	m	$155.00	$9,873.50
		iv) ST. 11 to ST.12 100D	71.7	m	$155.00	$11,113.50
		v) ST. 12 to ST. 8 100D	9.1	m	$155.00	$1,410.50
3.3	SPC-C6	**Storm Maintenance Hole** (1500mm dia. precast concrete including flat cap and frame & cover (OPSD401.010)				
		a) ST. 0	1	each	$2,800.00	$2,800.00
		b) ST.1	1	each	$2,800.00	$2,800.00
		c) ST.2	1	each	$2,800.00	$2,800.00
		d) ST.3	1	each	$2,800.00	$2,800.00
		e) ST.4	1	each	$2,800.00	$2,800.00
		f) ST. 13	1	each	$2,800.00	$2,800.00
		g) ST. 9	1	each	$2,800.00	$2,800.00
		h) ST. 10	1	each	$2,800.00	$2,800.00
		i) ST. 11	1	each	$2,800.00	$2,800.00
3.4	SPC-C6	**Storm Maintenance Hole** (1800mm dia. precast concrete including flat cap and frame & cover (OPSD401.010)				
		a) ST. 5	1	each	$3,500.00	$3,500.00
		b) ST.12	1	each	$3,500.00	$3,500.00

Contract No.: 03-024
Title: Vineyard Creek Estates
Location: The Town of Niagara on the Lake

SCHEDULE OF ESTIMATE UNIT PRICES

Item No.	Spec No.	Description	Quantity	Unit	Unit Price	Amount
		B - VINEYARD CREEK ESTATES - COMMUNAL POND				
3.5	SPC-C6	**Storm Maintenance Hole** (2400mm dia. precast concrete including flat cap and frame & cover (OPSD401.010)				
		a) ST.6	1	each	$4,000.00	$4,000.00
		b) ST.7	1	each	$4,000.00	$4,000.00
3.5	SPC-C6	**Storm Maintenance Hole** (2400mm dia. precast concrete including flat cap and frame & cover (OPSD401.010)				
		a) ST.8	1	each	$5,500.00	$5,500.00
		b) Control MH. 1	1	each	$22,000.00	$22,000.00
3.6	SPC-C6	**STORM OUTFALL C/W GATE - 965x1525 HE**	1	each	$22,000.00	$22,000.00
3.7		**Pond Works**				
		a) Excavation including shaping, access road, internal ditches and berm	2,960	cu.m.	$8.00	$23,680.00
		b) Supply and place Granular 'A' limestone for roadways	500	t	$15.00	$7,500.00
		c) 1.8m high chainlink fence (OPSD 972.13)	109	m	$45.00	$4,905.00
		d) RipRap including 270R geotextile OPSD 804.030)	30	sq.m.	$80.00	$2,400.00
		e) 300mm HDPE culvert pipe THRU berm	20	m	$110.00	$2,200.00
		f) Landscaping and plantings	3298.8	sm	$12.00	$39,585.60
		SUB-TOTAL SECTION 3 - Communal Pond				**$477,328**
		ENGINEERING & CONTINGENCIES				**$119,332**
		TOTAL SECTION 3 - Communal Pond				**$596,660**
3.8		POND LAND AREA	3298.8	sm	$135.00	**$445,338**
		TOTAL SECTION 3 - Storm Sewer A				**$1,041,998**
		TOTAL SECTION 3 - DIFFERENCE (A-B)				**$547,157**

DESCRIPTION	AREA ha.	UNIT	% of Pond area	% of Service area
Vineyard Creek Estates Area	5.67	ha.	40.85%	20.57%
Fiorucci Estates	3.93	ha.	28.31%	14.25%
Future Lands south of Warner Rd.	2.72	ha.	19.60%	9.87%
Future Commercial Lands at York Rd..	1.56	ha.	11.24%	5.66%
TotalNew Dev. directly connected to Communal pond	**13.88**	ha.	100.00%	
Existing residential lands controlled by pond	9.78	ha.		35.47%
Existing Municipal roads controlled by pond	3.44	ha.		12.48%
Municipal Park	0.47	ha.		1.70%
Total directly connected to Communal pond	**27.57**	ha.		100.00%
Lands to Pond G-1	1.59			
Total area controlled to present rate at outlet	**29.16**	ha.		

