# 177-179 Albert Street

## Functional Servicing Report

**Project Location:**
177-179 Albert Street, Waterloo, ON

**Prepared for:**
Marsi O Inc. Architects
609 Kumpf Drive, Waterloo, ON

**Prepared by:**
MTE Consultants Inc.
520 Bingemans Centre Drive
Kitchener, ON N2B 3X9

October 10, 2024

**MTE File No.:** 55702-100

*Engineers, Scientists, Surveyors.*

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Functional Site Grading and Servicing Plan
MTE Drawing No. C2.1 .....Appended Separately

# 1.0 INTRODUCTION

MTE Consultants Inc. was retained by Masri O Architects to complete a Functional Servicing Report for a new residential development to be constructed at 177-179 Albert Street (herein referred to as 'the Site') in the City of Waterloo in support of the Official Plan Amendment and Zoning By-Law Amendment Application. The current zoning of the site is RMU-81, with exemption C179. A Zoning By-law Amendment is proposed to add new exceptions to the RMU-81 zone, to permit the proposed development.

The property is bounded to the north and to the west by existing residential development, to the east by Albert Street, and to the south by Seagram Drive.

The proposed development for the Site is the construction of a 30-storey residential building complete with a ground commercial space and two levels of underground parking. The construction also includes the demolition of a garage and two residential buildings, with one that acts as an office space.

The purpose of this study is to support the Official Plan Amendment and Zoning By-Law Amendment Applications. This will be accomplished by reviewing the opportunities and constraints for the subject property with respect to servicing, grading, and stormwater management; reviewing the requirements of the reviewing agencies; describing the development concept; and demonstrating the functional serviceability of the property. Pending approval of the Amendment application, detailed design of the site will commence and be submitted to the City in support of Site Plan Approval.

# 2.0 CRITERIA

## 2.1 Existing Topography

The Site encompasses an area of 0.162ha and currently comprises of two separate parcels, both containing single detached dwellings. 177 Albert Street has a 2-storey house with a retaining wall and asphalt parking lot accessed off Seagram Drive. 179 Albert Street consists of a 2.5-storey house, a 1-storey block garage, asphalt driveway and a grass backyard with a few trees. In the existing condition, surface runoff from the Site drains from northeast to southwest. There is an elevation difference of approximately 2.3m between the northeast corner of the Site along Albert Street and the southwest corner of the Site along Seagram Drive. Drainage appears to be directed towards the retaining wall along the western boundary and drains along the base towards Seagram Drive. The site is approximately 39% impervious in the existing condition.

## 2.2 Existing Servicing

### *2.2.1 Water*

There is an existing 150mm diameter municipal watermain along Albert Street. The existing houses are assumed to be connected to the watermain on Albert Street. In addition, there are existing 150mm and 400mm diameter municipal watermains along Seagram Drive. It is assumed that neighbouring properties are connected to the 400mm diameter watermain. The 150mm watermain along Seagram Drive might be abandoned. The closest municipal fire hydrant is located approximately 30m north of the Site along Albert Street.

### 2.2.2 Sanitary

There is an existing 300mm diameter municipal sanitary sewer along Albert Street which drains toward the south. The closest manhole is located approximately 16m south from the Site and is approximately 3.1m deep.

There is an existing 200mm diameter sanitary sewer along Seagram Drive which drains toward the west but does not extend to the site frontage. The closest manhole is located approximately 14m west from the Site and is approximately 2.4m deep.

### 2.2.3 Storm

There is an existing 300mm diameter municipal storm sewer along Seagram Drive that drains towards the west. The closest existing manhole is located 2m east of the Site and is approximately 1.8m deep. Surface runoff from a majority of the Site is conveyed overland to the south of the Site where it enters the Seagram Drive storm sewer.

## 2.3 Existing Soils Information

A geotechnical investigation report dated July 28, 2023, was prepared by Chung & Vander Doelen Engineering Ltd (CVD). Generally, the pavement, topsoil and fill materials were underlain by very loose to compact fine granular deposits. The fine granular deposits were underlain by a very stiff to hard clayey silt till. Within the clayey silt till very dense, saturated sand layers were encountered.

Four boreholes, three with monitoring wells were advanced by Chung and Vander Doelen Engineering (CVD), on June 15, 2023.

Ground water was contracted in all monitoring wells at approximately 3.75-5.22mbgs.

A detailed Geotechnical Report should be completed for the site prior to final design.

## 2.4 Reviewing Agencies

Grading, servicing and stormwater management designs as well as this Functional Servicing and Stormwater Management Report will be required for submission to the City of Waterloo in support of the Official Plan Amendment, the Zoning By-Law Amendment and the Site Plan Applications. The City will also be responsible for the review and approval of site plans, site grading, servicing, stormwater management, lighting and landscape design and ultimately issuing building permits.

# 3.0 METHODOLOGY

Preliminary grading and servicing strategies for the proposed development have been developed based on the topographic survey, plan and profile information, and Conceptual Site Plan prepared by Masri O Inc. Architects, dated September 24, 2024.

## 3.1 Proposed Grading

The proposed development will have a 30-storey mixed-use building, complete with driveway access to ground level and underground parking off Seagram Drive and Albert Street. The proposed grading strategy will respect the existing grades along the north and west property lines and the existing grades along the curbs of Albert Street and Seagram Drive.

## 3.2 Proposed Servicing

### *3.2.1 Water*

A new connection to the existing 150mm diameter municipal watermain along Albert Street will be required to service the proposed building. The required private water service size will be determined during detailed design but will likely be 150mm diameter. The water service will run into the northeast corner of the building. The proposed building will have a sprinkler system. It is anticipated that a fire department connection will be added and located within 45m of the existing municipal fire hydrant located on Albert Street, north of the site and be sufficient for the proposed building.

Preliminary domestic and fire demands for the proposed development were calculated and summarized in the below table. Refer to Appendix A for further details.

**Table 3.1 – Required Demands**

| Scenario | Demand |
|---|---|
| Max Day | 2.92L/s |
| OBC Fire Flow | 9,000L/min |
| FUS Fire Flow | 13,000L/min |

It should be noted that an internal booster pump will likely be specified in the building to achieve appropriate flow and pressure on the upper floors given the proposed height of the building.

The pressure and flow at the existing hydrant must be sufficient for firefighting conditions as established by the Ontario Building Code (2012). The minimum residual pressure under fire fighting conditions is 140kPa (20.3psi) per OBC 2012 A-3.2.5.7 3(b).

Many municipalities in Ontario use both the OBC and the 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 Ontario Building Code.

For this design, information obtained from the hydrant flow test completed by Northern Sprinkler Design on the municipal hydrants located on Albert Street were utilized. Refer to Appendix A for the results of the hydrant flow test.

The residual pressure at the existing municipal hydrant was calculated to be 273kPa for a flow rate of 9,000L/min (150L/s) per OBC fire flow requirements, which is greater than the minimum allowable pressure of 140kPa. The residual pressure at the existing municipal hydrant was calculated to be 188kPa for a flow rate of 13,000L/min (217L/min) per FUS fire flow requirements which is greater than the minimum allowable pressure. Refer to Appendix A for water demand design sheets.

