



MTE Consultants

520 Bingham Centre Drive, Kitchener, Ontario N2B 3X9

July 21, 2023

MTE File No.: C52255-100

David Dow
Principal
Diamond Schmitt Architects
384 Adelaide Street West, Suite 100
Toronto, Ontario, Canada M5V 1R7

Dear David:

**RE: Functional Servicing and Stormwater Management Brief
New Student Residence Building, University of Waterloo**

Background and Existing Conditions

MTE Consultants Inc. was retained by Diamond Schmitt Architects on behalf of the University of Waterloo to prepare site servicing and grading designs for a proposed student residence building to be constructed near Parking Lot A at the University of Waterloo campus in the City of Waterloo. Parking Lot A is located northeast of the intersection of University Avenue West and Seagram Drive. The property is bounded to the west by University Avenue West, to the south and east by Seagram Drive, and to the north by the Laurel Trail and the Waterloo Spur rail line, which is part of the Region of Waterloo's Light Rail Transit (LRT) system. North of the rail line there are several existing student residence buildings.

The property has an area of approximately 4.8ha, and currently consists of a surface parking lot with an area of approximately 2.1ha, two driveways from Seagram Drive, and landscaped area with a significant number of mature trees. There is an existing pedestrian bridge across University Avenue West connecting the northwest corner of the property to the main university campus across the road.

The proposed development consists of a multi-storey student residence building to be constructed near the northwest corner of the property. The proposed development will include driveway access to the existing Parking Lot A, at-grade pedestrian connections to Laurel Trail and University Avenue West, an above-grade connection to the existing pedestrian bridge across University Avenue West, and a new above-grade pedestrian bridge connection to the existing student residence buildings north of the rail line. It is understood that the western limits of Parking Lot A may be developed in the future. The timing of the future development is unknown.

Site Grading

Existing topographic information of the property was obtained from a detailed survey completed by McKechnie Surveying Limited in October 2022. The north edge of asphalt of Parking Lot A immediately south of the proposed building location is at an elevation of approximately

329.90 meters above sea level (mASL). From there, the landscaped area slopes up to the Laurel Trail, which ranges in elevation from approximately 333.50mASL near University Avenue West, down to 332.50mASL near the east end of the initial building location. There is an existing culvert underneath the Laurel Trail approximately 90m east of University Avenue West which drains to a swale on the south side of the Laurel Trail. The swale subsequently drains overland to Parking Lot A.

As previously described, the proposed development will include a new student residence building, a driveway connection to the existing Parking Lot A, and at-grade pedestrian connections to University Avenue West and the Laurel Trail. The proposed grading strategy will respect the existing adjacent grades along the Laurel Trail, University Avenue West, and the northern limits of Parking Lot A. Re-grading a portion of the existing Parking Lot A will be required.

The proposed finished floor elevation of the building is proposed to be 331.80mASL. Barrier free access will be available along University Avenue West and the Laurel Trail. The grading strategy has been developed to ensure water will flow away from the building with a major storm overland flow route towards Parking Lot A.

Site Servicing

Water

There is an existing 300mm diameter watermain located along the east side of University Avenue West. To the west of University Avenue West on Ring Road, there is an existing 200mm diameter watermain. Branching off the 200mm diameter watermain near the intersection of Seagram Drive and Ring Road, there is an existing 150mm diameter watermain that crosses University Avenue West and then terminates (currently capped, watermain is not in use) near the southwest corner of Parking Lot A.

Based on discussions with the University of Waterloo, Region of Waterloo and the City of Waterloo, the development will be serviced off the existing 300mm diameter municipal watermain on University Avenue West. The required watermain size will be confirmed with mechanical during detailed design but will likely be 300mm diameter. The proposed water service will connect near the northwest corner of the building, directly into the proposed mechanical room. A new water meter will be required for the development. Due to exterior constraints, it is likely that the water meter will be located internally in the mechanical room.

The proposed 300mm diameter watermain will exit the mechanical room on the south side of the building where it will be capped for potential future development on the western limits of Parking Lot A. As such, it is recommended that the mechanical room for the future building be located along the northern limits. Furthermore, a 150mm diameter watermain will tee off the proposed 300mm diameter watermain to service the proposed private hydrant.

Water Demands

Preliminary water demands were calculated for the proposed development and are included in Appendix A. The maximum day domestic water demand was determined to be 2.41L/s.

The proposed development was analyzed using both the OBC and FUS fire flow requirements. The fire flow requirement was determined to be 150L/s and 133L/s based on the OBC and FUS fire flow requirements, respectively.

Many municipalities in Ontario use both the OBC and FUS fire flow requirements for assessing firefighting water supply requirements. Ideally, fire flow demands for new developments are calculated based on the FUS criteria; however, it is not reasonable to expect that the existing municipal watermain infrastructure always has the operational capacity to supply water at the rates prescribed in the FUS guidelines. As a result, at no time shall the available fire flow be less than that required by the OBC. The minimum allowable pressure permitted under firefighting conditions is 140.0kPa per OBC 2012.

A hydrant flow test was completed on the existing municipal hydrants located near the intersection of University Avenue West and Seagram Drive. The following table illustrates the results of the testing completed by Classic Fire and Life Safety.

Results of Flow Tests (completed October 25, 2022)

Test #	Outlet Inside Diameter (in.)	Number of Outlets	Pitot Pressure (PSI)	Residual Pressure (PSI)	Flow @ Residual (gal/min)
1	n/a	n/a	n/a	70	n/a
2	2.5	1	58	68	1,278
3	2.5	2	40 & 28	65	1,950

Refer to Appendix B for the information obtained by Classic Fire and Life Safety.

The residual pressure at the proposed private hydrant was calculated to be 248kPa and 291kPa when subject to a maximum day domestic flow + fire flow demand of 152.4L/s (9144L/min) and 135.7L/s (8142L/min) under the OBC and FUS conditions, respectively. Therefore, the residual pressures are greater than the minimum allowable pressure of 140.0kPa per OBC 2012. The residual pressure at the proposed private hydrant is subject to change during detailed design once further discussions are had with the mechanical engineer regarding the losses occurring inside the building. Refer to Appendix C for calculations.

Sanitary

There is an existing 600mm diameter municipal trunk sanitary sewer located in a servicing easement along the Laurel Trail, which drains east. There are two existing manholes along the sewer located at the northern limits of the property; one approximately 40m east of University Avenue West where the existing pipe invert is approximately 7.0m below grade, and another approximately 172m east of University Avenue West where the existing pipe invert is approximately 5.7m below grade. It is speculated that an existing 200mm diameter private (University of Waterloo) sanitary sewer crosses under University Avenue West and drains northeast into the existing 600mm sanitary sewer at the manhole located approximately 40m east of University Avenue West. The existing 200mm diameter sewer invert has not been field verified at this existing manhole location. There is no existing municipal sanitary sewer on University Avenue West along the property's frontage or on Seagram Drive.

It is proposed that the new student residence be serviced by a new 200mm diameter sanitary sewer connecting to the 600mm diameter municipal trunk sanitary sewer near the Laurel Trail which has a capacity of approximately 438.3L/s. The 200mm diameter sanitary sewer will enter the property at the northern limits, connecting to the existing manhole located approximately 172m east of University Avenue West. The proposed private sanitary sewer will be extended

south of the proposed building and north of the potential future development at 0.9% and 1.0%, which will allow for both the currently proposed and future buildings to be serviced for sanitary. With these slopes, the proposed 200mm diameter sanitary sewer will have a capacity of 31.1L/s and 32.8L/s, respectively. The proposed building is expected to generate a sanitary demand of 4.5L/s.

Storm

There is an existing 675mm diameter municipal storm sewer along University Avenue West draining south, approximately 3.9m below grade. Within Parking Lot A, there is an existing private storm sewer network generally consisting of 200mm diameter storm sewers, which ultimately outlets via a 375mm diameter storm sewer to an existing municipal 525mm diameter storm sewer on Seagram Drive. The Seagram Drive storm sewer drains east and ultimately outlets to Laurel Creek in Waterloo Park.

