Stormwater Master Servicing Study

Prepared For: Town of Strathmore

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Project Number: 16CG0023

Date: 06 July 2018

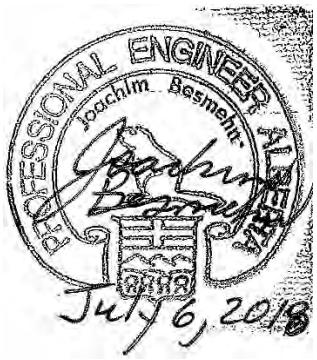
We trust this report satisfies your requirements at this time and thank you for the opportunity to work with you on the project. If you have questions or concerns do not hesitate to contact our office.

Yours truly,

ALLNORTH CONSULTANTS LIMITED

Allnorth Permit to Practice/Certificate of Authorization #P06366

Prepared By:



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Reviewed By:

Nicole Mills, P.Eng.
Sr. Civil Engineer

6 STORMWATER MANAGEMENT – MASTER DRAINAGE PLAN

6.1 Background and Introduction

The Town of Strathmore (Town) stormwater management plan is based on incorporating the requirements set out by regulation and agreements. As many of the Town's existing and future drainage systems drain into the Western Irrigation District (WID) irrigation system, the underlying criteria for the Stormwater Master Drainage Plan for the Town is provided by the WID. The WID underlying criteria is such that the three Strathmore drainage sources of the Eagle Lake Ditch, WID 'A' Main Canal, and WID 'A' North Canal have a maximum allowable release rate of 1700 L/s (60 ft^3/s), 1415 L/s (50 ft^3/s), and 141 L/s (5 ft^3/s), respectively. The Town has in addition to the WID sources, Eagle Lake drainage easement with a flow capacity of 85 L/s (3 ft^3/s) that drains south of Town into Eagle Lake, known as Eagle Lake Drainage. In addition, the Town of Strathmore must follow the Cooperative Stormwater Management Initiative (CSMI) regarding the allowable release rate on the annexed land area, and Alberta Environment (AE) requirements regarding water quality. The study area is shown in **Figure 6-1**.

In 2002, UMA Engineering Ltd. (UMA) was engaged to provide a Master Drainage Plan update for the Town. The report evaluated the existing stormwater management plan and provided servicing requirements for the Town up to the year 2020. The 2006 Master Drainage Plan, also prepared by UMA, assessed the capacity, water quality and other related stormwater issues of the existing storm system, highlighted current hydraulic concerns, and provided stormwater management objectives to guide future development in the Town of Strathmore up to the year 2037.

Although the Water and Sanitary Master Plans were updated in 2012 by AECOM, the Stormwater Master Study (SMS) was not updated due to unknowns regarding the WID agreement for the annexation lands. Since late 2011 the Town along with City of Chestermere, City of Calgary, Rocky View County, Wheatland County and Western Irrigation District have been working towards a cooperative regional stormwater plan through the Co-operative Stormwater Management Initiative (CSMI). CSMI has developed several studies, and the Town has agreed in principle to a regional solution. As such, the Town now needs to update their Master Stormwater Study to incorporate the requirements of the CSMI on the annexation lands and the other changes made since 2006 to their system. The primary objectives of this update are to:

- Incorporate the actual annexation lands into the study (MSSA 2006 only considered 13.5 quarter sections compared to the actual annexation of 18.5 quarter sections). **Figure 6-2** shows the old and new Town boundaries and **Figure 6-3** shows the annexation areas;
- Update the SMS with new stormwater infrastructure added since 2006;
- Update the SMS with future stormwater infrastructure identified through development processes;
- Incorporate the downtown minor storm sewer concept;
- Incorporate the requirement of the CSMI Engineering and Water Balance Studies into the updated SMS for the annexation lands;
- Update the SMS with latest technical data and standards;
- Identify the local (developer) requirement and community stormwater facilities requirements;
- Identify solutions for discrepancies in the original MSSA 2006 regarding upgrades to Pond 4;
- Provide costing and time requirements for the community stormwater upgrades;
- Extend the planning horizon from the current 2037 to 2047.

Date: 2018/04/13 | User: Hanwell Liu | File: P:\CG\2016\0-99\16CG0023 - Town of Strathmore - Master Plan Update - Storm Water\1000-Drawings\1011 Civil\01-Production\16CG0023_Figure 6-1 | Layout: Areas | Paper Size: 431.8mm x 558.8mm

SERVICEBERRY DRAINAGE
(UNNAMED WATER COURSE (C))

WID 'A' NORTH
CANAL (141L/$)

POND 1

POND 2

POND 3

POND 4B

POND 4A

WID 'A' CANAL
(1415L/S)

TO CALGARY

TO MEDICINE HAT
TRANS-CANADA

POND 5

POND 6

UNNAMED
WATER
COURSE (B)

UNNAMED
WATER
COURSE (A)

EAGLE LAKE
DITCH (1700L/S)

EAGLE LAKE
DRAINAGE (85L/S)

Legend

- CANAL
- TOWN BOUNDARY
- UNNAMED WATER COURSE

(1700L/S) ALLOWABLE STORMWATER DRAINAGE BY DESIGN/AGREEMENT

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
C	18/04/13	ISSUED FOR REPORT	HL	-
B	17/01/10	ISSUED FOR REPORT	LX	-
A	16/10/28	ISSUED FOR REVIEW	LX	-

CLIENT: Strathmore — Where Quality of Life is a Way of Life

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TITLE: **Study Area**

CLIENT NO:	-	DRWN:	LX	DATE:	16/10/28
PROJECT NO:	16CG0023	DSGN:	JB	DATE:	-
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	1:25000	APVD:	-	DATE:	-

PROJECT: **Town of Strathmore Stormwater Master Study**

DWG NO: **Figure 6-1**

REV: **C**

Date: 2018/04/13 | User: Hanwell Liu | File: P:\CG\2016\0-99\16CG0023 - Town of Strathmore - Master Plan Update - Storm Water\1000-Drawings\1011 Civil\01-Production\16CG0023_Figure 6-2 | Layout: Areas | Paper Size: 431.8mm x 558.8mm

SERVICEBERRY DRAINAGE
(UNNAMED WATER COURSE (C))

WID 'A' NORTH
CANAL 141L/S

POND 1

POND 2

POND 3

POND 4B

POND 4A

WID 'A' CANAL
1415L/S

TO CALGARY

TO MEDICINE HAT
TRANS-CANADA

POND 5

POND 6

UNNAMED
WATER
COURSE (B)

UNNAMED
WATER
COURSE (A)

EAGLE LAKE
DITCH 1700L/S

EAGLE LAKE
DRAINAGE 85L/S

Legend

- NEW TOWN BOUNDARY
- OLD TOWN BOUNDARY
- STORMWATER MANAGEMENT FACILITY

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
C	18/04/13	ISSUED FOR REPORT	HL	-
B	17/01/10	ISSUED FOR REPORT	LX	-
A	16/10/28	ISSUED FOR REVIEW	LX	-

CLIENT: Strathmore — Where Quality of Life is a Way of Life

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TITLE: **Old and New Town Boundaries**

CLIENT NO:	-	DRWN:	LX	DATE:	16/10/28
PROJECT NO:	16CG0023	DSGN:	JB	DATE:	-
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	1:25000	APVD:	-	DATE:	-

PROJECT: **Town of Strathmore Stormwater Master Study**

DWG NO: **Figure 6-2**

REV: **C**

Date: 2018/06/27 | User: Hanwell Liu | File: P:\CG\2016\0-99\16CG0023 - Town of Strathmore - Master Plan Update - Storm Water\1000-Drawings\1011 Civil\01-Production\16CG0023_Figure 6-3 | Layout: Areas | Paper Size: 431.8mm x 558.8mm

SERVICEBERRY DRAINAGE
(UNNAMED WATER COURSE (C))

WID 'A' NORTH
CANAL 141L/S

R2
69.01 Ha

W3
35.46 Ha

W4
118.53 Ha

W5
74.80 Ha

W6
29.90 Ha

X3
66.33 Ha

W7
130.40 Ha

X4
107.90 Ha

R1
98.16 Ha

POND 1

POND 2

W2
47.38 Ha

WID 'A' CANAL
1415L/S

E1
169.99 Ha

X2
86.06 Ha

X1
40.63 Ha

W1
7.69 Ha

POND 3

POND 4B

POND 4A

TO CALGARY

X5
52.45 Ha

POND 5

TO MEDICINE HAT
TRANS-CANADA

E2
65.41 Ha

TRANS-CANADA
HIGHWAY (TCH)
BY-PASS ROUTE

POND 6

UNNAMED
WATER
COURSE (B)

UNNAMED
WATER
COURSE (A)

EAGLE LAKE
DITCH 1700L/S

EAGLE LAKE
DRAINAGE 85L/S

Legend

- CATCHMENT BOUNDARY
- TOWN BOUNDARY
- ANNEXATION BOUNDARY
- UNNAMED WATER COURSE
- WID 'A' NORTH CANAL
- SERVICEBERRY DRAINAGE
- EAGLE LAKE DITCH DRAINAGE
- WID 'A' CANAL
- UNNAMED WATER COURSE (A)
- UNNAMED WATER COURSE (B)
- R1 SUBCATCHMENT AREA LABEL

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
C	18/04/13	ISSUED FOR REPORT	HL	-
B	17/01/10	ISSUED FOR REPORT	LX	-
A	16/11/09	ISSUED FOR REVIEW	LX	-

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TITLE: **Annexation Areas Existing Drainage**

CLIENT NO:	-	DRWN:	LX	DATE: 16/10/28
PROJECT NO:	16CG0023	DSGN:	JB	DATE: -
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE: -
SCALE:	1:25000	APVD:	-	DATE: -

PROJECT: **Town of Strathmore Stormwater Master Study**

DWG NO: **Figure 6-3**

REV: **C**

A review of the previous report and all development permit applications received from the Town was conducted as well as a review of the existing infrastructure in the Town. A topographic survey was completed of the missing control structures identified in the MSSA, including Ponds 1, 2, 3 and 6 (Note: Pond 6 outfall was modified).

This Master Drainage Plan provides an understanding of how the Town's stormwater network operates, and the impact development will have on the existing infrastructure. It is to be used as a planning document to provide a framework for future development, as well as provide an overview of the proposed system to meet the current stormwater objectives of the Town, the WID, CSMI, and AENV. The report also outlines order-of-magnitude cost estimates for various upgrading recommendations for the overall system to improve stormwater quality and reduce flooding downstream of the Town.

Generally, an urban drainage system is divided into two components, the minor system and the major system, which is often referred to as the "dual" drainage system. The minor system consists of local underground storm mains and trunk mains, designed to carry away water from frequent rainfall events, while the major system consists of overland flow paths designed to manage stormwater flows from major rainfall events. The Town of Strathmore's minor system uses a 1:5 year storm event, while the major system is designed to manage a 1:100 year event.

Further to the "dual" drainage concept within the watershed, it is desirable to limit the allowable discharge rate from the drainage basin to the receiving water body. According to the Alberta Environment (AE) Storm Water Management Guidelines, 1999, the post-development discharge rate should equal the pre-development rate. Best Management Practices (BMPs) should be incorporated in the drainage system to improve the quality of the storm effluent prior to discharging into adjacent streams. The BMPs will be designed to current guidelines and standards at the time of development. The control of the stormwater quantity, as well as quality, is necessary in order to minimize the ecological changes downstream of the urbanized area. According to the AE Storm Water Management Guidelines, 1999, it is necessary to detain the difference between the post- and pre-development runoff on-site.

6.2 Upgrades to the Stormwater System

Since the *2006 Master Drainage Plan* report was completed, there have been numerous upgrades to the Town's existing infrastructure. The following is a list of the significant changes that have occurred:

- The land area of the Town of Strathmore has increased since the 2006 Master Drainage Plan (see **Figure 6-3**).
- The proposed Trans-Canada Highway (TCH) by-pass route has been placed along the south side of the Town (see **Figure 6-3**).
- The Downtown Minor Storm Sewer Concept was initiated, which is summarized below.
- The Town of Strathmore along with neighboring counties, cities and the WID have been working towards a cooperative regional stormwater plan through the CSMI.
- The Master Servicing Study Annexation 2006 prepared by UMA does not have the detailed stage storage curves for the current stormwater storage facilities, which were incorporated into the 2016 stormwater computer model.
- New stormwater infrastructure has been installed.
    - Eagle Lake Ditch

- Underdrains to Pond #1
- Forebay around Pond #1
- Thomas Bioswale
- Centre Street stormwater system

All of these additions mentioned were taken into account when assessing the existing Town stormwater system.

6.2.1 Downtown Minor Storm Sewer Concept

The Town of Strathmore has a plan to redevelop and densify the downtown area bounded by Waddy Lane to the north, 6th Avenue to the south, Lakeside Boulevard to the east, and Wheatland Trail and Fourth Street to the west, as shown in **Figure 6-4**. One of the major constraints to redevelopment is managing the increased stormwater runoff generated by the redevelopment. Allnorth conducted a study in March, 2017 that outlined where new storm sewers are required, size and tie-in locations.

Storm sewers are proposed on Waddy Lane, 1st Avenue to 6th Avenue and 4th Street. It should be noted that 3rd Avenue, 4th Avenue and 4th Street already have storm sewers. A preliminary sizing of the proposed storm sewers on Waddy Lane, 1st Avenue to 6th Avenue and 4th Street was carried out. The following presents a summary of the analysis.

6.2.1.1 Design Criteria

The Town of Strathmore's minor system is designed to accommodate the 1:5 year design storm event, while the major system is designed to accommodate the 1:100 year design storm event. Therefore, the 1:5 year design storm was used to carry out preliminary sizing of the proposed storm sewer system in the study area. Thus, a 1:5 year, 1-hour duration design rainfall event with Chicago distribution that is provided in the City of Calgary Stormwater Management & Design Manual, 2011 was used for computer modelling purposes.

Following the procedure outlined in the *2006 Stormwater Management Master Drainage Plan* report stormwater computations performed in the study area were based on an average impervious ratio of 40 percent for all of the subcatchments in the study area. For areas such as industrial, commercial and high density residential developments where the impervious ratios are greater, on-site detention with local restricted outflow to the storm sewer main would be required.

6.2.1.2 Methodology

The XPSWMM computer model which is discussed below was used to size the proposed storm sewer system. Using the XPSWMM computer model, subcatchment runoff was computed and routed through the storm sewer pipes associated with each subcatchment. The subcatchments within the study area are shown in **Figure 6-5**.