Based on the flow tests provided by Northern Sprinkler Design it can be concluded that the minimum water supply flow rate of 13,000L/min (per FUS calculation) can be delivered to the existing hydrant with a residual pressure (at the nozzle of the hydrant) under firefighting conditions of 188kPa, thus meeting the minimum requirements of the Ontario Building Code (2012) and FUS.

### 3.2.2 Sanitary

A sanitary flow design sheet has been prepared to determine the flows anticipated to be generated by the proposed development. Refer to Appendix B. With the proposed building having 230 units and with a site area of 0.162ha and a commercial area of 0.022ha, the resulting flow is expected to be 5.28L/s from the site.

It is proposed that the Site will be serviced by a new 200mm diameter sanitary sewer complete with new manhole at the municipal sewer on Albert Street. The 200mm diameter sanitary service will enter the Site through the driveway in the northeast corner of the Site. The private sanitary sewer is to be installed at a slope that provides adequate capacity. The service sizes and inverts will be confirmed at detailed design. The sanitary flows for the underground levels will require pumping.

### 3.2.3 Storm

A new manhole will be installed on Seagram Drive to connect to the new 150mm diameter storm service to the municipal storm sewer, entering the Site from the south. Runoff from the roof will be directed to the new storm service. Runoff from the remainder of the Site will flow towards the Albert Street and Seagram Drive rights-of-way. Refer to the storm sewer design sheet in Appendix C.

# 4.0 PRELIMINARY STORMWATER MANAGEMENT DESIGN

## 4.1 SWM Criteria

The stormwater management design criteria for the subject site, as established by the City, are as follows:

i) Attenuation of the post-development peak flows for the 2-, 5-, and 100-year storm event to the pre-development (existing) peak flow.

ii) Implementation of Enhanced (Level 1) water quality controls.

iii) Implementation of Erosion and Sediment Control measures.

## 4.2 Water Quantity Control

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

i) Calculate the allowable runoff rates using MIDUSS NET using the City of Waterloo IDF parameters and three-hour Chicago rainfall distribution.

ii) Determine the percent impervious of the site and catchment parameters for inclusion in MIDUSSS modeling.

iii) Calculate post-development runoff hydrographs using MIDUSS NET.

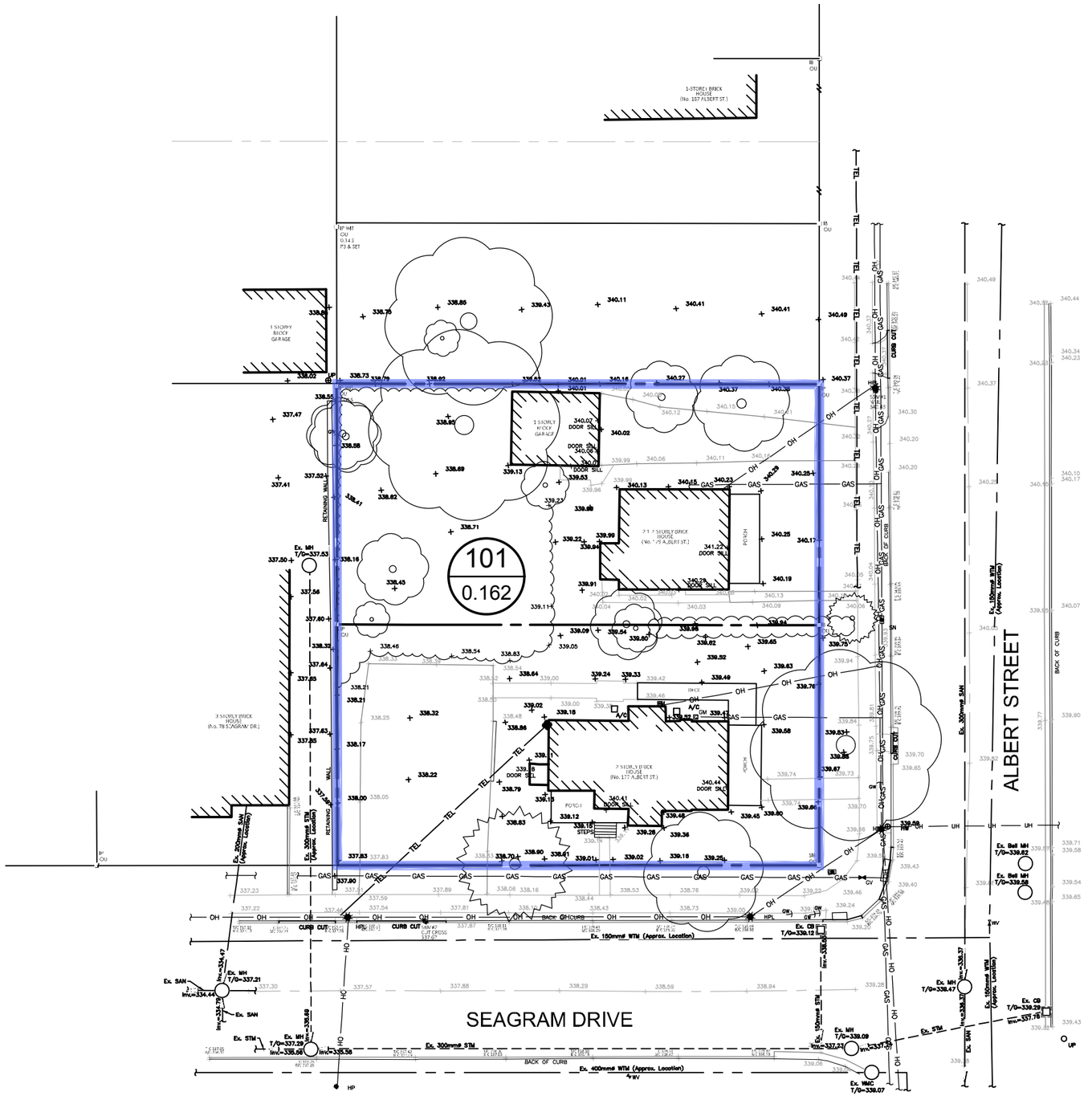
The following table summarizes the catchments used in modeling of the Site. The post-development condition was separated into two catchment areas; the controlled area and the uncontrolled area. Figure 1.0 illustrates the limits of the pre-development catchment area. Figure 2.0 illustrates the limits of the post-development catchment areas.

## Table 4.1 – Catchment Parameters

| # | Catchment | Area (ha) | % Impervious | Pervious CN | Impervious CN | Slope (%) | Flow Length (m) |
|---|---|---|---|---|---|---|---|
| **Pre-Development Catchment Area** | | | | | | | |
| 101 | Site Area | 0.162 | 39 | 75 | 98 | 3.0 | 29.0 |
| **Post-Development Catchment Area** | | | | | | | |
| 201 | Controlled Area | 0.100 | 100 | 75 | 98 | 2.0 | 7.5 |
| 202 | Uncontrolled Area | 0.062 | 50 | 75 | 98 | 5.0 | 14.0 |

Based on the soils found on site, a value of 75 is appropriate for the pervious CN.

