

**EXISTING THREE-STOREY MULTI-UNIT  
RESIDENTIAL BUILDING  
RENOVATIONS  
246 WESTHAVEN CRESCENT  
CITY OF OTTAWA**

**SERVICEABILITY BRIEF**

**REPORT No. R-823-124**

**T. L. MAK ENGINEERING CONSULTANTS LTD.**

**MARCH 2024**

**REF. FILE No. 823-124**

## **1.) INTRODUCTION**

The owner of the said residential property is proposing to renovate the existing 3-unit three-storey apartment building consisting of (2) [3-bedroom + office] units and (1) [2-bedroom + office] units and convert it to a 6-unit multi-unit building. Application to the City of Ottawa for residential re-zoning from R3R to R4UC is being made for further development of this site.

From the City of Ottawa's recent review comments, one of the requirements to complete this application is a serviceability brief and in particular for providing the water demands for the site (Avg. Day, Max. Day, Peak Hour and Fire Flow).

The existing residential building at 246 Westhaven Crescent is a three-storey slab on grade low-rise building. This existing building is to be re-configured to house a total of 6 apartment units consisting of two (2) 3-bedrooms, one (1) 2-bedrooms, two (2) 1-bedroom and one (1) bachelor unit. Each floor covers an area of approximately 292.0 m<sup>2</sup> for a gross floor area of 879.0 m<sup>2</sup>.

T.L. Mak Engineering Consultants Ltd. has been retained to prepare a "Serviceability Brief" for this site as a supplement to the re-zoning application process for the proposed re-development at this property.

## **2.) EXISTING SITE CONDITIONS AND SERVICING**

Presently, a three-storey low-rise residential building occupies the site. For details of the site's pre-restructuring conditions, refer to the Google image (2020) and aerial photography from (GeoOttawa 2022) in Appendix A.

Presently, the existing (3) residential units at this residential building is serviced by a 38mm dia. copper water service pipe which is connected to the existing City watermain system at Westhaven Crescent. The building's existing 150mm dia. PVC sanitary lateral is currently discharging and outletting to the City's 225mm dia. sanitary sewer. Because this is a slab on-grade building, there are no weeping tiles in placed for this building and therefore, no storm lateral was required by the developer and his Architects under the regulations of the Ontario Building Code in 2015.

As for the availability of underground municipal services, there are existing municipal services along Westhaven Crescent in front of this property consisting of a 225mm dia. concrete sanitary sewer and a 150mm dia. U.C.I. watermain for any re-development of this property.

Existing grading and drainage of the lot is primarily sloped from a back to front (west to east) direction. Refer to the approved lot grading plan (Dwg. 815-53, G-1 Rev. No. 2) attached in Appendix B for additional details.

Currently, there exists an asphalt driveway and a parking area located at the front of the building that will be re-configured with soft landscaping material to be placed north of the existing parking area in order to reduce the amount of asphalt area at the front of the building.



### 3.) POTABLE WATER

From discussions with the owner and the owner’s architects, the existing building will not have a sprinkler system. Our analysis will be based on a non-sprinklered building.

The building located within Pressure Zone 1W at 246 Westhaven Crescent is a 3-storey multi-unit residential building with no basement. The building contains six (6) total units, namely two (2) 3-bedroom, one (1) 2-bedroom, two (2) 1-bedroom and one (1) bachelor unit.

Each floor covers an area of around 292.0 m<sup>2</sup>, for a gross floor area of 879.0 m<sup>2</sup>. The building is to be serviced by the 150 mm diameter watermain along Westhaven Crescent. The ground elevation along Westhaven Crescent is approximately 79.4 m.

#### 3a.) DEMAND PROJECTIONS

The domestic demands were calculated using the City of Ottawa’s Water Design Guidelines, where the residential consumption rate of 280 L/cap/d was used to estimate average day demands (AVDY). Persons per unit (PPU) for each unit were estimated based on the City of Ottawa’s Water Design Guidelines.

Following discussions with the City, peaking factors are to be estimated from Table 3-3 of the MECP Design Guidelines for Drinking-Water Systems, given that the proposed development population is less than 500 people. Maximum day (MXDY) demands were calculated by multiplying AVDY demands by a factor of 9.5. Peak hour (PKHR) demands were calculated by multiplying AVDY by a factor of 14.3. **Table 1** shows the estimated domestic demands of the proposed building.

**Table 1: Estimated Domestic Demand**

Unit Type	Unit Count	PPU	Consumption	AVDY		MXDY		PKHR	
				L/d	L/s	L/d	L/s	L/d	L/s
Apartment, 3-Bedroom	2	3.1	280	1,736	0.02	16,492	0.19	24,825	0.29
Apartment, 2-Bedroom	1	2.1		588	0.01	5,586	0.06	8,408	0.10
Apartment, 1-Bedroom	2	1.4		784	0.01	7,448	0.09	11,211	0.13
Apartment, Bachelor	1	1.4		392	0.00	3,724	0.04	5,606	0.06
<b>Total</b>	<b>6</b>			<b>3,500</b>	<b>0.04</b>	<b>33,250</b>	<b>0.38</b>	<b>50,050</b>	<b>0.58</b>

The City had previously indicated that the City’s Fire Marshall and various City departments are currently reviewing fire flow requirements for low- and mid-rise buildings. As per the City of Ottawa’s Water Design Guidelines, the FUS method is to be used for fire flow requirements affecting watermain sizing; with regards to fire protection on private property and not requiring new watermains, these are covered by the Ontario Building Code (OBC). As such, the fire flow requirement was calculated using the OBC’s Office of the Fire Marshal (OFM) method.

The proposed building will be of wood frame construction, where floors are fire separations, but without fire-resistance ratings. It is understood that the building won’t be equipped with



sprinklers. The Resulting required fire flow is 4,500 L/min (75 L/s) for a duration Of 40 minutes. Details are provided in the attached **Fire Flow Calculations** in Appendix C. Furthermore, **Figure 1** attached in Appendix C provides separation distances from the street for the OFM calculations. The Proposed **Site Plan** attached in Appendix C was used to determine distances from the proposed building to the property lines.

In summary, the estimated water demands for the updated building are as follows:

- AVDY = 3,500 L/d (0.04 L/s);
- MXDY = 33,250 L/d (0.38 L/s);
- PKHR = 50,050 L/d (0.58 L/s); and
- Fire Flow = 4,500 L/min (75 L/s).

### 3b.) BOUNDARY CONDITIONS

The hydraulic gradeline (HGL) boundary conditions for 246 Westhaven Crescent, as presented in **Table 2**, were provided by the City on February 29, 2024 (see attached **Water Boundary Conditions Email** in Appendix C).

**Table 2: Boundary Conditions**

Demand Scenario	Head (m)	Flow (L/s)
Minimum HGL (Peak Hour)	108.6	
Maximum HGL (Average Day)	114.4	
Available Fire Flow @ Residual 20 psi		55 <sup>1</sup>

<sup>1</sup> From the 152 mm dia. watermain on Westhaven Crescent, only.

However, the City indicated that 111.8 L/s (6,700 L/min) can be met from the local hydrants flowing simultaneously (see attached **Multiple Hydrant Analysis Email** in Appendix C). This value was considered in the hydraulic analysis to compare to the fire flow requirement for the proposed building.

### 3c.) HYDRAULIC ANALYSIS

#### PEAK HOUR & AVERAGE DAY

During peak hour demands, the resulting minimum hydraulic gradeline of 108.6 m corresponds to a peak hour pressure of 286 kPa (42 psi). This value is above the minimum pressure objective of 276 kPa (40 psi) for residential buildings up to two storeys. Adding 5 psi per floor above two stories, to account for headloss due to elevation and pipe losses, a minimum pressure of 310 kPa (45 psi) would be required for the third floor. The peak hour pressure at ground level is slightly



below this objective but is still within reasonable range for peak hour conditions. As such, it is deemed acceptable.

During average day demands, the resulting maximum hydraulic gradeline of 114.4 m corresponds to a maximum pressure of 343 kPa (50 psi). This value is less than the maximum pressure objective of 552 kPa (80 psi) and therefore considered acceptable. **Supporting hydraulic calculations** are attached in Appendix C.

**MAXIMUM DAY + FIRE FLOW**

The reported available fire flow at a residual pressure of 20 psi is 55 L/s (3,330 L/min). This is less than the RFF of 4,500 L/min, as per OFM. However, the City indicated that 6,700 L/min can be met from the local hydrants flowing simultaneously. Hydrant coverage and classes in the vicinity of the proposed building are illustrated in **Figure 2** attached in Appendix C.

Based on Table 1 of Appendix I of the City of Ottawa Technical Bulletin ISTB-2018-02 and a desktop review (i.e., Google Street View) to confirm hydrant class, the combined hydrant flow coverage for the building is estimated to be 13,300 L/min, which exceeds the OFM RFF value of 4,500 L/min. Note that the hydrant coverage exceeds the available watermain flow per the City’s boundary condition. As such, fire flows are limited to the reported available fire flow noted above. A breakdown of the hydrant coverage is summarized in **Table 3** below.

**Table 3: Fire Hydrant Coverage**

Building	Fire Flow Demand (L/min)	Fire Hydrants				Combined Hydrant Flow Coverage (L/min)	
		Hydrant Class	Within 75 m		Between 75 m and 150 m		
			Quantity	Max Contrib. to RFF	Quantity		Max Contrib. to RFF
246 Westhaven Crescent	4,500 L/min (OFM)	AA	1	5,700		13,300*	
		A	2	3,800			
		B					
		C					

\* The hydrant coverage exceeds the available watermain flow per the City’s boundary condition. As such, fire flows are limited to the reported available fire flow noted above (i.e., 6,700 L/min).

