PROPOSED

THREE-STOREY LOW-RISE APARTMENT BUILDING SITE

NORTH HALF OF LOT 17

R-PLAN 58319

368 CHAPEL STREET

CITY OF OTTAWA

STORM DRAINAGE REPORT

REPORT R-817-61 (REV. 1)

OCTOBER 2018

T.L. MAK ENGINEERING CONSULTANTS LTD.

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REFERENCE FILE NUMBER 817-61

Introduction

The proposed low-rise three-storey apartment building site is located on the west side of Chapel Street, and situated north of Somerset Street and south of Osgoode Street. Its legal property description is north half of Lot 17 (west Chapel Street) Registered Plan 58319 City of Ottawa. At this time, the residential lot under consideration houses a 1½-storey residential development. The municipal address of the property is 368 Chapel Street.

The lot area under consideration is approximately 378.5 square metres. This property is proposed for the development of a three(3)-storey residential apartment building where the ground floor is approximately 50% below grade, and there are three(3) storeys above the ground-floor level. The total gross floor area of the proposed building [all four(4) floors] is 7792 square feet (723.5 square metres).

The building will house a total of seven(7) units consisting of one two(2)-bedroom and six three(3)-bedroom apartments. The storm-water outlet for this site is the existing 450mm diameter storm sewer located within the Chapel Street road right of way.

From storm-drainage criteria set by the staff at the City of Ottawa's Engineering Department, the allowable post-development runoff release rates shall not exceed the five(5)-year pre-development conditions. The allowable pre-development runoff coefficient is the calculated "C" existing value or C=0.5 maximum. 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=0.70, which exceeds the calculated pre-development allowable C=0.5 criteria for the Chapel Street 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 Site Grading and Servicing Plan (Dwg. 817-61 G-1), and on the Proposed Rooftop Storm-water Management Plan (Dwg. 817-61 SWM-1), the storm water of this lot will be controlled on site only by the building's flat rooftop.

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	=378.5m^2
Roof Surface Area	=190.65m^2
Asphalt Area	=5.0m^2
Concrete Area	=80.58m^2
Grass Area	=102.27m^2

$$C = \frac{(190.65 \times 0.9) + (5.0 \times 0.9) + (80.58 \times 0.8) + (102.27 \times 0.2)}{378.5}$$

$$C = \frac{261.003}{378.5}$$

$$C = 0.69$$

Say "C"=0.70

Therefore, the average post-development "C" for this site is 0.70.

2. Controlled Area Data

Roof Surface Area =190.65m^2
Total Storm-water Controlled Area =190.65m^2

$$C = \frac{(190.65 \times 0.9)}{190.65}$$

$$C = \frac{171.585}{190.65}$$

$$C = 0.9$$

Say "C"=0.9

Therefore, the post-development "C" for the controlled storm-water drainage area is 0.90.

3. Uncontrolled Area Data

Asphalt Area =5.0m^2
Grass Area =102.27m^2
Concrete Area =80.58m^2
Total Storm-water Uncontrolled Area =187.85m^2

$$C = \frac{(80.58 \times 0.8) + (102.27 \times 0.2) + (5.0 \times 0.9)}{187.85}$$

$$C = \frac{89.418}{187.85}$$

$$C = 0.476$$

Therefore, the post-development "C" for the uncontrolled storm-water drainage area of the site is 0.476.

The tributary area consisting of approximately 187.85 square metres will be out-letting off site uncontrolled from the residential apartment building site.

The SWM area to be controlled is 190.65m^2. Refer to the attached "Drainage Area Plan" in Figure 1 for details.

Pre-Development Flow Estimation

Maximum allowable off-site flow: five(5)-year storm

Pre-Development Site Area Characteristics

Development Lot Area	=378.5m^2
Asphalt Area	=49.2m^2
Concrete Area	=20.0m^2
Roof Area	=91.5m^2
Grass Area	=217.8m^2

$$C = \frac{(91.5 \times 0.9) + (20.0 \times 0.8) + (217.8 \times 0.2) + (49.2 \times 0.9)}{378.5}$$

$$C = \frac{186.19}{378.5}$$

$$C = 0.492$$

Say C=0.5

Use C_{pre}=0.5 maximum allowable for redevelopment

T_c=D/V where D=38.5m, ΔH=0.70m, S=1.8%, and V=1.0feet/second=0.31m/s
Therefore,

$$T_c = \frac{38.5m}{0.31m/s}$$

T_c=2.07 minutes
Use T_c=10 minutes
I_5=104.4mm/hr [City of Ottawa, five(5)-year storm]

Using the Rational Method

Q=2.78 (0.5) (104.4) (0.038)

Q=5.52L/s

Because 187.85 square metres are drained uncontrolled off site, the **net** allowable discharge for this site into the existing Chapel Street storm sewer system is Q={2.78 (0.5) (104.4) (0.038)−[2.78 (0.476) (120.0) (0.0188)]}=5.52L/s−2.99L/s=2.53L/s.