CAD: P:\P\55702\100\55702-100-F1.DWG




# LEGEND

CATCHMENT 101

101 / 0.162 — SUB-CATCHMENT NUMBER / AREA (ha.)

0 4 8 12 16 20m

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Engineers, Scientists, Surveyors

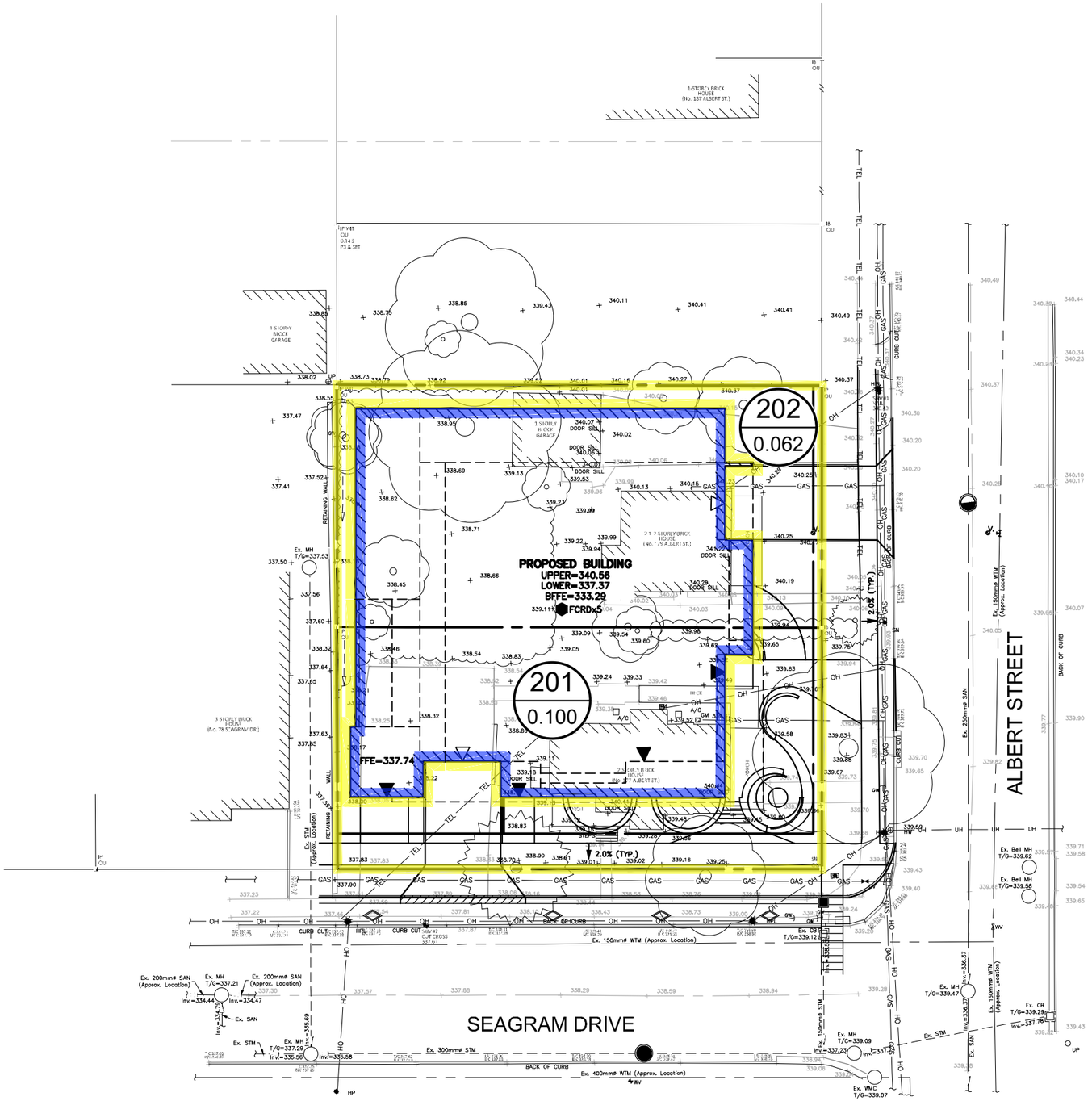
PROJECT
**177-179 ALBERT STREET**

TITLE
**PRE-DEVELOPMENT CATCHMENT AREA**

| | | |
|---|---|---|
| Drawn: BDW | Scale: 1:400 | Figure: **1.0** |
| Checked: CXM | Project No.: 55702-100 | |
| Date: 2024-09-03 | Rev No.: 0 | |

Plot Date: September 3, 2024 – 1:15 PM

CAD: P:\P\55702\100\55702-100-F1.DWG




# LEGEND

CATCHMENT 201

CATCHMENT 202

201 — SUB-CATCHMENT NUMBER

0.103 — AREA (ha.)

0 4 8 12 16 20m

MTE
Engineers, Scientists, Surveyors

PROJECT
**177-179 ALBERT STREET**

TITLE
**POST-DEVELOPMENT CATCHMENT AREAS**

| | | |
|---|---|---|
| Drawn: BDW | Scale: 1:400 | Figure: **2.0** |
| Checked: CXM | Project No.: 55702-100 | |
| Date: 2024-09-03 | Rev No.: 0 | |

Plot Date: October 10, 2024 – 1:02 PM

In order to achieve the stormwater management requirements for the Site, runoff generated from the roof area will be controlled using flow control roof drains. The following table summarizes the expected flows that will be generated by the whole site. Please note that these flows are subject to change at the detailed design stage.

**Table 4.2 – Summary of Flows**

| Modelling Condition | 2-Year Storm Event ($m^3/s$) | 5-Year Storm Event ($m^3/s$) | 100-Year Storm Event ($m^3/s$) |
|---|---|---|---|
| Pre-Development | 0.014 | 0.020 | 0.044 |
| Post-Development | 0.012 | 0.016 | 0.030 |

As summarized in Table 4.2 above, the post-development flow rate for the 2-, 5- and 100-year storm event is controlled to the pre-development flow rate.

The maximum ponding depth on the rooftop is 0.136m during the 100-year storm event. As above, the ponding values are subject to change at detailed design. Refer to Appendix D for the MIDUSS output.

## 4.3 Water Quality Control

The building roofs make up a majority of the Site. Most of the remainder of the Site will be landscaped or for pedestrian use only. Most of the runoff from the Site is considered clean water; therefore, quality controls not proposed. Additionally, the area of paving surfaces for vehicular traffic is significantly reduced in the post-development condition.

## 4.4 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:

i) Erosion and sedimentation facilities are to be installed prior to any area grading operations.

ii) All erosion control measures are to be inspected and monitored by the contractor and repairs are to be completed as required.

iii) 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.

iv) Stripping and strategic placement of topsoil stockpiles. Placement of sediment control fencing around all stockpile areas.

v) Re-vegetation of completed areas as soon as possible after construction, including those areas not slated for construction, within 60 days of rough grading.

vi) To minimize the amount of mud being tracked onto the roadway, a mud mat should be installed at the primary construction entrance.

