PROPOSED SEVEN-STOREY

RESIDENTIAL APARTMENT BUILDING SITE

LOT 12 (WEST FORWARD AVENUE)

R-PLAN 35

174 FORWARD AVENUE

CITY OF OTTAWA

STORM DRAINAGE REPORT

REPORT R-816-89

T.L. MAK ENGINEERING CONSULTANTS LTD.

APRIL 2017

REFERENCE FILE NUMBER 816-89

Introduction

The proposed seven-storey apartment building site is located on the southwest corner of the intersection at Forward Avenue and Lyndale Avenue and is situated east of Parkdale Avenue and west of Hinchey Avenue. Its legal property description is Lot 12 (West Forward Avenue) Registered Plan 35 City of Ottawa.

Currently, the existing residential lot under consideration is occupied by a two(2)-storey vinyl-sided dwelling. Most of the lot is asphalt-surfaced. The municipal address of the property is 174 Forward Avenue.

The lot area under consideration is approximately 457.1 square metres. The developer is proposing to re-develop this parcel of land into a seven(7)-storey residential apartment building site with a mechanical penthouse above the seventh floor. There will be vehicle parking only on the ground level of the building. Vehicle access to the building will be via a laneway off of Lyndale Avenue. The total square footage of the building is approximately 22,000 square feet (2043.0 square metres).

This proposed new building will house a total of 24 units consisting of one(1)-bedroom and two(2)-bedroom apartments. The storm-water outlet for this site is the existing 300mm diameter storm sewer located within the limits of the Forward Avenue road right of way.

From a pre-consultation meeting with the staff at the City of Ottawa's Engineering Department, the allowable post-development runoff release rates shall not exceed the two(2)-year pre-development conditions. The allowable pre-development runoff coefficient is the calculated "C" value under present conditions or C=0.5 maximum, and T_c=10.0 minutes. If the uncontrolled storm-water runoff exceeds the specified requirements, then on-site storm-water management (SWM) control measures are necessary. The post-development runoff coefficient for this site is estimated at C=0.75, which exceeds the calculated pre-development allowable C=0.5 criteria for the Forward Avenue storm sewer without on-site SWM control. Therefore, SWM measures are required. Refer to the attached Drainage Area Plan (Figure 1) as detailed in Appendix A.

This report will address and detail the grading, drainage, and storm-water management control measures required to develop this property. Based on the Proposed Grading, Servicing and Stormwater Management Plan (Dwg. 816-89 G-1), the storm water of this lot will be entirely controlled on site.

The storm-water management calculations that follow will detail the extent of on-site SWM control to be implemented and the storage volume required on site to attain the appropriate runoff release that will conform to the City's established drainage criteria.

Site Data

1. Development Property Area

Post-Development Site Area Characteristics

Development Lot Area =457.10m^2
Roof Surface Area =314.3m^2
Asphalt Area =7.0m^2
Paver and Concrete Area =12.5m^2
Grass Area =66.0m^2
River Stone Area =57.3m^2

$$C = \frac{(314.3 \times 0.9) + (7.0 \times 0.9) + (12.5 \times 0.8) + (66.0 \times 0.2) + (57.3 \times 0.5)}{457.10}$$

$$C = \frac{341.02}{457.10}$$

$$C = 0.746$$

Say “C”=0.75

Therefore, the average post-development “C” for this site is 0.75.

2. Controlled Area Data

Roof Surface Area =314.3m^2
Total Storm-Water Controlled Area =314.3m^2

$$C = \frac{(314.3 \times 0.9)}{314.3}$$

$$C = \frac{282.87}{314.3}$$

$$C = 0.9$$

Therefore, the post-development “C” for the controlled storm-water drainage area is 0.9.

3. Uncontrolled Area Data

Asphalt Area =7.0m^2
Grass Area =66.0m^2
Paver and Concrete Area =12.5m^2
Clear Stone Area =57.3m^2

Total Storm-water Uncontrolled Area =142.8m^2

$$C = \frac{(12.5 \times 0.8) + (66.0 \times 0.2) + (57.3 \times 0.5) + (7.0 \times 0.9)}{142.8}$$

$$C = \frac{58.15}{142.8}$$

$$C = 0.407$$

Say “C”=0.41

Therefore, post-development “C” for the uncontrolled storm-water drainage area of the site is 0.41.

The tributary area consisting of approximately 142.8 square metres will be out-letting off site uncontrolled from the proposed residential apartment building site.

The SWM area to be controlled is 314.30m^2 consisting of the various levels of the building rooftop area. Refer to the attached “Drainage Area Plan” in Figure 1 for details.

The site SWM storage tank (ST. MH #1) located under the ground-level parking lot is to be controlled by the ICD in the proposed underground drainage structure.