APPENDIX D – Digital Files – MIDUSS Output

MIDUSS Summary Tables

C1 – Present Model

C2 – Stand Alone Model

C3 – Communal Pond Model

TABLE NO. C2 - MIDUSS OUTPUT SUMMARY STANDALONE MODEL VARIOUS CONTROL POINTS

25 mm	2 YR.	5YR	100 Yr.
YORK RD 750 CULV US	**YORK RD 750 CULV US**	**YORK RD 750 CULV US**	**YORK RD 750 CULV US**
YORK750ALT.25mmhyd	YORK750ALT.2yearhyd	YORK750ALT.5yearhyd	YORK750ALT.100YRhyd
FLOW IN WEST ROADSIDE DITCH TANBARK RD.	FLOW IN WEST ROADSIDE DITCH TANBARK RD.	FLOW IN WEST ROADSIDE DITCH TANBARK RD.	FLOW IN WEST ROADSIDE DITCH TANBARK RD.
Total volume 288.870 c.m	Total volume 524.055 c.m	Total volume 897.456 c.m	Total volume 2323.619 c.m
Maximum flow 0.036 c.m/sec	Maximum flow 0.110 c.m/sec	Maximum flow 0.209 c.m/sec	Maximum flow 0.770 c.m/sec
West Ditch to 103	**West Ditch to 103**	**West Ditch to 103**	**West Ditch to 103**
WESTDITALT.25mmhyd	WESTDITALT.2yearhyd	WESTDITALT.5yearhyd	WESTDITALT.100YRhyd
FLOW IN WEST DITCH VCE.	FLOW IN WEST DITCH VCE.	FLOW IN WEST DITCH VCE.	FLOW IN WEST DITCH VCE.
Total volume 486.690 c.m	Total volume 858.424 c.m	Total volume 1441.779 c.m	Total volume 3645.194 c.m
Maximum flow 0.060 c.m/sec	Maximum flow 0.153 c.m/sec	Maximum flow 0.288 c.m/sec	Maximum flow 1.027 c.m/sec
Vineyard Creek Estates Pond	**Vineyard Creek Estates Pond**	**Vineyard Creek Estates Pond**	**Vineyard Creek Estates Pond**
0.100 Current peak flow c.m/sec	0.343 Current peak flow c.m/sec	0.558 Current peak flow c.m/sec	1.587 Current peak flow c.m/sec
496.0 Hydrograph volume c.m	755.0 Hydrograph volume c.m	1130.0 Hydrograph volume c.m	2380.0 Hydrograph volume c.m
Peak outflow 0.009 c.m/sec	Peak outflow 0.023 c.m/sec	Peak outflow 0.071 c.m/sec	Peak outflow 0.407 c.m/sec
Maximum level 117.406 metre	Maximum level 117.617 metre	Maximum level 117.801 metre	Maximum level 118.224 metre
Maximum storage 411.523 c.m	Maximum storage 586.367 c.m	Maximum storage 755.873 c.m	Maximum storage 1217.574 c.m
Main Ditch at 104	**Main Ditch at 104**	**Main Ditch at 104**	**Main Ditch at 104**
MAINAT104NALT.25mmhyd	MAINAT104NALT.2yearhyd	MAINAT104NALT.5yearhyd	MAINAT104NALT.100YRhyd
COMBINED FLOW JUST N. OF SITE.	COMBINED FLOW JUST N. OF SITE.	COMBINED FLOW JUST N. OF SITE.	COMBINED FLOW JUST N. OF SITE.
Total volume 942.528 c.m	Total volume 1548.955 c.m	Total volume 2492.550 c.m	Total volume 5947.875 c.m
Maximum flow 0.068 c.m/sec	Maximum flow 0.162 c.m/sec	Maximum flow 0.322 c.m/sec	Maximum flow 1.428 c.m/sec
West Main Ditch at 105	**West Main Ditch at 105**	**West Main Ditch at 105**	**West Main Ditch at 105**
MAINW105ALT.25mmhyd	MAINW105ALT.2yearhyd	MAINW105ALT.5yearhyd	MAINW105ALT.100YRhyd
Total volume 1016.734 c.m	Total volume 1709.979 c.m	Total volume 2798.983 c.m	Total volume 6835.950 c.m
Maximum flow 0.075 c.m/sec	Maximum flow 0.177 c.m/sec	Maximum flow 0.366 c.m/sec	Maximum flow 1.613 c.m/sec
West Ditch On Tanbark N. 105	**West Ditch On Tanbark N. 105**	**West Ditch On Tanbark N. 105**	**West Ditch On Tanbark N. 105**
TBRDN105ALT.25mmhyd	TBRDN105ALT.2yearhyd	TBRDN105ALT.5yearhyd	TBRDN105ALT.100YRhyd
FLOW IN WEST ROADSIDE DITCH TANBARK RD.	FLOW IN WEST ROADSIDE DITCH TANBARK RD.	FLOW IN WEST ROADSIDE DITCH TANBARK RD.	FLOW IN WEST ROADSIDE DITCH TANBARK RD.
Total volume 1270.963 c.m	Total volume 2098.316 c.m	Total volume 3379.961 c.m	Total volume 8079.346 c.m
Maximum flow 0.112 c.m/sec	Maximum flow 0.269 c.m/sec	Maximum flow 0.492 c.m/sec	Maximum flow 1.888 c.m/sec