# 5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the foregoing analysis, it is concluded that:

i) The proposed grading design will respect the natural topography of the site to achieve a reasonable cut/fill balance where possible.

ii) Existing municipal infrastructure for water and sanitary is available along Albert Street and existing municipal infrastructure for storm is available along Seagram Drive.

iii) The SWM quantity criteria can be satisfied with the implementation of flow control roof drains. On-site controls for water quality are not proposed as the majority of the stormwater runoff coming from the Site is considered clean. Additionally, the area of paving surfaces for vehicular traffic is significantly reduced in the post-development condition.

iv) Additional grading, servicing and stormwater management details will be provided during detailed design.

All of which is respectfully submitted,

**MTE Consultants Inc.**

Belle Wilson
I am the author of this document
2024.10.10 17:20:31 -04'00'




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# Appendix A

# Water Demand Sheets

# 177-179 Albert Street

## FIRE FLOW DEMANDS

**City, Ontario**

Project #: 55702-100
Date: September 9, 2024
Date Printed: 10/9/2024
By: BDW

| 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* | $m^2$ | $m^2$ | $m^3$ | | $m^3$ | | *L* | *L/min* | *L/s* | | $m^2$ | *L/min* | | | | *L/min* | *L/s* | *L/s* | *L/s* | *L/s* | *L/s* | *L/s* | *L/s* | *L/s* |
| A | 340.56 | Apartment | 230 | 407 | 916 | 18,478 | 63,634 | 10 | 63,634 | 2.00 | 1,272,676 | 9,000 | 150 | 0.80 | 4,194 | 11,398 | -15% | -30% | 60% | 13,000 | 217 | 217 | 1.060 | 1.060 | 2.915 | 4.378 | 0.424 | 220 |
| | | **TOTALS FOR SITE** | **230** | **407** | **916** | **18478** | **63634** | | | | **Max Fire Flow =** | | **150** | | | | | | **Max Fire Flow =** | | **217** | **217** | **1.06** | **1.06** | **2.92** | **4.38** | **0.42** | **220** |
| | | | | | | | | | | | | | | | | | | | | | | **Sum of Maximum Day Flows + Largest Fire Flow (L/s) =** | | | | | | **220** |

**Assumptions:**

1 All building areas and populations are based on the Site Plan by Masri O Architects. Assumed 1.77 persons per unit as per Region of Waterloo Water and Wastewater Monitoring Report 2017

2 All buildings are classified as occupancy group C (Residential Occupancy)

3 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

4 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 |

NORTHERN SPRINKLER DESIGN

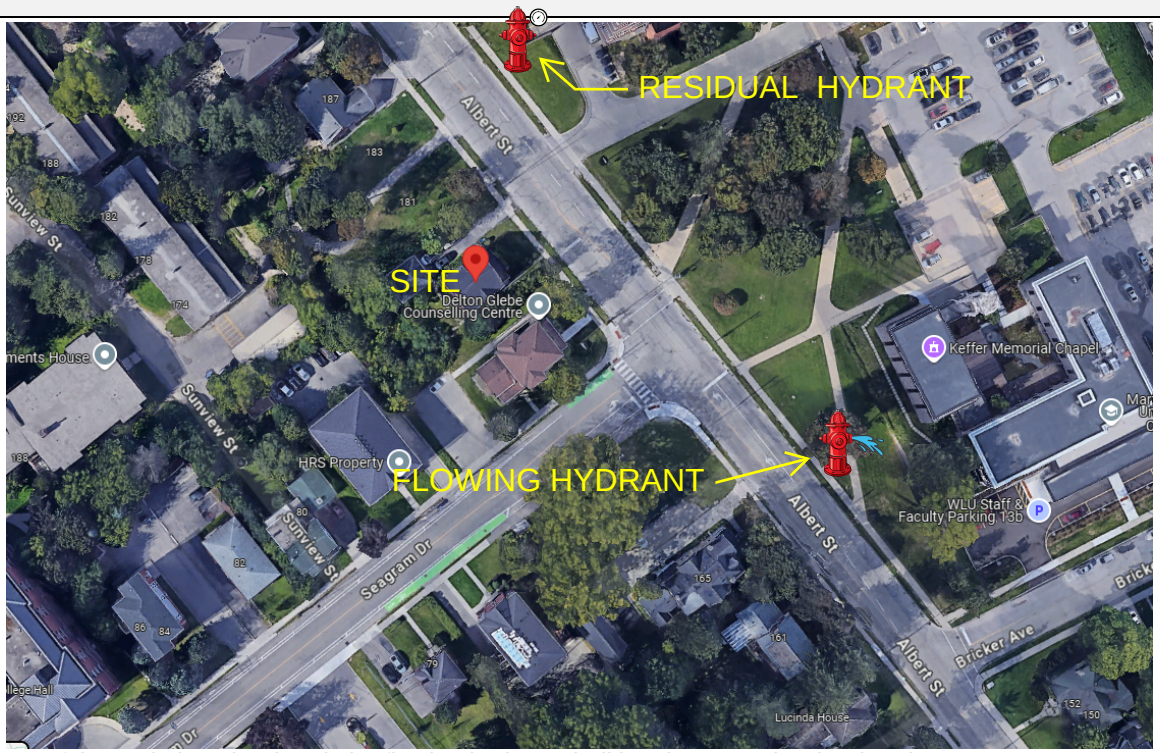
# FLOW TEST REPORT

**Form SD-003A RevDate: Dec 01, 2021**

| PROJECT INFORMATION | | | |
|---|---|---|---|
| Project Name: | 179 Albert Street Flow Test | Design Project #: | 2024-NSD-083 |
| Site Address: | 179 Albert Street Waterloo ON | Const. Project #: | NA |
| City Contact: | Mona | Phone #: | |
| Flow Tester: | **Rob Smith** | Phone #: | **226-376-3053** |
| 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: 150 pvc |
| ☐ Flow Direction (if the main is dead end) | ☐ Site Hydrant(s) | Site: |

### SITE NOTES



445 Colborne St. London, ON N6B 2T2 northernsprinklerdesign.com 1-866-798-1154

NORTHERN SPRINKLER DESIGN

# FLOW TEST REPORT

**Form SD-003A RevDate: Dec 01, 2021**

| TEST INFORMATION | | | |
|---|---|---|---|
| Minimum Required Flow: | NA | Min Ports: | 2 |
| Personnel Present: | Rob Smith | Test Date: | 2024-09-18 |
| City / External Company: | Waterloo Utilities | Test Time: | 10:00am |

| 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 | | | | | 52 |
| 1 Port | 2.5 | 0.9 | 44 | 1,113 | 50 |
| 2 Ports | 2.5 | 0.9 | 31 31 | 1,869 | 44 |
| 3 Ports | 2.5 | 0.9 | | 0 | |
| 4 Ports | 2.5 | 0.9 | | 0 | |
| 0 Ports | **STATIC RE-CHECK** | | | | 52 |