A private storm sewer system will be installed on-site to collect rooftop runoff from the building and the common driveway. Due to the capacity concerns of the existing storm sewers within Parking Lot A, the runoff collected in the proposed storm sewers will be directed around the northern and eastern limits of Parking Lot A, ultimately connecting to an existing manhole located near the southeast corner of the existing parking lot. At this manhole, the existing pipe invert is approximately 2.1m below grade and has a capacity of approximately 115.0L/s.

It is noted that two parallel 300mm diameter CSP pipes are proposed to be installed in a culvert near the northeast corner of the proposed building to convey the runoff from the northern limits of the property to the surface of Parking Lot A, maintaining existing drainage conditions.

Stormwater Management

The assumed stormwater management (SWM) criteria for the proposed development, based on best practice and presumed City of Waterloo requirements, are as follows:

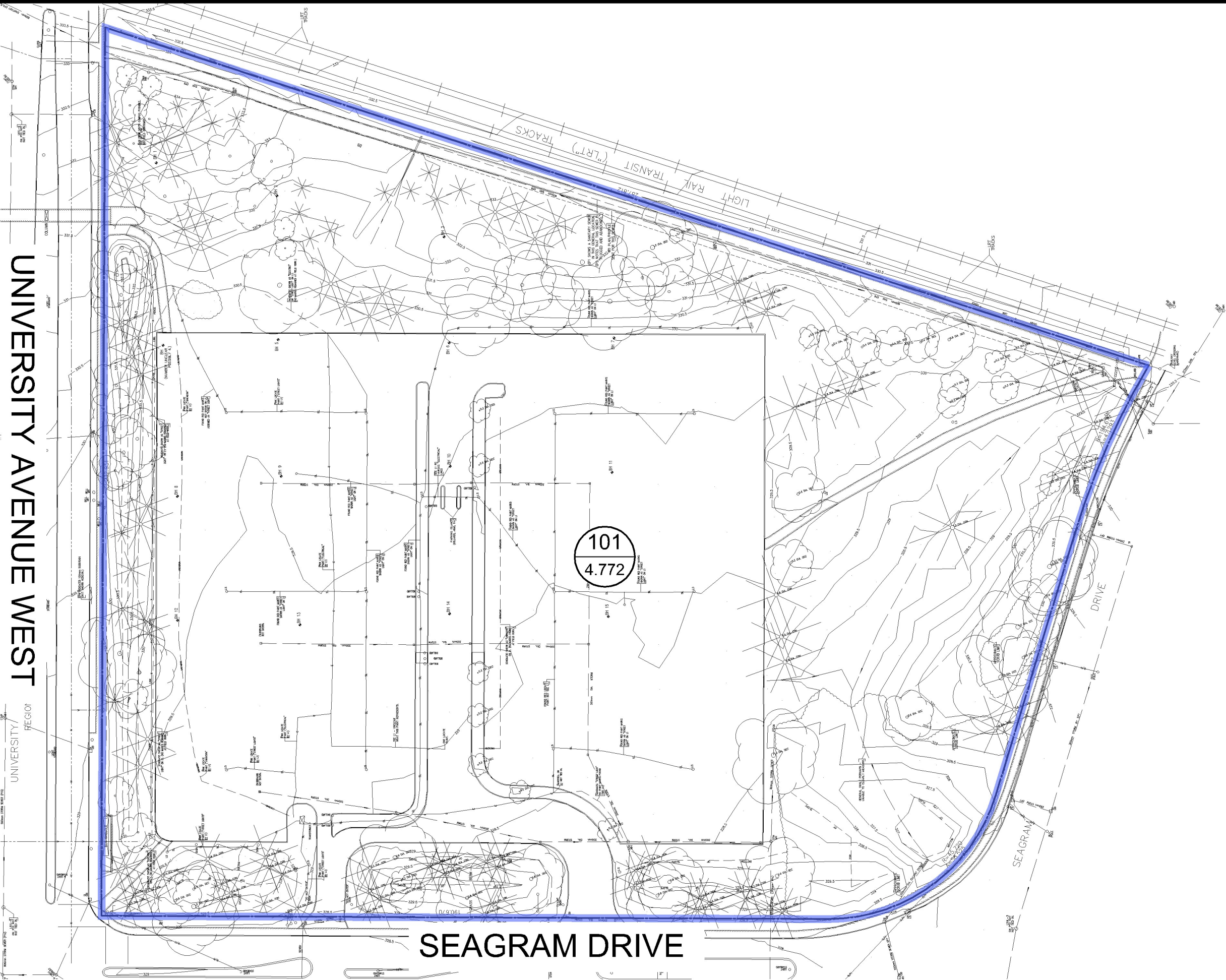
- Attenuation of the post-development peak flows for the 5- and 100-year storm events to the pre-development (existing) peak flows; and,
- Implementation of water quality controls.

Water Quantity Control

In order to successfully complete the preliminary stormwater management design for the site, the following specific tasks were undertaken:

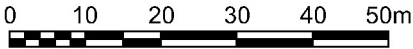
- Calculate the allowable runoff rates using MIDUSS NET;
- Determine the percent impervious of the site and catchment parameters for inclusion in MIDUSS modeling; and,
- Calculate post-development runoff hydrographs using MIDUSS NET.

The following table summarizes the catchments used in modeling of the site. The pre-development condition was separated into one catchment area; the uncontrolled site area. Figure 1.0 illustrates the limits of the pre-development catchment area. The post-development condition was separated into three catchment areas; the building roof, the controlled area, and the uncontrolled area. Figure 2.0 illustrates the limits of the post-development catchment areas.



LEGEND

- CATCHMENT 101
- SUB-CATCHMENT NUMBER
- AREA (ha.)