Storm-Water Management Analysis

The calculated flow rate of 2.53L/s for on-site storm-water management detention volume storage will be used for this SWM analysis. Four(4) controlled roof drains are proposed to restrict flow from the building at a rate of 4×0.63=2.52L/s into the Chapel Street storm sewer. Controlled roof drain details are found on Dwg. 817-61 SWM-1 entitled Proposed Rooftop Stormwater Management Plan.

Therefore, the total allowable five(5)-year release rate of 5.52L/s will be entering into the existing 450mm diameter Chapel Street storm sewer. The runoff that is greater than the allowable release rate will be stored on site at the flat rooftops of the proposed apartment building, all of which will be used for storm-water detention purposes.

The post-development inflow rate during the five(5)-year and 100-year storms for the (4) four rooftop areas can be calculated as follows.

Design Discharge Computation

Flat Rooftop Areas

To Calculate Roof Storage Requirements

The proposed flat roof of the apartment building on the property will incorporate four(4) roof drains to control flow off site. The smallest standard roof drain flow rate is each at 0.63L/s (10USgal./min.). Therefore, the minimum storm-water flow that can be controlled from this rooftop and outletted off site is 0.63L/s× 4=2.52L/s<2.53L/s, which is the net allowable. Refer to the Proposed Rooftop Stormwater Management Plan Dwg. 817-61 SWM-1 for roof drain details.

C=0.9 will be used for sizing roof storage volume in this case.

Inflow rate (Q_A)=2.78 CIA, where C=0.9, A=surface area of roof, I=mm/hr

For Roof Area 1, Q_{A1}=2.78 CIA
Five(5)-Year Event
C_5=0.90
A=45.32m^2
I=mm/hr

Q_1=2.78 (0.90)(0.0046ha.)I=0.0115I

100-Year Event
C_{100}=1.0

$A=45.32m^2$
I=mm/hr

$Q_1=2.78\ (1.0)(0.0046ha.)I=0.0128I$

For Roof Area 2, Q=2.78 CIA
Five(5)-Year Event
$C_5=0.90$
$A=39.99m^2$
I=mm/hr

$Q_2=2.78\ (0.90)(0.004ha.)I=0.010I$

100-Year Event
$C_{100}=1.0$
$A=39.99m^2$
I=mm/hr

$Q_2=2.78\ (1.0)(0.004ha.)I=0.0112$

For Roof Area 3, Q=2.78 CIA
Five(5)-Year Event
$C_5=0.90$
$A=52.05m^2$
I=mm/hr

$Q_3=2.78\ (0.90)(0.0052ha.)I=0.013I$

100-Year Event
$C_{100}=1.0$
$A=52.05m^2$
I=mm/hr

$Q_3=2.78\ (1.0)(0.0052ha.)I=0.0145I$

For Roof Area 4, Q=2.78 CIA
Five(5)-Year Event
$C_5=0.90$
$A=53.29m^2$
I=mm/hr

$Q_4=2.78\ (0.90)(0.0053ha.)I=0.0133I$

100-Year Event
C_{100}=1.0
A=53.29m^2
I=mm/hr

Q_4=2.78 (1.0)(0.0053ha.)I=0.0148I

The summary results of the calculated inflow and the storage volume of the site and building's flat rooftop to store the five(5)-year and 100-year storm events are shown in Tables 1 to 8 inclusive.

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 Chapel Street and all other areas that sheet drain off site. Maintenance hole sediment barriers to be AMOCO 4555 non-woven geotextile or approved equivalent.

Conclusion

For development of this residential site (±0.0379ha.) and in controlling the five(5)-year storm-water release rate off site to a net allowable rate of 2.53L/s, a site storage volume of approximately 1.49m^3 minimum is required during the five(5)-year event. For this site, four(4) flat rooftop storage areas will be used for storm-water management attenuation.