The existing incoming 38 mm (1 ½ inch) dia. water service line was access based on the current floor plans and water fixtures proposed for the renovations. Approximately 102 fixture units need to be considered based on the Ontario Building Code (specifically, Table 7.6.3.2.A.). At a length of 20.5 m, the existing water service line can serve a maximum of approximately 116 fixture units according to Table A-2.6.3.1.(2)-A of the National Plumbing Code 2015, under peak hour water pressure of 286 kPa (42 psi). Since the total fixture units for the building are below the maximum value specified by Table A-2.6.3.1.(2)-A, we can conclude that the existing 1 ½ inch water service line is adequate to service the building.



### **3d.) CONCLUSIONS**

In conclusion, based on the boundary conditions provided, the local watermain network in the vicinity of the proposed building at 246 Westhaven Crescent provides adequate fire flow capacity as per the OBC's Office of the Fire Marshal (OFM) method. Anticipated demand flows meet the pressure objectives during average demand conditions, as per the City of Ottawa's Drinking Water Design Guidelines. During peak hour conditions, the anticipated minimum pressure at ground level meets the pressure objectives for residential buildings up to two storeys. However, the minimum peak hour pressure is slightly below the objective when considering the 3rd floor (accounting for additional headloss due to elevation and pipe losses). Nonetheless, the minimum pressure is still within reasonable range at the 3rd floor for peak hour conditions and is deemed acceptable.

### **4.) SANITARY FLOW**

Peak sanitary flow for the proposed renovation of the existing residential apartment building is estimated at  $Q = 0.16$  L/s with an infiltration rate of 0.02 L/s. (See Appendix D Page 2 of 2 for details.) This flow will enter the existing 225mm diameter sanitary sewer via a 150 mm diameter PVC sanitary lateral sloped at 1.0% (min.).

The existing peak sanitary flow estimated for this lot prior to the proposed building conversion is  $Q = 0.13$  L/s with a infiltration rate of 0.02 L/s. (See Appendix D Page 1 of 2 for details.) Therefore, the estimated net increase in peak flow from this proposed residential building renovation is 0.03 L/s.

In view that the existing sanitary sewer size is 225 mm diameter in front of this property, an increase in sanitary flow to the existing sewer system by 0.03 L/s from this site is not expected to negatively impact the existing Westhaven Crescent sanitary sewer.

The existing 150mm dia. sanitary service lateral currently servicing this proposed multi-unit building was CCTV and the 150mm dia. PVC sanitary lateral video report recently completed at this building were reviewed and appears to be in good condition and meeting current pipe material standards. Therefore, the existing 150mm diameter PVC sanitary lateral meets the current pipe size and material standards. Refer to Appendix E for further details on the sanitary lateral CCTV report carried out by Aqua Drain dated March 13, 2024. This CCTV report in digital format was sent to the City on March 21, 2024 for their records.

### **5.) STORM FLOW**

The existing (3)-storey slab on-grade residential building do not have any weeping tiles or discharge mechanism in place because there are no basement occupancies in this building.

The current lot drainage on-site is primarily graded to surface drain across the site from west to east or (rear to front) whereupon most of ( $\pm 75.0\%$ ) surface stormwater outlets to the City's road right of way on Westhaven Crescent.



From the site modification works proposed (as per architect's site plan) and to comply with re-zoning requirements, the applicant is proposing to remove portions of the existing asphalt parking area currently located at the front of the building and reinstating it with soft landscaping. See Site Plan with Landscape Plan details shown in Appendix C. This newly added landscape feature will help promote storm water infiltration on-site from current condition and thus reduce storm water loading into the existing road right of way.

## 6.) CONCLUSIONS

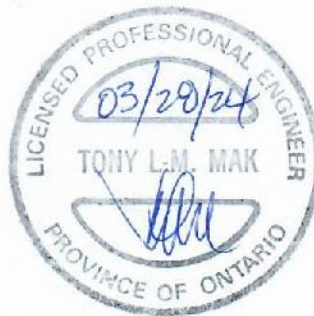
In conclusion, based on the water boundary conditions provided, the local watermain network along Westhaven Crescent and the vicinity of the building provides adequate fire flow capacity as per the OBC's office of the Fire Marshall (OFM) method, as well as anticipated demand flows within the pressure objectives during peak demand and basic demand conditions as per the City of Ottawa's Drinking Water Design Guidelines.

The existing incoming 38mm dia. copper water service and 150mm dia. sanitary service lateral at the existing (3)-storey building was installed in 2015 meets City of Ottawa pipe material standards for the proposed renovation of the apartment building.

**PREPARED BY T. L. MAK ENGINEERING CONSULTANTS LTD.**



TONY L. MAK, P. ENG.



**EXISTING THREE-STOREY MULTI-UNIT  
RESIDENTIAL BUILDING  
RENOVATIONS  
246 WESTHAVEN CRESCENT  
CITY OF OTTAWA**

**APPENDIX A**

**SITE PRE-DEVELOPMENT CONDITION**

**GOOGLE IMAGE (2020)**

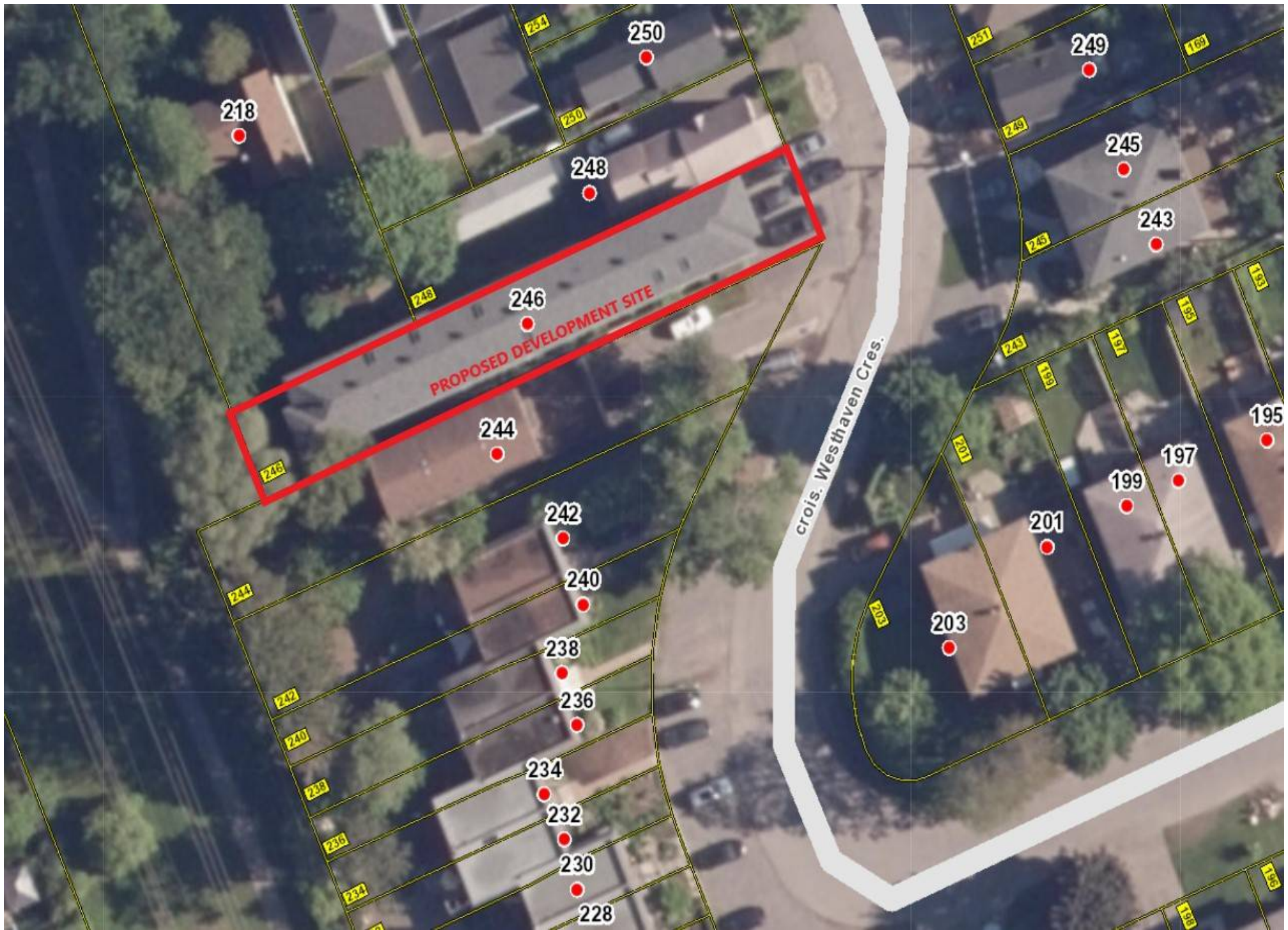
**AND**

**AERIAL PHOTOGRAPHY 2022 (GeoOTTAWA)**













**EXISTING THREE-STOREY MULTI-UNIT  
RESIDENTIAL BUILDING  
RENOVATIONS  
246 WESTHAVEN CRESCENT  
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**APPENDIX B**