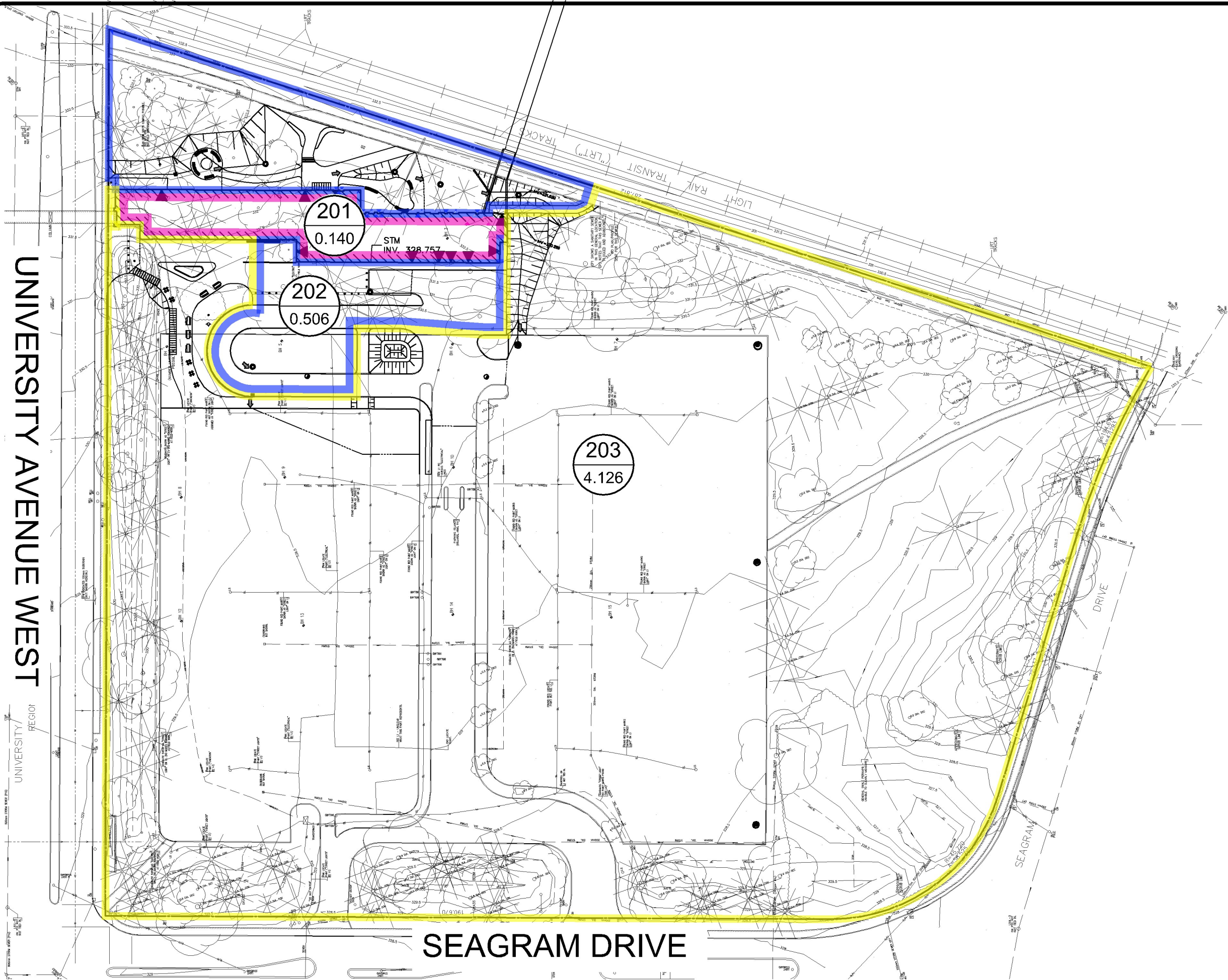




Engineers, Scientists, Surveyors

PROJECT		
UW CAMPUS NEW STUDENT RESIDENCE		
TITLE		
PRE-DEVELOPMENT DRAINAGE AREA FIGURE		
Drawn	JRS	Scale 1:1000
Checked	DXN	Project No. 52255-100
Date	2023-07-19	Rev No. 0

Figure
1.0



LEGEND

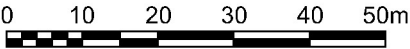
- CATCHMENT 201
- CATCHMENT 202
- CATCHMENT 203

203

4.126

SUB-CATCHMENT
NUMBER

AREA (ha.)





Engineers, Scientists, Surveyors

PROJECT

UW CAMPUS
NEW STUDENT RESIDENCE

TITLE

POST-DEVELOPMENT
DRAINAGE AREA FIGURE

Drawn JRS

Checked DXN

Date 2023-07-19

Scale 1:1000

Project No. 52255-100

Rev No. 0

Figure

2.0

Catchment Parameters

#	Catchment	Area (ha)	% Impervious	Pervious CN	Impervious CN	Slope (%)	Flow Length (m)
Pre-Development Catchment Area							
101	Site	4.772	48.8	88	98	2.0	30.0
Post-Development Catchment Areas							
201	Building Roof	0.140	100.0	88	98	1.0	15.0
202	Controlled Area	0.506	48.1	88	98	5.0	25.0
203	Uncontrolled Area	4.126	54.5	88	98	1.5	23.0

A geotechnical investigation was undertaken by Chung & Vander Doelen Engineering Ltd. and is dated November 4, 2022. The investigation revealed the site is generally underlain by fill materials comprised of silt with clay in the range of trace to clayey, sand in the range of trace to sandy, and trace gravel, followed by upper silt, clayey silt, lower silt, and clayey silt till. Therefore, a pervious CN of 88 is appropriate. Refer to the separately submitted geotechnical report for details regarding subsurface conditions and groundwater table elevation.

In order to achieve the stormwater management requirements for the site, runoff generated from the building roof will be controlled with the installation of a 175mm diameter on-line orifice plate on the outlet pipe of manhole MH12 and three runs of 750mm diameter supersize pipes for additional storage. In addition, four flow control roof drains, single notch, are proposed to be installed on the roof of the proposed building. This will help further reduce the post-development runoff from the site. A maximum of 0.15m of ponding is permitted on the rooftop.

The flow equations for the orifice and the weir are included in Appendix D. Refer to Appendix E for the MIDUSS NET output.

The following table illustrates the stage-storage-discharge relationship of the storm system.

Stage-Storage-Discharge Information (Catchment 202)

Elevation (m)	Head (m)	Orifice/Weir Flow (m ³ /s)	Volume (m ³)	Remarks
327.03	0.00	0.0000	0.0	175mm diameter orifice invert
329.75	2.72	0.1082	130.76	Top of grate CB9
329.90	2.87	0.1113	130.76	1.0m wide weir
329.95	2.92	0.1295	131.20	Contour

With the addition of the 175mm diameter orifice plate and the 1.0m wide weir, the post-development runoff from the controlled portion of the site for the 5- and 100-year storm events is controlled to 0.047m³/s and 0.108m³/s, respectively. The following table summarizes the expected flows that will be generated by the whole site.

Summary of Flows

Modeling Condition	5-Year Storm Event (m ³ /s)	100-Year Storm Event (m ³ /s)
Pre-Development	0.755	1.818
Post-Development	0.751	1.707

As seen in the table above, the post-development rates are controlled to the pre-development rates for both the 5- and 100-year storm events. The maximum ponding depth on the rooftop for each storm events are 9.1cm and 13.3cm, respectively. The proposed stormwater management design may be subject to change during detailed design.

Water Quality Control

In the existing condition, the site is approximately 48.8% impervious. In the proposed condition, the site is approximately 55.1% impervious, representing an increase of 6.3%. It is noted that the proposed building is responsible for approximately half of the total increase in the percent imperviousness and only clean runoff will be generated in this area. Furthermore, the proposed driveway is mainly located within the original footprint of the existing Parking Lot A. As such, an oil-grit separator unit is not proposed however, snouts will be installed in the new storm inlet structures to provide water quality control.

Erosion and Sediment Control

Precautions will need to be taken during construction to limit erosion and sedimentation. Typically, the following measures are recommended during construction for erosion and sedimentation control:

- Erosion and sedimentation facilities are to be installed prior to any site preparation;
- All erosion control measures are to be inspected and monitored by the contractor and repairs are to be completed as required; and,
- All materials and equipment used for the purpose of site preparation and project completion should be operated and stored in a manner that prevents any deleterious substance from leaving the site.

Conclusions

Based on the foregoing analysis, it is concluded that:

- The proposed grading design will respect the existing grades along all property lines;
- The water service connection is proposed off of University Avenue West;
- The anticipated maximum day domestic water demand is 2.41L/s and the maximum fire flow demand is 150L/s based on OBC calculations. Based on the flow tests provided by Classic Fire and Life Safety, it can be confirmed that the minimum residual pressure of 140.0kPa can be achieved;
- The sanitary service connection is proposed off of the Laurel Trail;
- The storm service connection is proposed off of an existing manhole connecting to the Seagram Drive right-of-way storm network;
- The proposed stormwater management design provides adequate attenuation of the 5- and 100-year storm events; and,
- On-site water quality control will be met through the installation of snouts.

All of which is respectfully submitted,

MTE Consultants Inc.



Dain Na, B.Eng.

Designer

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DXN:dlb

cc: Duncan Bates, Diamond Schmitt Architects
Justin Loucks, Diamond Schmitt Architects
Lynn Ingram, MTE Consultants Inc.

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Andrei Tchoumatchev, P.Eng.

Design Engineer

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Appendix A

Water Demand Calculation



UW Residence
FIRE FLOW DEMANDS

Waterloo, Ontario
Project #: 52255-100
Date: 7/17/2023
Date Printed: 7/17/2023
Designed By: DXN
Checked By: AXT

Development Information ¹								Fire Flow ²													Domestic Flow ^{3,4}							
								Ontario Building Code						Fire Underwriters Survey														
Node ID / Area ID / Building #	F.F.E. (m.a.s.l.)	Description	# of Units	Population	Bldg Area (1 st Floor)	Total Bldg Area	Building Volume	K	V	S _{tot}	Q	F	F	C	A	F	(2) Occupancy Reduction	(3) Sprinkler Protection	(4) Building Exposure	F	F	Fire Flow (Max OBC/FUS)	MOE Guidelines	Average Day	Max Day	Peak Hour	Minimum Hour	Max Day + Fire Flow
				# of people	m ²	m ²	m ³																	L/s	L/s	L/s	L/s	L/s
Proposed	331.80	Apartment	190	336	1,370	15,763	52,031	10	52,031	1.63	848,112	9,000	150	0.80	2,008	7,886	-15%	-30%	45%	8,000	133	150	0.876	0.876	2.408	3.617	0.350	152
TOTALS FOR SITE			190	336	1370	15763	52031	Max Fire Flow = 150						Max Fire Flow = 133							150	0.88	0.88	2.41	3.62	0.35	152	
																					Sum of Maximum Day Flows + OBC Fire Flow (L/s) =						152.4	
																					Sum of Maximum Day Flows + FUS Fire Flow (L/s) =						135.7	