TABLE NO. C1 - PRESENT MIDUSS MODEL OUTPUT SUMMARY VARIOUS CONTROL LOCATIONS

25 mm	2 YR.	5YR	100 Yr.
U.S. YORK ROAD CULVERT	**U.S. YORK ROAD CULVERT**	**U.S. YORK ROAD CULVERT**	**U.S. YORK ROAD CULVERT**
YORK750PRE.25MMhyd	YORK750PRE.2yearhyd	YORK750PRE.5yearhyd	YORK750PRE.100YRhyd
Total volume 288.870 c.m	Total volume 524.055 c.m	Total volume 897.456 c.m	Total volume 2323.619 c.m
Maximum flow 0.036 c.m/sec	Maximum flow 0.110 c.m/sec	Maximum flow 0.209 c.m/sec	Maximum flow 0.770 c.m/sec
QUEENSTON RD. N. ROAD DITCH E. SANDALWOOD	**QUEENSTON RD. N. ROAD DITCH E. SANDALWOOD**	**QUEENSTON RD. N. ROAD DITCH E. SANDALWOOD**	**QUEENSTON RD. N. ROAD DITCH E. SANDALWOOD**
QUEENPRE.25MMhyd	QUEENPRE.2yearhyd	QUEENPRE.5yearhyd	QUEENPRE.100YRhyd
Total volume 343.690 c.m	Total volume 613.504 c.m	Total volume 1039.092 c.m	Total volume 2654.517 c.m
Maximum flow 0.043 c.m/sec	Maximum flow 0.126 c.m/sec	Maximum flow 0.230 c.m/sec	Maximum flow 0.838 c.m/sec
QUEENSTON RD. N. ROAD DITCH W. SANDALWOOD	**QUEENSTON RD. N. ROAD DITCH W. SANDALWOOD**	**QUEENSTON RD. N. ROAD DITCH W. SANDALWOOD**	**QUEENSTON RD. N. ROAD DITCH W. SANDALWOOD**
ALL FLOW ACROSS VINEYARD CREEK ESTATES	**56 DIVERSION**	**56 DIVERSION**	**56 DIVERSION**
	Peak of diverted flow 0.067 c.m/sec	Peak of diverted flow 0.171 c.m/sec	Peak of diverted flow 0.779 c.m/sec
	Volume of diverted flow 81.562 c.m	Volume of diverted flow 414.393 c.m	Volume of diverted flow 1973.168 c.m
FLOW ACROSS VINEYARD CREEK	**FLOW ACROSS VINEYARD CREEK**	**FLOW ACROSS VINEYARD CREEK**	**FLOW ACROSS VINEYARD CREEK**
QUEENVPRE.25MMhyd	DIV00102.2yearhyd	DIV00102.5yearhyd	DIV00102.100YRhyd
Total volume 343.690 c.m	QUEENVPRE.2yearhyd	QUEENVPRE.5yearhyd	103 Node #
Maximum flow 0.043 c.m/sec	Total volume 531.942 c.m	Total volume 624.699 c.m	Maximum flow 0.059 c.m/sec
	Maximum flow 0.059 c.m/sec	Maximum flow 0.059 c.m/sec	Hydrograph volume 681.349 c.m
FLOW NORTH OF VINEYARD CREEK. DITCH	**FLOW NORTH OF VINEYARD CREEK. DITCH**	**FLOW NORTH OF VINEYARD CREEK. DITCH**	**FLOW NORTH OF VINEYARD CREEK. DITCH**
MAINS104PRE.25MMhyd	MAINS104PRE.2yearhyd	MAINS104PRE.5yearhyd	MAINS104PRE.100YRhyd
Total volume 477.637 c.m	Total volume 812.063 c.m	Total volume 1147.257 c.m	Total volume 2167.195 c.m
Maximum flow 0.054 c.m/sec	Maximum flow 0.092 c.m/sec	Maximum flow 0.146 c.m/sec	Maximum flow 0.497 c.m/sec
FLOW IN W. DITCH	**FLOW IN W. DITCH**	**FLOW IN W. DITCH**	**FLOW IN W. DITCH**
WBRW104PRE.25MMhyd	WBRW104PRE.2yearhyd	WBRW104PRE.5yearhyd	WBRW104PRE.100YRhyd
Total volume 77.869 c.m	Total volume 241.702 c.m	Total volume 710.424 c.m	Total volume 2807.197 c.m
Maximum flow 0.009 c.m/sec	Maximum flow 0.088 c.m/sec	Maximum flow 0.224 c.m/sec	Maximum flow 0.980 c.m/sec
FLOW IN NORTH DITCH NORTH OF SITE	**FLOW IN NORTH DITCH NORTH OF SITE**	**FLOW IN NORTH DITCH NORTH OF SITE**	**FLOW IN NORTH DITCH NORTH OF SITE**
MAINAT104NPRE.25MMhyd	MAINAT104NPRE.2yearhyd	MAINAT104NPRE.5yearhyd	MAINAT104NPRE.100YRhyd
Total volume 555.505 c.m	COMBINED FLOW JUST N. OF SITE.	COMBINED FLOW JUST N. OF SITE.	COMBINED FLOW JUST N. OF SITE.
Maximum flow 0.061 c.m/sec	Total volume 1053.765 c.m	Total volume 1857.681 c.m	Total volume 4974.392 c.m
	Maximum flow 0.177 c.m/sec	Maximum flow 0.366 c.m/sec	Maximum flow 1.424 c.m/sec

TABLE NO. C3 - SUMMARY OF MIDUSS OUTPUT COMMUNAL MODEL AT VARIOUS CONTROL LOCATIONS

25 mm	2 YR.	5YR	100 Yr.
QUEENSTON RD. AT SANDALWOOD CRES. E. LEG	**QUEENSTON RD. AT SANDALWOOD CRES. E. LEG**	**QUEENSTON RD. AT SANDALWOOD CRES. E. LEG**	**QUEENSTON RD. AT SANDALWOOD CRES. E. LEG**
QUEENPOST.25mmhyd	QUEENPOST.2yearhyd	QUEENPOST.5yearhyd	QUEENPOST.100YRhyd