REFERENCE DRAWINGS

DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

LEGEND

- STUDY AREA
- EX. STORM SEWER
- EX. STORM MANHOLE
- EX. CATCHBASIN
- ORIGINAL GROUND CONTOUR
- 977 ORIGINAL GROUND ELEVATION

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
A	17/01/11	ISSUED FOR REPORT	LX	-

CLIENT:

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CLIENT NO:	-	DRWN:	LX	DATE: 17/01/11
PROJECT NO:	16CG0023	DSGN:	JB	DATE: -
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE: -
SCALE:	1:4000	APVD:	-	DATE: -

PROJECT:

Town of Strathmore
Stormwater Master Study

TITLE:

Study Area of Downtown Storm Sewer System

DWG NO: **Figure 6-4**

REV: **A**

Date: 2017/02/07 | User: Annie Xu | File: P:\CG\2016\0-99\16CG0023 - Town of Strathmore - Master Plan Update - Storm Water\1000-Drawings\1011 Cvil\01-Production\16CG0023-Figure 6-4&5&6 | Layout: Study Area | Paper Size: 558.8mm x 431.8mm

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

LEGEND

- STUDY AREA
- CATCHMENT AREAS
- EXISTING STORM SEWER

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
A	17/01/11	ISSUED FOR REPORT	LX	-

CLIENT:

Allnorth

CLIENT NO:	-	DRWN:	LX	DATE:	17/01/11
PROJECT NO:	16CG0023	DSGN:	JB	DATE:	-
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	1:4000	APVD:	-	DATE:	-

PROJECT:

Town of Strathmore
Stormwater Master Study

TITLE:

Catchment Areas of Downtown Storm Sewer System

DWG NO:	REV:
Figure 6-5	**A**

Date: 2017/02/07 | User: Annie.Xu | File: P:\CG\2016\0-99\16CG0023 - Town of Strathmore - Master Plan Update - Storm Water\1000-Drawings\1011 Civil\01-Production\16CG0023-Figure 6-4&5&6.dwg | Layout: Catchment | Paper Size: 558.8mm x 431.8mm

6.2.1.3 Results Summary

Figure 6-6 shows the conceptual layout of the proposed storm sewer system in the study area and **Table 6-1** summarizes the preliminary design of the storm sewer system.

Table 6-1 Proposed Storm Sewer System

Description	Peak Flow (m^3/s)	Slope (%)	Pipe Diameter (mm)
Waddy Lane	0.254	1.0	375
1st Avenue Storm 1	0.235	2.0	375
1st Avenue Storm 2	0.147	1.50	375
2nd Avenue Storm 1	0.319	1.30	450
2nd Avenue Storm 2	0.148	0.60	375
3rd Avenue	0.168	0.46	450
5th Avenue Storm 1	0.164	0.49	450
5th Avenue Storm 2	0.294	1.35	450
6th Avenue	0.356	1.60	450
4th Street	0.217	0.46	450
ST 100 Ridge Road	0.311	0.40	525
ST 101 Lakeside Boulevard	0.203	1.0	450
ST 102 Lakeside Boulevard	0.417	0.5	525

It should be noted that the sizing provided in **Table 6-1** is conceptual and subject to change.

REFERENCE DRAWINGS		
DRAWING NO	DRAWING DESCRIPTION/TITLE	REF
-	-	1

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
A	17/01/11	ISSUED FOR REPORT	LX	-

CLIENT:

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CLIENT NO:	-	DRWN:	LX	DATE:	17/01/11
PROJECT NO:	16CG0023	DSGN:	JB	DATE:	-
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	1:4000	APVD:	-	DATE:	-

PROJECT:

Town of Strathmore
Stormwater Master Study

TITLE:

Conceptual Layout of Downtown Storm Sewer System

DWG NO: **Figure 6-6**

REV: **A**

Date: 2017/02/07 | User: Annie.Xu | File: P:\CG\2016\0-99\16CG0023 - Town of Strathmore - Master Plan Update - Storm Water\1000-Drawings\1011 Civil\01-Production\16CG0023-Figure 6-4&5&6 | Layout: Conceptual | Paper Size: 558.8mm x 431.8mm

6.3 Study Area Description

6.3.1 General

The topography of the Town is generally flat with a maximum elevation difference of 27 m generally sloping from north to southeast. The Town is bisected by the TCH and by the main irrigation canal owned and maintained by the WID. Overland drainage is currently conveyed through a series of existing ponds within the Town boundary and crosses under the TCH on the east side of Town and discharges to Eagle Lake, approximately 5 km southeast of Strathmore via Eagle Lake Ditch (see **Figure 6-7**).

The study area includes the Town and the annexation lands. The total area is 2,477 hectares (ha). This includes 1,566 ha contained within the existing Town (not including WID land) boundary.

6.3.2 Existing Catchment Conditions

For the purpose of this study, the area within the existing Town catchment (1,566 ha) was divided into 60 catchments (Catchment 1 – 24, 26 – 39 and 50, 54 – 56, 58, 59, 60, 62 – 64, 66 – 68, 70, 71, 73 – 76, 77 and 78). The existing catchments in the annexation areas (829 ha) were divided into 17 catchments (Catchments E1, E2, R1, R2, W1 – W7, X1 – X5), which can be seen in **Figure 6-7.** Descriptions of each catchment, including the status of current development, land use, and the existing storm system is presented below. The remaining 82 ha of the study area is occupied by the WID Canal.

Date: 2018/06/27 | User: Hanwell Liu | File: P:\CG\2016\0-99\16CG0023 - Town of Strathmore - Master Plan Update - Storm Water\1000-Drawings\1011 Civil\01-Production\16CG0023_figure 6-7 | Layout: Areas | Paper Size: 431.8mm x 558.8mm

SERVICEBERRY DRAINAGE
(UNNAMED WATER COURSE (C))

WID 'A' NORTH
CANAL 141L/S

R2
69.01 Ha

W3
37.19 Ha

W4
118.43 Ha

W5
74.80 Ha

W6
29.90 Ha

53
1.15 Ha

67
7.12 Ha

54
38.37 Ha

2
30.35 Ha

1
30.01 Ha

FREEMAN
SLOUGH

X3
66.33 Ha

58
15.44 Ha

59
21.23 Ha

3
3.22 Ha

66
17.86 Ha

60
18.03 Ha

5
6.44 Ha

56
22.73 Ha

55
13.84 Ha

19A
2.17 Ha

4
3.66 Ha

7B
27.06 Ha

W7
130.40 Ha

19B
39.62 Ha

6
30.90 Ha

7A
5.65 Ha

SLOUGH

X4
107.90 Ha

R1
98.16 Ha

50
105.30 Ha

18
58.51 Ha

20
25.40 Ha

62
15.10 Ha

63
8.10 Ha

8C
20.14 Ha

POND 1

22
23.48 Ha

8A
5.34 Ha

79
2.57 Ha

WID 'A' CANAL 1415L/S

15
38.72 Ha

17
22.83 Ha

POND 2

8B
6.21 Ha

80
1.04 Ha

68
15.30 Ha

W2
47.38 Ha

21
14.53 Ha

64
3.17 Ha

23
39.25 Ha

9
21.50 Ha

30
43.75 Ha

E1
169.99 Ha

13
13.28 Ha

14
53.81 Ha

12
11.49 Ha

16
11.44 Ha

POND 3

POND 4B

POND 4A

X2
86.06 Ha

X1
40.63 Ha

W1
7.69 Ha

36
36.18 Ha

24
8.62 Ha

31
6.65 Ha

78
3.33 Ha

11
11.60 Ha

TO CALGARY

10
14.73 Ha

37A
30.26 Ha

37B
12.75 Ha

26
13.00 Ha

27
6.56 Ha

TO MEDICINE HAT
TRANS-CANADA

E2
65.41 Ha

POND 5

X5
52.45 Ha

74
29.62 Ha

28
39.46 Ha

32
26.85 Ha

77
57.54 Ha

38
19.43 Ha

29
47.83 Ha

33
10.99 Ha

39
30.01 Ha

70
3.98 Ha

34
74.85 Ha

73
62.25 Ha

76
17.51 Ha

POND 6

75
27.47 Ha

35
59.75 Ha

71
3.69 Ha

UNNAMED
WATER
COURSE (B)

UNNAMED
WATER
COURSE (A)

EAGLE LAKE
DITCH 1700L/S

EAGLE LAKE
DRAINAGE 85L/S

Legend

- CATCHMENT BOUNDARY
- TOWN BOUNDARY
- UNNAMED WATER COURSE
- R1 — SUBCATCHMENT AREA LABEL

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
C	18/04/13	ISSUED FOR REPORT	HL	-
B	17/01/10	ISSUED FOR REPORT	LX	-
A	16/11/09	ISSUED FOR REVIEW	LX	-

CLIENT: Strathmore — Where Quality of Life is a Way of Life

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TITLE: **Catchment Areas Within Town Limits**

CLIENT NO:	-	DRWN:	LX	DATE:	16/11/09
PROJECT NO:	16CG0023	DSGN:	JB	DATE:	-
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	1:25000	APVD:	-	DATE:	-

PROJECT: **Town of Strathmore Stormwater Master Study**

DWG NO: **Figure 6-7**

REV: **C**

6.3.2.1 Drainage to Serviceberry Drainage (Catchments 50, R1, R2, X1, X2, X3, X4, W2)

Catchment 50

Proposed catchment 50 includes the previous Catchments 51, 53 and 72, as well as, the northern section of Catchment 50. This undeveloped catchment, with an area of 105.30 ha, currently drains overland to the Serviceberry Drainage.

Catchment R1

Catchment R1 lies on the west edge of the Town. Stormwater runoff flows overland to the north to the Serviceberry Drainage.

Catchment R2

Catchment R2 is a new undeveloped catchment located northwest of the Town, which has been added to the Town's annexation lands since the last storm water management report was issued in 2006. The catchment area of 69.01 ha currently drains north overland to the Serviceberry Drainage.

Catchment X1

Catchment X1 is a combination of the previous catchments X1 and X2. Previous catchment X1 is a feedlot and is unlikely to be developed in the near future. Any discharge from this site, with an area of 40.63 ha, flows north overland to the Serviceberry Drainage.

Catchment X2

Catchment X2 is a new undeveloped catchment located west of the Town. The catchment area of 86.06 ha currently drains north overland to catchment X4 and then on to the Serviceberry Drainage.

Catchment X3

Catchment X3 (area of 66.33 ha) is a combination of the previous catchments R2 and X3. The southern portion of X3 is a raw water reservoir and unlikely to be used for anything else in the near future. Therefore, the southern half of catchment X3 does not discharge any significant amount of water offsite. If the reservoir were relocated, it would discharge northward. The northern portion of X3 drains northward to the Serviceberry Drainage.

Catchment X4

Catchment X4 is a new undeveloped catchment located west of the Town. The catchment area of 107.90 ha currently drains north overland to the Serviceberry Drainage.

Catchment W2

Catchment W2 contains previous catchment W2 and approximately 85% of the northern portion of W1. This undeveloped catchment area of 47.38 ha currently drains northward to the Serviceberry Drainage.

6.3.2.2 Drainage to WID 'A' North Canal (Catchments 53, 54, W3, W4, W6)

Catchment 53

Catchment 53 is a small residential catchment with an area of 1.15 ha that represents the runoff from the back of the lots and discharges into the WID 'A' North Canal.

Catchment 54

Catchment 54 is a residential subdivision and discharges into the WID 'A' North Canal at a restricted released rate already established, as per an agreement with the WID at 70 L/s.

Catchment W3

Catchment W3 (37.19 ha) is located on the north Town boundary and has the North 'A' branch of the WID canal as its west boundary. Twp Rd 244 forms the south boundary. The area currently drains westward into the WID 'A' North Canal.

Catchment W4

Catchment W4 is located on the north Town boundary and drains westward overland to the WID 'A' North Canal. Twp Rd 244 forms the south boundary of this catchment (118.43 ha).

Catchment W6

Catchment W6 (29.90 ha) lies in the northeast corner and discharges west overland into the WID 'A' North Canal. Rge Rd 251 forms the west boundary.

6.3.2.3 Drainage to WID 'A' Canal (Catchments 55, 56, 58, 64, 67, 78, 79, 80, W1, W5, W7)

Catchment 55

Catchment 55 is a residential subdivision. The catchment area of 13.84 ha discharges stormwater runoff southward to the WID 'A' Canal at a maximum controlled release rate of 36 L/s.

Catchment 56

Catchment 56 with an area of 22.73 ha has remained as is, and drains southward to the WID 'A' Canal.

Catchment 58

Catchment 58 is a golf course that drains southward to the WID 'A' Canal.

Catchment 64

The southwest portion of the Parkwood subdivision is comprised of Catchment 64 with an area of 3.17 ha. Storm sewers do not service the area. Stormwater runoff from Catchment 64 is discharged to the WID 'A' Canal at an uncontrolled rate.

Catchment 67

Catchment 67 forms a portion of the east half of the Strathaven Subdivision and has an area of 7.12 ha. The catchment drains toward the east via a culvert toward a permanent water body located outside of the Town boundary referred to as the Freeman Slough in the annexation catchment W7.

Catchment 78

Catchment 78 is located on the southwest side of the Town of Strathmore. With an area of 3.33 ha, it discharges uncontrolled stormwater runoff into the WID 'A' Canal.

Catchments 79 and 80

Catchments 79 and 80 border the WID 'A' Canal on the eastern side of the Town. Uncontrolled stormwater runoff discharges out of these areas of 2.57 ha and 1.04 ha, respectively, into the WID 'A' Canal.

Catchment W1

This catchment has an area of 7.69 ha. It is bordered by the TCH to the south and discharges stormwater runoff into the western portion of the WID 'A' Canal.

Catchments W5 and W7

Catchment W5 is located in the northeast corner of the Town and drains towards Freeman slough located in Catchment W7. Catchment W7 consists of previous Catchments W7 and W8, and is located on the eastern side of Strathmore. It receives stormwater runoff from catchments 67 and W5 and discharges into the WID 'A' Canal, which makes up its southern border.

6.3.2.4 Drainage to Unnamed Watercourse (A) (Catchments 16, 36, 37A, 37B, 38, 39, 74, X5)

Catchments 16 and 36

Catchment 16 contains the existing Westmount residential subdivision, which is serviced by a storm sewer discharging to an unnamed water body in Catchment 74. The catchment is 11.44 ha in size and ranges in elevation from 977 m in the south to 972 m in the north.

Catchment 36 is located in the south part of Westmount and contains Westmount School, the Town offices, Public Works, and the RCMP headquarters. Catchment 36 is 36.18 ha and slopes from 978 m in the north to 975 m in the south. The area is serviced by storm sewers which convey stormwater flow south below the TCH into a pond located in Catchment 37.

Catchments 37A and 37B

These largely undeveloped areas totaling 43.01 ha, front onto the south side of the TCH. The catchment contains a small residential subdivision of Glenwood (2.2 ha), public offices and a storm pond. The site slopes from 978 m in the west to 974 m at the pond in the east. The pond itself is long and narrow with steep sides and a permanent water level of 971 m. It captures flows from Catchment 36 to the north and discharges stormwater runoff through a culvert toward Catchment 38 to the south.