**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: | 0 |
| **OTHER HYDRAULIC ADJUSTMENTS** | | | |
| Other adjustment as required by the City / AHJ: | | | |



445 Colborne St. London, ON N6B 2T2 northernsprinklerdesign.com 1-866-798-1154

# 177-179 ALBERT STREET
## FIRE FLOW ANALYSIS
**Waterloo, ON**

Project Number: 55702-100
Date: September 19, 2024
Design By: CXM
File: Q:\55702\100\FIRE FLOW\55702-100-Site Fire Flow Analysis.xlsx

## CALCULATION OF RESIDUAL PRESSURE

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

| | Metric | | Imperial | | |
|---|---|---|---|---|---|
| P0 - Starting Pressure | 36.57 | *m* | 52 | *psi* | |
| P1 - Pressure at Q1 | 30.94 | *m* | 44 | *psi* | |
| Q1 - From Fire Flow Test | 7075 | *L/min* | 1869 | *U.S. gal/min* | |
| Q2 - Required Flow | 9000 | *L/min* | 2378 | *U.S. gal/min* | From: OBC Demand calculations by MTE |
| P-loss 1 | 5.63 | *m* | 8 | *psi* | |
| P-loss 2 | 8.79 | *m* | 12 | *psi* | |
| **P2 - Residual Pressure** | **27.78** | ***m*** | **40** | ***psi*** | Extrapolated from Fire Flow Test Results |

**ANALYSIS SUMMARY**

| | | | | | |
|---|---|---|---|---|---|
| **Residual Pressure after Losses** | **27.78** | **m** | | | |
| | **273** | **kPa** | **39.5** | **psi** | **PASS** |
| *Allowable Residual Pressure* | *140* | *kPa* | *20.3* | *psi* | |

# 177--179 ALBERT STREET

## FIRE FLOW ANALYSIS

**Waterloo, ON**

Project Number: 55702-100
Date: September 19, 2024
Design By: CXM
File: Q:\55702\100\FIRE FLOW\55702-100-Site Fire Flow Analysis.xlsx

## CALCULATION OF RESIDUAL PRESSURE

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

| | Metric | | Imperial | | |
|---|---|---|---|---|---|
| P0 - Starting Pressure | 36.57 | *m* | 52 | *psi* | |
| P1 - Pressure at Q1 | 30.94 | *m* | 44 | *psi* | |
| Q1 - From Fire Flow Test | 7075 | *L/min* | 1869 | *U.S. gal/min* | |
| Q2 - Required Flow | 13000 | *L/min* | 3434 | *U.S. gal/min* | From: FUS Demand calculations by MTE |
| P-loss 1 | 5.63 | *m* | 8 | *psi* | |
| P-loss 2 | 17.36 | *m* | 25 | *psi* | |
| **P2 - Residual Pressure** | **19.21** | ***m*** | **27** | ***psi*** | Extrapolated from Fire Flow Test Results |

**ANALYSIS SUMMARY**

| | | | | | |
|---|---|---|---|---|---|
| **Residual Pressure after Losses** | **19.21** | **m** | | | |
| | **188** | **kPa** | **27.3** | **psi** | **PASS** |
| *Allowable Residual Pressure* | *140* | *kPa* | *20.3* | *psi* | |

# Appendix B

# Sanitary Sewer Design Sheet

**177-179 Albert Street**
**CITY OF WATERLOO**

# SANITARY SEWER DESIGN SHEET

**ENGINEERING AND PUBLIC WORKS**

Project Numbe 55702-100
Date: October 9, 2024
Design By: BDW
Checked By: CXM
File: Q:\55702\100\Sanitary Sewer Design Sheet 08_15_2024.xls

Drainage Area Plan No: xxxx-xxxx

**Design Parameters**

**Average Daily Flow**

| | | |
|---|---|---|
| Residential | 0.00318 | L/s/c |
| Commercial | 0.95 | L/s/ha |
| Industrial | 0.40 | L/s/ha |
| Inst. / School | 0.25 | L/s/ha |

| | | |
|---|---|---|
| Mannings "*n*" | 0.013 | |
| Min. Velocity | 0.6 | m/sec |
| Max. Velocity | 3.0 | m/sec |

Residential Harmon Peaking Factor (F) $F = 1 + 14/(4 + P^{0.5})$
Commercial Peaking Factor = 2.5
Residential Areas Infiltration 0.25 L/s/ha

| LOCATION | | | | RESIDENTIAL AREAS AND POPULATION | | | | | | SCHOOL, INSTITUTIONAL | | | COMMERCIAL | | | INDUSTRIAL | | | | INFILTRATION | | | DESIGN | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | HECTARES AND FLOW OF EACH ZONING | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | 0.25 *L/s/ha* | | | 0.95 *L/s/ha* | | | 0.40 *L/s/ha* | | | | | | | | | | | | |
| STREET | AREA NO. | MANHOLE LOCATION FROM MH | MANHOLE LOCATION TO MH | AREA | No. UNITS @ 1.76 PPU | No. UNITS @ 2.18 PPU | POPUL. | CUMUL POPUL. | PEAK FACTOR "F" | PEAK RES. FLOW | AREA | CUMUL AREA | PEAK FLOW | AREA | CUMUL AREA | PEAK FLOW | AREA | CUMUL AREA | PEAK FLOW | TOTALS-C-I FLOW | AREA | CUMUL AREA | INFIL FLOW | TOTAL VOLUME FLOW | LENGTH | SLOPE | PIPE SIZE | CAPACITY | FULL FLOW VELOCITY |
| | | | | *ha* | | | *1000s* | *1000s* | | *L/sec* | *ha* | *ha* | *L/sec* | *ha* | *ha* | *L/sec* | *ha* | *ha* | *L/sec* | *L/sec* | *ha* | *ha* | *L/sec* | *L/sec* | *m* | *%* | *mm* | *L/sec.* | *m/s* |
| Albert Street | 1 | bldg | 1A | 0.162 | 230.00 | | 0.405 | 0.405 | 4.019689 | 5.1791 | 0.00 | 0.00 | 0.0000 | 0.02 | 0.02 | 0.0523 | 0.00 | 0.00 | 0.0000 | 0.0523 | 0.18 | 0.18 | 0.0460 | 5.2773 | 20.1 | 2.00 | 200 | 46.3604 | 1.476 |

# Appendix C

# Storm Sewer Design Sheet

**177-179 Albert Street**

**CITY OF WATERLOO**

# STORM SEWER DESIGN SHEET

**ENGINEERING AND PUBLIC WORKS**

Project Number: 55702-100
Date: September 12, 2024
Design By: BDW
Checked By: CXM
File: Q:\55702\100\Storm Sewer Design Sheet 08_15_2024.xlsx