During the five-year storm event for the flat rooftop storage, the ponding depth on this rooftop is estimated at 100mm at the drain and 0mm at the roof perimeter, assuming a 2.5% minimum roof pitch to the drain. The rooftop storage available at Roof Area 1 is 0.66m^3, the rooftop storage available at Roof Area 2 is 0.58m^3, the rooftop storage available at Roof Area 3 is 0.73m^3, and the rooftop storage available at Roof Area 4 is 0.76m^3, for a total of 2.73m^3, which is greater than the required volume of 1.49m^3.

To control the 100-year storm-water release rate off site to a net allowable rate of 2.53L/s, a site storage volume of approximately 4.67m^3 minimum is required during the 100-year event.

During the 100-year storm event for the flat rooftop storage, the ponding depth on this rooftop is estimated at 150mm at the drain and 0mm at the roof perimeter, assuming a 2.5% minimum roof pitch to the drain. The rooftop storage available at Roof Area 1 is 2.26m^3, the rooftop storage available at Roof Area 2 is 2.01m^3, the rooftop storage available at Roof Area 3 is 2.60m^3, and the rooftop storage available at Roof Area 4 is 2.65m^3, for a total of 9.52m^3, which is greater than the required volume of 4.67m^3.

Therefore, by means of flat building rooftop storage and grading the site to the proposed grades as shown on the Proposed Grading and Servicing Plan and Proposed Rooftop Stormwater Management

Plan Dwg. 817-61 G-1 and 817-61 SWM-1 respectively, the desirable five(5)-year storm and 100-year storm event detention volume of 2.73m^3 and 9.52m^3 respectively will be available on site.

The building weeping tile drainage will outlet via its separate 150mm diameter PVC storm lateral and the roof drains will be outletted via a proposed 125mm PVC storm lateral where both laterals are connected directly to the existing Chapel Street 450mm diameter storm sewer.

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PROPOSED 368 CHAPEL STREET RESIDENTIAL DEVELOPMENT SITE

TABLE 1

FIVE(5)-YEAR EVENT

REQUIRED BUILDING ROOF AREA 1 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	141.20	1.62	0.63	0.99	0.30
10	104.20	1.20	0.63	0.57	0.34
15	83.50	0.96	0.63	0.33	0.30
20	70.30	0.81	0.63	0.18	0.22
25	60.90	0.70	0.63	0.07	0.11

Therefore, the required storage volume is 0.34m^3.

PROPOSED 368 CHAPEL STREET RESIDENTIAL DEVELOPMENT SITE

TABLE 2

FIVE(5)-YEAR EVENT

REQUIRED BUILDING ROOF AREA 2 STORAGE VOLUME

t_c TIME (minutes)	**I 5-YEAR** (mm/hr)	**Q ACTUAL** (L/s)	**Q ALLOW** (L/s)	**Q STORED** (L/s)	**VOLUME STORED** (m^3)
5	141.20	1.41	0.63	0.78	0.23
10	104.20	1.04	0.63	0.41	0.25
15	83.50	0.84	0.63	0.21	0.19
20	70.30	0.70	0.63	0.04	0.08

Therefore, the required rooftop storage volume is 0.25m^3.

PROPOSED 368 CHAPEL STREET RESIDENTIAL DEVELOPMENT SITE

TABLE 3

FIVE(5)-YEAR EVENT

REQUIRED BUILDING ROOF AREA 3 STORAGE VOLUME

t_c **TIME** (minutes)	**I 5-YEAR** (mm/hr)	**Q ACTUAL** (L/s)	**Q ALLOW** (L/s)	**Q STORED** (L/s)	**VOLUME STORED** (m^3)
5	141.20	1.84	0.63	1.21	0.36
10	104.20	1.36	0.63	0.73	0.44
15	83.50	1.09	0.63	0.46	0.41
20	70.30	0.91	0.63	0.28	0.34

Therefore, the required rooftop storage volume is 0.44m^3.

PROPOSED 368 CHAPEL STREET RESIDENTIAL DEVELOPMENT SITE

TABLE 4

FIVE(5)-YEAR EVENT

REQUIRED BUILDING ROOF AREA 4 STORAGE VOLUME

t_c TIME (minutes)	**I 5-YEAR** (mm/hr)	**Q ACTUAL** (L/s)	**Q ALLOW** (L/s)	**Q STORED** (L/s)	**VOLUME STORED** (m^3)
5	141.20	1.88	0.63	1.25	0.38
10	104.20	1.39	0.63	0.76	0.46
15	83.50	1.11	0.63	0.48	0.43
20	70.30	0.94	0.63	0.31	0.37

Therefore, the required rooftop storage volume is 0.46m^3.