Assumptions:

- 1 All building areas and populations are based on the Site Plan and correspondence with Diamond Schmitt Architects. Assumed 1.77 persons per unit as per Region of Waterloo Water and Wastewater Monitoring Report 2017.
- 2 Levels 1 and 2 of the proposed building is classified as occupancy group A (Assembly Occupancy), and levels 3 to 12 are classified as occupancy group C (Residential Occupancy).
- 3 For FUS area calculation, all vertical openings and exterior vertical communications are properly protected in accordance with the National Building Code thus, only the single largest floor area plus 25% of each of the two immediately adjoining floors were considered.
- 4 Average Daily Demands for each building are based on "Tri City Water Distribution Master Plan Final Report" by AECOM, Dated May 2009 :

Residential = 225 L/cap/day
- 5 Peaking Factors based on "Design Guidelines for Drinking-Water Systems" (MOE, 2008):

Average Day = 1

Maximum Day = 2.75

Peak Hour = 4.13

Minimum Hour = 0.4

Appendix B

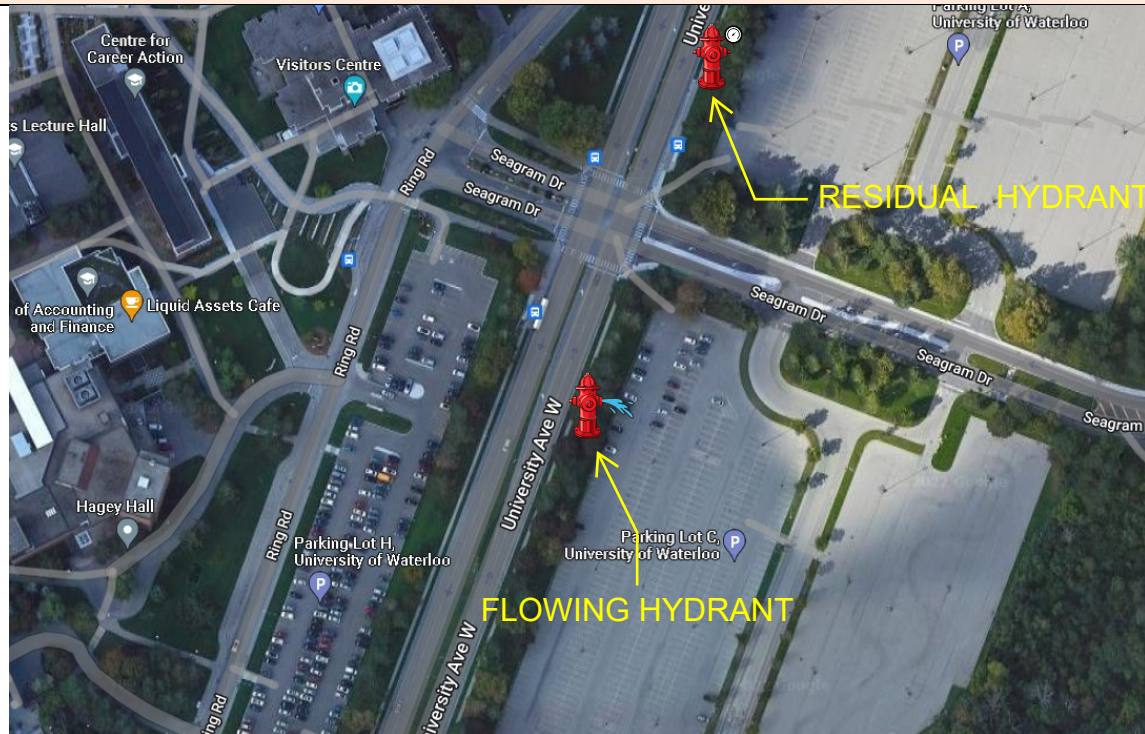
Fire Flow Results

PROJECT INFORMATION

Project Name:	200 University Ave Flow Test	Const. Project #:	22-GTA-690-0612
Site Address:	200 University Ave Waterloo ON	Design Project #:	2022-CFLS-652
City Contact:	Theresa	Phone #:	519-886-2310 x302
CFLS Contact:	Dean Wanders	Phone #:	905-514-7417
Technical Contact:	Andy Coghlin	Phone #:	519-476-0761

SITE INFORMATION

SITE MAP



Note: If the main is a dead end, the flowing hydrant shall be closest to the dead end

ITEMS TO LABEL ON MAP	HYDRANTS USED	MAIN SIZE
☒ Static / Residual & Flow Hydrants	☒ City Hydrant(s)	City:
☐ Flow Direction (if the main is dead end)	☐ Site Hydrant(s)	Site:
SITE NOTES		

TEST INFORMATION							
Minimum Required Flow:		NA			Min Ports:		2
CFLS Personnel Present:		Dean Wanders			Test Date:		2022-10-25
City / External Company:		City of Waterloo			Test Time:		8:00am
TEST EQUIPMENT							
☐ Hose Monsters with built in Pitot				Hose length used:			
☐ Hand held pitot gauge				☒ Pollard diffuser elbow with built in Pitot			
☐ Other:							
TEST RESULTS							
Number of Ports	Outlet Size (IN)	Discharge Coefficient	Pitot Reading (PSI)			Total Flow (GPM)	Static / Residual Pressure (PSI)
0 Ports	STATIC						70
1 Port	2.5	0.9	58			1,278	68
2 Ports	2.5	0.9	40	28		1,950	65
3 Ports	2.5	0.9				0	
4 Ports	2.5	0.9				0	
0 Ports	STATIC RE-CHECK						70
TEST NOTES							

HYDRAULIC ADJUSTMENTS (FOR OFFICE USE ONLY)			
ADJUSTMENTS FOR HYDRAULIC GRADE LINE (HGL)			
Reservoir HGL (m):			Site Elevation (m):
Theoretical Static Head (PSI):		0	PSI to subtract from test pressures:
			70
OTHER HYDRAULIC ADJUSTMENTS			
Other adjustment as required by the City / AHJ:			

Appendix C

Fire Flow Analysis



UW Residence FIRE FLOW ANALYSIS

Waterloo, Ontario

Project Number: 52255-100

Date: July 17, 2023

Design By: DXN

Checked By: AXT

File: Q:\52255\100\WATER\Site Fire Flow Analysis.xlsx

CALCULATION OF RESIDUAL PRESSURE AT ON-SITE HYDRANT (OBC)

1. Boundary Conditions (Based on Fire Flow Test Results):

	Metric	Imperial	
P0 - Starting Pressure	49.23 m	70 psi	
P1 - Pressure at Q1	45.71 m	65 psi	
Q1 - From Fire Flow Test	7382 L/min	1950 U.S. gal/min	
Q2 - Required Flow	9144 L/min	2416 U.S. gal/min	From: Water Demand calculations by MTE
P-loss 1	3.52 m	5 psi	
P-loss 2	5.23 m	7 psi	
P2 - Residual Pressure	44.00 m	63 psi	Extrapolated from Fire Flow Test Results

2. Friction Losses Through Water Service:

<u>Hazen-Williams Equation</u>	Metric	Imperial
C _{hw} = Pipe Friction Factor	150	150
k = conversion factor	10.675	4.727
n = constant	1.852	1.852
m = constant	4.8704	4.8704
Q = Flow	9144 L/min	
Q = Flow	0.1524 m ³ /s	2416 U.S. gal/min
d = Pipe Diameter	300 mm	11.81 in
	0.3 m	
p = Loss/Length	0.0108 m/m	0.0047 psi/ft
Length	28 m	92 ft
Loss	0.30 m	0.4 psi
	3 kPa	
C _{hw} = Pipe Friction Factor	150	150
k = conversion factor	10.675	4.727
n = constant	1.852	1.852
m = constant	4.8704	4.8704
Q = Flow	9144 L/min	
Q = Flow	0.1524 m ³ /s	12 U.S. gal/min
d = Pipe Diameter	150 mm	5.91 in
	0.15 m	
p = Loss/Length	0.3147 m/m	0.1364 psi/ft
Length	35 m	115 ft
Loss	11.01 m	15.7 psi
	108 kPa	
Total Loss	11 m	
	111 kPa	