Catchments 38 and 39

Catchment 38 (19.43 ha) is undeveloped. The area is low-lying, where the groundwater is usually near or at the surface, but without forming a permanent body of water. The area receives stormwater from the pond in Catchment 37B located to the north, and Catchment 38 has a small weir along its southern boundary. The WID has installed an inverted siphon along the catchment's southern boundary to convey irrigation water from the canal located in Catchment 37 to the east side of Catchment 38.

Catchment 39 is currently undeveloped with an area of 30.01 ha situated along the Town's southern boundary. Most of the catchment area consists of the floodplain of an unnamed watercourse, which originates in Catchment 74. The ground slopes from 964 m in the north to 960 m in the south.

Catchment 74

This catchment is approximately 29.62 ha and currently drains into an unnamed watercourse. It is undeveloped and slopes from 980 m in the north to 971 m at the south boundary.

Catchment X5

Catchment X5 is a new undeveloped catchment south of the town. The catchment area of 52.45 ha currently drains east overland to the Unnamed Watercourse (A).

6.3.2.5 Drainage to Unnamed Watercourse (B) (Catchments 73, 77, E1, E2)

Catchment 73

Catchment 73 discharges to an unnamed watercourse on the east side of Strathmore. Catchment 73 slopes from 967 m in the northwest to 944 m in the southeast. It is currently undeveloped and has an area of 62.25 ha.

Catchment 77

Catchment 77, with an area of 57.54 ha, is located on the southeastern side of the Town of Strathmore. Stormwater runoff drains eastward overland toward Catchments E2 and 73, and then via an unnamed watercourse to Eagle Lake.

Catchments E1 and E2

Catchments E1 and E2 lie outside the eastern Town boundary. Area E1 drains south below the Trans-Canada Highway into E2. Stormwater runoff from Catchments E1 and E2 discharge into an unnamed watercourse (intermittent) toward Eagle Lake.

6.3.2.6 Drainage to Eagle Lake Ditch (Catchment 1-18, 19A, 19B, 20, 21, 22, 23, 24, 26-35, 59, 60, 62, 63, 66, 68, 70, 71)

Catchments 1, 3 and 66

Catchment 1 and Catchment 3 comprise the Strathaven residential subdivision and have areas of 30.01 ha and 3.22 ha respectively. The land slopes gradually from 978 m in the northeast to 977 m in the southwest. Catchment 3 includes a dry pond, which captures stormwater runoff from Catchments 1 and 2. The discharge from the dry pond is pumped to a manhole in Catchment 6.

Catchments 66 forms the east half of the Strathaven Subdivision and has an area of 17.86 ha. The catchment drains south via a culvert toward catchment 7B.

Catchment 2

This catchment is located in the northeast half of the rodeo grounds and covers approximately 30.35 ha. The land drains from a high area of 985 m in the northwest corner to 980 m in the southeast. Stormwater runoff from this catchment drains into Catchment 3's dry pond.

Catchments 4 and 5

Catchment 4 is a small area of approximately 3.66 ha and currently contains an ambulance station. As this is a local low point, stormwater is stored on private property, and eventually evaporates or overflows to Catchment 5.

A hospital and its grounds currently occupy the 6.44 ha of Catchment 5 which is bound by Brentwood Boulevard to the south and Strathford Boulevard to the east. The hospital building is situated in the western half of the catchment, and hospital grounds are located to the east. The southeast corner of the catchment is a local low point; which captures excess runoff from the north portion of the catchment. In the basement of the hospital, groundwater from underneath the parking area is pumped to a manhole located in Catchment 5. Stormwater flow is conveyed from the manhole to the storm sewer system running along Maple Tree Way.

Catchment 6

This catchment is approximately 30.9 ha and consists of an older developed residential neighbourhood. The catchment is serviced by storm sewers, which discharge to the trunk sewer in Catchment 8A. The land slopes from 979 m in the north to 976 m in the south. Runoff from Catchment 6 is conveyed through the storm sewer system that runs through Catchments 63 and 8A, and ultimately to Pond 4B.

Catchments 7A and7B

The previous Catchment 7 has been divided into Catchments 7A and 7B. These catchments contain an existing residential development, and have approximate areas of 5.65 ha and 27.06 ha, respectively. These catchments are serviced by a storm sewer, which discharges to the trunk sewer located in Catchment 8. The area has a gentle gradient, from elevation 979 m in the north to 976 m in the south.

Catchments 8A, 8B and 8C

The previous Catchment 8 has been divided into Catchments 8A, 8B and 8C. The existing residential subdivisions of Green Meadows and Grande Point make up the majority of Catchments 8A, 8B and 8C. It also includes a portion of the Parkwood subdivision. The catchment areas are approximately 5.34 ha, 6.21 ha and 20.14 ha respectively, and are serviced by storm sewers. The land slopes from elevation 980 m in the north to 975 m in the south.

Catchments 9 and 68

Catchment 9 has an area of 21.5 ha and consists of previous Catchments 9 and 25. Catchment 9 consists of the western portion of Aspen Creek and approximately half of the Ranch Estates Mobile Park. The western portion of Aspen Creek is serviced by a relatively new storm sewer. There is a slight elevation change when moving across the site from the east (elevation 975 m) to the west (elevation 972 m). The storm sewer connects directly into the storm trunk from Catchment 8B, which outfalls into Pond 4, located in Catchment 9.

In addition, the mobile park in Catchment 9 drains to Pond 4, which receives flow from Pond 3 as well as from the main trunk sewer from northeast Strathmore. Pond 4 has been divided into two sections due to the construction of a new road for the Ranch Market development. The north section of Pond 4 is a long, narrow, and steep- sided valley, 4 m deep and does not have a permanent pool of water, the flow discharges through an existing 1800 mm diameter pipe to the south section of the pond that is a wet pond. Discharge from Pond 4 is through a 1500 mm diameter culvert below the TCH at the south end of the site. This culvert conveys stormwater flow to Catchment 27.

Catchment 68 has an area of 15.3 ha and consists of the eastern portion of the partially developed Aspen Creek residential subdivision. This catchment currently drains to Ranch Market (Catchment 30) at a controlled rate of 198 L/s.

Catchment 10

Catchment 10 is currently undeveloped in southwest Strathmore and has an area of 14.73 ha. It is situated between the TCH to the north, and the X5 annexation catchment to the south. The average gradient of the site is 1%, sloping from an elevation of 980 m in the south to 978 m in the north. Overland flow from this area discharges through a culvert under the TCH and drains towards Strathmore Lake in Catchment 14. (A short length of the canal has recently been diverted for development purposes.)

Catchments 11, 12 and 14

Catchment 11 is located on the western edge of the highway commercial area, which fronts West Ridge Road and the TCH. Only 0.5 ha of the total 11.6 ha catchment is serviced by a storm sewer. The rest of the storm flows are conveyed overland toward Strathmore Lake. This catchment gently slopes from elevation 979 m in the east to 977 m in the west.

The existing Strathmore Lake residential subdivision and its current undeveloped surroundings are included in Catchment 14. Catchment 14 and Catchment 12 and have areas of 53.81 ha and 11.49 ha, respectively. Catchment 12 has an average gradient of 1%, and ranges in elevation from 981 m in the east to 977 m in the west. The area is not serviced by a storm sewer system.

Strathmore Lake was constructed with no direct discharge into the Town's stormwater system. When the pond reaches the HWL, a portable pump is used to discharge the flow into Catchment 15.

Catchment 13

This triangular catchment of approximately 13.28 ha is located along the Town's western boundary. The catchment has been developed into a residential subdivision named Wildflower Heights. The land slopes from elevation 987 m in the southwest to 981 m in the northeast, and is bounded by the WID canal along the eastern edge and the Town boundary to the west. Stormwater flows are conveyed overland towards the northeast corner, where they are piped below the WID canal into Strathmore Lake (Catchment 14).

Catchments 15 and 17

Catchment 15 is currently undeveloped and has an approximate area of 38.72 ha. It lies between the Canadian Pacific (CP) railway right-of-way (ROW) to the north and Strathmore Lake to the south. An unnamed body of water accounts for approximately 10% of the catchment area on the northern boundary. The catchment slopes from elevation 980 m in the south to 974 m in the north. Catchment 15 drains east to Catchment 17, which is a low-lying 22.83 ha undeveloped site that is bound by the old CP ROW to the north. The land is partially covered by small ponds and has a gentle slope from 974 m in the south to 972 m in the north. Catchment 17 picks up overland flow from Catchment 15 and then drains to Catchment 18 via an existing culvert under the old railway berm.

Catchment 18

Catchment 18 is located in the southern part of the Strathmore Golf Course. It has an approximate area of 58.51 ha. An existing pond constitutes approximately 20% of the catchment area. Stormwater flows from other catchments do not directly enter the pond, but enter and exit the sub-catchment in its southeast corner. The water from the pond is utilized for irrigation of the golf course. The pond is filled intermittently by water from the WID canal and acts as a balancing pond for the downstream culvert.

Catchments 19A and 19B

Catchments 19A and 19B have a total area of 2.17 ha and 39.62 ha, respectively, and are bound by the WID canal to the west. The catchments contain the fully developed Brentwood Subdivision, which is a mix of residential and commercial land uses including Brentwood Business Park. The subdivision is serviced by storm sewers, which discharge through twin culverts under the WID canal into Pond 1 located in Catchment 20. Catchments 19A and 19B have elevations ranging from 981 m in the east to 976 m in the west.

Catchments 20, 21 and 22 (Ponds 1 and 2)

Catchment 20 has an area of 25.4 ha and includes Pond 1, which occupies nearly 50% of the total area. The Town of Strathmore owns the land north of the quarter section line while the remainder of the land is privately owned. Pond 1 lies on both of the properties north and south of the section line. The Town and the landowner reached an agreement to allow a maximum flood elevation in Pond 1 for stormwater purposes.

Catchment 21 encompasses the north part of the downtown area. This 14.53 ha site is used for residential (Westpark Village), semi-institutional (seniors housing), and community purposes (community centre). The catchment is relatively steep, ranging in elevation from 977 m in the southwest to 972 m in the northeast.

Catchment 22 has an area of 23.48 ha and contains Pond 2, which occupies approximately 15% of the mostly flat site. Stormwater flows enter Catchment 22 from Pond 1 to the north and from Catchment 21 to the southwest via the old railway ROW in the northeast part of Catchment 21. Outflow from Pond 2 is conveyed via a culvert toward Pond 3 located in Catchment 23.

Catchment 23

This area of 39.25 ha includes the downtown core of Strathmore and Pond 3, otherwise known as Kinsmen Lake. Stormwater flows down the streets toward Lakeside Boulevard, where it flows into a pipe system and outfalls into Pond 3. The catchment slopes from elevation 977 m in the southwest to 970 m at Lakeside Boulevard in the northeast portion. Pond 3's normal water level is 969 m and it receives flow from Pond 2. Discharge from Pond 3 is via a culvert to Pond 4 in Catchment 9.

Catchment 24

Catchment 24 located alongside the TCH consists of a commercial land use. It has an area of 8.62 ha and drains overland to Pond 4. The site slopes from elevation 977 m in the west to 970 m alongside Pond 4.

Catchments 26 and 27

Catchment 26 is a 13.0 ha strip of land zoned highway commercial which is partially developed. The catchment has a slope of 1 % from an elevation of 977 m in the west to a former Pond 5.

A former Pond 5 and its surroundings was located on a steep 6.56 ha site within Catchment 27. Pond 5 was a dry pond with the upper portion of the Eagle Lake Ditch flowing through it. Pond outflows were controlled by a weir at the south end of the pond, which is currently not operational. Thus, Pond 5 no longer functions as a stormwater storage facility.

Catchment 28

Catchment 28 includes the Spruce Business Park, which consists mainly of highway commercial and light industrial businesses. This catchment area of 39.46 ha is partially serviced by storm sewers. Stormwater runoff from the majority of the catchment area is conveyed overland toward Catchment 29. The site is relatively steep, sloping from an elevation of 976 m in the west to 966 m in the east.

Catchment 29

This 47.83 ha undeveloped area located alongside the old CP right-of-way receives drainage from Catchments 1 to 28 and contains Eagle Lake Ditch. Pond 6 has been constructed with a forebay and a dry pond. The discharge from the pond is via two control structures, one an R70 ICD for release into Eagle Lake Ditch by the Town and the other is a manhole with a gate for irrigation purposes to be used by the WID.

Catchment 30

Located north of the TCH on the east side of Strathmore, this 43.75 ha site is partially developed. The existing development includes a Wal-Mart and the remaining half of the Ranch Estates Mobile Home Park, which occupies the northwest portion of the catchment. The catchment slopes from elevation 970 m in the north to 965 m in the south. Some of the stormwater runoff is conveyed through a partially constructed pipe system and the rest of the stormwater flow is conveyed overland toward Pond 4. This area also receives flow from Aspen Creek at a controlled peak rate of 198 L/s.

Catchment 31

The TCH bisects Catchment 31, which has an area of 6.65 ha. It slopes from elevation 969 m in the west to 965 m in the east. Stormwater runoff from Catchment 31 flows overland to Catchment 32.

Catchment 32

Catchment 32 has an area of 26.85 ha which is undeveloped land and is located to the south of the TCH. The catchment slopes form elevation 964 m in the north to 959 m in the south. Storm flows enter this area from Catchments 30 and 31 located to the north, and is conveyed toward Catchment 33 located to the south.

Catchment 33

Catchment 33 (10.99 ha) is undeveloped and receives stormwater flows from Catchments 31 and 32. The land slopes from elevation 959 m in the north to 953 m in the south. Stormwater discharge is via the Eagle Lake drainage course.

Catchment 34

Catchment 34 is a large 74.85 ha, undeveloped tract of land located along the Town's eastern boundary. The land was used as an irrigation area for the disposal of treated effluent from the Town's old wastewater lagoons. Stormwater flows are conveyed overland to the south, discharging into the Eagle Lake Ditch located along the southwestern boundary. The ground slopes form elevation 966 m in the north to 946 m in the south.

Catchment 35

Catchment 35 is a 59.75 ha agricultural area located in the southeastern corner of the Town. The catchment drainage is conveyed overland to the south and discharges into the Eagle Lake Ditch along the southeastern boundary. The ground slopes from elevation 946 m in the north to 942 m in the south.

Catchments 59 and 60

Catchment 59 has an area of approximately 21.23 ha and includes the southwestern half of the rodeo grounds. The catchment drains towards the southwest. Approximately 18.03 ha in size, Catchment 60 is situated along the north side of Brentwood Boulevard. The site contains a sports arena and a high school.

Drainage from this catchment flows toward the southwest corner where it combines with stormwater flow from Catchment 59. A series of small culverts convey stormwater flow south into Pond 1.

Catchments 62 and 63

These catchments comprise the Thorncliff residential subdivision. Catchments 62 and 63 have areas of 15.10 ha and 8.10 ha, respectively. Each catchment is serviced by storm sewers, which discharge underneath the WID 'A' Canal into Pond 2.