Total volume 698.328 c.m	Total volume 1056.981 c.m	Total volume 1567.824 c.m	Total volume 3307.887 c.m
Maximum flow 0.139 c.m/sec	Maximum flow 0.465 c.m/sec	Maximum flow 0.753 c.m/sec	Maximum flow 1.773 c.m/sec
JCT 203S	**JCT 203S**	**JCT 203S**	**JCT 203S**
QUEENVPOST.25mmhyd	QUEENVPOST.2yearhyd	QUEENVPOST.5yearhyd	QUEENVPOST.100YRhyd
FLOW THRU VINEYARD ESTATES FROM UPSTREAM.	FLOW THRU VINEYARD ESTATES FROM UPSTREAM.	FLOW THRU VINEYARD ESTATES FROM UPSTREAM.	FLOW THRU VINEYARD ESTATES FROM UPSTREAM.
Total volume 698.328 c.m	Total volume 1056.982 c.m	Total volume 1567.823 c.m	Total volume 3307.884 c.m
Maximum flow 0.139 c.m/sec	Maximum flow 0.462 c.m/sec	Maximum flow 0.750 c.m/sec	Maximum flow 1.767 c.m/sec
Commercial Onsite Control	**Commercial Onsite Control**	**Commercial Onsite Control**	**Commercial Onsite Control**
0.054 Current peak flow c.m/sec	0.188 Current peak flow c.m/sec	0.297 Current peak flow c.m/sec	0.604 Current peak flow c.m/sec
250.0 Hydrograph volume c.m	348.0 Hydrograph volume c.m	482.0 Hydrograph volume c.m	893.0 Hydrograph volume c.m
Peak outflow 0.028 c.m/sec	Peak outflow 0.048 c.m/sec	Peak outflow 0.060 c.m/sec	Peak outflow 0.085 c.m/sec
Maximum level 120.164 metre	Maximum level 120.250 metre	Maximum level 120.363 metre	Maximum level 120.748 metre
Maximum storage 114.969 c.m	Maximum storage 175.167 c.m	Maximum storage 254.194 c.m	Maximum storage 523.928 c.m
Vineyard Creek Estates Pond	**Vineyard Creek Estates Pond**	**Vineyard Creek Estates Pond**	**Vineyard Creek Estates Pond**
0.252 Current peak flow c.m/sec	0.793 Current peak flow c.m/sec	1.288 Current peak flow c.m/sec	3.051 Current peak flow c.m/sec
1450.0 Hydrograph volume c.m	2170.0 Hydrograph volume c.m	3191.0 Hydrograph volume c.m	6622.0 Hydrograph volume c.m
	Peak outflow 0.157 c.m/sec	Peak outflow 0.223 c.m/sec	Peak outflow 1.262 c.m/sec
Peak outflow 0.107 c.m/sec	Maximum level 117.381 metre	Maximum level 117.709 metre	Maximum level 118.218 metre
Maximum level 117.223 metre	Maximum storage 1235.880 c.m	Maximum storage 1823.619 c.m	Maximum storage 2886.633 c.m
Maximum storage 980.127 c.m			
West Ditch to 103	**West Ditch to 103**	**West Ditch to 103**	**West Ditch to 103**
WBRW104POST.25mmhyd	Total volume 93.290 c.m	Total volume 150.357 c.m	Total volume 360.127 c.m
Total volume 55.915 c.m	Maximum flow 0.033 c.m/sec	Maximum flow 0.056 c.m/sec	Maximum flow 0.153 c.m/sec
Maximum flow 0.009 c.m/sec			
Main Ditch at 104	**Main Ditch at 104**	**Main Ditch at 104**	**Main Ditch at 104**
MAINATpondout.25mmhyd	MAINATpondout.2yearhyd	MAINATpondout.5yearhyd	MAINATpondout.100YRhyd
Total volume 1490.001 c.m	Total volume 2252.837 c.m	Total volume 3324.554 c.m	Total volume 6951.581 c.m
Maximum flow 0.113 c.m/sec	Maximum flow 0.165 c.m/sec	Maximum flow 0.238 c.m/sec	Maximum flow 1.346 c.m/sec
West Main Ditch at 105	**West Main Ditch at 105**	**West Main Ditch at 105**	**West Main Ditch at 105**
MAINW105POST.25mmhyd	MAINW105POST.2yearhyd	MAINW105POST.5yearhyd	MAINW105POST.100YRhyd
Total volume 1564.705 c.m	Total volume 2414.521 c.m	Total volume 3631.582 c.m	Total volume 7840.059 c.m
Maximum flow 0.120 c.m/sec	Maximum flow 0.181 c.m/sec	Maximum flow 0.282 c.m/sec	Maximum flow 1.548 c.m/sec
West Ditch 0n Tanbark N. 105	**West Ditch 0n Tanbark N. 105**	**West Ditch 0n Tanbark N. 105**	**West Ditch 0n Tanbark N. 105**
TBRDN105POST.25mmhyd	TBRDN105POST.2yearhyd	TBRDN105POST.5yearhyd	TBRDN105POST.100YRhyd
Total volume 1819.120 c.m	Total volume 2803.109 c.m	Total volume 4212.794 c.m	Total volume 9083.619 c.m
Maximum flow 0.142 c.m/sec	Maximum flow 0.253 c.m/sec	Maximum flow 0.455 c.m/sec	Maximum flow 1.810 c.m/sec