3. Friction Losses Through Apurtenances:						
Apurtenances	Number	K	Velocity	Head Loss	Total Loss	
			<i>m/s</i>	<i>m</i>	<i>m</i>	<i>psi</i>
300mm Tee (branch)	1	0.720	2.156	0.171	0.171	0.243
Valve - 300mm dia.	2	0.096	2.156	0.023	0.045	0.065
90 Deg Bend - 300mm dia.	1	0.360	2.156	0.085	0.085	0.121
150mm Tee (branch)	1	0.900	8.624	3.412	3.412	4.851
Valve - 150mm dia.	1	0.120	8.624	0.455	0.455	0.647
90 Deg Bend - 150mm dia.	1	0.450	8.624	1.706	1.706	2.426
Total Minor Losses					5.874	8.352

4. Elevation - Elevational differences from existing hydrant to proposed hydrant		
	Metric	Imperial
Elevation at Boundary (i.e. Residual Hydrant):	329.36 m	1081 ft
Elevation at Site Hydrant:	330.92 m	1086 ft
Elevation Difference = Loss/Gain	1.56 m	2.2 psi

ANALYSIS SUMMARY			
Total Losses	18.750 m		
	183.93 kPa	26.7 psi	
Residual Pressure after Losses	25.25 m		
	248 kPa	35.9 psi	PASS
<i>Allowable Residual Pressure</i>	140 kPa	20.3 psi	



UW Residence FIRE FLOW ANALYSIS

Waterloo, Ontario

Project Number: 52255-100

Date: July 17, 2023

Design By: DXN

Checked By: AXT

File: Q:\52255\100\WATER\Site Fire Flow Analysis.xlsx

CALCULATION OF RESIDUAL PRESSURE AT ON-SITE HYDRANT (FUS)

1. Boundary Conditions (Based on Fire Flow Test Results):

	Metric	Imperial	
P0 - Starting Pressure	49.23 m	70 psi	
P1 - Pressure at Q1	45.71 m	65 psi	
Q1 - From Fire Flow Test	7382 L/min	1950 U.S. gal/min	
Q2 - Required Flow	8142 L/min	2151 U.S. gal/min	From: Water Demand calculations by MTE
P-loss 1	3.52 m	5 psi	
P-loss 2	4.22 m	6 psi	
P2 - Residual Pressure	45.01 m	64 psi	Extrapolated from Fire Flow Test Results

2. Friction Losses Through Water Service:

<u>Hazen-Williams Equation</u>	Metric	Imperial
C _{hw} = Pipe Friction Factor	150	150
k = conversion factor	10.675	4.727
n = constant	1.852	1.852
m = constant	4.8704	4.8704
Q = Flow	8142 L/min	
Q = Flow	0.1357 m ³ /s	2151 U.S. gal/min
d = Pipe Diameter	300 mm	11.81 in
	0.3 m	
p = Loss/Length	0.0087 m/m	0.0038 psi/ft
Length	28 m	92 ft
Loss	0.24 m	0.3 psi
	2 kPa	
C _{hw} = Pipe Friction Factor	150	150
k = conversion factor	10.675	4.727
n = constant	1.852	1.852
m = constant	4.8704	4.8704
Q = Flow	8142 L/min	
Q = Flow	0.1357 m ³ /s	12 U.S. gal/min
d = Pipe Diameter	150 mm	5.91 in
	0.15 m	
p = Loss/Length	0.2538 m/m	0.1100 psi/ft
Length	35 m	115 ft
Loss	8.88 m	12.6 psi
	87 kPa	
Total Loss	9 m	
	90 kPa	



3. Friction Losses Through Apurtenances:						
Apurtenances	Number	K	Velocity	Head Loss	Total Loss	
			<i>m/s</i>	<i>m</i>	<i>m</i>	<i>psi</i>
300mm Tee (branch)	1	0.720	1.920	0.135	0.135	0.192
Valve - 300mm dia.	2	0.096	1.920	0.018	0.036	0.051
90 Deg Bend - 300mm dia.	1	0.360	1.920	0.068	0.068	0.096
150mm Tee (branch)	1	0.900	7.679	2.705	2.705	3.846
Valve - 150mm dia.	1	0.120	7.679	0.361	0.361	0.513
90 Deg Bend - 150mm dia.	1	0.450	7.679	1.352	1.352	1.923
Total Minor Losses					4.657	6.622

4. Elevation - Elevational differences from existing hydrant to proposed hydrant		
	Metric	Imperial
Elevation at Boundary (i.e. Residual Hydrant):	329.36 m	1081 ft
Elevation at Site Hydrant:	330.92 m	1086 ft
Elevation Difference = Loss/Gain	1.56 m	2.2 psi

ANALYSIS SUMMARY			
Total Losses	15.344 m		
	150.53 kPa	21.8 psi	
Residual Pressure after Losses	29.67 m		
	291 kPa	42.2 psi	PASS
Allowable Residual Pressure	140 kPa	20.3 psi	

Appendix D

MIDUSS Calculations

CALCULATIONS

Orifice Equation (MIDUSS NET)

$$Q = C_c \pi/4 D^5 \sqrt{2g(H-2/3D)}$$

where

- C_c coefficient of contraction
- H head relative to the invert of the orifice
- D orifice diameter
- g gravitational acceleration

Weir Equation (MIDUSS NET)

$$Q_{cr} = B \sqrt{g} y_{cr}^{3/2} \quad \text{where } y_{cr} = 2/3 (H-Z)$$

Where

- B weir breadth
- g gravitational acceleration
- H head relative to the invert of the weir
- Z weir sill elevation

Appendix E

MIDUSS Output

Pre-Development

```

"          MIDUSS Output ----->"
"          MIDUSS version          Version 2.25 rev. 473"
"          MIDUSS created          Sunday, February 7, 2010"
"          10 Units used:          ie METRIC"
"          Job folder:          Q:\52255\100\SWM\2023-07-16"
"          Output filename:          5 Year Pre.out"
"          Licensee name:          A"
"          Company          "
"          Date & Time last used:          7/16/2023 at 5:06:22 PM"
" 31          TIME PARAMETERS"
"          5.000 Time Step"
"          180.000 Max. Storm length"
"          1500.000 Max. Hydrograph"
" 32          STORM Chicago storm"
"          1 Chicago storm"
"          1755.000 Coefficient A"
"          12.347 Constant B"
"          0.895 Exponent C"
"          0.400 Fraction R"
"          180.000 Duration"
"          1.000 Time step multiplier"
"          Maximum intensity          136.512 mm/hr"
"          Total depth          47.549 mm"
"          6 005hyd Hydrograph extension used in this file"
" 33          CATCHMENT 101"
"          1 Triangular SCS"
"          1 Equal length"
"          1 SCS method"
"          101 Site"
"          48.800 % Impervious"
"          4.772 Total Area"
"          30.000 Flow length"
"          2.000 Overland Slope"
"          2.443 Pervious Area"
"          30.000 Pervious length"
"          2.000 Pervious slope"
"          2.329 Impervious Area"
"          30.000 Impervious length"
"          2.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"          88.000 Pervious SCS Curve No."
"          0.517 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          3.464 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"          98.000 Impervious SCS Curve No."
"          0.879 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"
"          0.755 0.000 0.000 0.000 c.m/sec"

```

```

"          Catchment 101          Pervious Impervious Total Area "
"          Surface Area          2.443 2.329 4.772 hectare"
"          Time of concentration 13.565 1.996 6.413 minutes"
"          Time to Centroid 110.671 88.629 97.044 minutes"
"          Rainfall depth 47.549 47.549 47.549 mm"
"          Rainfall volume 1161.75 1107.29 2269.04 c.m"
"          Rainfall losses 22.957 5.764 14.567 mm"
"          Runoff depth 24.592 41.785 32.982 mm"
"          Runoff volume 600.85 973.07 1573.92 c.m"
"          Runoff coefficient 0.517 0.879 0.694 "
"          Maximum flow 0.273 0.692 0.755 c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4 Add Runoff "
"          0.755 0.755 0.000 0.000"
" 40          HYDROGRAPH Copy to Outflow"
"          8 Copy to Outflow"
"          0.755 0.755 0.755 0.000"
" 38          START/RE-START TOTALS 101"
"          3 Runoff Totals on EXIT"
"          Total Catchment area          4.772 hectare"
"          Total Impervious area          2.329 hectare"
"          Total % impervious          48.800"
" 19          EXIT"