Catchment 70

Catchment 70 has an area of 3.98 ha. Stormwater runoff from Catchment 70 drains eastward towards Catchment 29 and the Eagle Lake Ditch.

Catchment 71

Catchment 71 (3.69 ha) is an undeveloped area containing the old CP right-of-way and is located adjacent to the Town of Strathmore Wastewater Treatment Plant. This catchment currently discharges into the Eagle Lake Ditch.

6.3.2.7 No Drainage (Catchment 75, 76)

Catchments 75 and 76

Previous catchment 75 has been divided into two catchments 75 and 76 with areas of 27.47 ha and 17.51 ha, respectively. There is no discharge of stormwater runoff from these catchments that includes the Town of Strathmore Wastewater Treatment Plant.

6.4 Design Criteria

All Stormwater Management design was based on the requirements of CSMI, the City of Calgary Design Guidelines as of the date of this report and AE guidelines that the Town of Strathmore has adopted.

The CSMI report has recommended:

- A maximum allowable unit area release rate of 0.8 L/s/ha for lands the Town has annexed.
- An average annual runoff volume of 40 mm for lands that drain to Serviceberry Creek.
- An average annual runoff volume of 20 mm for annexed lands that drain into the Eagle Lake drainage system.
- For continuous simulation of precipitation and runoff that 6% less of the precipitation recorded at the Calgary International Airport (YYC) be used for the Serviceberry drainage basin and 8% less precipitation be used for the Eagle Lake drainage basin. This is discussed in further detail in **Section 6.4.4**.

In addition, the 2006 Master Drainage Plan recommended a maximum allowable unit area release rate of 1.28 L/s/ha for undeveloped lands within the old Town boundary. This design criteria will changed based on new recommendations made in this master drainage study.

6.4.1 Criteria for Non-Developable Areas

A review of the study area resulted in the definition of non-developable areas based on the following criteria: slope setbacks, creek setbacks, floodplains, utility right-of-ways and environmentally sensitive areas.

6.4.2 Land Use and Impervious Land Cover

Impermeable surfaces, such as pavement or rooftops prevent the infiltration of water into the soil. Impervious land cover is one of the most important parameters to consider in determining stormwater runoff volumes and flow rates. Typical impervious ratios for the different land use types were acquired from Table 3-14 in the document entitled "Stormwater Management & Design Manual", 2011, The City of Calgary Water Resources.

6.4.3 General Storm Drainage Design

In general, streets in developed areas are used to convey the overland (major) stormwater flows. To facilitate this option, a series of recommendations should be adhered to:

- Maximum ponding depth of local trapped lows should be within the limits recommended by Alberta Environment;
- Roof-leaders should not be connected to the minor system;
- A sump pump system should be implemented for foundation drain or weeping tile in areas where gravity connection to a piped storm sewer is not feasible. It is noted that the Town does not allow new weeping tile connections to sanitary sewers; and
- To minimize surcharging of the minor (piped) system, an inlet control device (ICD) should be considered at catch basins to control the inflow to the minor system.

During detailed design, proposed drainage courses and facilities should be protected with registered easements. Geotechnical investigations are necessary to confirm the suitability of pond construction at proposed locations.

Best Management Practices (BMPs) should be incorporated in the drainage system to improve the quality of the storm effluent prior to discharging into adjacent streams. The BMPs will be designed to current guidelines and standards at the time of development. Current guidelines state a requirement of 85% removal of particles larger than 50 µm in size before release into the receiving body of water. The control of the stormwater quantity, as well as quality, is necessary in order to minimize the ecological impacts downstream of the urbanized area.

6.4.4 Stormwater Management Design Parameters

6.4.4.1 Minor System

The Town of Strathmore uses the 1:5 year flow to design local storm mains and trunk mains, as described above.

The Rational Formula in conjunction with Intensity-Duration-Frequency (IDF) curves is the most widely used method for design of minor storm systems that has been used in the past. The peak flow relationship using the Rational Formula Method is defined as follows: $Q = 0.00278\ CIA$

where:
- **Q** - peak flow (m^3/s)
- **C** - runoff coefficient
- **I** - rainfall intensity (mm/hr)
- **A** - subcatchment area (ha)

The Rational Method was replaced by the Unit Area Release Rate Method in the 1990s, except for remaining catchment areas that were originally designed using the rational method, provided the remaining area is less than, or equal to, 30 ha. Areas larger than 30 ha should be designed using the Unit Area Release Rate Method or the Modified Unit Area Release Rate Method. The use of the Rational Method should be limited where possible, even for areas smaller than 30 ha.

6.4.4.2 Major System

According to the AE *Stormwater Management Guidelines*, 1999, it is necessary to detain on-site the difference between the pre-development and post-development runoff on-site.

In accordance with the AE guidelines, and based on protection of receiving streams in terms of erosion and sedimentation, the 1:100 year storm was adopted in this study for design of the major system stormwater facilities.

When designing a major conveyance system, it is necessary to ensure that the rate and volume of overland flow along the drainage routes are acceptable and that the trapped lows do not create safety hazards. The allowable depth and velocity of flow in gutters and swales recommended by AE are shown in **Table 6-2**.

Table 6-2 Allowable Velocity and Permissible Depths

Water Velocity (m/s)	Permissible Depth (m)
0.5	0.8
1.0	0.32
2.0	0.21
3.0	0.09

For roadways, the AE Stormwater Management Guidelines state: "… flow depths of no more than 0.30 m at the gutter are desirable. Standing water at low points should not exceed 0.50 m or extend to adjacent buildings. For arterial roads, the depths of flow should be less; typical criteria are that two lanes of traffic remain open and that the depth of flow be not greater than 0.05 m where major drainage flows cross arterials. No buildings should be allowed in the area flooded by the major event unless they have been specially designed with flood proofing-techniques to withstand flood water."

6.4.4.3 Computer Modelling

Single Event Simulation Model

The XPSWMM 2016 computer model was used to carry out the single event runoff simulations for this study. The XPSWMM model uses either a historic storm or a design storm to compute stormwater runoff. The model's capabilities include generation of storm runoff hydrographs, runoff volumes, and dynamic routing of runoff through storage facilities, open channels and pipes. The model is commonly used in the design of stormwater management facilities in many Canadian municipalities. A detailed description of this model is included in the XPSWMM 2016 user manual.

The original XPSWMM model that was developed in 2006 was used as a base and updated with new data. The modeling update included catchments, newly constructed infrastructure and design parameters.

The characteristics of the contributing subcatchment areas were compiled for input into the XPSWMM computer model to simulate the single event design storms. Stormwater storage facilities that are existing were included in the existing conditions model and proposed and existing stormwater storage facilities with their contributing subcatchment areas were included in the future conditions stormwater models.

Stage-storage data for Ponds 1, 2, 3 and 6 were developed from the Town's LiDAR for input to the single event and continuous simulation computer models. The stage-storage data for Pond 4A was acquired from the Urban Systems report entitled "The Town of Strathmore Pond 4 Culvert/Pond 4B Assessment", 2014.

Continuous Simulation

The operation of detention storage facilities is often influenced by the soil conditions of their contributing drainage areas. This varies from year to year depending on precipitation and wet/dry cycles. As a supplemental procedure to single event analysis, runoff from a catchment can be computed by simulating historic precipitation as a continuous event and taking into account evaporation and the recovery of infiltration. Continuous simulation also accommodates the computation of long term runoff volumes from a catchment.

Continuous simulation alone is not a recommended procedure for sizing a stormwater storage facility because the available rainfall data is limited to a large time increment of one hour. This limits the calculation of peak flow rates that can be simulated from a catchment because high rainfall intensities result in higher peak runoff flow rates. However, this procedure provides a good assessment of storage volume requirements over a long period for comparison to single event analysis. Continuous simulation will govern the sizing of evaporation ponds. Experience in Calgary has shown that continuous simulation will govern the sizing of a stormwater storage facility at very low outflow rates. It is also the most appropriate method for predicting the performance of storm ponds in removing sediment from the stormwater.

The continuous simulation analyses were carried out with the QUALHYMO computer model. The QUALHYMO computer model was originally developed in 1983 during the creation of a methodology for analysis of stormwater detention ponds for water quality control, funded by a grant from the Ontario Ministry of the Environment. QUALHYMO can be used as a general tool for simulating rainfall runoff; however, it is most suited to analyses in basins where the land surface is developing from a rural or undeveloped state to an urban land use.

The basic structure for QUALHYMO is new, but several concepts have been retained from two earlier models, OTTHYMO and HYMO. HYMO, created in 1973 by J. R. Williams, has proven to be a very popular model for use in stormwater quantity studies to date. HYMO, in its original form, is a single event runoff model using a United States Soil Conservation Service (SCS) loss procedure, and is most suitable for use in simulation of direct runoff from rural areas. The model is able to simulate sediment generation using the Universal Soil Loss Equation. HYMO and QUALHYMO employ a concept in code structure that has proven to be excellent for practical applications; basic hydrologic functions (such as runoff generation and routing) are represented by a series of specific "commands" which correspond to distinct subroutines within the model.

QUALHYMO uses the basic input structure developed by Williams for HYMO, and applies some of the IMPSWM concepts implemented in OTTHYMO. The HYMO input structure was chosen partly due to the wide experience with the HYMO, and more recent, OTTHYMO models, and also reflects the effectiveness of this concept for use in planning studies where a simple, flexible, and rapid data input method is desirable.

QUALHYMO is distinct from HYMO and OTTHYMO in its ability to simulate the generation and routing of pollutants, and in its orientation towards continuous simulation. Constituents that can be simulated are:

- Stormwater runoff,
- One pollutant exhibiting first order decay, and/or
- Sediment (in up to 5 size fractions).

The above convention was selected to maintain model simplicity and economy, without unduly restricting its usefulness. Other pollutants (especially heavy metals) can be related to sediments on a mass fraction basis, so simulation of sediments indirectly provides scope for assessment of a variety of pollutants.

An updated version of QUALHYMO has been used for this study that has the capability to compute evaporative losses from ponds. This was accomplished by incorporating a long term historical record of evaporation data. Evaporative losses are calculated at each time step, and are computed as a volumetric loss rate that is the product of pond area at the time, the recorded monthly evaporation rate, and a correction coefficient, which represents the difference between a recorded pan evaporation and the actual evaporation rate for the pond. This means that evaporation rate is a function not only of the recorded meteorological conditions, but the changing volume in the pond.

Continuous modelling using the QUALHYMO computer model was carried out for the future development areas. QUALHYMO simulates both water quantity and sediment removal in stormwater management facilities (SWMF) for several years of data. The results of this modelling show the water balance for each catchment both pre- and post-development.

Continuous simulation of the historic precipitation, temperature and evaporation data was conducted to compute the long term water balance of catchments located in the Annexation Areas to assess the impact of implementing the maximum unit area release rate of 0.8 L/s/ha on average annual runoff volume. The continuous simulations were used to compute the average annual runoff volumes to compare to the CSMI's requirements.

6.4.4.4 Design Storm

A design storm can be either a historical storm that is considered critical for a given area, or a statistically derived synthetic design storm based on an acceptable limit of liability for a given statistical return storm. Depending on the hydrologic technique selected, the design storm can be inferred from point precipitation depths (rainfall data), fabricated (synthetic) hyetographs, or isohyetal maps using predetermined spatial storm patterns. It is important to note that the design storm is not an actual storm of record. Rather, it is a fabricated storm compiled from average characteristics of previous storm events, and for convenience and standardization, most review agencies stipulate the design storm(s) for use in the design process.

The City of Calgary stipulates the use of the Chicago Method for developing synthetic design storms. This method distributes the rainfall indicated by an intensity-duration-frequency (IDF) curve of a selected recurrence frequency (i.e., 1:100 year storm). The 1:100 year return period Chicago design storm is provided in Appendix K of the City of Calgary Stormwater Management & Design Manual, 2011, and was used as input into the XPSWMM computer model.

Precipitation and temperature from the Calgary International Airport (YYC) that has gone through a quality control process and provided by the City of Calgary is used in the QUALHYMO computer model. Long term monthly evaporation data is also provided by the City of Calgary. The data spans the time period from 1960 to 2009, inclusive.

Precipitation generally decreases from west to east across the study area. Long term average climate data shows that the average annual precipitation from 1981 to 2010 at YYC was 419 mm and included 327 mm of rainfall (mostly falling between April and October) and 92 mm of precipitation from snowfall. Gleichen is the next closest long term official gauge (approximately 70 km east southeast of YYC) and has an annual average precipitation of 338 mm, which is 19% less than YYC over the 1981 to 2010 period. Interpolating between YYC and Gleichen suggests that Weed Lake has 4% less precipitation than YYC, Strathmore 6% less, and Eagle Lake 8% less. The YYC precipitation data is adjusted in the continuous simulation model to represent the variation across the study area.

Based on this we used 6% less precipitation for the Serviceberry drainage basin and 8% less precipitation for the Eagle Lake drainage basin.

6.4.5 Model Development

Single Event Simulations

There were seven XPSWMM models developed for this study, the models files can be found on CD in **Appendix C.** The following is a description of each one:

1. **ExTown2016.xp**
   The model represents the existing Town system as of 2016. All the areas that currently go to the Town system are included (1784.3 ha) and the imperviousness for each catchment is as per 2016 conditions. The existing Town infrastructure has also been modelled as well as all the current stormwater ponds.

2. **ExWID2016.xp**
   The model represents the existing areas that currently discharge stormwater runoff into the WID 'A' Canal (262.9 ha). The imperviousness for each catchment is as per 2016 conditions. This was modeled to assess what discharge is actually being released to the WID 'A' Canal as of 2016.

3. **ExWIDNorthA2016.xp**
   The model represents the existing areas that currently discharge stormwater runoff into the WID 'A' North Canal (225.0 ha). The imperviousness for each catchment is as per 2016 conditions. This was modeled to assess what discharge is actually being released to the WID 'A' North Canal as of 2016.

4. **ExServiceBerryCreek2016.xp**
   The model represents the existing areas that currently drain to Serviceberry Creek. The imperviousness for each catchment is as per 2016 conditions. This was modeled to assess the rate of stormwater runoff to Serviceberry Creek for existing conditions.

5. **FutureTown.xp**
   The model represents the proposed Town stormwater management system with the future development. The catchment area has increased to 2078.8 ha. The impervious land cover is as per future development. The existing and proposed infrastructure was modeled as well as upgrades to the ponds as required.

6. **FutureWID.xp**
   The model represents the areas that will continue to discharge into the WID 'A' Canal. The total area that will discharge to the WID ' A' Canal has decreased to 50.58 ha.

7. **FutureWIDNorthA.xp**
   The model represents the areas that will continue to discharge into the WID 'A' North Canal. The total area that will discharge to the WID 'A' North Canal has decreased to 39.52 ha.

Continuous Simulations

Continuous simulations were carried out with the QUALHYMO computer model for the future condition for the Eagle Lake Drainage System and various catchment areas for the future condition when development proceeds in the Serviceberry Creek watershed and Unnamed Watercourse (B).