APPENDIX B

Tanbark Road Reconstruction Storm Drainage Areas

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project title
TANBARK ROAD RECONSTRUCTION
ST. DAVIDS, NIAGARA-ON-THE-LAKE

drawing title
STORM DRAINAGE AREAS
SECTION A
FROM WARNER ROAD
TO YORK ROAD

drawn by	designed by
JTB	HEK
scale	date
1:2500	29-NOV-2012
job number	issue
12947	A
drawing number	
STM-01	

APPENDIX C

Stage-Storage-Discharge Calculations

Stage-Storage-Discharge Calculations

Project Name: Tawny Ridge Estates (Phase 2)
Project No.: 21178
Date: May 30, 2025

		MH 6 to MH 7		MH 5 to MH 7		MH 3 to MH 5		MH 4 to MH 3		MH 2 to MH 3		MH 1 to MH 2		TOTAL STORAGE VOLUME	Orifice
Controlling Rim Elev:	**125.80**	Pipe	MH 6	Pipe	MH 5	Pipe	MH 3	Pipe	MH 4	Pipe	MH 2	Pipe	MH 1		
Invert:		122.63	122.68	122.63	122.64	122.70	122.74	125.10	125.22	122.80	122.83	122.86	124.39		Dia (m) = 0.185
Pipe Diameter:		1.200		1.500		1.350		0.375		1.200		0.300			Cd = 0.60
Structure/Pipe Length:		98.40	2400	25.10	3000	74.10	2400	39.00	1200	69.50	2400	69.50	1200		Invert (m) = 122.61
Elevation (m)		(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	Total (m^3)	Orifice (m^3/s)
125.80		114.88	14.11	45.79	22.34	109.49	13.84	4.45	0.66	81.14	13.44	5.07	1.59	426.8	0.125
125.07		114.88	10.81	45.79	17.18	109.49	10.54	-	-	81.14	10.13	5.07	0.77	405.8	0.109
124.32		114.88	7.42	45.79	11.88	109.49	7.15	-	-	81.14	6.74	5.07	-	389.5	0.090
123.32		67.06	2.90	20.14	4.81	48.07	2.62	-	-	33.00	2.22	5.07	-	185.9	0.055
122.95		23.52	1.20	6.83	2.16	13.25	0.93	-	-	5.44	0.52	1.16	-	55.0	0.033
122.57		-	-	-	-	-	-	-	-	-	-	-	-	0.0	0.000

APPENDIX D

MIDUSS Output Files (5 Year Design Storm)