Pre-Development Flow Estimation

Maximum allowable off-site flow: two(2)-year storm

Pre-Development Site Area Characteristics

Development Lot Area	=457.10m^2
Roof Area	=77.5m^2
Asphalt Area	=363.4m^2
Concrete Area	=16.2m^2

$$C = \frac{(77.5 \times 0.9) + (363.4 \times 0.9) + (16.2 \times 0.8)}{457.1}$$

$$C = \frac{409.77}{457.1}$$

$$C = 0.897$$

Use C_{pre}=0.5 maximum allowable for redevelopment

T_c=D/V where D=35.0m, ΔH=0.55m, S=1.57%, and V=2.5feet/sec=0.76m/s (See Appendix B)

Therefore,

$$T_c = \frac{35.0m}{0.76m/s}$$

T_c=0.77 minutes
Use T_c=10 minutes
I_2=77.10mm/hr [City of Ottawa, two(2)-year storm]

Using the Rational Method

Q=2.78 (0.5) (77.10) (0.04571)

Q=4.90L/s

Because 142.8 square metres are drained uncontrolled off site, the **net** allowable discharge for this site into the existing storm sewer system is Q={2.78 (0.5) (77.1) (0.04571)−[2.78 (0.41) (120.0) (0.0143)]}=4.90L/s−1.96L/s=2.94L/s.

Storm-Water Management Analysis

The calculated flow rate of 2.94L/s for on-site storm-water management detention volume storage will be used for this SWM analysis. The runoff greater than the allowable release rate will be stored on site in the proposed concrete storm-water oversized manhole with an ICD control installed at the 150mm outlet pipe. The proposed underground drainage structure is to be located under the car-parking area in the building.

Therefore, the total allowable five(5)-year release rate of 4.90L/s will be entering into the existing 300mm diameter Forward Avenue storm sewer. The runoff that is greater than the allowable release rate will be stored on site in the proposed underground storm-water storage tank.

The post-development inflow rate during the five(5)-year and 100-year storms for the SWM in the oversized storm manhole (ST. MH #1) from rooftop drainage areas can be calculated as follows.

Design Discharge Computation

Storm Manhole #1 for Storm-water Attenuation

The Rational Method was used to estimate peak flows.

Q=2.78 CIA

Inflow rate Q_{ACTUAL} for the site is:

Five(5)-year event
C_5=0.9 (controlled storm-water area)
A=0.03143ha.
Inflow rate Q_{A5}= 2.78 CIA=2.78 (0.9) (0.03143ha.) I
Q_{A1}= 0.0787 I
I=mm/hr

The inflow rate for the controlled site tributary area can be calculated as follows:
Q_5= 0.0787 I

100-year event

$$C = \frac{(1.25 \times 0.9 \times 314.3)}{314.3}$$

Therefore, the controlled storm-water area C_{100}=1.0

Inflow rate $(Q_A)_{100}$= 2.78 CIA=2.78 (1.0) (0.03143ha.) I
$(Q_A)_{100}$= 0.0874 I
I=mm/hr

This can be used to determine the storage volume for the site using the Modified Rational Method.

Actual flow Q_{ACTUAL} is calculated as Q_A=2.78 CIA

Q_{STORED} is calculated as $Q_S = Q_A - Q_{ALLOW}$

The summary results of the calculated inflow and the storage volume required for the proposed underground oversized storm manhole to store the five(5)-year and 100-year storm events are shown in Tables 1 and 2 inclusive (see Appendix C).

Erosion and Sediment Control

The contractor shall implement Best Management Practices to provide for protection of the receiving storm sewer during construction activities. These practices are required to ensure no sediment and/or associated pollutants are released to the receiving watercourse. These practices include installation of a silt fence barrier (as per OPSD 219.110 and associated specifications) along Forward Avenue and all other areas that sheet drain off site. Maintenance hole sediment barriers to be AMOCO 4555 non-woven geotextile or approved equivalent.

Conclusion

To control the five(5)-year storm-water release rate off site to an allowable rate of 4.90L/s, a site storage volume of approximately 3.27m^3 minimum is required during the five(5)-year event. We estimate that approximately 3.27m^3 minimum of site storm-water storage areas are required to attenuate the five(5)-year storm event from the storm-water flow of the building's rooftops (see Table 1).

A proposed underground concrete oversized manhole (ST. MH #1) structure is proposed to provide a tank storage volume of 3.35m^3 at an elevation of 59.96m, which is greater than the required storage volume of 2.70m^3. The proposed holding tank storm water flow will be regulated by an appropriately sized ICD installed in the 150mm diameter outlet pipe.

During the 100-year storm event, to control the 100-year storm-water release rate off site to a net allowable rate of 3.71L/s, a site storage volume of approximately 9.21m^3 minimum is required during the 100-year event. We estimate that approximately 9.21m^3 minimum of site storm-water storage areas are required to attenuate the 100-year storm event from the storm-water flow of the building's rooftops (see Table 2).

A proposed underground concrete oversized manhole (ST. MH #1) structure is proposed to provide a tank storage volume of 9.3m^3 at an elevation of 60.6m, which is greater than the required storage volume of 9.21m^3.