6.4.6 Detention Ponds

The estimated storage volumes for the proposed ponds in the future conditions scenario included in the storage and flow-through options are based on outlets with assumed orifice sizes and configurations.

Both dry ponds and wet ponds can be used for stormwater detention. The design considerations are described below.

6.4.6.1 Option A - Wet Pond

Alberta Environment recommends wet ponds or wetlands to be used for water quality improvement prior to discharge of stormwater runoff to watercourses.

The general design criteria for wet ponds are:

- Minimum water surface area of 2 ha
- Maximum side slopes above active storage zone are 4:1 to 5:1
- Maximum interior side slopes in active storage zone are 5:1 to 7:1
- Length to width ratio from 4:1 to 5:1
- Minimum freeboard of 0.3 m
- Minimum permanent pool depth of 2.0 m, maximum 3.0 m
- Maximum active detention storage depth (above permanent pool) of 2.0 m.

It is important to incorporate a sediment forebay at each pond inlet to capture the larger suspended contaminants and to improve the performance of the wet pond. In many incidences, wet ponds have been used as recreation facilities for non-body contact activities. With appropriate landscaping, the wetland or wet pond can be an amenity within a development. Backup water supply is required to turn over or maintain the permanent pool in the wet pond during dry seasons and aerators can be installed to increase water circulation. The edge of the pond will have to be designed properly to address riparian vegetation, safety, and maintenance concerns. Typically, the capital and the maintenance costs of the wet pond are higher than those of the dry pond. However, wet ponds have proven to be more effective stormwater quality enhancement facilities, relative to dry ponds.

6.4.6.2 Option B - Dry Pond

Dry ponds are acceptable for attenuating major flows and reducing the size of downstream piping and detention pond facilities. Generally, dry ponds are designed to only capture water for storm events larger than a 1:5 year event and preferably operate as an "off-line" (as opposed to a flow-through) type facility.

The general design criteria for the dry pond are:

- Maximum storage depth of 1.5 m
- Maximum interior side slopes of 4:1 to 5:1
- Minimum ratio of effective length to effective width of 4:1 to 5:1
- Minimum freeboard of 0.3 m
- Minimum pond bottom slope of 1% (2% is preferred)

Similar to the wet pond, a sediment forebay at each pond inlet is recommended. Dry ponds have been widely adopted and proven effective for quantity control; however, compared to wet ponds, they are generally less effective at pollutant removal. Typically, sports fields and other active recreation uses can be incorporated in the dry pond design. A low-flow bypass should be considered to reduce the frequency of inundation of the pond surface. To aid in the design of dry ponds, the current AE Protection Guidelines should be utilized.

6.4.7 Wetlands

The Town implemented the *Strathmore Wetland Conservation Policy* in April, 2007. A study named *Town of Strathmore, Wetland Conservation Plan* by Thomas S. Sadler, P.Biol., was done in 2005 and Wetland Mapping was done by Wade Hawkins which defined the classification of the wetlands within the Town.

Any development that is to occur will have to adhere to the current policy that the Town has implemented. As the development continues around the Town, a developer must ensure the current guidelines are being used in their design.

6.5 Stormwater Management

6.5.1 General

The primary objectives of the stormwater management study are to identify the major flows in the study area and to calculate the allowable discharge rates for future developments and to assess the impact of the criteria for stormwater runoff recommended by the CSMI study.

The result is a master drainage plan that identifies outfall requirements, water quality enhancement facilities, and storage facilities to temporarily store the difference between the post development runoff and allowable release rates established for the study area by the regulatory authorities.

The maximum allowable discharge rate of 1700 L/s from the Town lands to the Eagle Lake Ditch was an underlying criterion in this study, which shaped development of options for stormwater management within the study area.

The maximum allowable discharge rate to the WID Main 'A' Canal is 1415 L/s and the maximum allowable discharge into the North 'A' Canal is 141 L/s. The maximum allowable discharge into the Eagle Lake Drainage is 85 L/s.

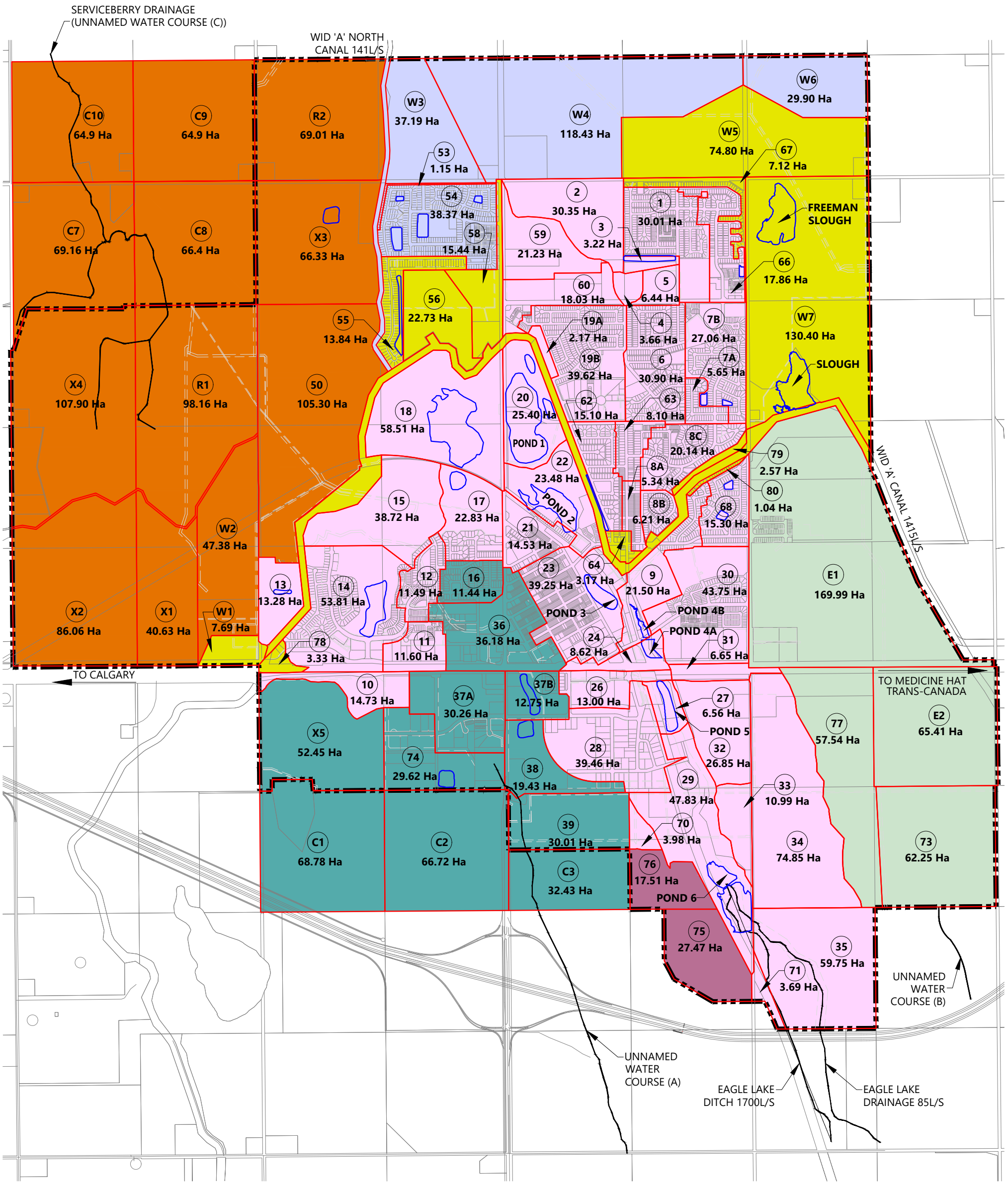
6.5.2 Site Description

There are a few watercourses of interest within the study area. The main watercourse is the Eagle Lake Ditch located on the southeast side the Town; just east of the ditch is the Eagle Lake Drainage watercourse owned by the Town which flows into Eagle Lake, as well there is another unnamed watercourse with intermittent flows on the west side of the Town referred to as Unnamed Watercourse (A), and there is an Unnamed Watercourse (B) located on the east side of the Town. All four watercourses are tributary to Eagle Lake. The WID 'A' Canal is also of interest because the Town is releasing stormwater at uncontrolled rates from some areas within the Town into the canal. As well, the annexation areas outside the Town boundary to the north and the east are contributing to two watercourses, the Serviceberry Creek and the WID A North Canal.

The general drainage within the study area is depicted in **Figure 6-8**, which identifies the following sources of stormwater runoff:

- The catchments that discharge to the WID 'A' North Canal.
- The Town's stormwater management system that discharges to the Eagle Lake Ditch.
- The catchments that discharge to the WID 'A' Canal.
- The catchments that contribute runoff to Serviceberry Drainage.
- The catchments that contribute runoff to Unnamed Watercourse (A).
- The catchments that contribute runoff to Unnamed Watercourse (B).

Date: 2018/04/13 | User: Hanwell Liu | File: P:\CG\2016\0-99\16CG0023 - Town of Strathmore - Master Plan Update - Storm Water\1000-Drawings\1011 Civil\01-Production\16CG0023_Figure 6-8 | Layout: Areas | Paper Size: 431.8mm x 558.8mm



Legend

- CATCHMENT BOUNDARY
- TOWN BOUNDARY
- UNNAMED WATER COURSE
- WID 'A' NORTH CANAL
- SERVICEBERRY DRAINAGE
- WID 'A' CANAL
- UNNAMED WATER COURSE (A)
- UNNAMED WATER COURSE (B)
- NO DRAINAGE
- EAGLE LAKE DITCH DRAINAGE
- R1 SUBCATCHMENT AREA LABEL

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
C	18/04/13	ISSUED FOR REPORT	HL	-
B	17/01/10	ISSUED FOR REPORT	LX	-
A	16/11/09	ISSUED FOR REVIEW	LX	-

CLIENT: Strathmore — Where Quality of Life is a Way of Life

Allnorth

TITLE: **Watershed Areas Existing System**

CLIENT NO:	-	DRWN:	LX	DATE:	16/11/09
PROJECT NO:	16CG0023	DSGN:	JB	DATE:	-
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	1:25000	APVD:	-	DATE:	-

PROJECT: **Town of Strathmore Stormwater Master Study**

DWG NO: **Figure 6-8**

REV: **C**

6.5.3 Current Stormwater Management System

The major feature of the existing stormwater management system is the stormwater ponds that attenuate the stormwater runoff within the developed areas. The following presents rating data for the major stormwater ponds for the existing condition.

Table 6-3 provides the rating data for Pond 1. It is noted that there is limited outflow control from Pond 1 because stormwater outflow from Pond 1 is conveyed via a 450 mm diameter conduit that provides limited outflow control.

Table 6-3 Stage-Storage-Discharge Rating for Pond 1

Elevation (m)	Area (m^2)	Active Volume (m^3)	Discharge (m^3/s)
971.00	111,351	0.0	0.0
971.20	133,010	24,436	0.133
971.40	143,505	52,088	0.188
971.50 (HWL)	148,893	66,708	0.210

Table 6-4 provides the rating data for Pond 2. Similarly to Pond 1, there is limited outflow control from Pond 2 because stormwater outflow from Pond 2 is conveyed via a 600 mm dimeter conduit that provides limited outflow control.

Table 6-4 Stage-Storage-Discharge Rating for Pond 2

Elevation (m)	Area (m^2)	Volume (m^3)	Discharge (m^3/s)
970.40	24,067	0.0	0.0
970.60	54,594	7,866	0.122
970.80	67,994	20,125	0.172
971.00	98,021	36,726	0.211
971.20	111,544	57,683	0.243
971.40 (HWL)	124,860	81,323	0.272

Table 6-5 provides the rating data for Pond 3. Outflow out of Pond 3 is controlled by a 471 mm long rectangular weir with a crest elevation set at elevation 970.20 m.

Table 6-5 Stage-Storage-Discharge Rating for Pond 3

Elevation (m)	Area (m^2)	Volume (m^3)	Discharge (m^3/s)
970.20	5,380	0.0	0.0
970.40	18,986	2,437	0.0843
970.60	23,434	6,679	0.238
970.80	25,617	11,584	0.438
971.00	29,004	17,046	0.674
971.20	36,424	23,589	0.942
971.30 (HWL)	41,002	27,460	1.087

Table 6-6 provides the rating data for Pond 4B. There is no outflow control from Pond 4B because stormwater outflow from Pond 4B is conveyed via an 1800 mm dimeter culvert that does not provide outflow control.

Table 6-6 Stage-Storage-Discharge Rating for Pond 4B

Elevation (m)	Area (m^2)	Volume (m^3)	Discharge (m^3/s)
964.00	1	0.0	0.0
965.00	480	241	2.917
966.00	3,540	2251	4.125
966.70 (HWL)	7,124	6,521	4.755
967.00	8,660	8351	5.052
968.00	14,220	19,791	5.833

An upgrade to Pond 4B is proposed as described in **Section 6.6.5**.

Table 6-7 provides the rating data for Pond 4A. Similarly to Pond B, there is no outflow control from Pond 4A because stormwater outflow from Pond 4A is conveyed via a 1500 mm dimeter culvert that does not provide outflow control.

Table 6-7 Stage-Storage-Discharge Rating for Pond 4A

Elevation (m)	Area (m^2)	Total Volume (m^3)	Discharge (m^3/s)
961.00	1,400	0.0	0.0
963.36 (NWL)	3,900	6,254	0.0
965.50 (HWL)	6,800	17,703	5.757

Table 6-8 provides the rating data for Pond 6. Pond 6 discharges outflow at two locations, Eagle Lake Ditch and Eagle Lake Drainage. The hydraulic control structure that discharges to Eagle Lake Drainage consists of an 80 mm diameter orifice with an invert elevation of 953.634 m. The emergency overflow consists of an overflow weir with a crest elevation of 955.75 m that is 10 m long. The hydraulic control system that discharges to Eagle Ditch consists of a 250 mm diameter pipe and a hydraulic control structure with a 900 mm diameter gate opening at an invert elevation of 954.31 m, an overflow weir with a crest elevation of 955.70 m that is 1.40 m long, and a weir with a crest elevation of 955.375 m and a length of 0. 8 m. It is noted that Pond 6 has not been upgraded since the 2006 Stormwater Master Study.

Table 6-8 Stage-Storage-Discharge Rating for Pond 6

Elevation (m)	Area (m^2)	Total Volume (m^3)	Discharge (m^3/s)
952.00	8,826	0.0	0.0
953.634 (NWL)	15,822	20,976	0.0
954.00	17,389	25,675	0.101
954.20	20,239	29,438	0.122
954.40	22,163	33,678	0.152
954.60	25,296	38,424	0.271
954.80	28,945	43,848	0.439
955.00	33,177	50,060	0.759
955.20	42,949	57,673	1.086
955.40	50,635	67,031	1.390
955.60	56,477	77,742	1.912
955.70 (HWL)	62,860	83,709	2.115

There are other stormwater ponds that convey outflow to the major ponds described above. The following summarizes some of these ponds.