5 Year Existing

```
         Output File (4.7) 5YREX.OUT    opened 2024-12-11   8:23
         Units used are defined by G =    9.810
             24   144    10.000        are MAXDT MAXHYD & DTMIN values
         Licensee: UPPER CANADA CONSULTANTS
 35      COMMENT
        4     line(s) of comment
         STORMWATER MANAGEMENT PLAN
         TAWNY RIDGE ESTATES
         TOWN OF NIAGARA ON THE LAKE
         5 YR Existing
 35      COMMENT
        3     line(s) of comment
         START
              1=Zero; 2=Define
         COMMENT
  2      STORM
             1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
       664.000     Coefficient  a
         4.700     Constant  b    (min)
          .744     Exponent  c
          .450     Fraction to peak  r
       240.000     Duration ó  240 min
                  44.365 mm     Total depth
  3      IMPERVIOUS
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .015     Manning "n"
        98.000     SCS Curve No or C
          .100     Ia/S Coefficient
          .518     Initial Abstraction
  4      CATCHMENT
        10.000     ID No.ó 99999
         1.170     Area in hectares
        90.000     Length (PERV) metres
         1.000     Gradient (%)
        30.000     Per cent Impervious
        90.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        68.000     SCS Curve No or C
          .100     Ia/S Coefficient
        11.593     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .058       .000       .000       .000 c.m/s
                .159       .873       .373     C perv/imperv/total
 15      ADD RUNOFF
                .058       .058       .000       .000 c.m/s
  4      CATCHMENT
        11.000     ID No.ó 99999
         2.640     Area in hectares
       135.000     Length (PERV) metres
         1.000     Gradient (%)
        30.000     Per cent Impervious
       135.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        68.000     SCS Curve No or C
          .100     Ia/S Coefficient
        11.593     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .127       .058       .000       .000 c.m/s
                .159       .861       .369     C perv/imperv/total
 15      ADD RUNOFF
                .127       .180       .000       .000 c.m/s
  4      CATCHMENT
        12.000     ID No.ó 99999
         1.680     Area in hectares
       110.000     Length (PERV) metres
         1.000     Gradient (%)
        35.000     Per cent Impervious
       110.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        68.000     SCS Curve No or C
          .100     Ia/S Coefficient
        11.593     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .092       .180       .000       .000 c.m/s
                .159       .869       .407     C perv/imperv/total
 15      ADD RUNOFF
                .092       .272       .000       .000 c.m/s
 20      MANUAL
```

5 Year Future without SWM

```
         Output File (4.7) 5YRFUT.OUT   opened 2025-04-16  10:55
         Units used are defined by G =    9.810
             24   144    10.000        are MAXDT MAXHYD & DTMIN values
         Licensee: UPPER CANADA CONSULTANTS
 35      COMMENT
        4     line(s) of comment
         STORMWATER MANAGEMENT PLAN
         TAWNY RIDGE ESTATES
         TOWN OF NIAGARA ON THE LAKE
         5 YR FUTURE
 35      COMMENT
        3     line(s) of comment
         START
              1=Zero; 2=Define
         COMMENT
  2      STORM
             1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
       664.000     Coefficient  a
         4.700     Constant  b    (min)
          .744     Exponent  c
          .450     Fraction to peak  r
       240.000     Duration    240 min
                  44.365 mm     Total depth
  3      IMPERVIOUS
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .015     Manning "n"
        98.000     SCS Curve No or C
          .100     Ia/S Coefficient
          .518     Initial Abstraction
  4      CATCHMENT
        10.000     ID No.  99999
         1.170     Area in hectares
        90.000     Length (PERV) metres
         1.000     Gradient (%)
        30.000     Per cent Impervious
        90.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        68.000     SCS Curve No or C
          .100     Ia/S Coefficient
        11.593     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .058       .000       .000       .000 c.m/s
                .159       .873       .373     C perv/imperv/total
 15      ADD RUNOFF
                .058       .058       .000       .000 c.m/s
  4      CATCHMENT
        11.000     ID No.  99999
         2.640     Area in hectares
       135.000     Length (PERV) metres
         1.000     Gradient (%)
        73.000     Per cent Impervious
       135.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        68.000     SCS Curve No or C
          .100     Ia/S Coefficient
        11.593     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .304       .058       .000       .000 c.m/s
                .159       .861       .671     C perv/imperv/total
 15      ADD RUNOFF
                .304       .357       .000       .000 c.m/s
  4      CATCHMENT
        12.000     ID No.  99999
         1.680     Area in hectares
       110.000     Length (PERV) metres
         1.000     Gradient (%)
        35.000     Per cent Impervious
       110.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        68.000     SCS Curve No or C
          .100     Ia/S Coefficient
        11.593     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .092       .357       .000       .000 c.m/s
                .159       .869       .407     C perv/imperv/total
 15      ADD RUNOFF
                .092       .449       .000       .000 c.m/s
 20      MANUAL
```

5 Year Future w/ SWM

```
        Output File (4.7) 5YRSWM.OUT   opened 2025-05-29   9:35
        Units used are defined by G =    9.810
            24   144    10.000        are MAXDT MAXHYD & DTMIN values
        Licensee: UPPER CANADA CONSULTANTS
 35     COMMENT
       4     line(s) of comment
        STORMWATER MANAGEMENT PLAN
        TAWNY RIDGE ESTATES
        TOWN OF NIAGARA ON THE LAKE
        5 YR FUTURE W/ SWM
 35     COMMENT
       3     line(s) of comment
        START
             1=Zero; 2=Define
        COMMENT
  2     STORM
            1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
      664.000     Coefficient  a
        4.700     Constant  b    (min)
         .744     Exponent  c
         .450     Fraction to peak  r
      240.000     Duration ó  240 min
                 44.365 mm     Total depth
  3     IMPERVIOUS
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .015     Manning "n"
       98.000     SCS Curve No or C
         .100     Ia/S Coefficient
         .518     Initial Abstraction
  4     CATCHMENT
       10.000     ID No.ó 99999
        1.170     Area in hectares
       90.000     Length (PERV) metres
        1.000     Gradient (%)
       30.000     Per cent Impervious
       90.000     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .058       .000       .000       .000 c.m/s
                .159       .873       .373     C perv/imperv/total
 15     ADD RUNOFF
                .058       .058       .000       .000 c.m/s
  4     CATCHMENT
       11.000     ID No.ó 99999
        2.640     Area in hectares
      135.000     Length (PERV) metres
        1.000     Gradient (%)
       73.000     Per cent Impervious
      135.000     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .304       .058       .000       .000 c.m/s
                .159       .861       .671     C perv/imperv/total
 15     ADD RUNOFF
                .304       .357       .000       .000 c.m/s
 10     POND
       6 Depth - Discharge - Volume sets
        122.570        .000          .0
        122.950       .0330        55.0
        123.320       .0550       185.9
        124.320       .0900       389.5
        125.070        .109       405.8
        125.800        .125       426.8
        Peak Outflow    =      .113 c.m/s
        Maximum Depth   =   125.274 metres
        Maximum Storage =      412. c.m
                .304       .357       .113       .000 c.m/s
 16     NEXT LINK
                .304       .113       .113       .000 c.m/s
  4     CATCHMENT
       12.000     ID No.ó 99999
        1.680     Area in hectares
      110.000     Length (PERV) metres
        1.000     Gradient (%)
       35.000     Per cent Impervious
      110.000     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .092       .113       .113       .000 c.m/s
                .159       .869       .407     C perv/imperv/total
 15     ADD RUNOFF
                .092       .171       .113       .000 c.m/s
```