Therefore, by out-letting all the roof areas from various levels to outlet directly in the proposed underground storm-water holding tank and installing the proposed underground drainage structure as shown on the Proposed Grading, Servicing and Stormwater Management Plan Dwg. 816-89 G-1, the desirable five(5)-year storm event level of 59.96m will provide a detention volume of 3.35m^3, and the 100-year storm event level of 60.6m will provide a detention volume of 9.3m^3 on site.

Therefore, an inlet control devise (ICD) will be installed at the outlet of ST. MH #1 in the 150mm diameter storm pipe (outlet pipe). The ICD type recommended is a Hydrovex model 75-VHV-1 where Q=2.94L/s and H=0.93m. See Appendix D for details.

PREPARED BY T.L. MAK ENGINEERING CONSULTANTS LTD.

TONY L. MAK, P.ENG.

LICENSED PROFESSIONAL ENGINEER
04/21/17
TONY L-M. MAK
PROVINCE OF ONTARIO

PROPOSED 174 FORWARD AVENUE RESIDENTIAL DEVELOPMENT SITE

TABLE 1

FIVE(5)-YEAR EVENT

PARKING AREA UNDERGROUND STORAGE/DRAINAGE SYSTEM

REQUIRED STORAGE VOLUME

t_c **TIME** (minutes)	**I** **FIVE(5)-YEAR** (mm/hr)	**Q** **ACTUAL** (L/s)	**Q** **ALLOW** (L/s)	**Q** **STORED** (L/s)	**VOLUME** **STORED** (m^3)
5	140.20	11.03	2.94	8.09	2.43
10	104.20	8.20	2.94	5.26	3.16
15	83.50	6.57	2.94	3.63	3.27
20	70.30	5.53	2.94	2.59	3.11
25	60.90	4.79	2.94	1.85	1.85
30	53.93	4.251	2.94	1.31	2.78

Therefore, the required underground storage volume is 3.27m^3.

PROPOSED 174 FORWARD AVENUE RESIDENTIAL DEVELOPMENT SITE

TABLE 2

100-YEAR EVENT

PARKING AREA UNDERGROUND STORAGE/DRAINAGE SYSTEM

REQUIRED STORAGE VOLUME

t_c **TIME** (minutes)	**I** **100-YEAR** (mm/hr)	**Q** **ACTUAL** (L/s)	**Q** **ALLOW** (L/s)	**Q** **STORED** (L/s)	**VOLUME** **STORED** (m^3)
5	242.60	21.20	2.94	18.26	5.48
10	178.6	15.61	2.94	12.67	7.60
15	142.9	12.49	2.94	9.55	8.60
20	120.0	10.49	2.94	7.55	9.06
25	103.9	9.08	2.94	6.14	9.21
30	91.9	8.03	2.94	5.09	9.16
35	82.6	7.22	2.94	4.28	8.99

Therefore, the required underground storage volume is $9.21m^3$.

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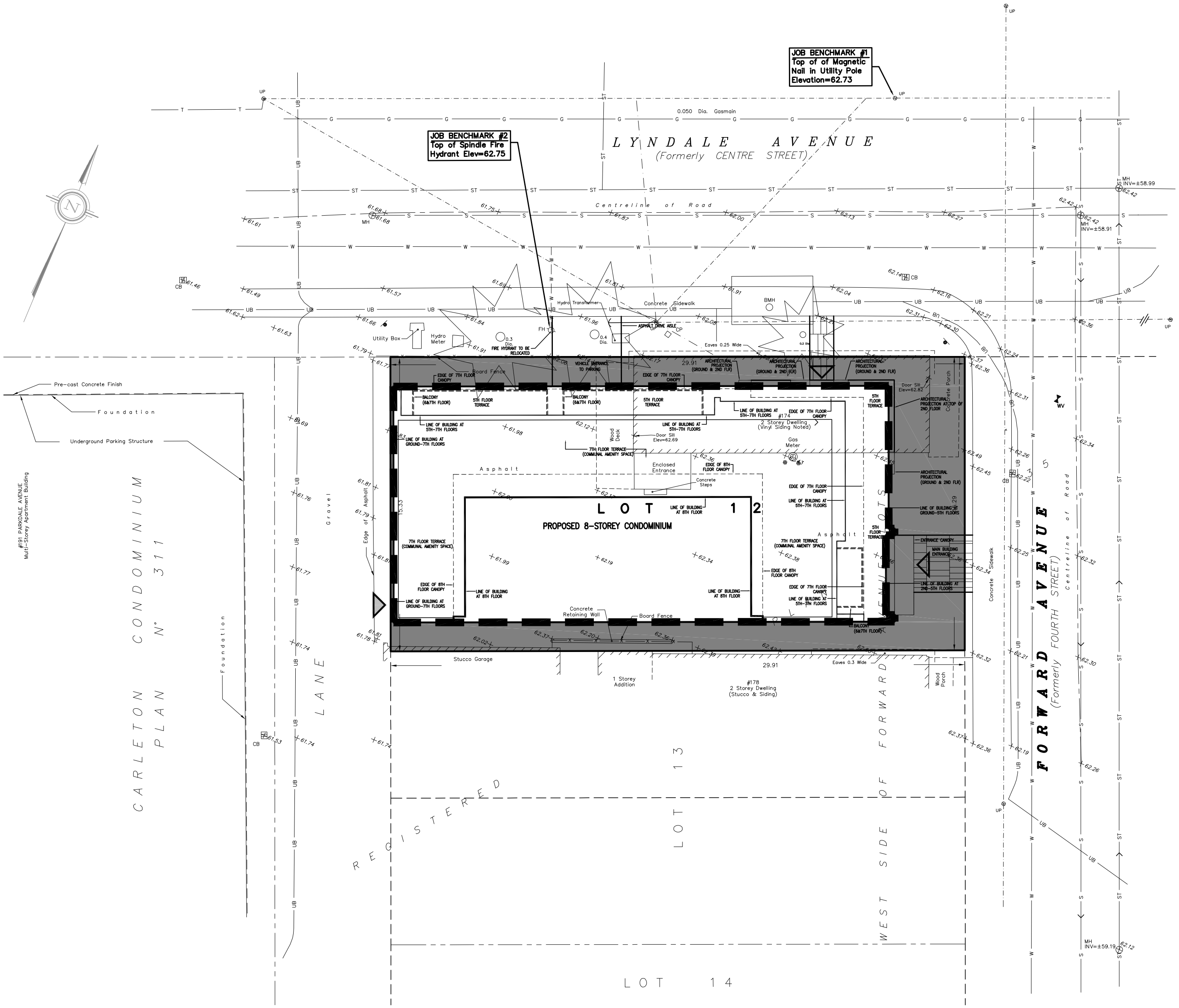
APPENDIX A