```

```

"          MIDUSS Output ----->"
"          MIDUSS version          Version 2.25 rev. 473"
"          MIDUSS created          Sunday, February 7, 2010"
"          10 Units used:          ie METRIC"
"          Job folder:             Q:\52255\100\SWMM\2023-07-16"
"          Output filename:        100 Year Pre.out"
"          Licensee name:          A"
"          Company                  "
"          Date & Time last used:   7/16/2023 at 5:02:18 PM"
" 31          TIME PARAMETERS"
"          5.000 Time Step"
"          180.000 Max. Storm length"
"          1500.000 Max. Hydrograph"
" 32          STORM Chicago storm"
"          1 Chicago storm"
"          4692.000 Coefficient A"
"          17.437 Constant B"
"          0.956 Exponent C"
"          0.400 Fraction R"
"          180.000 Duration"
"          1.000 Time step multiplier"
"          Maximum intensity        239.793 mm/hr"
"          Total depth              89.960 mm"
"          6 100hyd Hydrograph extension used in this file"
" 33          CATCHMENT 101"
"          1 Triangular SCS"
"          1 Equal length"
"          1 SCS method"
"          101 Site"
"          48.800 % Impervious"
"          4.772 Total Area"
"          30.000 Flow length"
"          2.000 Overland Slope"
"          2.443 Pervious Area"
"          30.000 Pervious length"
"          2.000 Pervious slope"
"          2.329 Impervious Area"
"          30.000 Impervious length"
"          2.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"          88.000 Pervious SCS Curve No."
"          0.683 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          3.464 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"          98.000 Impervious SCS Curve No."
"          0.927 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"
"          1.818 0.000 0.000 0.000 c.m/sec"

```

```

"          Catchment 101          Pervious Impervious Total Area "
"          Surface Area          2.443 2.329 4.772 hectare"
"          Time of concentration 9.520 1.573 5.038 minutes"
"          Time to Centroid      101.775 86.185 92.983 minutes"
"          Rainfall depth        89.960 89.960 89.960 mm"
"          Rainfall volume        2197.96 2094.93 4292.89 c.m"
"          Rainfall losses        28.482 6.542 17.775 mm"
"          Runoff depth           61.479 83.418 72.185 mm"
"          Runoff volume          1502.08 1942.58 3444.67 c.m"
"          Runoff coefficient      0.683 0.927 0.802 "
"          Maximum flow           0.833 1.327 1.818 c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4 Add Runoff "
"          1.818 1.818 0.000 0.000"
" 40          HYDROGRAPH Copy to Outflow"
"          8 Copy to Outflow"
"          1.818 1.818 1.818 0.000"
" 38          START/RE-START TOTALS 101"
"          3 Runoff Totals on EXIT"
"          Total Catchment area          4.772 hectare"
"          Total Impervious area         2.329 hectare"
"          Total % impervious            48.800"
" 19          EXIT"

```

Post-Development

```

"          MIDUSS Output ----->"
"          MIDUSS version          Version 2.25 rev. 473"
"          MIDUSS created          Sunday, February 7, 2010"
"          10 Units used:          ie METRIC"
"          Job folder:             Q:\52255\100\SWM\2023-07-16"
"          Output filename:        5 Year Post C.out"
"          Licensee name:          A"
"          Company                 "
"          Date & Time last used:   7/17/2023 at 11:35:57 AM"
" 31      TIME PARAMETERS"
"          5.000 Time Step"
"          180.000 Max. Storm length"
"          1500.000 Max. Hydrograph"
" 32      STORM Chicago storm"
"          1 Chicago storm"
"          1755.000 Coefficient A"
"          12.347 Constant B"
"          0.895 Exponent C"
"          0.400 Fraction R"
"          180.000 Duration"
"          1.000 Time step multiplier"
"          Maximum intensity        136.512 mm/hr"
"          Total depth              47.549 mm"
"          6 005hyd Hydrograph extension used in this file"
" 33      CATCHMENT 201"
"          1 Triangular SCS"
"          1 Equal length"
"          1 SCS method"
"          201 Building Roof"
"          100.000 % Impervious"
"          0.140 Total Area"
"          15.000 Flow length"
"          1.000 Overland Slope"
"          0.000 Pervious Area"
"          15.000 Pervious length"
"          1.000 Pervious slope"
"          0.140 Impervious Area"
"          15.000 Impervious length"
"          1.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"          88.000 Pervious SCS Curve No."
"          0.000 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          3.464 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"          98.000 Impervious SCS Curve No."
"          0.879 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"
"          0.043 0.000 0.000 0.000 c.m/sec"

```

```

"          Catchment 201          Pervious Impervious Total Area "
"          Surface Area          0.000 0.140 0.140 hectare"
"          Time of concentration 11.019 1.621 1.621 minutes"
"          Time to Centroid      107.274 88.048 88.048 minutes"
"          Rainfall depth        47.549 47.549 47.549 mm"
"          Rainfall volume       0.00 66.57 66.57 c.m"
"          Rainfall losses       22.949 5.754 5.754 mm"
"          Runoff depth          24.600 41.795 41.795 mm"
"          Runoff volume         0.00 58.51 58.51 c.m"
"          Runoff coefficient    0.000 0.879 0.879 "
"          Maximum flow          0.000 0.043 0.043 c.m/sec"
" 40      HYDROGRAPH Add Runoff "
"          4 Add Runoff "
"          0.043 0.043 0.000 0.000"
" 54      POND DESIGN"
"          0.043 Current peak flow c.m/sec"
"          0.021 Target outflow c.m/sec"
"          58.5 Hydrograph volume c.m"
"          11. Number of stages"
"          0.000 Minimum water level metre"
"          0.150 Maximum water level metre"
"          0.000 Starting water level metre"
"          0 Keep Design Data: 1 = True; 0 = False"
"          Level Discharge Volume"
"          0.000 0.000 0.000"
"          0.01500 0.00090 0.1575"
"          0.03000 0.00180 1.260"
"          0.04500 0.00270 4.253"
"          0.06000 0.00360 10.080"
"          0.07500 0.00450 19.688"
"          0.09000 0.00540 33.878"
"          0.1050 0.00630 49.628"
"          0.1200 0.00720 65.378"
"          0.1350 0.00810 81.128"
"          0.1500 0.00900 96.878"
" 1.      ROOFTOP"
"          Roof area Store area Area/drain Drain flow Roof slope"
"          hectare hectare sq.metre L/min/25mm g H:1V"
"          0.140 0.105 300.000 22.500 100.000"
"          Using 4 roofdrains on roofstorage area of 1050. square metre"
"          Peak outflow 0.005 c.m/sec"
"          Maximum level 0.091 metre"
"          Maximum storage 35.138 c.m"
"          Centroidal lag 2.678 hours"
"          0.043 0.043 0.005 0.000 c.m/sec"
" 40      HYDROGRAPH Combine 1"
"          6 Combine "
"          1 Node #"
"          Total Site"
"          Maximum flow 0.005 c.m/sec"