Table 6-9 provides the rating data for the Wildflower Phase 1 Pond which is a dry pond.

Table 6-9 Stage-Storage-Discharge Rating for the Wildflower Phase 1 Pond

Elevation (m)	Area (m^2)	Volume (m^3)	Discharge (m^3/s)
979.70	580	0.0	0.0
980.10	1,750	466	0.329
980.30	1,960	837	0.340
980.50	2,240	1,257	0.350
980.70	2,430	1,724	0.360
980.90	2,710	2,238	0.370
981.10	2,920	2,801	0.379
981.20 (HWL)	3,080	3,101	0.384
981.80	3,727	5,143	0.411

Table 6-10 provides the rating data for the Strathaven Pond which is a dry pond.

Table 6-10 Stage-Storage-Discharge Rating for the Strathaven Pond

Elevation (m)	Area (m^2)	Volume (m^3)	Discharge (m^3/s)
973.00	1	0.0	0.0
973.20	1,050	105	0.085
973.40	2,013	411	0.085
973.60	3,028	916	0.085
973.80	5,433	1,762	0.085
974.00	7,271	3,032	0.085
974.20	8,497	4,609	0.085
974.40	9,296	6,388	0.085
974.60	9,854	8,303	0.085
974.80	9,854	10,274	0.085
975.00 (HWL)	11,029	12,362	0.085
975.20	11,861	14,651	0.085

The outflow from the Strathaven Pond is pumped to a manhole located in Catchment 6, as described previously. The outflow from the Strathaven Pond is constant, because it is conveyed by a pump that is rated at a flow of 0.085 m^3/s.

Table 6-11 provides the rating data for the Strathmore Lakes Estates Stormwater Pond which is a wet pond.

Table 6-11 Stage-Storage-Discharge Rating for the Strathmore Lakes Estates Stormwater Pond

Elevation (m)	Area (m^2)	Total Volume (m^3)	Discharge (m^3/s)
966.58	49,658	0.0	0.0
971.88	74,503	326,885	0.0
972.33	84,605	362,661	0.0
973.08 (NWL)	84,606	426,115	0.0
973.83	84,607	489,570	0.0211
974.25	97,671	527,815	0.0260
974.30 (HWL)	98,645	532,723	0.0266
974.50	100,645	552,652	0.0286

Outflow out of the pond is via a 200 mm diameter conduit.

A computer simulation of the existing condition was conducted with the XPSWMM computer model. The computer simulation shows that the Stormwater Management system currently does not meet the criteria of a maximum discharge of 1700 L/s to Eagle Lake Ditch. **Table 6-12** summarizes the results of the computer simulation for 1:100 year design storm for the existing ponds.

Table 6-12 Existing Conditions Pond Summary

Pond ID	Design HWL (m)	Simulated 1:100 HWL (m)	Simulated Maximum Outflow (m3/s)
1	971.50	971.25	0.150
2	971.40	970.88	0.190
3	971.30	970.88	0.530
4B	966.70	965.77	3.884
4A	965.50	965.66	5.859
6	955.70	955.99	4.935

Table 6-12 indicates that Ponds 4B, 4A and 6 release a high flow rate for the 1:100 year design storm event. Ponds 4B and 4A do not have hydraulic control structures to limit the outflow. Pond 4B has an 1800 mm diameter culvert that conveys flow out of the pond and Pond 4A has 1500 mm diameter culvert that conveys flow out of the pond. These conduits to do not provide flow control, as described previously. The simulated HWL exceeds the design HWL for Pond 4A, indicating that it is somewhat undersized. Changes are proposed to Pond 4B which are discussed in **Section 6.6** that will bring the simulated 1:100 year water level in Pond 4A to less than the design HWL.

Pond 6 discharges outflow to two locations, Eagle Lake Ditch and Eagle Lake Drainage, as described above. The hydraulic control system that discharges to Eagle Lake Drainage discharges at maximum flow rate of 2.061 m^3/s for the 1:100 year design storm event. The hydraulic control system that discharges to Eagle Lake Ditch discharges at a maximum flow rate of 2.874 m^3/s for the 1:100 year design storm event. Thus, the total maximum outflow from Pond 6 is 4.935 m^3/s for the 1:100 year design storm event. The outflow rate from Pond 6 is higher than the discharge rating indicated in **Table 6-8** because the overflow weirs are activated for the 1:100 year design storm event, as a result of the water level rising above the design HWL. Thus, the criteria for maximum discharge to Eagle Lake Ditch and Eagle Lake Drainage is not met. **Table 6-12** indicates that Pond 6 is undersized for current conditions.

A total flow rate of 5.740 m^3/s (5,740 L/s) is discharged from all of the catchments (including the catchment areas in the annexation lands) that are tributary to the WID 'A' Canal as shown in **Figure 6-8** for the 1:100 year design storm event. A total flow rate of 2.612 m^3/s (2,612 L/s) is discharged from the annexation areas for the 1:100 year design storm event. The current conditions do not meet the regulatory requirement of 1415 L/s.

A total flow rate of 1.766 m^3/s (1,766 L/s) is discharged from all of the catchments (including the catchment areas in the annexation lands) that are tributary to the WID 'A' North Canal as shown in **Figure 6-8** for the 1:100 year design storm event. A total flow rate of 1.634 m^3/s (1,634 L/s) is discharged from the annexation areas. The current conditions do not meet the regulatory requirement of 141 L/s.

A total flow rate of 8.175 m^3/s (8,175 L/s) is discharged from all of the catchments (including the catchments in the annexation areas) that are tributary to Serviceberry Creek as shown in **Figure 6-8** for the 1:100 year design storm event. The unit area release rate for these undeveloped catchments has been computed to be 9.225 L/s/ha for the 1:100 year design storm event which is much greater than the unit area release rate of 0.8 L/s/ha recommended by CSMI.

6.5.4 Strathmore Lakes Estates Stormwater Pond

The Town has observed that the Strathmore Lakes Estates Stormwater Pond has flooded over the adjacent pathway in the last few years even during relative minor storm events. The Town requested that an investigation be conducted to assess why the flooding is occurring.

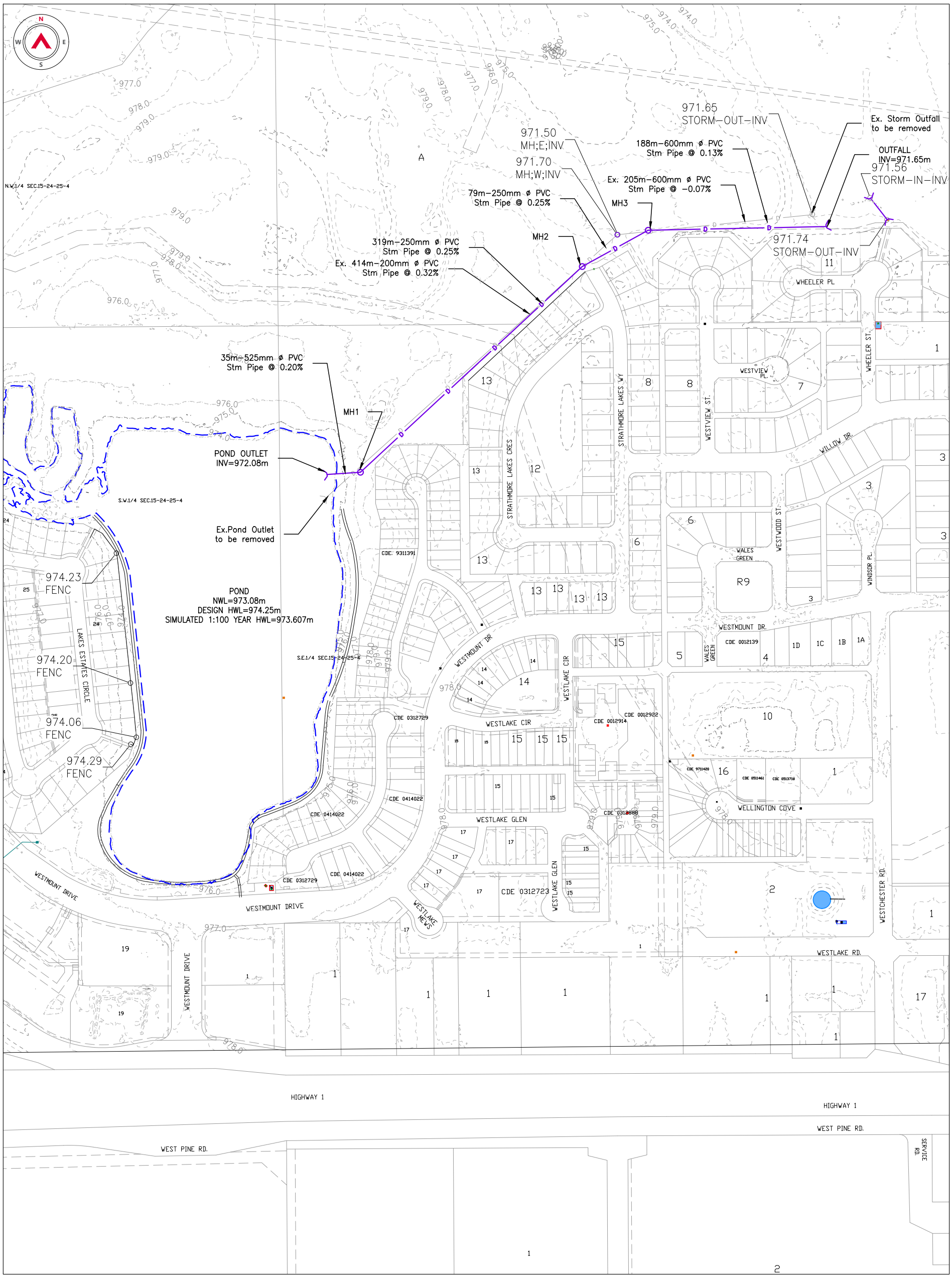
A survey was carried out as follows:

- The pathway located on the west side of Strathmore Lakes from Westmount Drive to the end of the asphalt pathway, to define the location and elevation at approximately 20 m intervals.
- The invert of the gravity outlet located on the northeast side of the pond, along with the irrigation valves located on the east side of the pond, including the irrigation pump station.
- The manhole rim and dip of the outlet system located east of Strathmore Lakes Way, including a manhole dip and the outlet located to the east of the upstream manhole.

The survey data that was acquired on the outlet system was input into the XPSWMM computer model. The HWL that was simulated in the Strathmore Lakes Estates Stormwater Pond was 973.607 m for the 1:100 year design storm event. The simulated 1:100 year HWL does not flood the adjacent pathway. Thus, the simulated result does not match the observed condition. On November 1, 2016 Allnorth conducted a site inspection and observed that the water level was 34 cm above the invert elevation of the outlet pipe. After review of the rainfall data, the irrigation pump records for Strathmore Lakes stormwater pond, survey data and model results, it is likely that there is an issue with the outlet system. Perhaps there could be a construction issue, a blockage in the outlet pipe, or the pipe has a hump in the profile which has raised the NWL and thus reduced the active storage volume. There are no engineering drawings or record drawings of the outlet system, and therefore, it is recommended that the outlet system be upgraded and replaced.

Figure 6-9 presents a conceptual design for the replacement of the outlet system. The outlet system would consist of approximately 35 m of 525 mm diameter PVC pipe, 388 m of 250 mm diameter PVC pipe, and 393 m of 600 mm diameter PVC pipe. The 525 mm diameter PVC pipe is the outlet pipe that conveys outflow from the pond. It is sized larger than the downstream outlet pipe system to achieve negligible hydraulic losses to provide very similar water levels in MH1 as in the pond. The pipe system downstream of MH1 is sized as 250 mm diameter pipe to restrict the outflow from the stormwater pond and to ensure that the outflow is not restricted to such a low flow rate that the pond would exceed the design HWL for the 1:100 year design storm event. The outlet system would replace the existing 600 mm diameter storm sewer pipe, and realigned as shown in **Figure 6-9**.

Because it has been observed that the Strathmore Lakes Estates Stormwater Pond has flooded over the adjacent pathway in the last few years even during relative minor storm events, it is concluded that there is no adequate storage capacity in the Strathmore Lakes Estates Stormwater Pond to accommodate stormwater discharge from any new additional development. Any future development will require upgrading of the pond outlet system as proposed in **Figure 6-9**.



Legend

- POND
- EXISTING STORM PIPE/ CULVERT
- NEW STORM PIPE/ CULVERT
- EXISTING STORM MANHOLE
- NEW STORM MANHOLE
- EXISTING INLET/ OUTLET
- NEW INLET/ OUTLET
- 974.29 PATH.07 — TOPO SURVEY ELEVATION

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
-	-	-	-	-

CLIENT: Strathmore — Where Quality of Life is a Way of Life

Allnorth

TITLE:
Strathmore Lake Estates Stormwater Pond Outlet System

CLIENT NO:Town of Strathmore		DRWN: -	DATE:	16/11/30
PROJECT NO:	-	DSGN: FI	DATE:	-
DRAWING SIZE:	ANSI "B"	CHKD: -	DATE:	-
SCALE:	1:4000	APVD: -	DATE:	-

PROJECT:
Town of Strathmore Stormwater Master Plan Update

DWG NO: **Figure 6-9**

REV: **A**

6.6 Future Stormwater Management System

In adherence with current AE and City of Calgary policies, stormwater management systems should be designed to enhance water quality and limit the discharge of stormwater runoff to the receiving waterbodies to the regulated allowable release rates. This can be achieved by a combination of source control and end-of-pipe techniques that allow a large proportion of post-development runoff to infiltrate or evaporate.

At this level of design, recommendations are put forward to encourage a developer to accommodate as many source control measures as possible into the design of a subdivision to reduce the amount of land required by a stormwater management facility (SWMF).

For the purpose of preliminary sizing of stormwater storage facilities and cost estimation, it is conservatively assumed that no source control measures will be constructed, and that all flow attenuation and quality enhancement will take place in the SWMF.

6.6.1 Proposed Stormwater Management System

The current Town's stormwater management systems do not meet the regulated allowable release rates for stormwater runoff. Thus, modifications are proposed to the stormwater management systems, as shown in **Figure 6-10**. Stormwater will be diverted away from the WID 'A' Canal and the WID 'A' North Canal as described below. In addition, an upgrade to Pond 4B and a regional stormwater storage facility is proposed as discussed below.