STORM DRAINAGE AREA PLAN

FIGURE 1

PROPOSED 174 FORWARD AVENUE
SITE DEVELOPMENT
DRAINAGE AREA PLAN
NOT TO SCALE



LEGEND

LIMIT OF CONTROLLED STORM DRAINAGE AREA =314.3 SQ. M

UNCONTROLLED STORM DRAINAGE AREA =142.8 SQ. M

TOTAL AREA = 457.10 SQ. M

POST-DEVELOPMENT SITE AVERAGE "C" = 0.75

FIGURE 1

PROPOSED SEVEN-STOREY RESIDENTIAL APARTMENT BUILDING SITE

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APPENDIX B

MODERN SEWER DESIGN

FIGURE 3-14

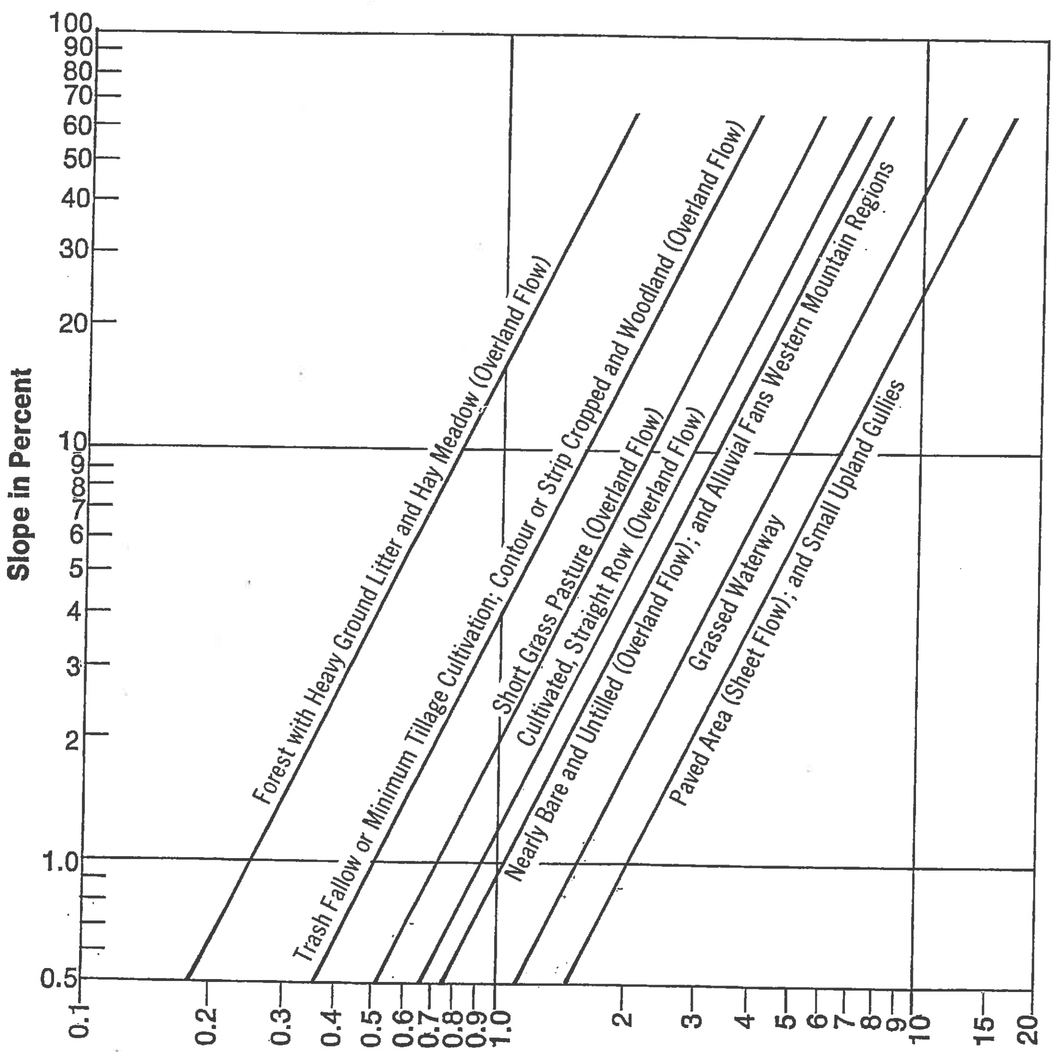

Figure 3-14 Velocities for upland method for estimating travel time for overland flow.

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APPENDIX C

DETAILED CALCULATIONS FOR

FIVE(5)- AND 100-YEAR

AVAILABLE STORAGE VOLUME

AVAILABLE STORAGE VOLUME CALCULATIONS

Five(5)-Year Event

The proposed underground oversized storm manhole structure (ST. MH #1) on this site is designed to provide storm-water detention and to control the net allowable five(5)-year release rate of 2.94L/s.

Underground Drainage Structure Storage, Oversized Manhole (ST. MH #1)