```

"	Hydrograph volume	58.497	c.m"
"	0.043 0.043 0.005 0.005"		
" 40	HYDROGRAPH Start - New Tributary"		
"	2 Start - New Tributary"		
"	0.043 0.000 0.005 0.005"		
" 33	CATCHMENT 202"		
"	1 Triangular SCS"		
"	1 Equal length"		
"	1 SCS method"		
"	202 Controlled Area"		
"	48.100 % Impervious"		
"	0.506 Total Area"		
"	25.000 Flow length"		
"	5.000 Overland Slope"		
"	0.263 Pervious Area"		
"	25.000 Pervious length"		
"	5.000 Pervious slope"		
"	0.243 Impervious Area"		
"	25.000 Impervious length"		
"	5.000 Impervious slope"		
"	0.250 Pervious Manning 'n'"		
"	88.000 Pervious SCS Curve No."		
"	0.517 Pervious Runoff coefficient"		
"	0.100 Pervious Ia/S coefficient"		
"	3.464 Pervious Initial abstraction"		
"	0.015 Impervious Manning 'n'"		
"	98.000 Impervious SCS Curve No."		
"	0.876 Impervious Runoff coefficient"		
"	0.100 Impervious Ia/S coefficient"		
"	0.518 Impervious Initial abstraction"		
"	0.088 0.000 0.005 0.005 c.m/sec"		
"	Catchment 202 Pervious Impervious Total Area "		
"	Surface Area 0.263 0.243 0.506 hectare"		
"	Time of concentration 9.237 1.359 4.425 minutes"		
"	Time to Centroid 104.920 87.712 94.410 minutes"		
"	Rainfall depth 47.549 47.549 47.549 mm"		
"	Rainfall volume 124.87 115.73 240.60 c.m"		
"	Rainfall losses 22.950 5.895 14.746 mm"		
"	Runoff depth 24.599 41.654 32.803 mm"		
"	Runoff volume 64.60 101.38 165.98 c.m"		
"	Runoff coefficient 0.517 0.876 0.690 "		
"	Maximum flow 0.035 0.076 0.088 c.m/sec"		
" 40	HYDROGRAPH Add Runoff "		
"	4 Add Runoff "		
"	0.088 0.088 0.005 0.005"		
" 54	POND DESIGN"		
"	0.088 Current peak flow c.m/sec"		
"	0.021 Target outflow c.m/sec"		
"	166.0 Hydrograph volume c.m"		
"	4. Number of stages"		

"	327.033 Minimum water level metre"		
"	329.950 Maximum water level metre"		
"	327.033 Starting water level metre"		
"	0 Keep Design Data: 1 = True; 0 = False"		
"	Level Discharge Volume"		
"	327.033 0.000 0.000"		
"	329.750 0.1082 130.760"		
"	329.900 0.1113 130.760"		
"	329.950 0.1295 131.200"		
"	1. WEIRS"		
"	Crest Weir Crest Left Right"		
"	elevation coefficie breadth sideslope sideslope"		
"	329.900 0.900 1.000 0.000 0.000"		
"	1. ORIFICES"		
"	Orifice Orifice Orifice Number of"		
"	invert coefficie diameter orifices"		
"	327.033 0.630 0.1750 1.000"		
"	Peak outflow 0.047 c.m/sec"		
"	Maximum level 328.218 metre"		
"	Maximum storage 57.033 c.m"		
"	Centroidal lag 1.909 hours"		
"	0.088 0.088 0.047 0.005 c.m/sec"		
" 40	HYDROGRAPH Combine 1"		
"	6 Combine "		
"	1 Node #"		
"	Total Site"		
"	Maximum flow 0.053 c.m/sec"		
"	Hydrograph volume 224.478 c.m"		
"	0.088 0.088 0.047 0.053"		
" 40	HYDROGRAPH Start - New Tributary"		
"	2 Start - New Tributary"		
"	0.088 0.000 0.047 0.053"		
" 33	CATCHMENT 203"		
"	1 Triangular SCS"		
"	1 Equal length"		
"	1 SCS method"		
"	203 Uncontrolled Area"		
"	54.500 % Impervious"		
"	4.126 Total Area"		
"	23.000 Flow length"		
"	1.500 Overland Slope"		
"	1.877 Pervious Area"		
"	23.000 Pervious length"		
"	1.500 Pervious slope"		
"	2.249 Impervious Area"		
"	23.000 Impervious length"		
"	1.500 Impervious slope"		
"	0.250 Pervious Manning 'n'"		
"	88.000 Pervious SCS Curve No."		
"	0.518 Pervious Runoff coefficient"		

```

"      0.100 Pervious Ia/S coefficient"
"      3.464 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
"      0.879 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"
"      0.518 Impervious Initial abstraction"
"          0.727      0.000      0.047      0.053 c.m/sec"
"      Catchment 203      Pervious      Impervious      Total Area "
"      Surface Area      1.877      2.249      4.126      hectare"
"      Time of concentration 12.609      1.855      5.402      minutes"
"      Time to Centroid      109.403      88.426      95.344      minutes"
"      Rainfall depth      47.549      47.549      47.549      mm"
"      Rainfall volume      892.65      1069.22      1961.87      c.m"
"      Rainfall losses      22.920      5.766      13.571      mm"
"      Runoff depth      24.629      41.783      33.978      mm"
"      Runoff volume      462.37      939.57      1401.94      c.m"
"      Runoff coefficient      0.518      0.879      0.715      "
"      Maximum flow      0.213      0.673      0.727      c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
"          0.727      0.727      0.047      0.053"
" 40 HYDROGRAPH Copy to Outflow"
" 8 Copy to Outflow"
"          0.727      0.727      0.727      0.053"
" 40 HYDROGRAPH Combine 1"
" 6 Combine "
" 1 Node #"
"      Total Site"
"      Maximum flow      0.751      c.m/sec"
"      Hydrograph volume      1626.419      c.m"
"          0.727      0.727      0.727      0.751"
" 40 HYDROGRAPH Confluence 1"
" 7 Confluence "
" 1 Node #"
"      Total Site"
"      Maximum flow      0.751      c.m/sec"
"      Hydrograph volume      1626.419      c.m"
"          0.727      0.751      0.727      0.000"
" 38 START/RE-START TOTALS 1"
" 3 Runoff Totals on EXIT"
"      Total Catchment area      4.772      hectare"
"      Total Impervious area      2.632      hectare"
"      Total % impervious      55.156"
" 19 EXIT"

```

```

"          MIDUSS Output ----->"
"          MIDUSS version          Version 2.25 rev. 473"
"          MIDUSS created          Sunday, February 7, 2010"
"          10 Units used:          ie METRIC"
"          Job folder:          Q:\52255\100\SWM\2023-07-16"
"          Output filename:          100 Year Post C.out"
"          Licensee name:          A"
"          Company          "
"          Date & Time last used:          7/17/2023 at 11:33:51 AM"
" 31          TIME PARAMETERS"
"          5.000 Time Step"
"          180.000 Max. Storm length"
"          1500.000 Max. Hydrograph"
" 32          STORM Chicago storm"
"          1 Chicago storm"
"          4692.000 Coefficient A"
"          17.437 Constant B"
"          0.956 Exponent C"
"          0.400 Fraction R"
"          180.000 Duration"
"          1.000 Time step multiplier"
"          Maximum intensity          239.793 mm/hr"
"          Total depth          89.960 mm"
"          6 100hyd Hydrograph extension used in this file"
" 33          CATCHMENT 201"
"          1 Triangular SCS"
"          1 Equal length"
"          1 SCS method"
"          201 Building Roof"
"          100.000 % Impervious"
"          0.140 Total Area"
"          15.000 Flow length"
"          1.000 Overland Slope"
"          0.000 Pervious Area"
"          15.000 Pervious length"
"          1.000 Pervious slope"
"          0.140 Impervious Area"
"          15.000 Impervious length"
"          1.000 Impervious slope"
"          0.250 Pervious Manning 'n'"
"          88.000 Pervious SCS Curve No."
"          0.000 Pervious Runoff coefficient"
"          0.100 Pervious Ia/S coefficient"
"          3.464 Pervious Initial abstraction"
"          0.015 Impervious Manning 'n'"
"          98.000 Impervious SCS Curve No."
"          0.923 Impervious Runoff coefficient"
"          0.100 Impervious Ia/S coefficient"
"          0.518 Impervious Initial abstraction"
"          0.081 0.000 0.000 0.000 c.m/sec"