APPENDIX E

MIDUSS Output Files (100 Year Design Storm)

100 Year Post Tawny Ridge Development w/ SWM

```
        Output File (4.7) 100YRSWM.OUT opened 2025-05-29   9:34
        Units used are defined by G =    9.810
            24   144    10.000        are MAXDT MAXHYD & DTMIN values
        Licensee: UPPER CANADA CONSULTANTS
 35     COMMENT
       4     line(s) of comment
        STORMWATER MANAGEMENT PLAN
        TAWNY RIDGE ESTATES
        TOWN OF NIAGARA ON THE LAKE
        100 YR FUTURE W/ SWM
 35     COMMENT
       3     line(s) of comment
        ****************************************
        * 100 YR DESIGN STORM                  *
        ****************************************
 14     START
       1     1=Zero; 2=Define
  2     STORM
            1     1=Chicago;2=Huff;3=User;4=Cdn1hr;5=Historic
    1815.300     Coefficient  a
       3.090     Constant  b    (min)
        .847     Exponent  c
        .450     Fraction to peak  r
     240.000     Duration ó  240 min
               69.221 mm     Total depth
  3     IMPERVIOUS
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .015     Manning "n"
      98.000     SCS Curve No or C
        .100     Ia/S Coefficient
        .518     Initial Abstraction
  4     CATCHMENT
      10.000     ID No.ó 99999
       1.170     Area in hectares
      90.000     Length (PERV) metres
       1.000     Gradient (%)
      30.000     Per cent Impervious
      90.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      68.000     SCS Curve No or C
        .100     Ia/S Coefficient
      11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .146       .000       .000       .000 c.m/s
              .271       .914       .464     C perv/imperv/total
 15     ADD RUNOFF
              .146       .146       .000       .000 c.m/s
  4     CATCHMENT
      11.000     ID No.ó 99999
       2.640     Area in hectares
     135.000     Length (PERV) metres
       1.000     Gradient (%)
      73.000     Per cent Impervious
     135.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      68.000     SCS Curve No or C
        .100     Ia/S Coefficient
      11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .707       .146       .000       .000 c.m/s
              .271       .916       .742     C perv/imperv/total
 15     ADD RUNOFF
              .707       .852       .000       .000 c.m/s
 10     POND
       7 Depth - Discharge - Volume sets
        122.570        .000          .0
        122.950       .0330        55.0
        123.320       .0550       185.9
        124.320       .0900       389.5
        125.070        .109       405.8
        125.800        .125       426.8
        126.000      20.000       427.0
        Peak Outflow    =      .711 c.m/s
        Maximum Depth   =   125.806 metres
        Maximum Storage =      427. c.m
              .707       .852       .711       .000 c.m/s
 16     NEXT LINK
              .707       .711       .711       .000 c.m/s
  4     CATCHMENT
      12.000     ID No.ó 99999
       1.680     Area in hectares
     110.000     Length (PERV) metres
       1.000     Gradient (%)
      35.000     Per cent Impervious
     110.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      68.000     SCS Curve No or C
        .100     Ia/S Coefficient
      11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .232       .711       .711       .000 c.m/s
              .271       .918       .497     C perv/imperv/total
 15     ADD RUNOFF
              .232       .901       .711       .000 c.m/s
  4     CATCHMENT
     103.000     ID No.ó 99999
        .310     Area in hectares
      62.800     Length (PERV) metres
        .800     Gradient (%)
      30.000     Per cent Impervious
      62.800     Length (IMPERV)
        .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      68.000     SCS Curve No or C
        .100     Ia/S Coefficient
      11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .041       .901       .711       .000 c.m/s
              .270       .909       .462     C perv/imperv/total
 15     ADD RUNOFF
              .041       .930       .711       .000 c.m/s
  4     CATCHMENT
       6.000     ID No.ó 99999
        .580     Area in hectares
      85.900     Length (PERV) metres
       1.000     Gradient (%)
      30.000     Per cent Impervious
      85.900     Length (IMPERV)
        .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      68.000     SCS Curve No or C
        .100     Ia/S Coefficient
      11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .073       .930       .711       .000 c.m/s
              .271       .912       .463     C perv/imperv/total
 15     ADD RUNOFF
              .073       .986       .711       .000 c.m/s
  4     CATCHMENT
       7.000     ID No.ó 99999
        .490     Area in hectares
      79.000     Length (PERV) metres
       1.000     Gradient (%)
      30.000     Per cent Impervious
      79.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      68.000     SCS Curve No or C
        .100     Ia/S Coefficient
      11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .063       .986       .711       .000 c.m/s
              .270       .910       .462     C perv/imperv/total
 15     ADD RUNOFF
              .063      1.033       .711       .000 c.m/s
  4     CATCHMENT
       8.000     ID No.ó 99999
        .280     Area in hectares
      59.700     Length (PERV) metres
       1.000     Gradient (%)
      30.000     Per cent Impervious
      59.700     Length (IMPERV)
        .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      68.000     SCS Curve No or C
        .100     Ia/S Coefficient
      11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .038      1.033       .711       .000 c.m/s
              .270       .908       .462     C perv/imperv/total
 15     ADD RUNOFF
              .038      1.060       .711       .000 c.m/s
  4     CATCHMENT
       9.000     ID No.ó 99999
        .650     Area in hectares
      91.000     Length (PERV) metres
       1.000     Gradient (%)
      30.000     Per cent Impervious
      91.000     Length (IMPERV)
        .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      68.000     SCS Curve No or C
        .100     Ia/S Coefficient
      11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .081      1.060       .711       .000 c.m/s
              .271       .914       .464     C perv/imperv/total
 15     ADD RUNOFF
              .081      1.123       .711       .000 c.m/s
  4     CATCHMENT
      10.000     ID No.ó 99999
        .420     Area in hectares
      73.100     Length (PERV) metres
       1.000     Gradient (%)
      30.000     Per cent Impervious
      73.100     Length (IMPERV)
        .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      68.000     SCS Curve No or C
        .100     Ia/S Coefficient
      11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .055      1.123       .711       .000 c.m/s
              .270       .909       .461     C perv/imperv/total
 15     ADD RUNOFF
              .055      1.162       .711       .000 c.m/s
  4     CATCHMENT
      11.000     ID No.ó 99999
        .280     Area in hectares
      59.700     Length (PERV) metres
       1.000     Gradient (%)
      30.000     Per cent Impervious
      59.700     Length (IMPERV)
        .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
        .250     Manning "n"
      68.000     SCS Curve No or C
        .100     Ia/S Coefficient
      11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .038      1.162       .711       .000 c.m/s
              .270       .908       .462     C perv/imperv/total
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 15     ADD RUNOFF
              .038      1.189       .711       .000 c.m/s
  4     CATCHMENT
       12.000     ID No.ó 99999
         .370     Area in hectares
       68.600     Length (PERV) metres
        1.000     Gradient (%)
       30.000     Per cent Impervious
       68.600     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .049      1.189       .711       .000 c.m/s
              .270       .909       .462     C perv/imperv/total
 15     ADD RUNOFF
              .049      1.223       .711       .000 c.m/s
  4     CATCHMENT
       13.000     ID No.ó 99999
         .570     Area in hectares
       85.200     Length (PERV) metres
        1.000     Gradient (%)
       30.000     Per cent Impervious
       85.200     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .072      1.223       .711       .000 c.m/s
              .271       .912       .463     C perv/imperv/total
 15     ADD RUNOFF
              .072      1.279       .711       .000 c.m/s
  4     CATCHMENT
       14.000     ID No.ó 99999
         .290     Area in hectares
       60.800     Length (PERV) metres
        1.000     Gradient (%)
       30.000     Per cent Impervious
       60.800     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .039      1.279       .711       .000 c.m/s
              .271       .908       .462     C perv/imperv/total
 15     ADD RUNOFF
              .039      1.306       .711       .000 c.m/s
  4     CATCHMENT
      106.000     ID No.ó 99999
         .250     Area in hectares
       56.400     Length (PERV) metres
         .800     Gradient (%)
       30.000     Per cent Impervious
       56.400     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .033      1.306       .711       .000 c.m/s
              .271       .909       .462     C perv/imperv/total
 15     ADD RUNOFF
              .033      1.330       .711       .000 c.m/s
  4     CATCHMENT
      108.000     ID No.ó 99999
         .466     Area in hectares
       77.000     Length (PERV) metres
         .800     Gradient (%)
       15.000     Per cent Impervious
       77.000     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .031      1.330       .711       .000 c.m/s
              .271       .912       .367     C perv/imperv/total
 15     ADD RUNOFF
              .031      1.358       .711       .000 c.m/s
  4     CATCHMENT
      105.000     ID No.ó 99999
         .410     Area in hectares
       72.300     Length (PERV) metres
         .800     Gradient (%)
       30.000     Per cent Impervious
       72.300     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .052      1.358       .711       .000 c.m/s
              .271       .910       .463     C perv/imperv/total
 15     ADD RUNOFF
              .052      1.398       .711       .000 c.m/s
  4     CATCHMENT
      104.000     ID No.ó 99999
         .240     Area in hectares
       55.300     Length (PERV) metres
         .800     Gradient (%)