$V = 3.81m \times 2.44m \times 0.36m$
$V = 3.35m^3$ (internal storage volume)

For the five(5)-year storm event, from the proposed in-ground holding tank, the total available underground drainage system storage volume is $3.35m^3$, which is greater than the required $3.27m^3$ calculated volume at the estimated HWL=59.96m.

AVAILABLE STORAGE VOLUME CALCULATIONS

100-Year Event

The proposed underground concrete storage tank structure on this site is designed to provide storm-water detention and to control the net allowable five(5)-year release rate of 2.94L/s.

Underground Drainage Structure Storage, Oversized Manhole (ST. MH #1)

$V = 3.81m \times 2.44m \times 1.0m$
$V = 9.3m^3$ (internal storage volume)

For storm events up to and including the 100-year event, from the proposed in-ground holding tank, the total available underground drainage system storage volume is $9.3m^3$, which is greater than the required $9.21m^3$ calculated volume at the estimated HWL=60.6m.

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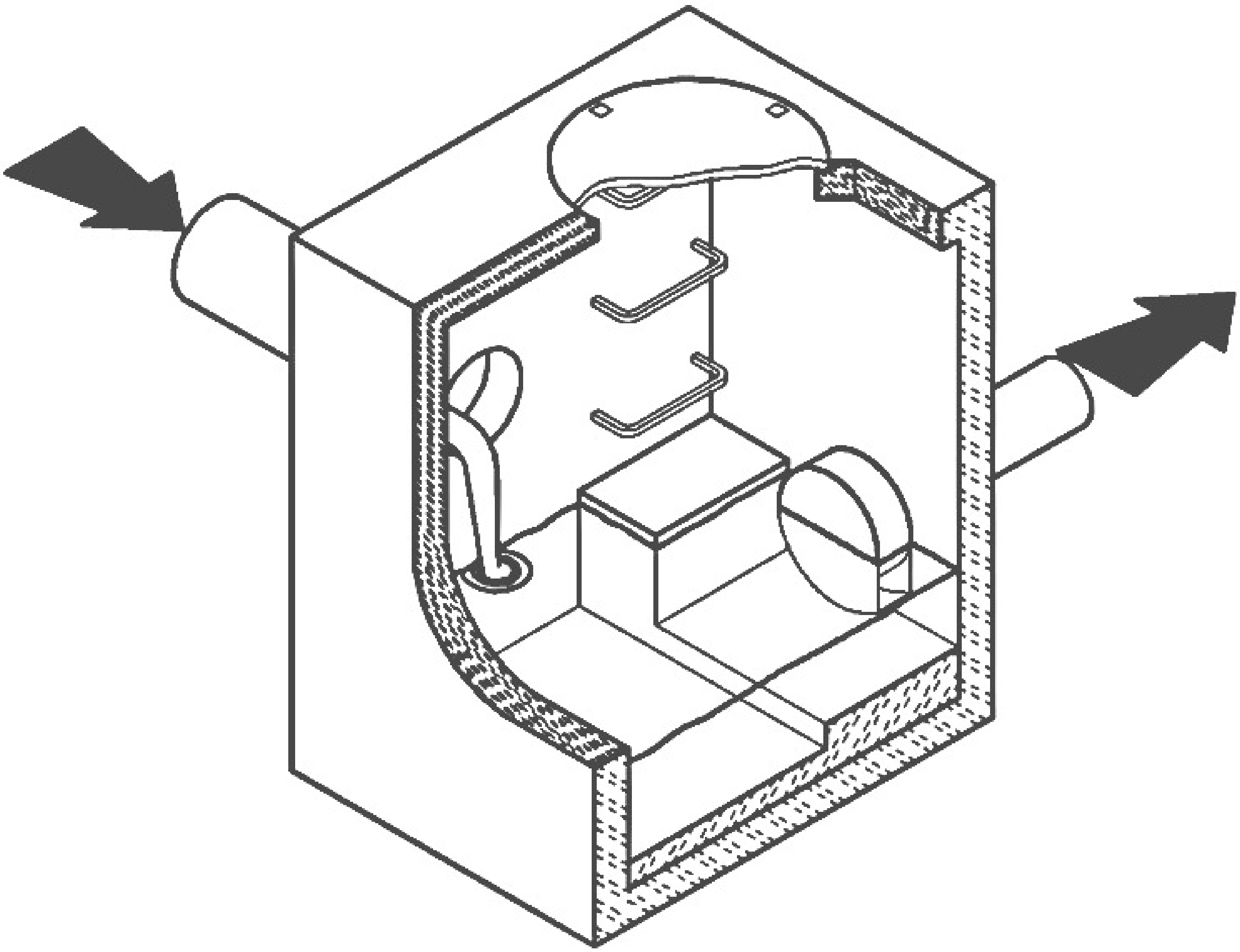
APPENDIX D