```

```

"          Catchment 201          Pervious Impervious Total Area "
"          Surface Area          0.000 0.140 0.140 hectare"
"          Time of concentration          7.732 1.278 1.278 minutes"
"          Time to Centroid          99.472 85.809 85.809 minutes"
"          Rainfall depth          89.960 89.960 89.960 mm"
"          Rainfall volume          0.00 125.94 125.94 c.m"
"          Rainfall losses          28.430 6.968 6.968 mm"
"          Runoff depth          61.530 82.992 82.992 mm"
"          Runoff volume          0.00 116.19 116.19 c.m"
"          Runoff coefficient          0.000 0.923 0.923 "
"          Maximum flow          0.000 0.081 0.081 c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"          4 Add Runoff "
"          0.081 0.081 0.000 0.000"
" 54          POND DESIGN"
"          0.081 Current peak flow c.m/sec"
"          0.021 Target outflow c.m/sec"
"          116.2 Hydrograph volume c.m"
"          11. Number of stages"
"          0.000 Minimum water level metre"
"          0.150 Maximum water level metre"
"          0.000 Starting water level metre"
"          0 Keep Design Data: 1 = True; 0 = False"
"          Level Discharge Volume"
"          0.000 0.000 0.000"
"          0.01500 0.00090 0.1575"
"          0.03000 0.00180 1.260"
"          0.04500 0.00270 4.253"
"          0.06000 0.00360 10.080"
"          0.07500 0.00450 19.688"
"          0.09000 0.00540 33.878"
"          0.1050 0.00630 49.628"
"          0.1200 0.00720 65.378"
"          0.1350 0.00810 81.128"
"          0.1500 0.00900 96.878"
" 1. ROOFTOP"
"          Roof area Store area Area/drain Drain flow Roof slope"
"          hectare hectare sq.metre L/min/25mm g H:1V"
"          0.140 0.105 300.000 22.500 100.000"
"          Using 4 roofdrains on roofstorage area of 1050. square metre"
"          Peak outflow          0.008 c.m/sec"
"          Maximum level          0.133 metre"
"          Maximum storage          79.005 c.m"
"          Centroidal lag          3.360 hours"
"          0.081 0.081 0.008 0.000 c.m/sec"
" 40          HYDROGRAPH Combine 1"
"          6 Combine "
"          1 Node #"
"          Total Site"
"          Maximum flow          0.008 c.m/sec"

```

"	Hydrograph volume	116.161	c.m"
"	0.081 0.081 0.008 0.008"		
" 40	HYDROGRAPH Start - New Tributary"		
"	2 Start - New Tributary"		
"	0.081 0.000 0.008 0.008"		
" 33	CATCHMENT 202"		
"	1 Triangular SCS"		
"	1 Equal length"		
"	1 SCS method"		
"	202 Controlled Area"		
"	48.100 % Impervious"		
"	0.506 Total Area"		
"	25.000 Flow length"		
"	5.000 Overland Slope"		
"	0.263 Pervious Area"		
"	25.000 Pervious length"		
"	5.000 Pervious slope"		
"	0.243 Impervious Area"		
"	25.000 Impervious length"		
"	5.000 Impervious slope"		
"	0.250 Pervious Manning 'n'"		
"	88.000 Pervious SCS Curve No."		
"	0.680 Pervious Runoff coefficient"		
"	0.100 Pervious Ia/S coefficient"		
"	3.464 Pervious Initial abstraction"		
"	0.015 Impervious Manning 'n'"		
"	98.000 Impervious SCS Curve No."		
"	0.914 Impervious Runoff coefficient"		
"	0.100 Impervious Ia/S coefficient"		
"	0.518 Impervious Initial abstraction"		
"	0.201 0.000 0.008 0.008 c.m/sec"		
"	Catchment 202 Pervious Impervious Total Area "		
"	Surface Area 0.263 0.243 0.506 hectare"		
"	Time of concentration 6.482 1.071 3.482 minutes"		
"	Time to Centroid 97.880 85.569 91.054 minutes"		
"	Rainfall depth 89.960 89.960 89.960 mm"		
"	Rainfall volume 236.25 218.95 455.20 c.m"		
"	Rainfall losses 28.754 7.751 18.651 mm"		
"	Runoff depth 61.206 82.209 71.309 mm"		
"	Runoff volume 160.74 200.09 360.82 c.m"		
"	Runoff coefficient 0.680 0.914 0.793 "		
"	Maximum flow 0.103 0.141 0.201 c.m/sec"		
" 40	HYDROGRAPH Add Runoff "		
"	4 Add Runoff "		
"	0.201 0.201 0.008 0.008"		
" 54	POND DESIGN"		
"	0.201 Current peak flow c.m/sec"		
"	0.021 Target outflow c.m/sec"		
"	360.8 Hydrograph volume c.m"		
"	4. Number of stages"		

"	327.033 Minimum water level metre"		
"	329.950 Maximum water level metre"		
"	327.033 Starting water level metre"		
"	0 Keep Design Data: 1 = True; 0 = False"		
"	Level Discharge Volume"		
"	327.033 0.000 0.000"		
"	329.750 0.1082 130.760"		
"	329.900 0.1113 130.760"		
"	329.950 0.1295 131.200"		
"	1. WEIRS"		
"	Crest Weir Crest Left Right"		
"	elevation coefficie breadth sideslope sideslope"		
"	329.900 0.900 1.000 0.000 0.000"		
"	1. ORIFICES"		
"	Orifice Orifice Orifice Number of"		
"	invert coefficie diameter orifices"		
"	327.033 0.630 0.1750 1.000"		
"	Peak outflow 0.108 c.m/sec"		
"	Maximum level 329.913 metre"		
"	Maximum storage 130.876 c.m"		
"	Centroidal lag 1.853 hours"		
"	0.201 0.201 0.108 0.008 c.m/sec"		
" 40	HYDROGRAPH Combine 1"		
"	6 Combine "		
"	1 Node #"		
"	Total Site"		
"	Maximum flow 0.115 c.m/sec"		
"	Hydrograph volume 476.598 c.m"		
"	0.201 0.201 0.108 0.115"		
" 40	HYDROGRAPH Start - New Tributary"		
"	2 Start - New Tributary"		
"	0.201 0.000 0.108 0.115"		
" 33	CATCHMENT 203"		
"	1 Triangular SCS"		
"	1 Equal length"		
"	1 SCS method"		
"	203 Uncontrolled Area"		
"	54.500 % Impervious"		
"	4.126 Total Area"		
"	23.000 Flow length"		
"	1.500 Overland Slope"		
"	1.877 Pervious Area"		
"	23.000 Pervious length"		
"	1.500 Pervious slope"		
"	2.249 Impervious Area"		
"	23.000 Impervious length"		
"	1.500 Impervious slope"		
"	0.250 Pervious Manning 'n'"		
"	88.000 Pervious SCS Curve No."		
"	0.684 Pervious Runoff coefficient"		

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"      0.100 Pervious Ia/S coefficient"
"      3.464 Pervious Initial abstraction"
"      0.015 Impervious Manning 'n'"
" 98.000 Impervious SCS Curve No."
"      0.926 Impervious Runoff coefficient"
"      0.100 Impervious Ia/S coefficient"
"      0.518 Impervious Initial abstraction"
"      1.618      0.000      0.108      0.115 c.m/sec"
"      Catchment 203      Pervious      Impervious Total Area "
"      Surface Area      1.877      2.249      4.126 hectare"
"      Time of concentration 8.849      1.462      4.279 minutes"
"      Time to Centroid      100.867      86.024      91.684 minutes"
"      Rainfall depth      89.960      89.960      89.960 mm"
"      Rainfall volume      1688.85      2022.90      3711.75 c.m"
"      Rainfall losses      28.454      6.647      16.569 mm"
"      Runoff depth      61.506      83.313      73.391 mm"
"      Runoff volume      1154.68      1873.43      3028.11 c.m"
"      Runoff coefficient      0.684      0.926      0.816 "
"      Maximum flow      0.651      1.289      1.618 c.m/sec"
" 40 HYDROGRAPH Add Runoff "
" 4 Add Runoff "
"      1.618      1.618      0.108      0.115"
" 40 HYDROGRAPH Copy to Outflow"
" 8 Copy to Outflow"
"      1.618      1.618      1.618      0.115"
" 40 HYDROGRAPH Combine 1"
" 6 Combine "
" 1 Node #"
" Total Site"
" Maximum flow      1.707 c.m/sec"
" Hydrograph volume      3504.707 c.m"
"      1.618      1.618      1.618      1.707"
" 40 HYDROGRAPH Confluence 1"
" 7 Confluence "
" 1 Node #"
" Total Site"
" Maximum flow      1.707 c.m/sec"
" Hydrograph volume      3504.707 c.m"
"      1.618      1.707      1.618      0.000"
" 38 START/RE-START TOTALS 1"
" 3 Runoff Totals on EXIT"
" Total Catchment area      4.772 hectare"
" Total Impervious area      2.632 hectare"
" Total % impervious      55.156"
" 19 EXIT"

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