Drainage Area Plan No: xxxx-xxxx

**Design Parameters**

**5 YEAR STORM**

Q=kAIR, k=0.00277
Intensity (I) = a/(tc+b)$^c$
a = 1755
b = 12.347
c = 0.895

Manning's "n" 0.013
Min. Velocity 0.600 m/s
Max. Velocity 6.000 m/s

| LOCATION | | | | STORMWATER FLOW 5 YEAR STORM | | | | | | | | DESIGN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREET | AREA NUMBER | MANHOLE LOCATION FROM MH | MANHOLE LOCATION TO MH | AREA (A) | RUNOFF COEFF. (C) | A x C | CUMUL. A x C | CONCENTRATION TIME TOTAL | CONCENTRATION TIME IN PIPE | RAIN INTENSITY (I) | FLOW (Q) | PIPE SIZE | LENGTH | SLOPE | CAPACITY | FULL FLOW VELOCITY | PIPE FULL |
| | | | | *ha* | | *ha* | *ha* | *min* | *min* | *mm/hr* | *L/s* | *mm* | *m* | *%* | *L/s* | *m/s* | *%* |
| Seagram Drive | 1 | BLDG | 1 | 0.103 | 0.90 | 0.0927 | 0.0927 | 10.0000 | 0.3116 | 108.82431 | 8.00000 | 150 | 21.1 | 2.00 | 21.53765 | 1.2188 | 37.14 |

*Note: Flow was taken from MIDUSS 5 year output for controlled flows

# Appendix D

# MIDUSS Outputs

# 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:\55702\100"
"                Output filename:                                   2yr pre.out"
"                Licensee name:                                               A"
"                Company                                                       "
"                Date & Time last used:                 8/22/2024 at 2:24:49 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     1101.000   Coefficient A"
"        9.258   Constant B"
"        0.882   Exponent C"
"        0.400   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity          105.659    mm/hr"
"             Total depth                 32.400    mm"
"            6   002hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 101"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          101   Total Site"
"       39.000   % Impervious"
"        0.162   Total Area"
"       29.000   Flow length"
"        3.000   Overland Slope"
"        0.099   Pervious Area"
"       29.000   Pervious length"
"        3.000   Pervious slope"
"        0.063   Impervious Area"
"       29.000   Impervious length"
"        3.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.163   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.836   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.014     0.000     0.000     0.000 c.m/sec"
"             Catchment 101          Pervious   Impervious Total Area "
```

```
"             Surface Area           0.099      0.063      0.162      hectare"
"             Time of concentration  24.302     1.949      7.166      minutes"
"             Time to Centroid       128.567    89.195     98.385     minutes"
"             Rainfall depth         32.400     32.400     32.400     mm"
"             Rainfall volume        32.02      20.47      52.49      c.m"
"             Rainfall losses        27.129     5.323      18.625     mm"
"             Runoff depth           5.271      27.077     13.775     mm"
"             Runoff volume          5.21       17.11      22.32      c.m"
"             Runoff coefficient     0.163      0.836      0.425      "
"             Maximum flow           0.002      0.014      0.014      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.014     0.014     0.000     0.000"
" 38          START/RE-START TOTALS 101"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                      0.162    hectare"
"             Total Impervious area                     0.063    hectare"
"             Total % impervious                       39.000"
" 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:\55702\100"
"                Output filename:                                 5yr pre a.out"
"                Licensee name:                                               A"
"                Company                                                       "
"                Date & Time last used:                 8/22/2024 at 2:12:25 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   Total Site"
"       39.000   % Impervious"
"        0.162   Total Area"
"       29.000   Flow length"
"        3.000   Overland Slope"
"        0.099   Pervious Area"
"       29.000   Pervious length"
"        3.000   Pervious slope"
"        0.063   Impervious Area"
"       29.000   Impervious length"
"        3.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.259   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   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"
"                     0.020     0.000     0.000     0.000 c.m/sec"
"             Catchment 101          Pervious   Impervious Total Area "
```

```
"             Surface Area           0.099      0.063      0.162      hectare"
"             Time of concentration  16.686     1.732      6.452      minutes"
"             Time to Centroid       118.249    88.228     97.703     minutes"
"             Rainfall depth         47.549     47.549     47.549     mm"
"             Rainfall volume        46.99      30.04      77.03      c.m"
"             Rainfall losses        35.222     5.743      23.725     mm"
"             Runoff depth           12.327     41.806     23.824     mm"
"             Runoff volume          12.18      26.41      38.59      c.m"
"             Runoff coefficient     0.259      0.879      0.501      "
"             Maximum flow           0.005      0.019      0.020      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.020     0.020     0.000     0.000"
" 38          START/RE-START TOTALS 101"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                      0.162    hectare"
"             Total Impervious area                     0.063    hectare"
"             Total % impervious                       39.000"
" 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:\55702\100"
"                Output filename:                                 100yr pre.out"
"                Licensee name:                                               A"
"                Company                                                       "
"                Date & Time last used:                8/21/2024 at 1:11:49 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   Total Site"
"       39.000   % Impervious"
"        0.162   Total Area"
"       29.000   Flow length"
"        3.000   Overland Slope"
"        0.099   Pervious Area"
"       29.000   Pervious length"
"        3.000   Pervious slope"
"        0.063   Impervious Area"
"       29.000   Impervious length"
"        3.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.442   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.924   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.044     0.000     0.000     0.000 c.m/sec"
"             Catchment 101          Pervious   Impervious Total Area "
```

```
"             Surface Area           0.099      0.063      0.162      hectare"
"             Time of concentration  10.135     1.365      5.118      minutes"
"             Time to Centroid       105.872    85.902     94.446     minutes"
"             Rainfall depth         89.960     89.960     89.960     mm"
"             Rainfall volume        88.90      56.84      145.74     c.m"
"             Rainfall losses        50.195     6.795      33.269     mm"
"             Runoff depth           39.765     83.165     56.691     mm"
"             Runoff volume          39.30      52.54      91.84      c.m"
"             Runoff coefficient     0.442      0.924      0.630      "
"             Maximum flow           0.020      0.036      0.044      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.044     0.044     0.000     0.000"
" 38          START/RE-START TOTALS 101"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                      0.162    hectare"
"             Total Impervious area                     0.063    hectare"
"             Total % impervious                       39.000"
" 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:\55702\100"
"                Output filename:                              2YR - POSTb-L.out"
"                Licensee name:                                              A"
"                Company                                                      "
"                Date & Time last used:                10/10/2024 at 1:18:44 PM"
" 31          TIME PARAMETERS"
"        5.000   Time Step"
"      180.000   Max. Storm length"
"     1500.000   Max. Hydrograph"
" 32          STORM Chicago storm"
"            1   Chicago storm"
"     1101.000   Coefficient A"
"        9.258   Constant B"
"        0.882   Exponent C"
"        0.400   Fraction R"
"      180.000   Duration"
"        1.000   Time step multiplier"
"             Maximum intensity           105.659    mm/hr"
"             Total depth                  32.400    mm"
"            6   002hyd   Hydrograph extension used in this file"
" 33          CATCHMENT 201"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          201   Roof"
"      100.000   % Impervious"
"        0.100   Total Area"
"        7.500   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"        7.500   Pervious length"
"        2.000   Pervious slope"
"        0.100   Impervious Area"
"        7.500   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.000   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.816   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.023     0.000     0.000     0.000 c.m/sec"
"             Catchment 201          Pervious   Impervious Total Area "
```