**APPROVED LOT GRADING PLAN**

**(DWG. No. 815-53, G-1 Rev. 2**

**DATED 06/16/15)**





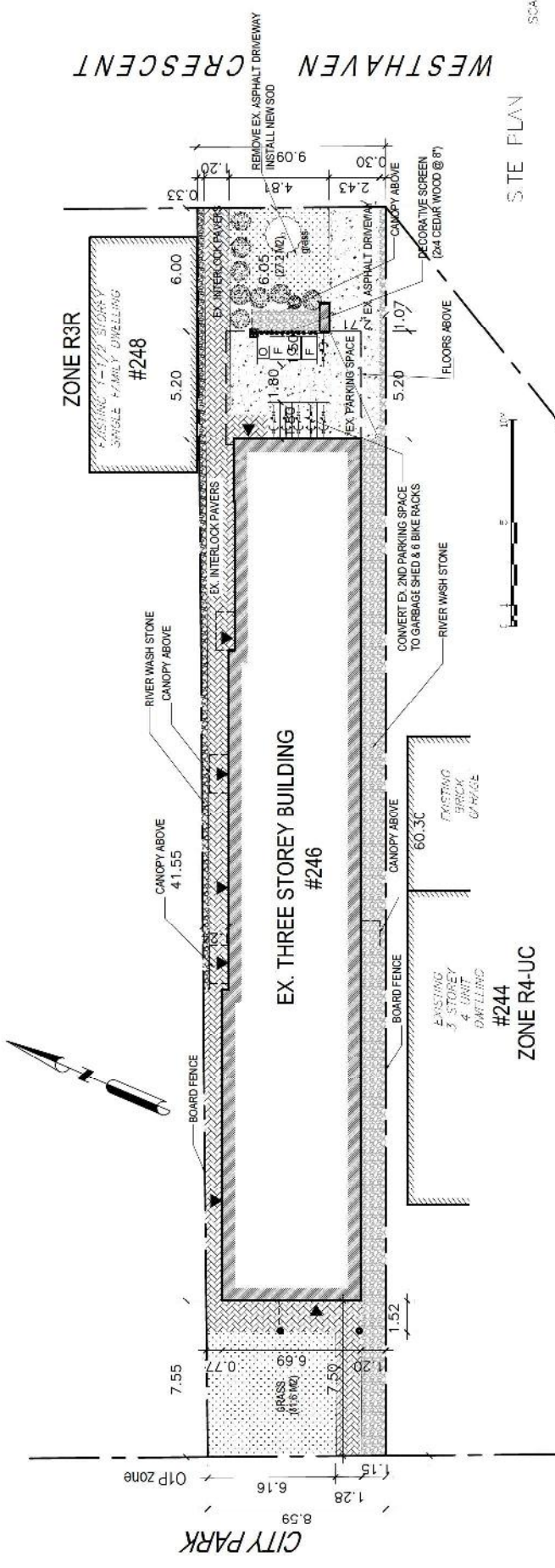
**EXISTING THREE-STOREY MULTI-UNIT  
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246 WESTHAVEN CRESCENT  
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**APPENDIX C**

- **SITE PLAN / ARCHITECTURAL DRAWINGS**
- **WATER BOUNDARY CONDITIONS**
- **MULTI-HYDRANT ANALYSIS E-MAIL**
- **FUS FIRE FLOW CALCULATION**
- **OFM EXPOSURE DISTANCE (FIGURE 1)**
- **SUPPORTING HYDRAULIC CALCULATIONS**
- **HYDRANT SPACING (FIGURE 2)**



**ATTACHMENT 1 : SITE PLAN / ARCHITECTURAL DRAWINGS**



LEGAL DESCRIPTION: PART OF LOT H&I REGISTERED PLAN 253 & ALL OF LOT 30 REGISTERED PLAN 308 CITY OF OTTAWA  
 Base on survey prepared by Surveyed by Amnis, O'Sullivan, Vollebakk Ltd.

DEVELOPMENT DATA:  
 Current Zoning Designation: R3R  
 Site area: 532.8 m<sup>2</sup>  
 Frontage as per survey: 9.09 m.  
 Depth as per survey: 60.30 m.  
 Existing Building Area (Footprint): 266.85 m<sup>2</sup> (47% lot coverage)  
 Gross Floor Area : 875.14 m<sup>2</sup>  
 Application for rezoning to R4-UC  
 Application for building permit to conversion of existing 3 unit to 6 unit apartment

UNIT	#BEDROOM	AR-A (M <sup>2</sup> )
A	3	24.3
B	2	19.5
C	3	27.9
D	1	7.0
F	0	41.7
I	1	87.5

REQUIRE	PROPOSED
MINIMUM LOT WIDTH	9.1m (EXCEPTION)
MINIMUM LOT AREA	532.8m <sup>2</sup>
MAXIMUM BUILDING HEIGHT	11m
MINIMUM FRONT YARD SETBACK	6m
MINIMUM CORNER SIDEYARD SETBACK	N/A
MINIMUM REARYARD SETBACK	7.5m
MINIMUM INTERIOR SIDEYARD SETBACK	NORTH SIDE: 0.77m (EXCEPTION) SOUTH SIDE: 1.2m (EXCEPTION)
MINIMUM LANDSCAPE AREA	43% (232.9 m <sup>2</sup> )
SOFTLANDSCAPE FRONT YARD	50% (27.2m <sup>2</sup> )
REAR YARD	80% (51.6m <sup>2</sup> )
REINTEGRATION ON FRONT WALL	30%
RECESS ON FRONT WALL	20%
BICYCLE PARKING (0.5 UNIT)	3 spaces
VEHICLE PARKING	0

REQUIRE	PROPOSED
MINIMUM LOT WIDTH	9.1m (EXCEPTION)
MINIMUM LOT AREA	532.8m <sup>2</sup>
MAXIMUM BUILDING HEIGHT	11m
MINIMUM FRONT YARD SETBACK	6m
MINIMUM CORNER SIDEYARD SETBACK	N/A
MINIMUM REARYARD SETBACK	7.5m
MINIMUM INTERIOR SIDEYARD SETBACK	NORTH SIDE: 0.77m (EXCEPTION) SOUTH SIDE: 1.2m (EXCEPTION)
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SOFTLANDSCAPE FRONT YARD	50% (27.2m <sup>2</sup> )
REAR YARD	80% (51.6m <sup>2</sup> )
REINTEGRATION ON FRONT WALL	30%
RECESS ON FRONT WALL	20%
BICYCLE PARKING (0.5 UNIT)	3 spaces
VEHICLE PARKING	0

LEGEND:  
 ENTRANCE  
 PROPERTY LINE  
 SETBACK LINE  
 EXISTING BUILDING  
 SOFT LANDSCAPE  
 INTERLOCKING WALKWAY  
 ASPHALT DRIVEWAY

SCALE: 1/200

LOCATION PLAN

3 ZONING  
 THREE STOREY BUILDING  
 246 Westhaven Cres. OTTAWA, ONT.

CLIENT:  
 M.C. BACHUJ  
 485 BRKWOOD AVE. OTT. K1Z 5W8  
 8-36842323

DESIGNER:  
 SUSAN D. SMITH ARCHITECT  
 841 Merivale Road  
 s.smith@sdsarch.ca  
 613-722-5327 or 291-3777

DATE: 06/18/2023  
 DRAWING BY: ID & VW  
 JOB # 2336

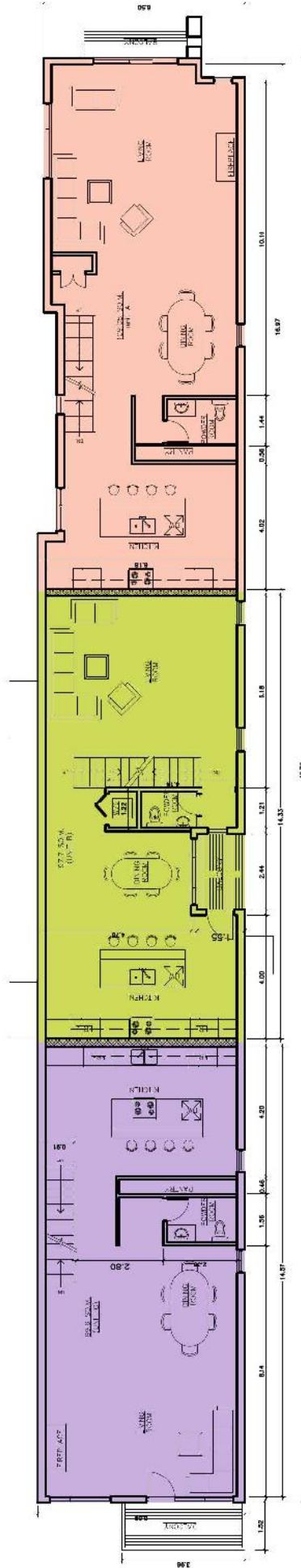
REQUIRE	PROPOSED
MINIMUM LOT WIDTH	9.1m (EXCEPTION)
MINIMUM LOT AREA	532.8m <sup>2</sup>
MAXIMUM BUILDING HEIGHT	11m
MINIMUM FRONT YARD SETBACK	6m
MINIMUM CORNER SIDEYARD SETBACK	N/A
MINIMUM REARYARD SETBACK	7.5m
MINIMUM INTERIOR SIDEYARD SETBACK	NORTH SIDE: 0.77m (EXCEPTION) SOUTH SIDE: 1.2m (EXCEPTION)
MINIMUM LANDSCAPE AREA	43% (232.9 m <sup>2</sup> )
SOFTLANDSCAPE FRONT YARD	50% (27.2m <sup>2</sup> )
REAR YARD	80% (51.6m <sup>2</sup> )
REINTEGRATION ON FRONT WALL	30%
RECESS ON FRONT WALL	20%
BICYCLE PARKING (0.5 UNIT)	3 spaces
VEHICLE PARKING	0



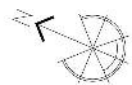


GROUND FLOOR PLAN  
(266.67 SQ.M)