       30.000     Per cent Impervious
       55.300     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .032      1.398       .711       .000 c.m/s
              .271       .909       .462     C perv/imperv/total
 15     ADD RUNOFF
              .032      1.420       .711       .000 c.m/s
  4     CATCHMENT
       31.000     ID No.ó 99999
         .180     Area in hectares
       47.900     Length (PERV) metres
         .800     Gradient (%)
       30.000     Per cent Impervious
       47.900     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       70.000     SCS Curve No or C
         .100     Ia/S Coefficient
       10.886     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .025      1.420       .711       .000 c.m/s
              .293       .906       .476     C perv/imperv/total
 15     ADD RUNOFF
              .025      1.438       .711       .000 c.m/s
  4     CATCHMENT
      107.000     ID No.ó 99999
         .540     Area in hectares
       82.900     Length (PERV) metres
         .800     Gradient (%)
       65.000     Per cent Impervious
       82.900     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .140      1.438       .711       .000 c.m/s
              .270       .915       .689     C perv/imperv/total
 15     ADD RUNOFF
              .140      1.538       .711       .000 c.m/s
  4     CATCHMENT
       20.000     ID No.ó 99999
         .586     Area in hectares
       86.400     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
       86.400     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .078      1.538       .711       .000 c.m/s
              .271       .909       .462     C perv/imperv/total
 15     ADD RUNOFF
              .078      1.593       .711       .000 c.m/s
  4     CATCHMENT
       21.000     ID No.ó 99999
         .392     Area in hectares
       70.600     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
       70.600     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .054      1.593       .711       .000 c.m/s
              .270       .906       .461     C perv/imperv/total
 15     ADD RUNOFF
              .054      1.630       .711       .000 c.m/s
  4     CATCHMENT
       22.000     ID No.ó 99999
        1.185     Area in hectares
      122.800     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
      122.800     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .146      1.630       .711       .000 c.m/s
              .270       .915       .464     C perv/imperv/total
 15     ADD RUNOFF
              .146      1.746       .711       .000 c.m/s
  4     CATCHMENT
       23.000     ID No.ó 99999
         .453     Area in hectares
       75.900     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
       75.900     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .061      1.746       .711       .000 c.m/s
              .270       .908       .462     C perv/imperv/total
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 15     ADD RUNOFF
              .061      1.789       .711       .000 c.m/s
  4     CATCHMENT
       24.000     ID No.ó 99999
         .212     Area in hectares
       52.000     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
       52.000     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .031      1.789       .711       .000 c.m/s
              .271       .896       .458     C perv/imperv/total
 15     ADD RUNOFF
              .031      1.809       .711       .000 c.m/s
  4     CATCHMENT
       25.000     ID No.ó 99999
        1.160     Area in hectares
      121.500     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
      121.500     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .144      1.809       .711       .000 c.m/s
              .270       .915       .464     C perv/imperv/total
 15     ADD RUNOFF
              .144      1.923       .711       .000 c.m/s
  4     CATCHMENT
       26.000     ID No.ó 99999
         .221     Area in hectares
       53.000     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
       53.000     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .032      1.923       .711       .000 c.m/s
              .271       .897       .459     C perv/imperv/total
 15     ADD RUNOFF
              .032      1.944       .711       .000 c.m/s
  4     CATCHMENT
       27.000     ID No.ó 99999
         .480     Area in hectares
       78.200     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
       78.200     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .065      1.944       .711       .000 c.m/s
              .270       .908       .462     C perv/imperv/total
 15     ADD RUNOFF
              .065      1.989       .711       .000 c.m/s
  4     CATCHMENT
       28.000     ID No.ó 99999
         .460     Area in hectares
       76.500     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
       76.500     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .062      1.989       .711       .000 c.m/s
              .270       .908       .462     C perv/imperv/total
 15     ADD RUNOFF
              .062      2.033       .711       .000 c.m/s
  4     CATCHMENT
       29.000     ID No.ó 99999
         .300     Area in hectares
       61.600     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
       61.800     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .042      2.033       .711       .000 c.m/s
              .270       .902       .459     C perv/imperv/total
 15     ADD RUNOFF
              .042      2.062       .711       .000 c.m/s
  4     CATCHMENT
       30.000     ID No.ó 99999
         .502     Area in hectares
       79.900     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
       79.900     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .067      2.062       .711       .000 c.m/s
              .271       .908       .462     C perv/imperv/total
 15     ADD RUNOFF
              .067      2.109       .711       .000 c.m/s
  4     CATCHMENT
      110.000     ID No.ó 99999
        1.798     Area in hectares
      151.300     Length (PERV) metres
         .800     Gradient (%)
        65.000     Per cent Impervious
      151.300     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       70.000     SCS Curve No or C
         .100     Ia/S Coefficient
       10.866     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .405      2.109       .711       .000 c.m/s
              .294       .910       .694     C perv/imperv/total
 15     ADD RUNOFF
              .405      2.493       .711       .000 c.m/s
  4     CATCHMENT
       32.000     ID No.ó 99999
         .160     Area in hectares
       45.100     Length (PERV) metres
         .800     Gradient (%)
       30.000     Per cent Impervious
       45.100     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       70.000     SCS Curve No or C
         .100     Ia/S Coefficient
       10.866     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .022      2.493       .711       .000 c.m/s
              .293       .904       .476     C perv/imperv/total
 15     ADD RUNOFF
              .022      2.509       .711       .000 c.m/s
  4     CATCHMENT
       33.000     ID No.ó 99999
         .291     Area in hectares
       60.900     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
       60.900     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .041      2.509       .711       .000 c.m/s
              .270       .901       .459     C perv/imperv/total
 15     ADD RUNOFF
              .041      2.537       .711       .000 c.m/s
  4     CATCHMENT
       34.000     ID No.ó 99999
         .220     Area in hectares
       52.900     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
       52.900     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .032      2.537       .711       .000 c.m/s
              .271       .897       .459     C perv/imperv/total
 15     ADD RUNOFF
              .032      2.558       .711       .000 c.m/s
  4     CATCHMENT
       35.000     ID No.ó 99999
         .330     Area in hectares
       64.800     Length (PERV) metres
        1.700     Gradient (%)
       30.000     Per cent Impervious
       64.800     Length (IMPERV)
         .000     %Imp. with Zero Dpth
            1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
         .250     Manning "n"
       68.000     SCS Curve No or C
         .100     Ia/S Coefficient
       11.593     Initial Abstraction
            1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
              .046      2.558       .711       .000 c.m/s
              .269       .903       .460     C perv/imperv/total
 15     ADD RUNOFF
              .046      2.589       .711       .000 c.m/s
 10     POND
        6 Depth - Discharge - Volume sets
        116.590        .000         .0
        117.223        .107       989.0
        117.381        .157      1236.0
        117.709        .245      1824.0
        118.218       1.262      2887.0
        118.250       1.372      2960.0
        Peak Outflow    =     1.260 c.m/s
        Maximum Depth   =   118.217 metres
        Maximum Storage =     2885. c.m
              .046      2.589      1.260       .000 c.m/s
 16     NEXT LINK
              .046      1.260      1.260       .000 c.m/s
  4     CATCHMENT
       36.000     ID No.ó 99999
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          .100     Area in hectares
        35.700     Length (PERV) metres
          .800     Gradient (%)
        10.000     Per cent Impervious
        35.700     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        70.000     SCS Curve No or C
          .100     Ia/S Coefficient
        10.866     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .007      1.260      1.260       .000 c.m/s
                .293       .896       .354     C perv/imperv/total
 15     ADD RUNOFF
                .007      1.267      1.260       .000 c.m/s
  4     CATCHMENT
       111.000     ID No.ó 99999
         1.225     Area in hectares
       124.900     Length (PERV) metres
         1.700     Gradient (%)
        13.500     Per cent Impervious
       124.900     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             1     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        70.000     SCS Curve No or C
          .100     Ia/S Coefficient
        10.866     Initial Abstraction
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .074      1.267      1.260       .000 c.m/s
                .294       .916       .378     C perv/imperv/total
 15     ADD RUNOFF
                .074      1.328      1.260       .000 c.m/s
```