```
"             Surface Area           0.000      0.100      0.100      hectare"
"             Time of concentration  12.192     0.978      0.978      minutes"
"             Time to Centroid       114.375    87.837     87.837     minutes"
"             Rainfall depth         32.400     32.400     32.400     mm"
"             Rainfall volume        0.00       32.40      32.40      c.m"
"             Rainfall losses        27.140     5.951      5.951      mm"
"             Runoff depth           5.260      26.449     26.449     mm"
"             Runoff volume          0.00       26.45      26.45      c.m"
"             Runoff coefficient     0.000      0.816      0.816      "
"             Maximum flow           0.000      0.023      0.023      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                    0.023     0.023     0.000     0.000"
" 54          POND DESIGN"
"         0.023   Current peak flow    c.m/sec"
"         0.014   Target outflow    c.m/sec"
"          26.4   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   0.00112   0.05607"
"                 0.03000   0.00225    0.4485"
"                 0.04500   0.00338     1.514"
"                 0.06000   0.00450     3.588"
"                 0.07500   0.00563     7.008"
"                 0.09000   0.00675    12.111"
"                  0.1050   0.00788    19.231"
"                  0.1200   0.00900    28.707"
"                  0.1350   0.01013    39.883"
"                  0.1500   0.01125    51.097"
"            1.   ROOFTOP"
"                 Roof area  Store area  Area/drain  Drain flow  Roof slope"
"                   hectare     hectare    sq.metre  L/min/25mm      g H:1V"
"                     0.100       0.075     150.000      22.500      50.000"
"               Using 5 roofdrains on roofstorage area of 748. square metre"
"               Peak outflow                  0.006    c.m/sec"
"               Maximum level                 0.085    metre"
"               Maximum storage              10.270    c.m"
"               Centroidal lag                1.741   hours"
"                    0.023     0.023     0.006     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total Site"
"               Maximum flow                  0.006    c.m/sec"
"               Hydrograph volume            26.422    c.m"
"                       0.023     0.023     0.006     0.006"
```

```
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.023     0.000     0.006     0.006"
" 33          CATCHMENT 202"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          202   Uncontrolled"
"       50.000   % Impervious"
"        0.062   Total Area"
"       14.000   Flow length"
"        5.000   Overland Slope"
"        0.031   Pervious Area"
"       14.000   Pervious length"
"        5.000   Pervious slope"
"        0.031   Impervious Area"
"       14.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.162   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.822   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.007     0.000     0.006     0.006 c.m/sec"
"             Catchment 202          Pervious   Impervious Total Area "
"             Surface Area           0.031      0.031      0.062      hectare"
"             Time of concentration  13.469     1.080      3.122      minutes"
"             Time to Centroid       115.906    87.990     92.591     minutes"
"             Rainfall depth         32.400     32.400     32.400     mm"
"             Rainfall volume        10.04      10.04      20.09      c.m"
"             Rainfall losses        27.142     5.757      16.450     mm"
"             Runoff depth           5.258      26.643     15.950     mm"
"             Runoff volume          1.63       8.26       9.89       c.m"
"             Runoff coefficient     0.162      0.822      0.492      "
"             Maximum flow           0.001      0.007      0.007      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.007     0.007     0.006     0.006"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.007     0.007     0.007     0.006"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total Site"
"             Maximum flow                 0.012    c.m/sec"
```

```
"             Hydrograph volume            36.312    c.m"
"                     0.007     0.007     0.007     0.012"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Total Site"
"             Maximum flow                  0.012    c.m/sec"
"             Hydrograph volume            36.312    c.m"
"                     0.007     0.012     0.007     0.000"
" 38          START/RE-START TOTALS 1"
"            3   Runoff Totals on EXIT"
"             Total Catchment area                      0.162    hectare"
"             Total Impervious area                     0.131    hectare"
"             Total % impervious                       80.864"
" 19          EXIT"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                        Sunday, February 7, 2010"
"            0   Units used:                                        ie IMPERIAL"
"                Job folder:                                      Q:\55702\100"
"                Output filename:                                5YR-POSTB.Out"
"                Licensee name:                                              A"
"                Company                                                      "
"                Date & Time last used:                                       "
" 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   Roof"
"      100.000   % Impervious"
"        0.100   Total Area"
"        7.500   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"        7.500   Pervious length"
"        2.000   Pervious slope"
"        0.100   Impervious Area"
"        7.500   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.000   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.852   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.032     0.000     0.000     0.000 c.m/sec"
"             Catchment 201          Pervious   Impervious Total Area "
```

```
"             Surface Area           0.000      0.100      0.100      hectare"
"             Time of concentration  8.371      0.869      0.869      minutes"
"             Time to Centroid       108.068    87.072     87.072     minutes"
"             Rainfall depth         47.549     47.549     47.549     mm"
"             Rainfall volume        0.00       47.55      47.55      c.m"
"             Rainfall losses        35.238     7.061      7.061      mm"
"             Runoff depth           12.311     40.488     40.488     mm"
"             Runoff volume          0.00       40.49      40.49      c.m"
"             Runoff coefficient     0.000      0.852      0.852      "
"             Maximum flow           0.000      0.032      0.032      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.032     0.032     0.000     0.000"
" 54          POND DESIGN"
"         0.032   Current peak flow    c.m/sec"
"         0.014   Target outflow    c.m/sec"
"          40.5   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   0.00112   0.05607"
"                  0.03000   0.00225    0.4485"
"                  0.04500   0.00338     1.514"
"                  0.06000   0.00450     3.588"
"                  0.07500   0.00563     7.008"
"                  0.09000   0.00675    12.111"
"                   0.1050   0.00788    19.231"
"                   0.1200   0.00900    28.707"
"                   0.1350   0.01013    39.883"
"                   0.1500   0.01125    51.097"
"            1.   ROOFTOP"
"                 Roof area  Store area  Area/drain  Drain flow  Roof slope"
"                   hectare     hectare    sq.metre  L/min/25mm      g H:1V"
"                     0.100       0.075     150.000      22.500      50.000"
"               Using 5 roofdrains on roofstorage area of 748. square metre"
"               Peak outflow                  0.008    c.m/sec"
"               Maximum level                 0.101    metre"
"               Maximum storage              17.136    c.m"
"               Centroidal lag                1.855   hours"
"                    0.032     0.032     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            40.504    c.m"
"                       0.032     0.032     0.008     0.008"
```