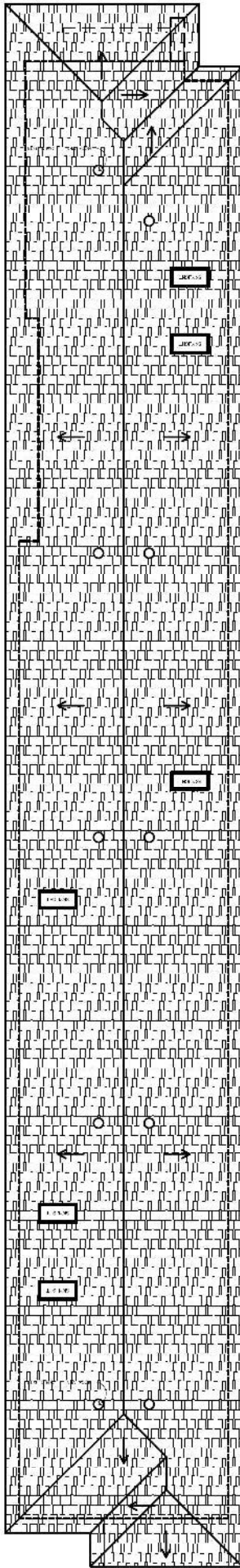
UNIT	NO. OF ROOMS	AREA (M <sup>2</sup> )
A	3	243
B	2	193
C	3	217.8
D	1	70
E	0	71.7
F	1	97.3



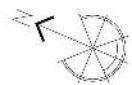
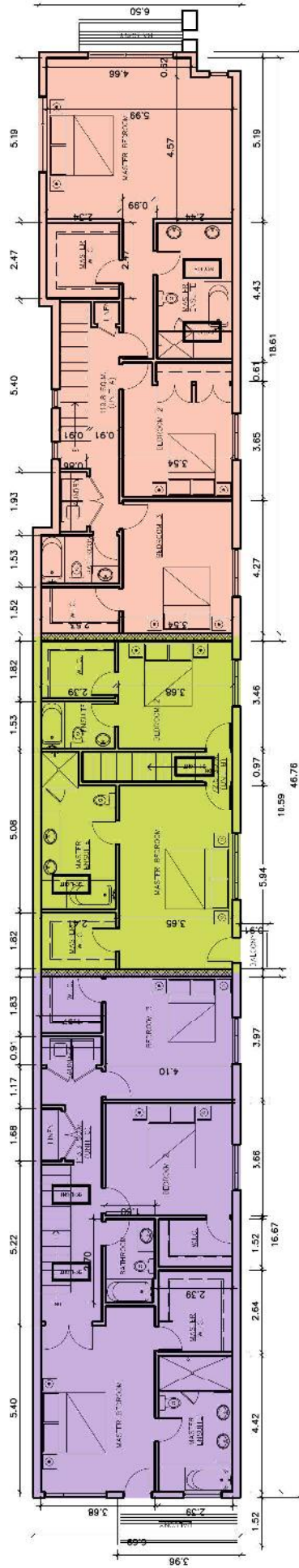
SECOND FLOOR PLAN  
(306.04 SQ.M)



<p><b>SUSAN D. SMITH ARCHITECT</b> 941 Mervale Rd Ottawa, Ontario K1Z 6A1 613-722-5327 s.smith@sdsarch.ca</p>		<p>Project Title: <b>RENOVATION</b> NEW 6 UNIT DWELLING 246 WESTAVEN CRESCENT OTTAWA, ON K1Z 7G3</p>		<p>Drawing Title: GROUND FLOOR &amp; SECOND FLOOR PLANS</p>		<p>Scale: 3/32" = 1'-0" Date: OCT 2023 Drawn: W.P. &amp; B. Checked: Job No.: 1459</p>	
<p>1. 05/02/15 ISSUED FOR PERMITS TO</p>		<p>No. Date Revision</p>		<p>By</p>		<p>Drawing No. <b>A1</b></p>	



ROOF PLAN



<p><b>SUSAN D. SMITH ARCHITECT</b>          941 Mervale Rd          Ottawa, Ontario          K1Z 6A1          613-722-5327          s.smith@sdsarch.ca</p>		<p>Project Title: <b>RENOVATION</b>          NEW 6 UNIT DWELLING          246 WESTHAVEN CRESCENT          OTTAWA, ON K1Z 7G3</p>		<p>Drawing Title: <b>THIRD FLOOR &amp; ROOF PLANS</b></p>		<p>Scale: 3/32" = 1'-0"</p>		<p>Drawing No. <b>A2</b></p>	
<p>1 05/02/15 ISSUED FOR PERMITS</p>		<p>Date: 05/02/15</p>		<p>Date: OCT 2023</p>		<p>Drawn: W.P.B.</p>		<p>Checked: 1459</p>	
<p>No. Date Revision</p>		<p>By</p>		<p>Job No.</p>		<p>Job No.</p>		<p>Job No.</p>	



CLIENT :

MICHELE FAROUD  
 485 KIRKWOOD AV., 011  
 K1Z 5W8  
 613-867-5253

DRAWINGS SHOW EXISTING  
 OTHERWISE NOTED

SUSAN D. SMITH ARCHITECT  
 941 Merrivale Rd  
 Ottawa, Ontario  
 K1Z 6A1  
 613-722-5327  
 s.smith@sdsararch.ca

No.	Date	Revision	By
1	06/02/15	ISSUED FOR PERMITS	TS

Project Title: **RENOVATION**

NEW 6 UNIT DWELLING  
 246 WESTHAVEN CRESCENT  
 OTTAWA, ON K1Z 7G3

Drawing Title:

EXISTING ELEVATIONS

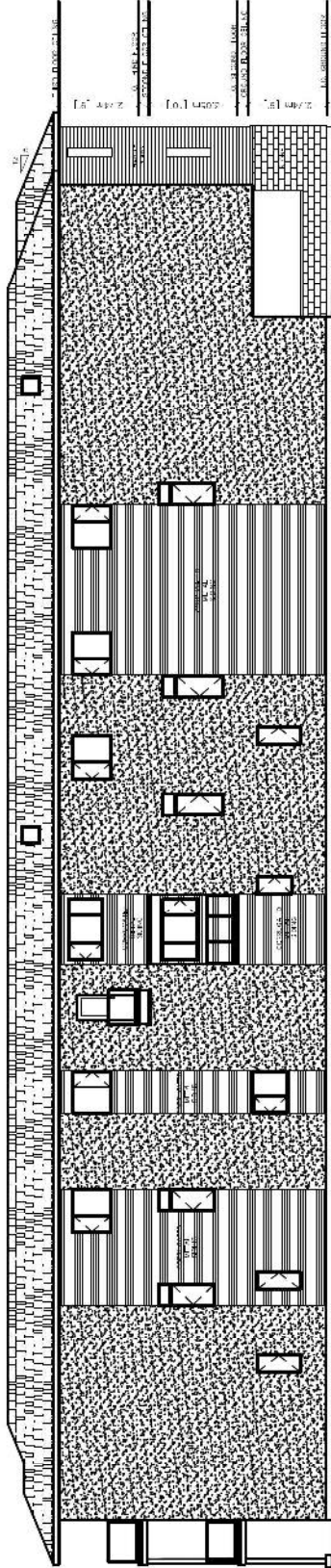
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Date OCT 2023

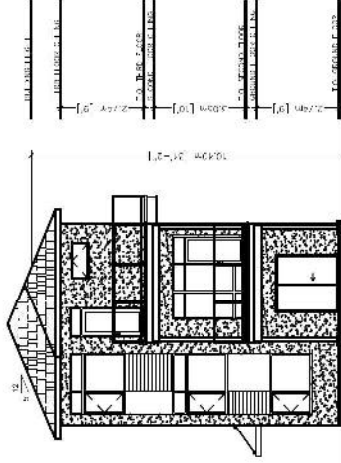
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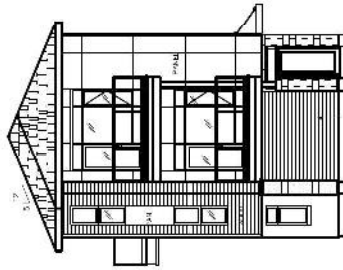
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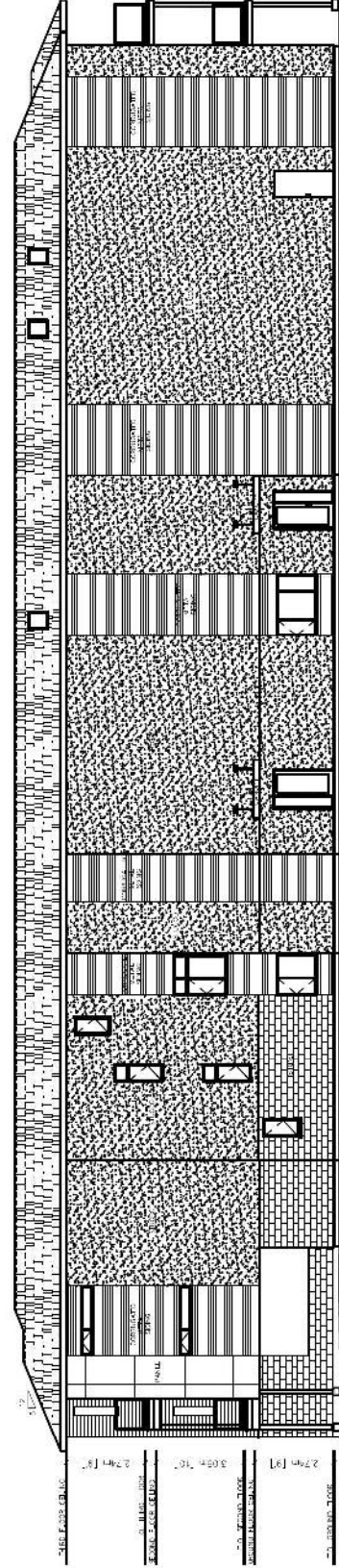
SOUTH ELEVATION



WEST ELEVATION



EAST ELEVATION



SOUTH ELEVATION

**ATTACHMENT 2 : WATER BOUNDARY CONDITIONS**



## Mineault-Guitard, Alexandre

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**From:** TL MaK <tlmakecl@bellnet.ca>  
**Sent:** Thursday, February 29, 2024 10:14 AM  
**To:** Mineault-Guitard, Alexandre  
**Cc:** Alemany, Kevin  
**Subject:** RE: 246 Westhaven Crescent - Water Boundary Conditions Request  
**Attachments:** 246 Westhaven Cres February 2024.pdf

Hi Alex,

Attached please find the Water Boundary Conditions received from the City today for your calculation use.