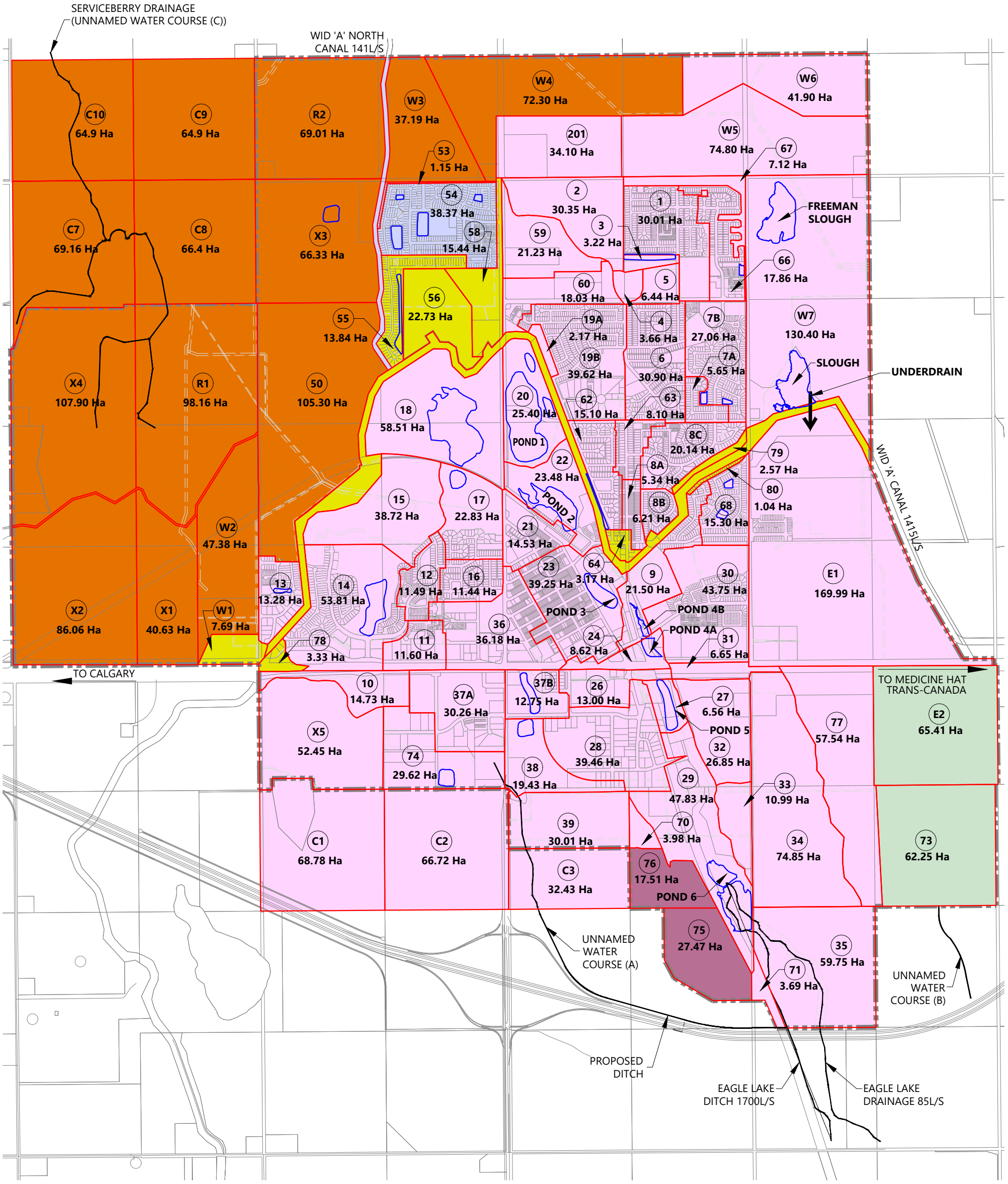
6.6.2 Removing Stormwater from WID Main Canals

The stormwater runoff from catchments W6, W5, 67 and W7 would be controlled to the allowable release rate and diverted underneath the WID 'A' Canal and would be conveyed to a proposed regional stormwater storage facility. The proposed modifications shown in **Figure 6-10** were modelled with the XPSWMM computer model and a total peak stormwater runoff flow rate of 1.415 m^3/s (1,415 L/s) was computed from the catchments that are tributary to the WID 'A' Canal for the 1:100 year design storm event. This meets the criteria of a maximum allowable discharge of 1415 L/s to the WID 'A' Canal for the 1:100 year design storm event.

The stormwater runoff from Catchments W4 and W3 would be diverted north to Serviceberry Drainage and no longer contribute stormwater runoff to the WID 'A' North Canal. The runoff from these catchments would need to be controlled to the maximum allowable unit area release rate of 0.8 L/s/ha and would need to meet an average annual runoff volume control target of 40 mm. It is noted that Catchment W4 has been reduced in size, as it was originally shown in **Figure 6-7** and a portion of Catchment W4 designated as Catchment 201 in **Figure 6-10** now drains southward to Catchment 2.

Catchments 53 and 54 would still drain to the WID 'A' North Canal. The proposed modifications shown in **Figure 6-10** were modeled with the XPSWMM computer model and a total peak stormwater runoff flow rate of 0.131 m^3/s (131 L/s) was computed from the catchments (Catchments 53 and 54) that are tributary to the WID 'A' North Canal for the 1:100 year design storm event. This meets the criteria of a maximum allowable discharge of 141 L/s to the WID 'A' North Canal for the 1:100 year design storm event.

Date: 2018/06/27 | User: Hanwell Liu | File: P:\CG\2016\0-99\16CG0023 - Town of Strathmore - Master Plan Update - Storm Water\1000-Drawings\1011 Civil\01-Production\16CG0023_Figure 6-10 | Layout: Areas | Paper Size: 431.8mm x 558.8mm



Legend

- CATCHMENT BOUNDARY
- TOWN BOUNDARY
- UNNAMED WATER COURSE
- WID 'A' NORTH CANAL
- SERVICEBERRY DRAINAGE
- WID 'A' CANAL
- UNNAMED WATER COURSE (B) /EAGLE LAKE DRAINAGE
- NO DRAINAGE
- EAGLE LAKE DITCH DRAINAGE
- R1 SUBCATCHMENT AREA LABEL

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
D	18/05/10	ISSUED FOR REPORT	HL	-
C	18/04/13	ISSUED FOR REPORT	HL	-
B	17/01/10	ISSUED FOR REPORT	LX	-
A	16/11/09	ISSUED FOR REVIEW	LX	-

CLIENT: Strathmore — Where Quality of Life is a Way of Life

Allnorth

TITLE: **Watershed Areas Future Condition**

CLIENT NO:	-	DRWN:	LX	DATE: 16/11/09
PROJECT NO:	16CG0023	DSGN:	JB	DATE: -
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE: -
SCALE:	1:25000	APVD:	-	DATE: -

PROJECT: **Town of Strathmore Stormwater Master Study**

DWG NO: **Figure 6-10**

REV: **D**

6.6.3 Serviceberry Drainage

Post-development runoff that is diverted to Serviceberry Drainage will need to be controlled to an allowable unit area release rate (UARR) of 0.8 L/s/ha and will need to meet an average annual runoff volume control target of 40 mm. Preliminary sizing of stormwater storage facilities was carried out for catchments located in the Serviceberry Drainage watershed for a UARR of 0.8 L/s/ha and continuous simulations were carried out with the QUALHYMO computer model to determine the average annual runoff volume for the 50 years of historic data provided by the City of Calgary and corrected for the precipitation in the Serviceberry Drainage watershed by reducing the hourly precipitation data from the Calgary International Airport (YYC) by 6%, as described above. The results of the QUALHYMO simulation is presented in **Table 6-13**, assuming residential land use with an impervious ratio of 55%.

Table 6-13 Post-Development Runoff in the Serviceberry Creek Watershed

Average Annual Precipitation (mm)	Average Annual Runoff Volume for 55% Impervious Land Cover (mm)	Assuming Stormwater Storage With Allowable Release Rate of 0.8 L/s/ha and Standard Pond With 2.0 m Dead Storage and 2.0 m Live Storage Average Annual Runoff Volume (mm)	Allowable Average Annual Runoff Volume as Stipulated by CSMI (mm)	Additional Volume Control (Infiltration/ Evaporation/ BMPs) (mm)
390	152	129	40	89

Table 6-13 indicates that implementing stormwater storage with a UARR of 0.8 L/s/ha results in an estimated average annual runoff volume of 129 mm for a residential land use with an impervious ratio of 55%. Thus, an additional 89 mm of volume control would be required by implementing infiltration, evaporation and/or BMPs.

Figure 6-11 presents the conceptual stormwater servicing concept for the catchments located in the Serviceberry Drainage watershed. The proposed stormwater conveyance system would consist of a system of 6 ditches located along the section lines and major roadways, as shown in **Figure 6-11**. The design flow rates are based on the contributing catchment area and UARR of 0.8 L/s/ha. The ditch design cross section would be grassed and consist of a 2.0 m bottom width with 2.5H:1V side slopes. The design flow rates in the ditches could be conveyed within a depth of 1.0 m.

Date: 2017/02/07 | User: Annie Xu | File: P:\CG\2016\0-99\16CG0023 - Town of Strathmore - Master Plan Update - Storm Water\1000-Drawings\1011 Civil\01-Production\16CG0023_Figure 6-11 | Layout: Areas | Paper Size: 431.8mm x 558.8mm

Ditch 6

Area 6
168.6Ha

Ditch 5

Ditch 4

Area 5
42.13Ha

Area 4
132.59 Ha

Ditch 3

Area 3
56.97 Ha

Ditch 1

Ditch 2

Area 1
34.36 Ha

Area 2
33.51 Ha

Legend

- TOWN BOUNDARY
- CATCHMENT AREAS
- WATER COURSE
- OVERLAND FLOW
- DITCH

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
B	17/01/10	ISSUED FOR REPORT	FI	-
A	16/11/09	ISSUED FOR REVIEW	FI	-

CLIENT: Strathmore — Where Quality of Life is a Way of Life

Allnorth

TITLE: Serviceberry Stormwater Conveyance System

CLIENT NO:	-	DRWN:	FI	DATE:	16/11/09
PROJECT NO:	16CG0023	DSGN:	JB	DATE:	-
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	1:10000	APVD:	-	DATE:	-

PROJECT: Town of Strathmore Stormwater Master Study

DWG NO: Figure 6-11

REV: A

6.6.4 Unnamed Watercourse (B)

It has been assumed that Unnamed Watercourse (B) ties to the Town's Eagle Lake drainage easement. When the land that is tributary to the Unnamed Watercourse (B) is developed a new drainage easement will need to be registered from the discharge point to the Town's easement.

Post-development runoff that is conveyed to Unnamed Watercourse (B) will need to be controlled to a maximum allowable discharge rate of 85 L/s for the total contributing catchment area. Catchments E2 and 73, as shown in **Figure 6-10**, are tributary to Unnamed Watercourse (B) and are allowed to discharge 85 L/s to this watercourse for the post-development condition which translates to an allowable unit area release rate (UARR) of 0.67 L/s/ha. Post-development runoff from Catchments E2 and 73 will need to meet an average annual runoff volume control target of 20 mm. Preliminary sizing of stormwater storage facilities was carried out for these catchments for a UARR of 0.67 L/s/ha and continuous simulation was carried out with the QUALHYMO computer model to determine the average annual runoff volume for the 50 years of historic data provided by the City of Calgary and corrected for the precipitation in the Eagle Lake watershed by reducing the hourly precipitation data from the Calgary International Airport (YYC) by 8%, as described above. The results of the QUALHYMO simulation is presented in **Table 6-14**, assuming residential land use with an impervious ratio of 55%.

Table 6-14 Post-Development Runoff in Unnamed Watercourse (B) Watershed

Average Annual Precipitation (mm)	Average Annual Runoff Volume For 55% Impervious Land Cover (mm)	Assuming Stormwater Storage With Allowable Release Rate of 0.67 L/s/ha Standard Pond With 2.0m Dead Storage and 2.0 m Live Storage Average Annual Runoff Volume (mm)	Allowable Average Annual Runoff Volume As Stipulated by CSMI	Additional Volume Control (Infiltration/ Evaporation/ BMPs) (mm)
382	148	127	20	107

Table 6-14 indicates that implementing stormwater storage with a UARR of 0.67 L/s/ha results in an estimated average annual runoff volume of 127 mm for a residential land use with an impervious ratio of 55%. Thus, and additional 107 mm of volume control would be required by implementing infiltration, evaporation and/or BMPs.

6.6.5 Eagle Lake Watershed

The allowable release rate for the Town's stormwater management system to Eagle Lake Ditch is 1,700 L/s. The annexation areas within the Eagle Lake watershed are shown on **Figure 6-3**. According to CSMI these areas should control post-development runoff to a UARR of 0.8 L/s/ha and achieve an average annual runoff volume control target of 20 mm. The catchments that are subject to the CSMI criteria are Catchments W6, W5, W7 and E1, as shown in **Figure 6-10**. Proposed stormwater storage facilities located in Catchments W7 and E1 to accommodate post-development runoff will need to accommodate a flow-through of 0.766 m^3/s to accommodate the estimated peak flow rate from Catchment 67 resulting from the 1:100 year design storm event, as well as restricting the maximum outflow rate to 0.8 L/s/ha at the design HWL for the contributing catchment area.

A regional stormwater storage facility is proposed in Catchment 35, as shown in **Figure 6-12**, to accommodate development in the upstream Catchments W6, W5, W7 and E1 and meet CSMI's criteria

of 20 mm of average annual runoff volume. In addition, this regional stormwater storage facility should contribute to achieving a maximum flow rate of 1,700 L/s in the Eagle Lake Ditch for the 1:100 year design storm event. At this conceptual level stage the site area at the proposed location of the regional stormwater storage facility has been maximized to assess the capability of the proposed regional stormwater storage facility in achieving the average annual runoff volume target of 20 mm for the annexed lands and contributing to achieving a maximum flow rate of 1,700 L/s in the Eagle Lake Ditch for the 1:100 year design storm event.

The proposed regional stormwater storage facility would consist of a forebay (Pond E1) to capture coarse sediments, two infiltration areas (Ponds E2 and E3) and a wet pond designated as Pond 7. Pond E1 outflows to Pond E2 and Pond E2 outflows to Pond E3. Pond E3 outflows to Pond 7. Thus, the proposed regional stormwater storage facility consists of a series of ponds.

The forebay (Pond E1) receives controlled stormwater flows from Catchments W6, W5, W7, E1 and 77. The proposed stormwater storage facilities in Catchments W7 and E1 would receive uncontrolled stormwater runoff from Catchment 67 and discharge it as flow-through as well as limiting the outflow from the contributing catchment area to the UARR of 0.8 L/s/ha. The proposed stormwater storage facility in Catchment 77 would discharge at the predevelopment flow rate which has been estimated to be 0.480 m^3/s.

Pond E2 receives stormwater runoff from Catchments 34 and 35 as well as the outflow from Pond E1. Pond E3 receives the overflow from Pond E2 which is the stormwater that has not infiltrated into the ground. Ponds E2 and E3 are designed to infiltrate the stormwater runoff that they receive with the overflow being stormwater runoff that is not infiltrated discharging to the next pond in the series.