PROPOSED 368 CHAPEL STREET RESIDENTIAL DEVELOPMENT SITE

TABLE 5

100-YEAR EVENT

REQUIRED BUILDING ROOF AREA 1 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)
10	178.6	2.29	0.63	1.66	1.00
15	142.9	1.83	0.63	1.20	1.08
20	120.0	1.54	0.63	0.91	1.09
25	103.9	1.33	0.63	0.70	1.05
30	91.9	1.18	0.63	0.55	0.99
35	82.6	1.06	0.63	0.43	0.90

Therefore, the required storage volume is 1.09m^3.

TABLE 6

100-YEAR EVENT

REQUIRED BUILDING ROOF AREA 2 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)
10	178.6	2.00	0.63	1.37	0.82
15	142.9	1.60	0.63	0.97	0.87
20	120.0	1.34	0.63	0.71	0.85
25	103.9	1.16	0.63	0.53	0.80
30	91.9	1.03	0.63	0.40	0.72

Therefore, the required rooftop storage volume is 0.87m^3.

TABLE 7

100-YEAR EVENT

REQUIRED BUILDING ROOF AREA 3 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)
10	178.6	2.59	0.63	1.96	1.18
15	142.9	2.07	0.63	1.44	1.30
20	120.0	1.74	0.63	1.11	1.33
25	103.9	1.51	0.63	0.88	1.32
30	91.9	1.33	0.63	0.70	1.26
35	82.6	1.20	0.63	0.57	1.20

Therefore, the required rooftop storage volume is 1.33m^3.

PROPOSED 368 CHAPEL STREET RESIDENTIAL DEVELOPMENT SITE

TABLE 8

100-YEAR EVENT

REQUIRED BUILDING ROOF AREA 4 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)
10	178.6	2.64	0.63	2.01	1.21
15	142.9	2.12	0.63	1.49	1.34
20	120.0	1.78	0.63	1.15	1.38
25	103.9	1.54	0.63	0.91	1.37
30	91.9	1.36	0.63	0.73	1.31
35	82.6	1.22	0.63	0.59	1.24

Therefore, the required rooftop storage volume is 1.38m^3.