Thank you,

Tony Mak

T.L. Mak Engineering Consultants Ltd.  
1455 Youville Drive, Suite 218  
Ottawa, ON. K1C 6Z7  
Tel. 613-837-5516 | Fax: 613-837-5277  
E-mail: [tlmakecl@bellnet.ca](mailto:tlmakecl@bellnet.ca)

---

**From:** Duquette, Vincent [<mailto:Vincent.Duquette@ottawa.ca>]  
**Sent:** February 29, 2024 9:29 AM  
**To:** TL MaK  
**Cc:** Wu, John  
**Subject:** RE: 246 Westhaven Crescent - Water Boundary Conditions Request

Hi Tony,

See below results of the water boundary conditions. The requested fireflow is not available. Onsite mitigation measures will be required lower the fire flow demand.

The following are boundary conditions, HGL, for hydraulic analysis at 246 Westhaven Crescent (zone 1W) assumed to be connected to the 152mm watermain on Westhaven Crescent (see attached PDF for location).

Minimum HGL: 108.6 m

Maximum HGL: 114.4 m

Available Fire Flow at 20 (psi): 55.0 L/s, assuming ground elevation of 79.4 m

These are for current conditions and are based on computer model simulation.

*Disclaimer: The boundary condition information is based on current operation of the city water distribution system. The computer model simulation is based on the best information available at the time. The operation of the water distribution system can change on a regular basis, resulting in a variation in boundary conditions.*

*The physical properties of watermains deteriorate over time, as such must be assumed in the absence of actual field test data. The variation in physical watermain properties can therefore alter the results of the computer model simulation.*

Best Regards,

**Vincent Duquette, E.I.T**

Project Manager, Infrastructure Approvals

Planning, Real Estate and Economic Development Department – Direction général de la planification, des biens immobilier et du développement économique

Development Review – Central Branch

City of Ottawa | Ville d'Ottawa

110 Laurier Avenue West Ottawa, ON | 110, avenue. Laurier Ouest. Ottawa (Ontario) K1P 1J1

613.580.2424 ext./poste 14048, [vincent.duquette@ottawa.ca](mailto:vincent.duquette@ottawa.ca)

---

**From:** TL MaK <[tlmakecl@bellnet.ca](mailto:tlmakecl@bellnet.ca)>

**Sent:** February 27, 2024 10:50 AM

**To:** Duquette, Vincent <[Vincent.Duquette@ottawa.ca](mailto:Vincent.Duquette@ottawa.ca)>

**Subject:** RE: 246 Westhaven Crescent - Water Boundary Conditions Request

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Hi Vincent,

We are following-up on our e-mail of January 31, 2024 requesting for water boundary conditions for development of this site. Could you please update us on this request at your earliest convenience.

Thank you for your help in this matter.

Regards,

Tony Mak

T.L. Mak Engineering Consultants Ltd.

1455 Youville Drive, Suite 218

Ottawa, ON. K1C 6Z7

Tel. 613-837-5516 | Fax: 613-837-5277

E-mail: [tlmakecl@bellnet.ca](mailto:tlmakecl@bellnet.ca)

---

**From:** Duquette, Vincent [<mailto:Vincent.Duquette@ottawa.ca>]

**Sent:** January 31, 2024 7:04 PM

**To:** TL MaK

**Subject:** RE: 246 Westhaven Crescent - Water Boundary Conditions Request

Thanks for revising the calculations. I have requested boundary conditions for both fire flow conditions.

Best Regards,



**Vincent Duquette, E.I.T**

Project Manager, Infrastructure Approvals

Planning, Real Estate and Economic Development Department – Direction général de la planification, des biens immobilier et du développement économique

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613.580.2424 ext./poste 14048, [vincent.duquette@ottawa.ca](mailto:vincent.duquette@ottawa.ca)

**From:** TL MaK <[tlmakecl@bellnet.ca](mailto:tlmakecl@bellnet.ca)>

**Sent:** January 31, 2024 3:03 PM

**To:** Duquette, Vincent <[Vincent.Duquette@ottawa.ca](mailto:Vincent.Duquette@ottawa.ca)>

**Subject:** RE: 246 Westhaven Crescent - Water Boundary Conditions Request

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Hi Vincent,

Here is the updated boundary condition request for the 246 Westhaven Crescent multi-unit residential building.

The building located within Pressure Zone 1W at 246 Westhaven Crescent is a 3-storey multi-unit residential building with no basement. The building contains six (6) total units, namely two (2) 3-bedroom, one (1) 2-bedroom, two (2) 1-bedroom and one (1) bachelor unit. Each floor covers an area of around 292 m<sup>2</sup>, for a gross floor area of 879 m<sup>2</sup>. The building is to be serviced by the 150 mm diameter watermain along Westhaven Crescent.

The domestic demands were calculated using the City of Ottawa’s Water Design Guidelines, where the residential consumption rate of 280 L/cap/d was used to estimate average day demands (AVDY). Persons per unit (PPU) for each unit were estimated based on the City of Ottawa’s Water Design Guidelines. Following discussions with the City, peaking factors are to be estimated from Table 3-3 of the MECP Design Guidelines for Drinking-Water Systems, given that the proposed development population is less than 500 people. Maximum day (MXDY) demands were calculated by multiplying AVDY demands by a factor of 9.5. Peak hour (PKHR) demands were calculated by multiplying AVDY by a factor of 14.3. Table 1 shows the estimated domestic demands of the existing building.

**Table 1: Estimated Domestic Demand**

Unit Type	Unit Count	PPU	Consumption	AVDY		MXDY		PKHR	
				L/d	L/s	L/d	L/s	L/d	L/s
Apartment, 3-Bedroom	2	3.1	280	1,736	0.02	16,492	0.19	24,825	0.29
Apartment, 2-Bedroom	1	2.1		588	0.01	5,586	0.06	8,408	0.10
Apartment, 1-Bedroom	2	1.4		784	0.01	7,448	0.09	11,211	0.13
Apartment, Bachelor	1	1.4		392	0.00	3,724	0.04	5,606	0.06
<b>Total</b>	<b>6</b>			<b>3,500</b>	<b>0.04</b>	<b>33,250</b>	<b>0.38</b>	<b>50,050</b>	<b>0.58</b>

The City had previously indicated that the City's Fire Marshall and various City departments are currently reviewing fire flow requirements for low- and mid-rise buildings. As per the City of Ottawa's Water Design Guidelines, the FUS method is to be used for fire flow requirements affecting watermain sizing; with regards to fire protection on private property and not requiring new watermains, these are covered by the Ontario Building Code (OBC). As such, the fire flow requirement was calculated by both the FUS and the OBC's Office of the Fire Marshal (OFM) method.

The proposed building will be of wood frame construction, where floors are fire separations, but without fire-resistance ratings. It is understood that the building won't be equipped with sprinklers. First, the resulting required fire flow, based on the FUS calculation, is 14,000 L/min (233 L/s) for a duration of 3 hours. Secondly, based on the OFM calculation, the resulting required fire flow is 4,500 L/min (75 L/s) for a duration of 40 minutes.

In summary:

- AVDY = 3,500 L/d (0.04 L/s);
- MXDY = 33,250 L/d (0.38 L/s);
- PKHR = 50,050 L/d (0.58 L/s);
- Fire Flow (FUS) = 14,000 L/min (233 L/s) and,
- Fire Flow (OFM) = 4,500 L/min (75 L/s).

The City is requested to provide boundary conditions for the Average Day, Maximum Day, Peak Hour and the two (2) Fire Flow conditions indicated above.

Thank you for your help.

Regards,

Tony Mak

T.L. Mak Engineering Consultants Ltd.  
1455 Youville Drive, Suite 218  
Ottawa, ON, K1C 6Z7  
Tel. 613-837-5516 | Fax: 613-837-5277  
E-mail: [tlmakecl@bellnet.ca](mailto:tlmakecl@bellnet.ca)

---

**From:** Duquette, Vincent [<mailto:Vincent.Duquette@ottawa.ca>]  
**Sent:** January 31, 2024 12:21 PM  
**To:** TL MaK  
**Subject:** RE: 246 Westhaven Crescent - Water Boundary Conditions Request

Hi Tony,

For populations of less than 500, the peaking factors used must be from Table 3.3 of the MOE Design Guidelines for Drinking-Water Systems. See table below. Please revise the max day and peak hour demand accordingly. Note that the peak hour demand is obtained by multiplying average day demand by only the peak hour factor.



**Table 3-3: Peaking Factors for Drinking-Water Systems Serving Fewer than 500 People**

DWELLING UNITS SERVICED	EQUIVALENT POPULATION	NIGHT MINIMUM HOUR FACTOR	MAXIMUM DAY FACTOR	PEAK HOUR FACTOR
10	30	0.1	9.5	14.3
50	150	0.1	4.9	7.4
100	300	0.2	3.6	5.4
150	450	0.3	3.0	4.5
167	500	0.4	2.9	4.3

Lastly, seeing as the calculated OBC fire flow demand is less than 9000L/min, the OBC fire flow demand (4500L/min) will be used in the in the boundary condition request.