```
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.032     0.000     0.008     0.008"
" 33          CATCHMENT 202"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          202   Uncontrolled"
"       50.000   % Impervious"
"        0.062   Total Area"
"       14.000   Flow length"
"        5.000   Overland Slope"
"        0.031   Pervious Area"
"       14.000   Pervious length"
"        5.000   Pervious slope"
"        0.031   Impervious Area"
"       14.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.258   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.859   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.010     0.000     0.008     0.008 c.m/sec"
"             Catchment 202          Pervious   Impervious Total Area "
"             Surface Area           0.031      0.031      0.062      hectare"
"             Time of concentration  9.248      0.960      2.875      minutes"
"             Time to Centroid       109.179    87.178     92.262     minutes"
"             Rainfall depth         47.549     47.549     47.549     mm"
"             Rainfall volume        14.74      14.74      29.48      c.m"
"             Rainfall losses        35.277     6.716      20.996     mm"
"             Runoff depth           12.272     40.834     26.553     mm"
"             Runoff volume          3.80       12.66      16.46      c.m"
"             Runoff coefficient     0.258      0.859      0.558      "
"             Maximum flow           0.002      0.010      0.010      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.010     0.010     0.008     0.008"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.010     0.010     0.010     0.008"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total Site"
"             Maximum flow                 0.016    c.m/sec"
```

```
"             Hydrograph volume            56.967    c.m"
"                     0.010     0.010     0.010     0.016"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Total Site"
"             Maximum flow                  0.016    c.m/sec"
"             Hydrograph volume            56.967    c.m"
"                     0.010     0.016     0.010     0.000"
```

```
"                MIDUSS Output ----------------------------------------------->"
"                MIDUSS version                          Version 2.25  rev. 473"
"                MIDUSS created                        Sunday, February 7, 2010"
"           10   Units used:                                          ie METRIC"
"                Job folder:                                      Q:\55702\100"
"                Output filename:                               100yr POSTB.out"
"                Licensee name:                                              A"
"                Company                                                      "
"                Date & Time last used:                10/10/2024 at 1:25:48 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 201"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          201   Roof"
"      100.000   % Impervious"
"        0.100   Total Area"
"        7.500   Flow length"
"        2.000   Overland Slope"
"        0.000   Pervious Area"
"        7.500   Pervious length"
"        2.000   Pervious slope"
"        0.100   Impervious Area"
"        7.500   Impervious length"
"        2.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.000   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.875   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.057     0.000     0.000     0.000 c.m/sec"
"             Catchment 201          Pervious   Impervious Total Area "
```

```
"             Surface Area           0.000      0.100      0.100      hectare"
"             Time of concentration  5.085      0.685      0.685      minutes"
"             Time to Centroid       99.564     85.208     85.208     minutes"
"             Rainfall depth         89.960     89.960     89.960     mm"
"             Rainfall volume        0.00       89.96      89.96      c.m"
"             Rainfall losses        50.240     11.221     11.221     mm"
"             Runoff depth           39.720     78.739     78.739     mm"
"             Runoff volume          0.00       78.74      78.74      c.m"
"             Runoff coefficient     0.000      0.875      0.875      "
"             Maximum flow           0.000      0.057      0.057      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.057     0.057     0.000     0.000"
" 54          POND DESIGN"
"         0.057   Current peak flow    c.m/sec"
"         0.014   Target outflow    c.m/sec"
"          78.7   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   0.00112   0.05607"
"                  0.03000   0.00225    0.4485"
"                  0.04500   0.00338     1.514"
"                  0.06000   0.00450     3.588"
"                  0.07500   0.00563     7.008"
"                  0.09000   0.00675    12.111"
"                   0.1050   0.00788    19.231"
"                   0.1200   0.00900    28.707"
"                   0.1350   0.01013    39.883"
"                   0.1500   0.01125    51.097"
"            1.   ROOFTOP"
"                 Roof area  Store area  Area/drain  Drain flow  Roof slope"
"                   hectare     hectare    sq.metre  L/min/25mm      g H:1V"
"                     0.100       0.075     150.000      22.500      50.000"
"               Using 5 roofdrains on roofstorage area of 748. square metre"
"               Peak outflow                  0.010    c.m/sec"
"               Maximum level                 0.136    metre"
"               Maximum storage              40.451    c.m"
"               Centroidal lag                2.158   hours"
"                    0.057     0.057     0.010     0.000 c.m/sec"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total Site"
"               Maximum flow                  0.010    c.m/sec"
"               Hydrograph volume            78.710    c.m"
"                       0.057     0.057     0.010     0.010"
```

```
" 40          HYDROGRAPH Start - New Tributary"
"            2   Start - New Tributary"
"                     0.057     0.000     0.010     0.010"
" 33          CATCHMENT 202"
"            1   Triangular SCS"
"            1   Equal length"
"            1   SCS method"
"          202   Uncontrolled"
"       50.000   % Impervious"
"        0.062   Total Area"
"       14.000   Flow length"
"        5.000   Overland Slope"
"        0.031   Pervious Area"
"       14.000   Pervious length"
"        5.000   Pervious slope"
"        0.031   Impervious Area"
"       14.000   Impervious length"
"        5.000   Impervious slope"
"        0.250   Pervious Manning 'n'"
"       75.000   Pervious SCS Curve No."
"        0.441   Pervious Runoff coefficient"
"        0.100   Pervious Ia/S coefficient"
"        8.467   Pervious Initial abstraction"
"        0.015   Impervious Manning 'n'"
"       98.000   Impervious SCS Curve No."
"        0.885   Impervious Runoff coefficient"
"        0.100   Impervious Ia/S coefficient"
"        0.518   Impervious Initial abstraction"
"                     0.022     0.000     0.010     0.010 c.m/sec"
"             Catchment 202          Pervious   Impervious Total Area "
"             Surface Area           0.031      0.031      0.062      hectare"
"             Time of concentration  5.617      0.757      2.374      minutes"
"             Time to Centroid       100.233    85.214     90.210     minutes"
"             Rainfall depth         89.960     89.960     89.960     mm"
"             Rainfall volume        27.89      27.89      55.78      c.m"
"             Rainfall losses        50.257     10.319     30.288     mm"
"             Runoff depth           39.703     79.641     59.672     mm"
"             Runoff volume          12.31      24.69      37.00      c.m"
"             Runoff coefficient     0.441      0.885      0.663      "
"             Maximum flow           0.007      0.018      0.022      c.m/sec"
" 40          HYDROGRAPH Add Runoff "
"            4   Add Runoff "
"                     0.022     0.022     0.010     0.010"
" 40          HYDROGRAPH Copy to Outflow"
"            8   Copy to Outflow"
"                     0.022     0.022     0.022     0.010"
" 40          HYDROGRAPH   Combine    1"
"            6   Combine "
"            1   Node #"
"                Total Site"
"             Maximum flow                 0.030    c.m/sec"
```

```
"             Hydrograph volume           115.706    c.m"
"                     0.022     0.022     0.022     0.030"
" 40          HYDROGRAPH   Confluence    1"
"            7   Confluence "
"            1   Node #"
"                Total Site"
"             Maximum flow                  0.030    c.m/sec"
"             Hydrograph volume           115.706    c.m"
"                     0.022     0.030     0.022     0.000"
```