PROPOSED THREE(3)-STOREY LOW-RISE APARTMENT BUILDING SITE

NORTH HALF OF LOT 17

R-PLAN 58319

368 CHAPEL STREET

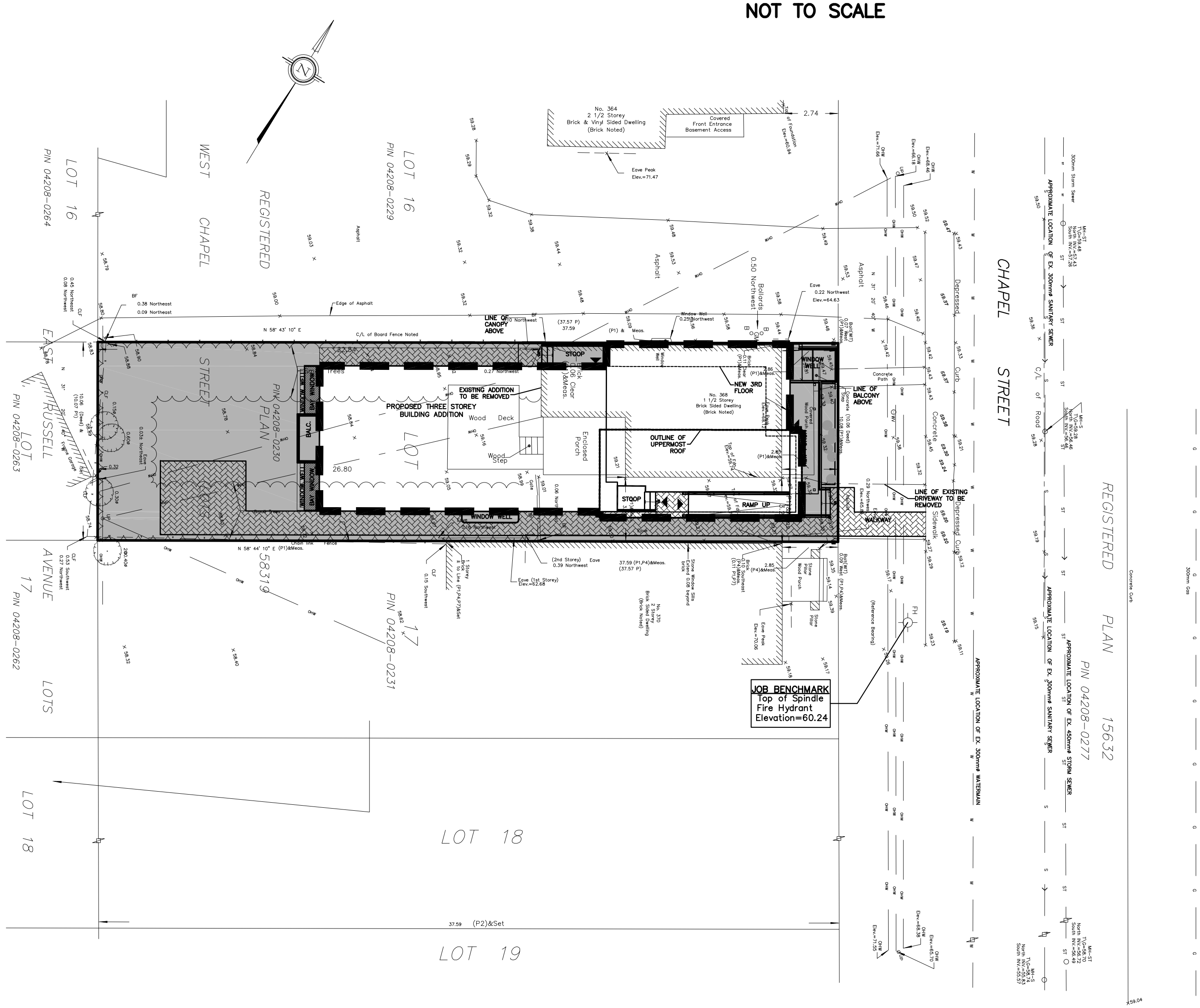
CITY OF OTTAWA

APPENDIX A

STORM DRAINAGE AREA PLAN

FIGURE 1

PROPOSED 368 CHAPEL STREET
SITE DEVELOPMENT
DRAINAGE AREA PLAN
NOT TO SCALE



LEGEND

LIMIT OF CONTROLLED STORM DRAINAGE AREA =190.65 SQ. M

UNCONTROLLED STORM DRAINAGE AREA =187.85 SQ. M

TOTAL AREA = 378.5 SQ. M

POST-DEVELOPMENT SITE AVERAGE "C" = 0.70

FIGURE 1

PROPOSED THREE(3)-STOREY LOW-RISE APARTMENT BUILDING SITE

NORTH HALF OF LOT 17

R-PLAN 58319

368 CHAPEL STREET

CITY OF OTTAWA

APPENDIX B

DETAILED CALCULATIONS

FOR FIVE(5)-YEAR AND 100-YEAR

AVAILABLE STORAGE VOLUME

AVAILABLE STORAGE VOLUME CALCULATIONS

Five(5)-Year Event

Roof Storage at Flat Roof Building

The flat Roof Area 1 to Roof Area 4 inclusive will be used for storm-water detention. Each roof area will be drained by a controlled drain designed for a release rate of 10U.S.gal./min. or 0.63L/s. Refer to Dwg. 817-61 SWM-1 for roof drain details.

Roof Storage Area 1

Available flat roof area for storage =45.32m^2 @roof slope of 2.5% minimum or 100mm of water height above the roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.10\text{m})[19.72 + 4(4.93) + 0]}{6}$$

$$V = \frac{(0.10)(39.44)}{6}$$

$$V = 0.66\text{m}^3$$

The available Roof Area 1 storage volume of 0.66m^3 >required five(5)-year storage volume of 0.34m^3 from Table 1.

Roof Storage Area 2

Available flat roof area for storage =39.99m^2 @roof slope of 2.5% minimum or 100mm of water height above the roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.10\text{m})[17.36 + 4(4.42) + 0]}{6}$$

$$V = \frac{(0.10)(35.04)}{6}$$

$$V = 0.58\text{m}^3$$

The available Roof Area 2 storage volume of 0.58m^3 >required five(5)-year storage volume of 0.25m^3 from Table 2.