Best Regards,

**Vincent Duquette, E.I.T**

Project Manager, Infrastructure Approvals

Planning, Real Estate and Economic Development Department – Direction général de la planification, des biens immobilier et du développement économique

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613.580.2424 ext./poste 14048, [vincent.duquette@ottawa.ca](mailto:vincent.duquette@ottawa.ca)

---

**From:** TL MaK <[tlmakecl@bellnet.ca](mailto:tlmakecl@bellnet.ca)>

**Sent:** January 31, 2024 10:44 AM

**To:** Duquette, Vincent <[Vincent.Duquette@ottawa.ca](mailto:Vincent.Duquette@ottawa.ca)>

**Subject:** 246 Westhaven Crescent - Water Boundary Conditions Request

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Hi Vincent,

Regarding this site, we are requesting for water boundary conditions from the City of Ottawa to be provided for our hydraulic analysis. The particulars are as follows:

The building located within Pressure Zone 1W at 246 Westhaven Crescent is a 3-storey multi-unit residential building with no basement. The building contains six (6) total units, namely two (2) 3-bedroom, one (1) 2-bedroom, two (2) 1-bedroom and one (1) bachelor unit. Each floor covers an area of around 292 m<sup>2</sup>, for a gross floor area of 879 m<sup>2</sup>. The building is to be serviced by the 150 mm diameter watermain along Westhaven Crescent.

The domestic demands were calculated using the City of Ottawa's Water Design Guidelines, where the residential consumption rate of 280 L/cap/d was used to estimate average day demands (AVDY). Maximum day (MXDY) demands were calculated by multiplying AVDY demands by a factor of 2.5. Peak hour (PKHR) demands were calculated by

multiplying MXDY by a factor of 2.2. Persons per unit (PPU) for each unit were estimated based on the City of Ottawa's Water Design Guidelines. Table 1 shows the estimated domestic demands of the existing building.

**Table 1: Estimated Domestic Demand**

Unit Type	Unit Count	PPU	Consumption	AVDY		MXDY		PKHR	
				L/d	L/s	L/d	L/s	L/d	L/s
Apartment, 3-Bedroom	2	3.1	280	1,736	0.02	4,340	0.05	9,548	0.11
Apartment, 2-Bedroom	1	2.1		588	0.01	1,470	0.02	3,234	0.04
Apartment, 1-Bedroom	2	1.4		784	0.01	1,960	0.02	4,312	0.05
Apartment, Bachelor	1	1.4		392	0.00	980	0.01	2,156	0.02
<b>Total</b>	<b>6</b>			<b>3,500</b>	<b>0.04</b>	<b>8,750</b>	<b>0.10</b>	<b>19,250</b>	<b>0.22</b>

The City had previously indicated that the City's Fire Marshall and various City departments are currently reviewing fire flow requirements for low- and mid-rise buildings. As per the City of Ottawa's Water Design Guidelines, the FUS method is to be used for fire flow requirements affecting watermain sizing; with regards to fire protection on private property and not requiring new watermains, these are covered by the Ontario Building Code (OBC). As such, the fire flow requirement was calculated by both the FUS and the OBC's Office of the Fire Marshal (OFM) method.

The proposed building will be of wood frame construction, where floors are fire separations, but without fire-resistance ratings. It is understood that the building won't be equipped with sprinklers. First, the resulting required fire flow, based on the FUS calculation, is 14,000 L/min (233 L/s) for a duration of 3 hours. Secondly, based on the OFM calculation, the resulting required fire flow is 4,500 L/min (75 L/s) for a duration of 40 minutes.

In summary:

- AVDY = 3,500 L/d (0.04 L/s);
- MXDY = 8,750 L/d (0.10 L/s);
- PKHR = 19,250 L/d (0.22 L/s);
- Fire Flow (FUS) = 14,000 L/min (233 L/s) and,
- Fire Flow (OFM)= 4,500 L/min (75 L/s).

The City is requested to provide boundary conditions for the Average Day, Maximum Day, Peak Hour and Fire Flow conditions indicated above.

Thank you for your prompt attention to this matter. Please forward the boundary conditions as soon as possible.

Have a good day.

Regards,

Tony Mak

T.L. Mak Engineering Consultants Ltd.  
 1455 Youville Drive, Suite 218  
 Ottawa, ON. K1C 6Z7  
 Tel. 613-837-5516 | Fax: 613-837-5277  
 E-mail: [tlmakecl@bellnet.ca](mailto:tlmakecl@bellnet.ca)



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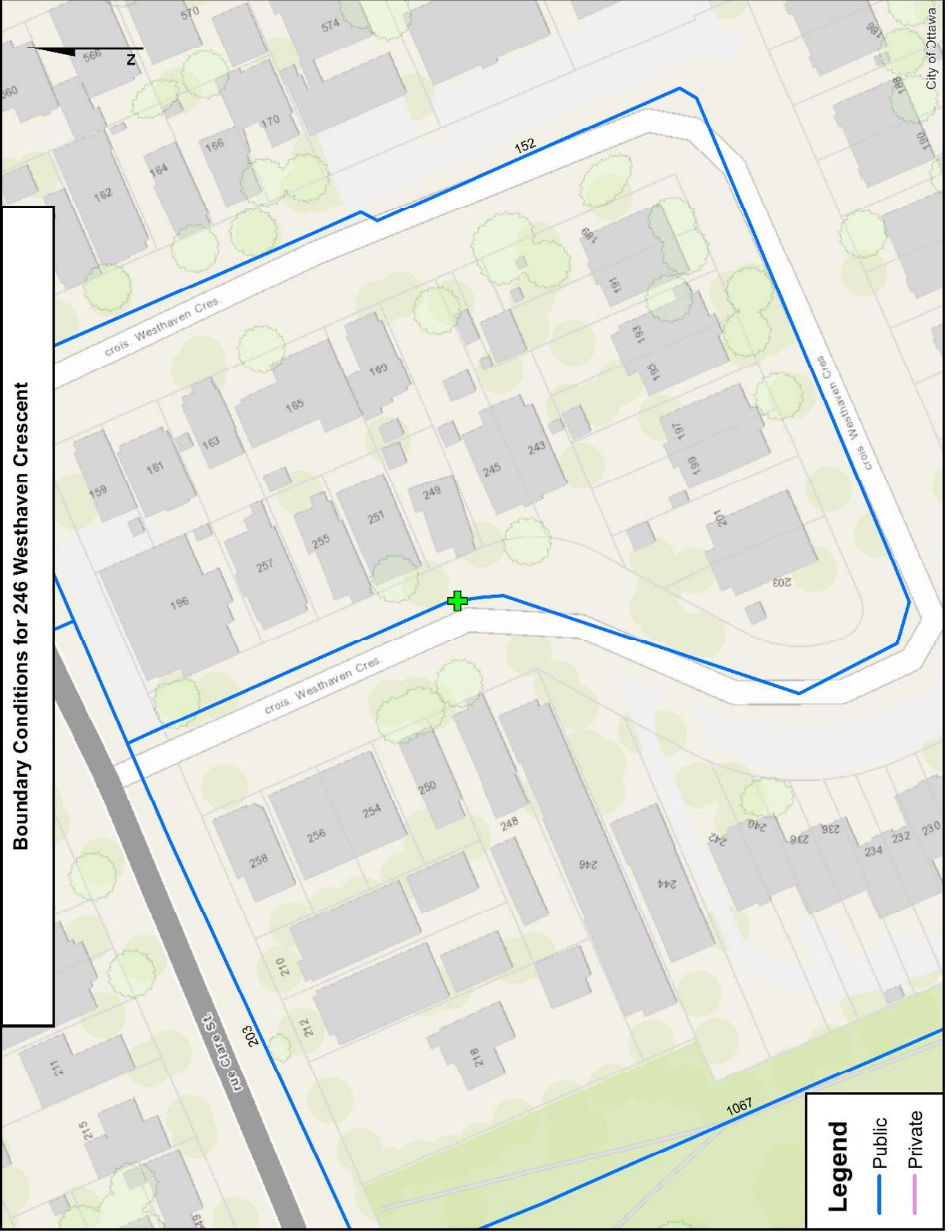
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Boundary Conditions for 246 Westhaven Crescent

**Legend**

- Public
- Private



**ATTACHMENT 3 : MULTI-HYDRANT ANALYSIS E-MAIL**

## Mineault-Guitard, Alexandre

---

**From:** Duquette, Vincent <Vincent.Duquette@ottawa.ca>  
**Sent:** Monday, March 11, 2024 10:49 AM  
**To:** Mineault-Guitard, Alexandre  
**Cc:** TL MaK; Wu, John  
**Subject:** RE: 246 Westhaven Crescent - Water Boundary Conditions Request  
**Attachments:** 246 Westhaven Cres Multi-Hydrant Analysis March 2024.pdf

You don't often get email from vincent.duquette@ottawa.ca. [Learn why this is important](#)

Hi Alexandre,

Please see below the results from the requested multi-hydrant analysis. Please note that we allow the use of the OBC fireflow calculation method for individual buildings without a private watermain and where the fireflow demand (as per OBC) is less than 9000L/min (150L/s).

The following are boundary conditions, HGL, for hydraulic analysis at 246 Westhaven Crescent (zone 1W) assumed to be connected to the 152mm watermain on Westhaven Crescent (see attached PDF for location).