INLET CONTROL DEVICE (ICD) DETAILS

HYDROVEX MODEL 75 VHV-1

CSO/STORMWATER MANAGEMENT

® HYDROVEX® VHV / SVHV
Vertical Vortex Flow Regulator



JOHN MEUNIER

APPLICATIONS

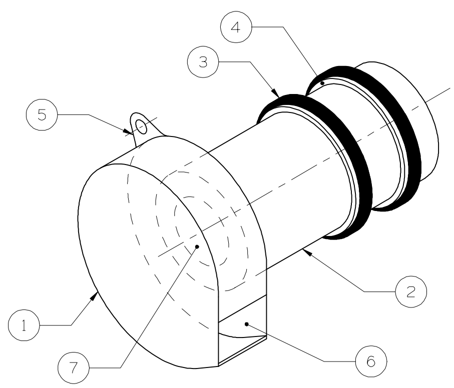
One of the major problems of urban wet weather flow management is the runoff generated after a heavy rainfall. During a storm event, uncontrolled flows may overload the drainage system and cause flooding. Sewer pipe wear and network deterioration are increased dramatically as a result of increased flow velocities. In a combined sewer system, the wastewater treatment plant will experience a significant increase in flows during storms, thereby losing its treatment efficiency.

A simple means of managing excessive water runoff is to control excessive flows at their point of origin, the manhole. **John Meunier Inc.** manufactures the **HYDROVEX® VHV / SVHV** line of vortex flow regulators for point source control of stormwater flows in sewer networks, as well as manholes, catch basins and other retention structures.

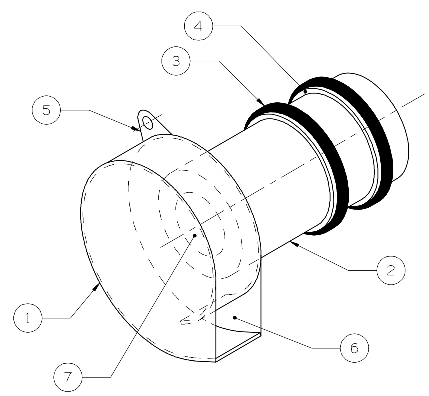
The **HYDROVEX® VHV / SVHV** design is based on the fluid mechanics principle of the forced vortex. The discharge is controlled by an air-filled vortex which reduces the effective water passage area without physically reducing orifice size. This effect grants precise flow regulation without the use of moving parts or electricity, thus minimizing maintenance. Although the concept is quite simple, over 12 years of research and testing have been invested in our vortex technology design in order to optimize its performance.

The **HYDROVEX® VHV / SVHV** Vertical Vortex Flow Regulators **(refer to Figure 1)** are manufactured entirely of stainless steel, and consist of a hollow body (**1**) (in which flow control takes place) and an outlet orifice (**7**). Two rubber "O" rings (**3**) seal and retain the unit inside the outlet pipe. Two stainless steel retaining rings (**4**) are welded on the outlet sleeve to ensure that there is no shifting of the "O" rings during installation and operation.