Roof Storage Area 3

Available flat roof area for storage =52.05m^2 @roof slope of 2.5% minimum or 100mm of water height above the roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.10\text{m})[21.86 + 4(5.47) + 0]}{6}$$

$$V = \frac{(0.10)(43.74)}{6}$$

$$V = 0.73\text{m}^3$$

The available Roof Area 3 storage volume of 0.73m^3 >required five(5)-year storage volume of 0.44m^3 from Table 3.

Roof Storage Area 4

Available flat roof area for storage =53.09m^2 @roof slope of 2.5% minimum or 100mm of water height above the roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.10\text{m})[22.8 + 4(5.76) + 0]}{6}$$

$$V = \frac{(0.10)(45.84)}{6}$$

$$V = 0.76\text{m}^3$$

The available Roof Area 4 storage volume of 0.76m^3 >required five(5)-year storage volume of 0.46m^3 from Table 4.

Therefore, the ponding depth at the drain location is approximately 0.10m (100mm), and the five(5)-year level is estimated not to reach the roof perimeter of the building.

Hence, Roof Area 1, Roof Area 2, Roof Area 3, and Roof Area 4 of the proposed residential building flat rooftop storage are adequate to store the minimum required five(5)-year storm event volume of 1.49m^3 given it can store up to 2.73m^3.

AVAILABLE STORAGE VOLUME CALCULATIONS

100-Year Event

Roof Storage at Flat Roof Building

The flat Roof Area 1 to Roof Area 4 inclusive will be used for storm-water detention. Each roof area will be drained by a controlled drain designed for a release rate of 10U.S.gal./min. or 0.63L/s. Refer to Dwg. 817-61 SWM-1 for roof drain details.

Roof Storage Area 1

Available flat roof area for storage =45.32m^2 @roof slope of 2.5% minimum or 150mm of fall from roof perimeter to roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.15\text{m})[45.32 + 4(11.22) + 0]}{6}$$

$$V = \frac{(0.15)(90.20)}{6}$$

$$V = 2.26\text{m}^3$$

The available Roof Area 1 storage volume of 2.26m^3 >required 100-year storage volume of 1.09m^3 from Table 5.

Roof Storage Area 2

Available flat roof area for storage =39.99m^2 @roof slope of 2.5% minimum or 150mm of fall from roof perimeter to roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.15\text{m})[39.99 + 4(10.10) + 0]}{6}$$
$$V = \frac{(0.15)(80.39)}{6}$$
$$V = 2.01\text{m}^3$$

The available Roof Area 2 storage volume of 2.01m^3 >required 100-year storage volume of 0.87m^3 from Table 6.

Roof Storage Area 3

Available flat roof area for storage =52.05m^2 @roof slope of 2.5% minimum or 150mm of fall from roof perimeter to roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.15\text{m})[52.05 + 4(12.96) + 0]}{6}$$
$$V = \frac{(0.15)(103.89)}{6}$$
$$V = 2.60\text{m}^3$$

The available Roof Area 3 storage volume of 2.60m^3 >required 100-year storage volume of 1.33m^3 from Table 7.

Roof Storage Area 4

Available flat roof area for storage =53.09m^2 @roof slope of 2.5% minimum or 150mm of fall from roof perimeter to roof drain. Therefore, the available roof area will store a volume as shown below using the reservoir volume equation.

$$V = \frac{(0.15\text{m})[53.29 + 4(13.14) + 0]}{6}$$
$$V = \frac{(0.15)(105.85)}{6}$$
$$V = 2.65\text{m}^3$$

The available Roof Area 4 storage volume of 2.65m^3 >required 100-year storage volume of 1.38m^3 from Table 8.

Therefore, the ponding depth at the drain location is approximately 0.15m (150mm), and at the perimeter of the flat roof area is 0mm above the roof perimeter surface. Accordingly, it is recommended that eight(8) roof scuppers as shown on Dwg. 817-61 G-1 and 817-61 SWM-1 and the architect's roof plan be installed at the perimeter height of the rooftop for emergency overflow purposes in case of blockage from debris buildup at the roof drain.

Hence, Roof Area 1, Roof Area 2, Roof Area 3, and Roof Area 4 of the proposed residential building flat rooftop storage are adequate to store the minimum required 100-year storm event volume of 4.67m^3 given it can store up to 9.52m^3.