Minimum HGL: 108.6 m

Maximum HGL: 114.4 m

Available Fire Flow at 20 (psi): 55.0 L/s, assuming ground elevation of 79.4 m

A multi-hydrant analysis was performed with three existing hydrants within 150 m of the property. The total aggregate flow, assuming hydrants running simultaneously, provides **111.8 L/s** of Fire flow for the site.

These are for current conditions and are based on computer model simulation.

Disclaimer: The boundary condition information is based on current operation of the city water distribution system. The computer model simulation is based on the best information available at the time. The operation of the water distribution system can change on a regular basis, resulting in a variation in boundary conditions. The physical properties of watermains deteriorate over time, as such must be assumed in the absence of actual field test data. The variation in physical watermain properties can therefore alter the results of the computer model simulation.

Best Regards,

**Vincent Duquette, E.I.T**

Project Manager, Infrastructure Approvals

Planning, Real Estate and Economic Development Department – Direction général de la planification, des biens immobilier et du développement économique

Development Review – Central Branch

City of Ottawa | Ville d'Ottawa

110 Laurier Avenue West Ottawa, ON | 110, avenue. Laurier Ouest. Ottawa (Ontario) K1P 1J1

613.580.2424 ext./poste 14048, vincent.duquette@ottawa.ca

---

**From:** Duquette, Vincent

**Sent:** March 01, 2024 1:33 PM

**To:** Mineault-Guitard, Alexandre <Alexandre.Mineault-Guitard@stantec.com>



Cc: TL MaK <tlmakecl@bellnet.ca>

Subject: RE: 246 Westhaven Crescent - Water Boundary Conditions Request

Hi Alexandre,

The multi-hydrant analysis request for three hydrants has been submitted. I will keep you posted on the results.

Best Regards,

**Vincent Duquette, E.I.T**

Project Manager, Infrastructure Approvals

Planning, Real Estate and Economic Development Department – Direction général de la planification, des biens immobilier et du développement économique

Development Review – Central Branch

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110 Laurier Avenue West Ottawa, ON | 110, avenue. Laurier Ouest. Ottawa (Ontario) K1P 1J1

613.580.2424 ext./poste 14048, [vincent.duquette@ottawa.ca](mailto:vincent.duquette@ottawa.ca)

---

**From:** Mineault-Guitard, Alexandre <[Alexandre.Mineault-Guitard@stantec.com](mailto:Alexandre.Mineault-Guitard@stantec.com)>

**Sent:** March 01, 2024 9:48 AM

**To:** Duquette, Vincent <[Vincent.Duquette@ottawa.ca](mailto:Vincent.Duquette@ottawa.ca)>

**Cc:** TL MaK <tlmakecl@bellnet.ca>

**Subject:** RE: 246 Westhaven Crescent - Water Boundary Conditions Request

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Good morning Vincent,

I hope this email finds you well.

Based on the Water Boundary Conditions provided for this project, it appears that there is limited fire flow capacity along Westhaven Crescent. To address this, we recommend considering flow from multiple hydrants (as per ISTB-2018-02) to assess whether the distribution network can deliver the required fire flow.

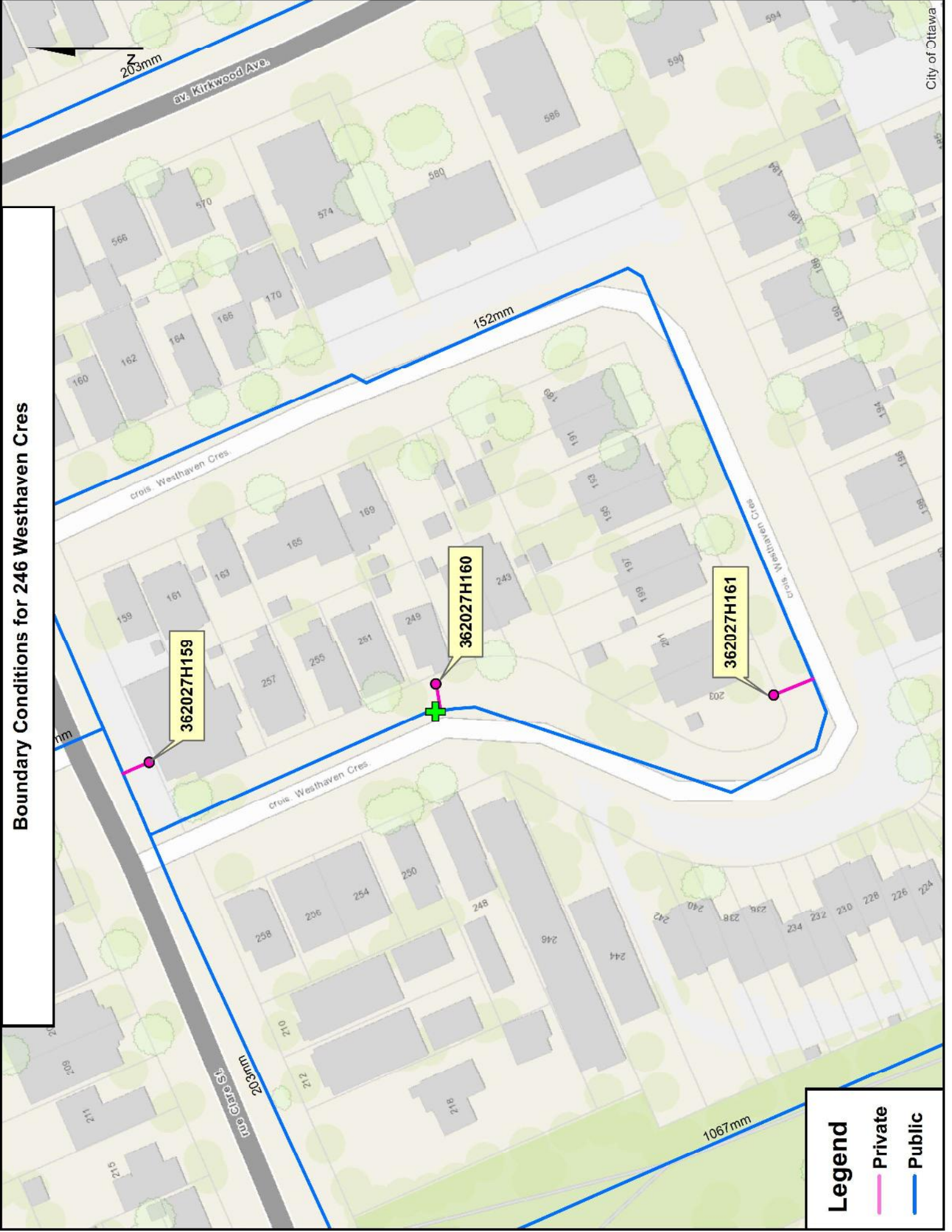
Our desktop review, which included Google Street view, identified two (2) Class A hydrants within 75 metres of the proposed building. Additionally, there is an extra Class AA hydrant also located within the same distance from the building. The attached figure, extracted from GeoOttawa, provides a visual representation of these hydrants.

Given this information, we kindly request a multi-hydrant analysis from the City. This analysis will help confirm the hydrant flow coverage at the proposed location. The results will be compared to the previously identified fire flow demand of 75 L/s to determine if any additional mitigation measures are necessary.

Please feel free to reach out if you have any questions or would like to discuss this further.

Kind regards,

**Alexandre Mineault-G**, M.A.Sc., ing., P.Eng.  
Water Resources Engineer



**Boundary Conditions for 246 Westhaven Cres**

**Legend**

- Private
- Public

362027H159

362027H160

362027H161



**ATTACHMENT 4 : FUS FIRE FLOW CALCULATION**

**Fire Flow Calculations as per the Ontario Building Code (OBC)**



**OFM Fire Flow Calculation**

Calculations based on *Fire Protection Water Supply Guideline for Part 3 in the Ontario Building Code* by the Office of the Fire Marshal (OFM 1999)

Stantec Project #: 163401084  
 Project Name: 246 Westhaven Crescent Water Servicing Analysis  
 Date: January 31, 2024  
 Data inputted by: Hamidreza Mohabbat, MASC.  
 Data reviewed by: Alexandre Mineault-Guitard, P.Eng, Ing.