1. BODY
2. SLEEVE
3. O-RING
4. RETAINING RINGS (SQUARE BAR)
5. ANCHOR PLATE
6. INLET
7. OUTLET ORIFICE



VHV



SVHV

FIGURE 1: HYDROVEX® VHV-SVHV VERTICAL VORTREX FLOW REGULATORS

ADVANTAGES

- As a result of the air-filled vortex, a **HYDROVEX® VHV / SVHV** flow regulator will typically have an opening 4 to 6 times larger than an orifice plate. Larger opening sizes decrease the chance of blockage caused by sediments and debris found in stormwater flows. **Figure 2** shows the discharge curve of a vortex regulator compared to an equally sized orifice plate. One can see that for the same height of water and same opening size, the vortex regulator controls a flow approximately four times smaller than the orifice plate.
- Having no moving parts, they require minimal maintenance.
- Submerged inlet for floatables control.
- The **HYDROVEX® VHV / SVHV** line of flow regulators are manufactured entirely of stainless steel, making them durable and corrosion resistant.
- Installation of the **HYDROVEX® VHV / SVHV** flow regulators is quick and straightforward and is performed after all civil works are completed.
- Installation requires no assembly, special tools or equipment and may be carried out by any contractor.

HYDROVEX®

VHV/SVHV Vortex Flow Regulator

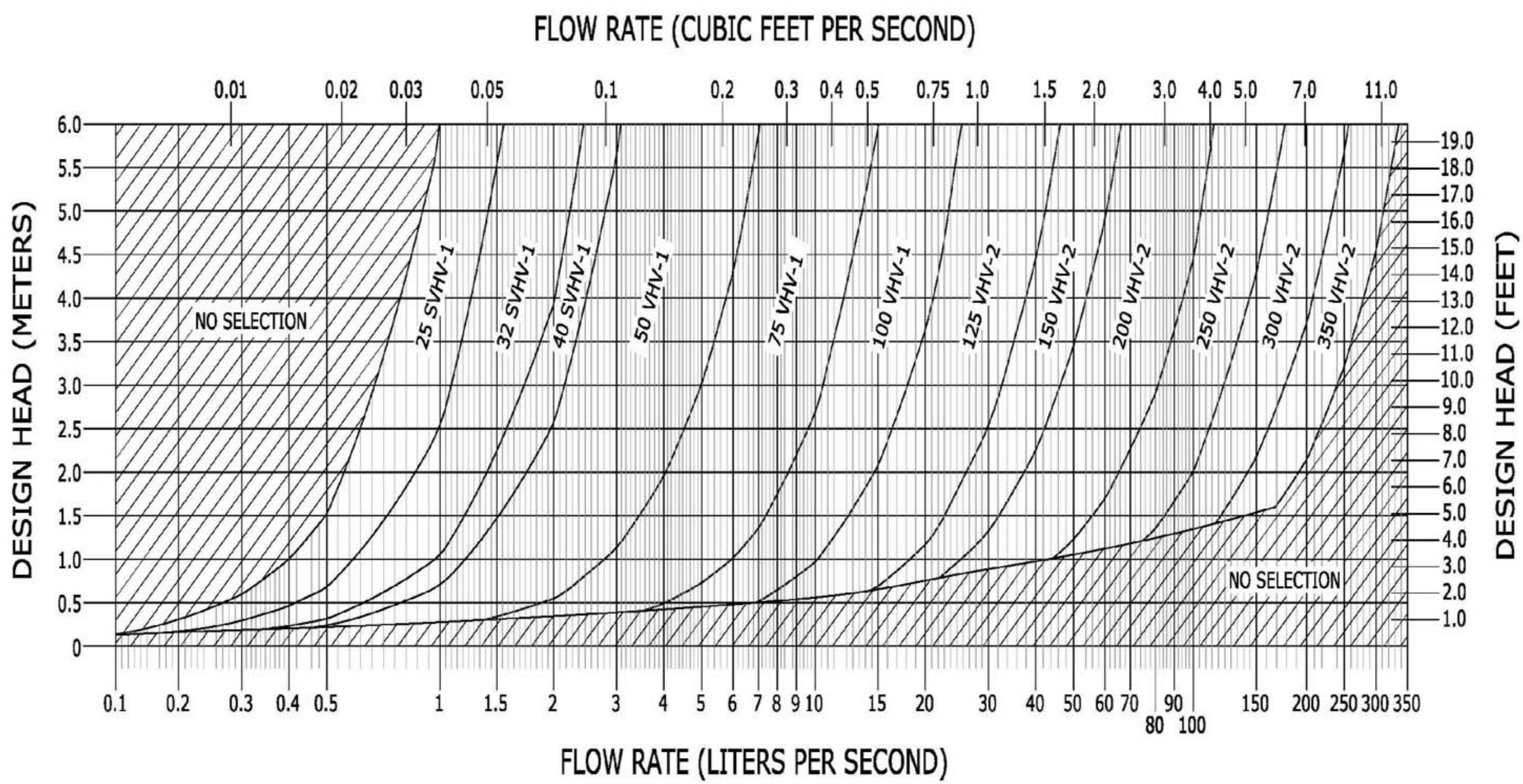