Fire Flow Calculation #: 1  
 Building Type/Description/Name: Residential

Office of the Fire Marshal Determination of Required Fire Protection Water Supply									
Step	Task	Term	Options	Multiplier Associated with Option	Choose:	Value Used	Unit		
<b>1</b>									
<b>General Building Details</b>									
1.1	Enter Number of Storeys		Number of Floors/Storeys in the Unit (incl. basement):		3	3	Storeys		
1.2	Choose Type of Housing (If TH, Enter Number of Units Per TH Block)	Type of Housing	Single Family	0	Other (Comm, Ind, Apt etc.)	6	Units		
			Townhouse - indicate # of units	0					
			Other (Comm, Ind, Apt etc.)	6					
1.3	Choose Presence of Sprinklers		Sprinklers?		None	None	N/A		
1.4	Choose Presence of Firewalls		Firewall separations?		None	None	N/A		
1.5	Choose Presence of Stand-Pipe System		Stand-pipe system?		None	None	N/A		
<b>2</b>									
<b>Determining Water Supply Coefficient K</b>									
2.1	Choose Type of Construction	Type of Construction	Type of Construction				Type IV	N/A	N/A
			Non-combustible construction + fire separations + fire-resistance ratings in accordance with Section 3.2.2 of OBC	Type I					
			Non-combustible construction + fire separations + no fire-resistance rating	Type II					
			Combustible construction + fire separations + fire-resistance ratings in accordance with Section 3.2.2 of OBC	Type III					
			Combustible construction + fire separations + no fire-resistance rating	Type IV					
2.2	Choose Classification	Occupancy Classification (OBC)	Building Classification				C	A-2, B-1, B-2, B-3, C, D	N/A
			A-2, B-1, B-2, B-3, C, D	23					
			A-4, F-3	28					
			A-1, A-3	32					
			E, F-2	39					
2.3	Water Supply Coefficient (K)		Water Supply Coefficient K			23	N/A		
<b>3</b>									
<b>Determining Building Volume V</b>									
3.1	Enter Ground Floor Area of One Unit	Floor Space Area				293	293	Area in Square Meters (m <sup>2</sup> )	
		Average Floor Area (A) :	Square Metres (m <sup>2</sup> )						
3.2	Building Height (h)	Building Height				10.4	10.4	Height in Meters (m)	
		Bottom Elevation :	Meters (m)	0.0					
		Top Elevation :	Meters (m)	10.4					
3.3	Building Volume (V)		Building Volume V = A * h			3,050	Volume in Meters Cube (m <sup>3</sup> )		
<b>4</b>									
<b>Determining Spatial Coefficient S</b>									
4.1	Choose Exposure Distances from Building to Property Line	Exposure Distance from Building to Property Line in Meters (m)	North Side		0.50	1.25	Distance In Meters (m)		
			Property Line to Street Centreline (Street Facing)	0					
			Total Exposure Distance	0.8					
			East Side						
			Property Line to Street Centreline (Street Facing)	6.0				0.00	
			Total Exposure Distance	15.8					
			South Side						
			Property Line to Street Centreline (Street Facing)	1.2				0.50	
			Total Exposure Distance	1.2					
			West Side						
Property Line to Street Centreline (Street Facing)	7.6	0.25							
Total Exposure Distance	7.6								
4.2	Total Spatial Coefficient		Total Spatial Coefficient $S_{2x} = 1 + \sum S_x$			2.00	N/A		
<b>5</b>									
<b>Determining Required Minimum Supply of Water Q and Fire Flow</b>									
5.1	Obtain Required Fire Volume, Flow & Duration	Minimum Supply of Water, rounded to nearest 1,000 L; $Q = K^*V^*S_{tot}$				140,000 L			
		Required Minimum Water Supply Flow Rate (L/min)				4,500 L/min			
		Required Minimum Water Supply Flow Rate (L/s)				75 L/s			
		Required Minimum Duration of Fire Flow (min)				40 min			



**ATTACHMENT 5 : FIGURE 1 – OFM EXPOSURE DISTANCE**



**Figure 1: OFM Exposure Distances (Property Line to Street)**

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**ATTACHMENT 6 : SUPPORTING HYDRAULIC CALCULATIONS**



### Supporting Hydraulic Calculations

Stantec Project #: 163401084

Project Name: 246 Westhaven Crescent

Date: March 1, 2024

Data inputted by: Alexandre Mineault-Guitard, M.A.Sc., P.Eng.

Data reviewed by: Kevin Alemany, M.A.Sc., P.Eng.

#### Boundary Conditions provided by the City:

Scenario 1: Peak Hour (Min HGL): 108.6 m;

Scenario 2: Average Day (Max HGL): 114.4 m; and

Scenario 3: Maximum Day plus Fire Flow: 93.5 m.

#### Sample Calculations

$$HGL (m) = hp + hz \quad (1)$$

where:  $hp$  = Pressure Head (m); and  $hz$  = Elevation Head (m), estimated from topography.

For Scenario 1, we have:

$$HGL(m) = 108.6 \text{ and } hz (m) = 79.4.$$

Rearranging Equation 1, we can calculate the Pressure Head ( $hp$ ) as follow:

$$hp (m) = HGL - hz$$

$$\therefore hp = 108.6 - 79.4 \text{ m} = 29.2 \text{ m.}$$

To convert from Pressure Head (m) to a pressure value (kPa), the following equation can be used:

$$P (kPa) = (\rho * g * hp) / 1000 \quad (2)$$

where:  $\rho$  = density of water =  $1000 \text{ kg/m}^3$ ; and  $g$  = gravitational acceleration =  $9.81 \text{ m/s}^2$ .

Using Equation 2, we can calculate the Pressure Head ( $hp$ ) as follow:

$$P (kPa) = (1000 * 9.81 * 29.2) / 1000$$

$$\therefore P = 286 \text{ kPa.}$$

Considering that  $1 \text{ kPa} = 0.145 \text{ psi}$ , the pressure under Scenario 1 is equal to:

$$P = 42 \text{ psi.}$$

Applying the same procedures, the pressures under Scenario 2 and Scenario 3 are calculated as follows:

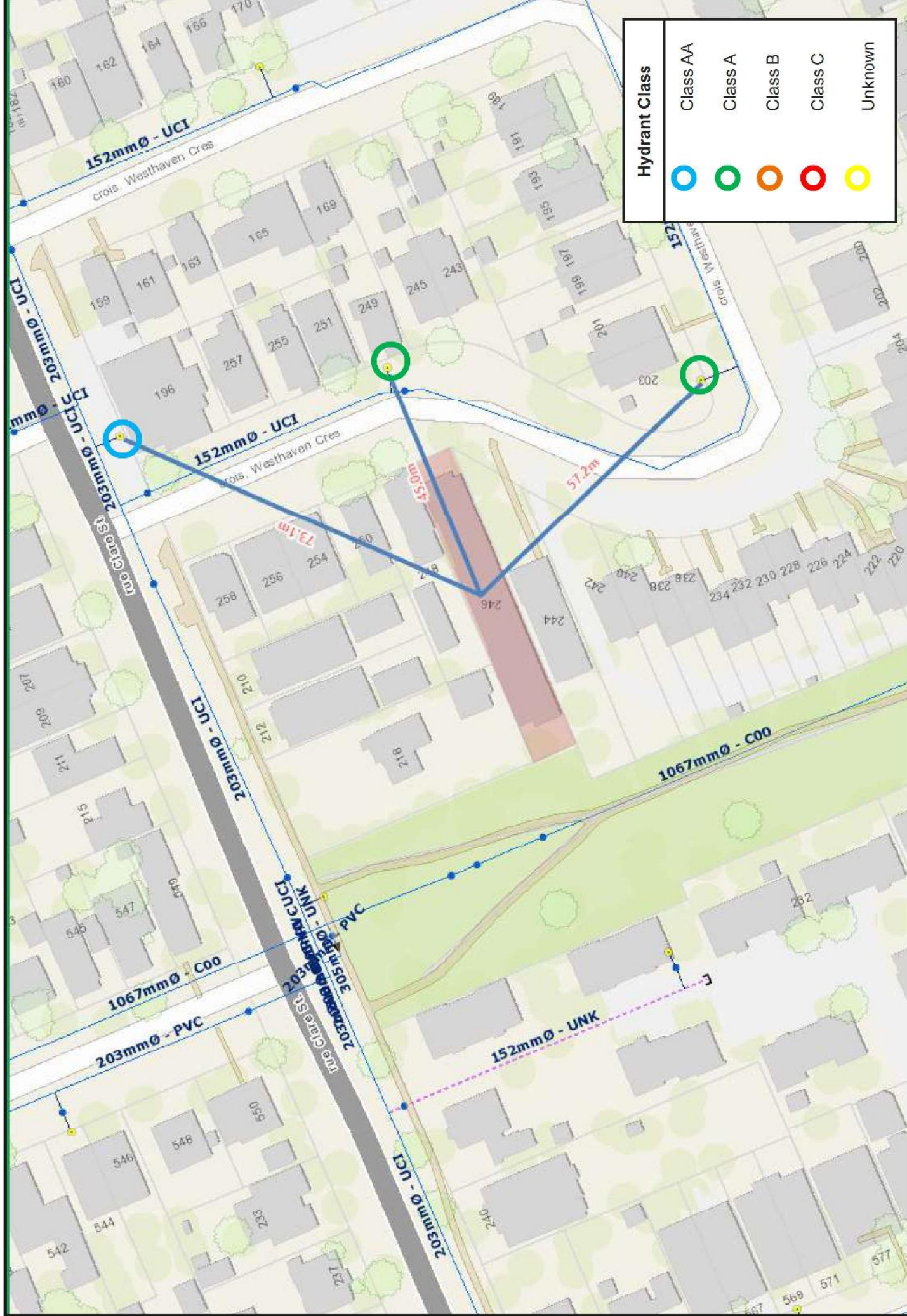
Scenario 2:  $P = 50 \text{ psi}$ ; and Scenario 3:  $P = 20 \text{ psi}$ .

To summarize:

Scenario 1: Minimum Pressure under Peak Hour Demand: 286 kPa (42 psi)
Scenario 2: Maximum Pressure under Average Day Demand: 343 kPa (50 psi)
Scenario 3: Minimum Pressure under Maximum Day + Fire Flow Demand: 138 kPa (20 psi)



**ATTACHMENT 7 : FIGURE 2 – HYDRANT SPACING**



**Figure 2: Hydrant Spacing**

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**EXISTING THREE-STOREY MULTI-UNIT  
RESIDENTIAL BUILDING  
RENOVATIONS  
246 WESTHAVEN CRESCENT  
CITY OF OTTAWA**

**APPENDIX D**

**SANITARY SEWER DESIGN SHEET**

**PAGE 1 OF 2**

**AND**

**PAGE 2 OF 2**







**EXISTING THREE-STOREY MULTI-UNIT  
RESIDENTIAL BUILDING  
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246 WESTHAVEN CRESCENT  
CITY OF OTTAWA**

**APPENDIX E**

**AQUA DRAIN  
CCTV REPORT SUMMARY  
DATED MARCH 13, 2024**