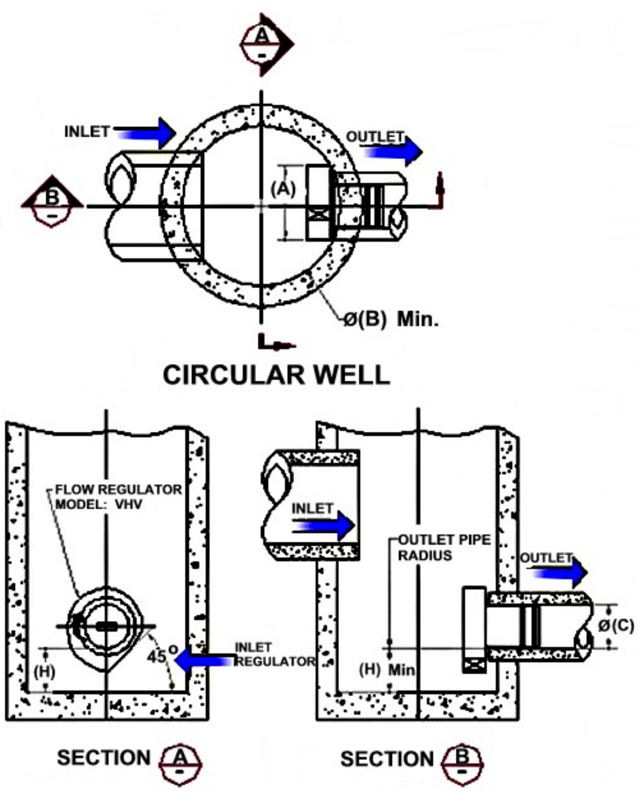
FIGURE 3

JOHN MEUNIER

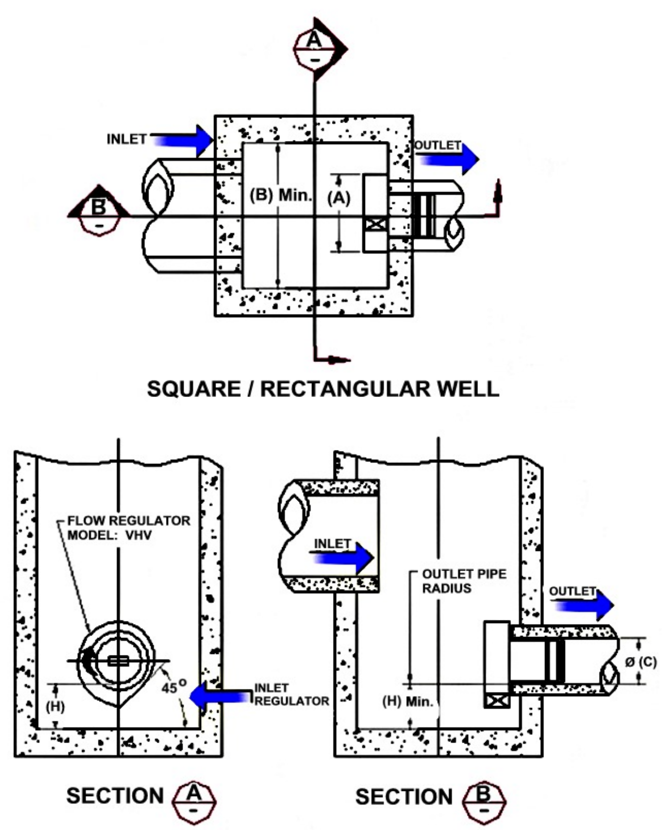
TYPICAL INSTALLATION OF A VORTEX FLOW REGULATOR IN
A CIRCULAR OR SQUARE/RECTANGULAR MANHOLE
FIGURE 4

Model	Regulator Diameter **A** (mm) [in]	**CIRCULAR** Minimum Manhole Diameter **B** (mm) [in]	**SQUARE** Minimum Chamber Width **B** (mm) [in]	Minimum Outlet Pipe Diameter **C** (mm) [in]	Minimum Clearance **H** (mm) [in]
25 SVHV-1	125 [5]	600 [24]	600 [24]	150 [6]	150 [6]
32 SVHV-1	150 [6]	600 [24]	600 [24]	150 [6]	150 [6]
40 SVHV-1	200 [8]	600 [24]	600 [24]	150 [6]	150 [6]
50 VHV-1	150 [6]	600 [24]	600 [24]	150 [6]	150 [6]
75 VHV-1	250 [10]	600 [24]	600 [24]	150 [6]	150 [6]
100 VHV-1	325 [13]	900 [36]	600 [24]	150 [6]	200 [8]
125 VHV-2	275 [11]	900 [36]	600 [24]	150 [6]	200 [8]
150 VHV-2	350 [14]	900 [36]	600 [24]	150 [6]	225 [9]
200 VHV-2	450 [18]	1200 [48]	900 [36]	200 [8]	300 [12]
250 VHV-2	575 [23]	1200 [48]	900 [36]	250 [10]	350 [14]
300VHV-2	675 [27]	1600 [64]	1200 [48]	250 [10]	400 [16]
350VHV-2	800 [32]	1800 [72]	1200 [48]	300 [12]	500 [20]

Circular Manhole



Square / Rectangular Manhole



NOTE: *In the case of a square manhole, the outlet pipe must be centered on the wall to ensure that there is enough clearance for installation of the regulator.*