Based on a cursory review of the soils within proximity to the proposed regional stormwater storage facility, the soil type at this location is expected to be a silty sand. Table 3.5, "Range of Hydraulic Conductivity of Natural Soils" in the text entitled "Construction Dewatering and Groundwater Control, New Methods and Applications", 2007, indicates a hydraulic conductivity range for silty sand of 1×10^{-5} to 5×10^{-5} m/s. Using the lower value of 1×10^{-5} m/s translates to an infiltration rate of 36 mm/hr. This value was rounded down to 30 mm/hr which is the infiltration rate that was assumed for Ponds E2 and E3. This infiltration rate would need to be confirmed by a geotechnical investigation and percolation tests carried out in the area.

The future stormwater management system will consist of the existing series of ponds, Ponds 1, 2, 3, 4B, 4A and 6 and a proposed series of ponds in the annexation areas.

A summary of the proposed ponds on the east side of Strathmore that are tributary to Pond E1 is provided in **Table 6-15**.

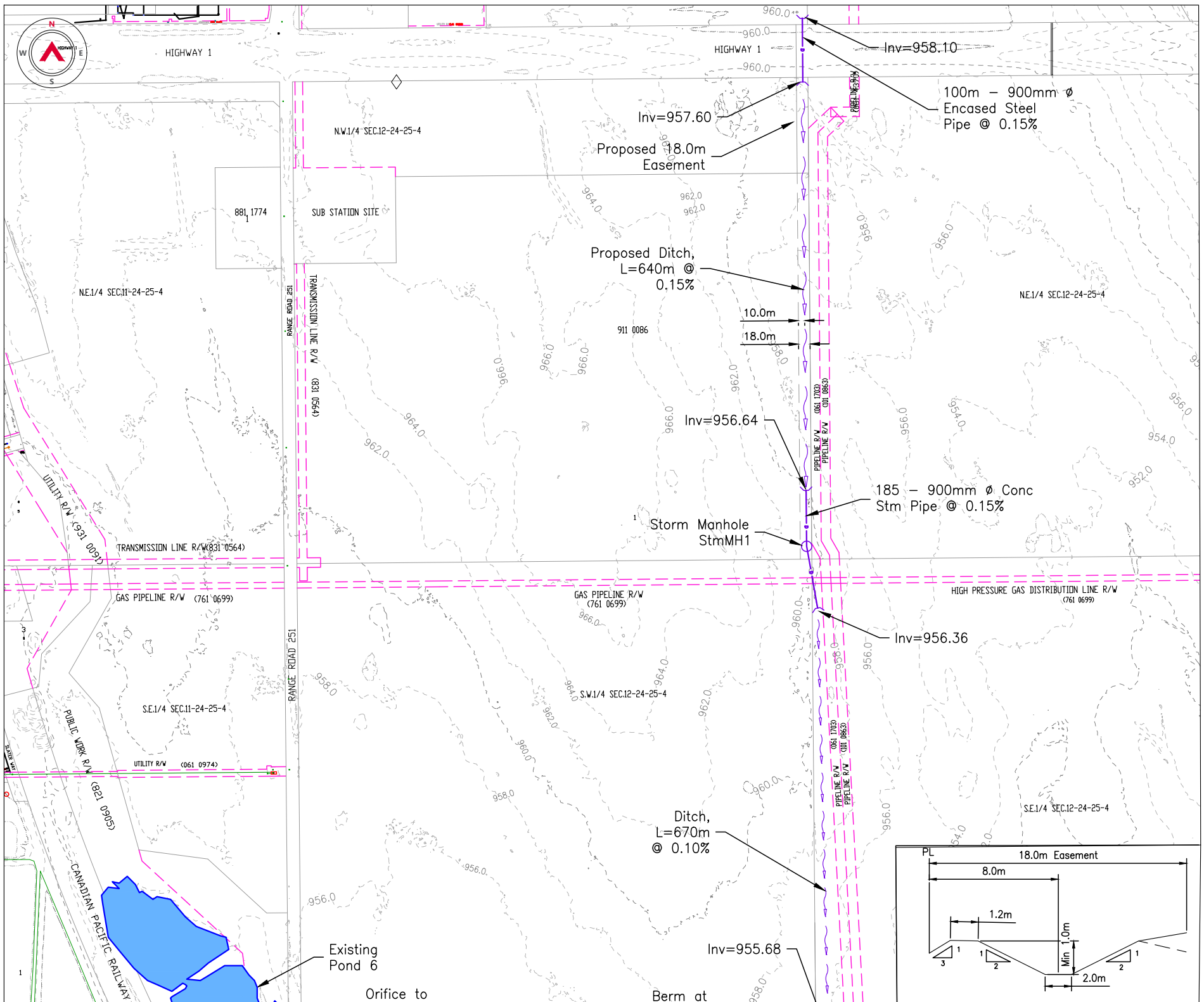
Table 6-15 Proposed Stormwater Storage Facilities Tributary to Pond E1

Catchment	Local Catchment Area (ha)	Tributary Catchment Area (ha)	Maximum Depth (m)	Discharge Criteria	Volume (m^3)	Surface Area (m^2)	Simulated Peak Inflow (m^3/s)	Design Outflow Rate (m^3/s)
W5	74.80	116.70	4.3	0.8 L/s/ha	105,630	34,041	15.313	0.0934
W7	130.40	247.10	4.3	0.8 L/s/ha + 0.766 m^3/s	163,847	48,390	15.662	0.964
E1	169.99	417.09	4.3	0.8 L/s/ha + 0.766 m^3/s	374,041	102,630	18.567	1.0997
77	57.54	57.54	4.3	Predevelopment Flow	28,069	10,690	8.132	0.480

The ponds in **Table 6-15** are standard ponds with 2.0 m of dead storage and 2.0 m of live storage. The internal side slopes of the ponds are assumed to be 5H:1V. The design HWL is set at an active storage depth of 2.0 m (total depth of 4.0 m) and the design discharge is based on an active storage depth of 2.0 m (total depth of 4.0 m). A freeboard height of 0.300 m above the design HWL has been provided in the ponds. Thus, the total depth of the ponds are 4.30 m, as indicated in column 3 of **Table 6-15**. The values of volume and surface area provided in **Table 6-15** are based on a total pond depth of 4.30 m. The sizing of the proposed stormwater storage facilities provided in **Table 6-15** are preliminary estimates and the sizing methodology used by the City of Calgary would need to be used to confirm the sizing.

It is noted that the ponds proposed in **Table 6-15** provide flow rate control, and the average annual runoff volume control of 20 mm is to be achieved with the regional stormwater storage facility, as described above.

Date: 2017/02/07 | User: Annie Xu | File: P:\CG\2016\0-99\16CG0023 - Town of Strathmore - Master Plan Update - Storm Water\1000-Drawings\1011 Civil\01-Production\16CG0023_Figure 6-12 | Layout: 'B' Portrait (Horizontal Title) | Paper Size: 431.8mm x 558.8mm



Legend

- PROPOSED STORM DITCH CENTERLINE
- SPILL ELEVATION
- POND EXTENT
- PROPOSED STORM PIPE/ CULVERT
- PROPOSED STORM MANHOLE
- PROPOSED INLET/ OUTLET

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
-	-	-	-	-

CLIENT: Strathmore — Where Quality of Life is a Way of Life

Allnorth

TITLE: **Pond 7 and Upstream Infiltration Ponds Concept Plan**

CLIENT NO:Town of Strathmore		DRWN:	-	DATE:	16/11/30
PROJECT NO:	-	DSGN:	FI	DATE:	-
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE:	-
SCALE:	1:7500	APVD:	-	DATE:	-

PROJECT: **Town of Strathmore Stormwater Master Study**

DWG NO: **Figure 6-12**

REV: **A**

The rating data for the forebay (Pond E1) is provided in **Table 6-16**, the rating data for Pond E2 is provided in **Table 6-17**, the rating data for Pond E3 is provided in **Table 6-18**, and the rating data for Pond 7 is provided in **Table 6-19**.

Table 6-16 Stage-Storage-Discharge Rating for Pond E1

Elevation (m)	Area (m^2)	Total Volume (m^3)	Discharge (m^3/s)
953.65	3,900	0.0	
955.65 (NWL)	8,500	12,400	0.0
955.95	9,250	15,063	1.816

Pond E1 is a wet pond with design dead storage depth of 2.0 m. When the water level in Pond E1 exceeds the normal water level (NWL) outflow occurs into Pond E2 via an overflow weir with its crest elevation set at the NWL.

Table 6-17 Stage-Storage-Discharge Rating for Pond E2

Elevation (m)	Area (m^2)	Total Volume (m^3)	Discharge (m^3/s)
954.50	211	0.0	0.0
954.80	9,600	1,472	0.0800
955.00	12,300	3,662	0.1025
955.30 (HWL)	20,700	8,612	0.1725
955.60	26,800	15,737	2.8262

Pond E2 is a dry pond that promotes infiltration of stormwater runoff. It has been designed with a HWL elevation of 0.8 m above the bottom of the pond. It should be noted that the discharge out of Pond E2 up to the design HWL of 955.30 m is based solely on an infiltration rate of 30 mm/hr. Once the water level in the pond exceeds the design HWL, outflow is the result of the constant infiltration rate that occurs at the design HWL plus the flow that occurs over the overflow weir set at the design HWL elevation. Pond E2 outflows to Pond E3 via an overflow weir with a length of 9.50 m and its crest elevation set at the design HWL.

Table 6-18 Stage-Storage-Discharge Rating for Pond E3

Elevation (m)	Area (m^2)	Total Volume (m^3)	Discharge (m^3/s)
952.40	612	0.0	0.0
952.70	11,350	1,794	0.0946
953.00	35,500	8,822	0.2958
953.30	47,900	21,332	0.3992
953.60 (HWL)	61,265	37,707	0.5105
953.90	74,100	58,011	2.6055

Pond E3 is a dry pond that promotes infiltration of stormwater runoff. It has been designed with a HWL elevation of 1.2 m above the bottom of the pond. The discharge out of Pond E3 up to the design HWL of 953.60 m is based solely on an infiltration rate of 30 mm/hr. Once the water level in the pond

exceeds the design HWL, outflow is the result of the constant infiltration rate that occurs at the design HWL plus the flow that occurs over the overflow weir set at the design HWL elevation. Pond E3 outflows to Pond 7 via an overflow weir with a length of 7.50 m and its crest elevation set at the design HWL.

Table 6-19 Stage-Storage-Discharge Rating for Pond 7

Elevation (m)	Area (m^2)	Total Volume (m^3)	Discharge (m^3/s)
947.00	35,800	0.0	
949.00 (NWL)	46,500	82,300	0.0
950.00	148,500	179,800	0.0594
951.00	194,000	351,050	0.0858
951.70 (HWL)	245,000	504,700	0.1000
952.00	264,000	581,050	0.1055

Pond 7 is a wet pond with a design dead storage depth of 2.0 m. It has been designed for a HWL elevation of 951.70 m that provides an active storage depth of 2.70 m. The maximum outflow rate out of Pond 7 at the design HWL was set to maximize the storage that is available at the site. The design outflow rate is 0.100 m^3/s (100 L/s) at the design HWL.

The outflow from Pond 7 combines with the stormwater runoff that is discharged to Unnamed Watercourse (A). The maximum flow rate in the Unnamed Watercourse (A) combined with the outflow rate out of Pond 7 resulting from the 1:100 design storm should not exceed 1700 L/s.

A series of ponds are proposed in the catchment areas that are tributary to Unnamed Watercourse (A). A summary of the proposed ponds within the Unnamed Watercourse (A) watershed is provided in **Table 6-20**.

Table 6-20 Proposed Stormwater Storage Facilities Tributary to Unnamed Watercourse (A)

Catchment	Area (ha)	Maximum Depth (m)	Discharge Criteria	Volume (m^3)	Surface Area (m^2)	Simulated Peak Inflow (m^3/s)	Design Outflow Rate (m^3/s)
39	30.01	4.3	0.8 L/s/ha	174,052	51,090	9.167	0.1120
C1	68.78	4.3	0.8 L/s/ha	28,071	10,690	0.640	0.0550
X5	52.45	4.3	0.8 L/s/ha	97,007	30,430	1.929	0.0970
74	29.62	4.3	0.8 L/s/ha	35,724	13,020	5.072	0.0237
C2	66.72	4.3	0.8 L/s/ha	26,170	10,100	0.621	0.0534
C3	32.43	4.3	0.8 L/s/ha	11,367	5,250	0.344	0.0259

It should be noted that the proposed pond in Catchment 39 receives stormwater runoff at a peak flow rate of 9.167 m^3/s from Catchments 16, 36, 37A, 37B, 38 and 39, as shown in **Table 6-20**. The ponds in **Table 6-20** are standard ponds with 2.0 m of dead storage and 2.0 m of live storage. The design HWL is set at an active storage depth of 2.0 m (total depth of 4.0 m) and the design discharge is based on an active storage depth of 2.0 m (total depth of 4.0 m). A freeboard height of 0.300 m above the design HWL has been provided in the ponds. Thus, the total depth of the ponds are 4.30 m, as indicated in column 3 of **Table 6-20**. The values of volume and surface area provided in **Table 6-20** are based on a total pond depth of 4.30 m. The sizing of the proposed stormwater storage facilities provided in **Table**

6-20 are preliminary estimates and the sizing methodology used by the City of Calgary would need to be used to confirm the sizing.

The future condition stormwater management system that was modeled consisted of the following:

- The series of existing ponds, Ponds 1, 2, 3, 4B, 4A and 6, and their tributary areas.
- The proposed stormwater storage facilities indicated in **Table 6-15** that are tributary to Pond E1 and their tributary areas.
- Ponds E1, E2 and its tributary areas, and Ponds E3 and 7.
- The proposed stormwater storage facilities indicated in **Table 6-20** that are tributary to Unnamed Watercourse (A). The total stormwater flow in the Unnamed Watercourse (A) resulting from the 1:100 year design storm is a combination of the stormwater storage facilities discharging controlled stormwater runoff to the watercourse and uncontrolled runoff from Catchment 71. The combined peak outflow rate from Pond 7 and the peak discharge rate in the Unnamed Watercourse (A) resulting from the 1:100 year design storm should not exceed 1,700 L/s.

It should be noted that for the future condition the top of the berm of Pond 1 was increased to elevation 972.00 m, resulting in an active storage volume of 146,795 m^3, and the discharge out of Pond 1 was restricted by a rectangular orifice set at elevation 971.00 m with dimensions of 50 mm high by 100 mm wide. Thus the outflow out of Pond 1 was restricted to a very low flow rate of 13.1 L/s to maximize the storage in Pond 1. The rating data for Pond 1 for the future condition is provided in **Table 6-21**.

Table 6-21 Stage-Storage-Discharge Rating for the Future Condition Scenario for Pond 1

Elevation (m)	Area (m^2)	Active Storage Volume (m^3)	Discharge (m^3/s)
971.00 (NWL)	111,351	0.0	0.0
971.20	133,010	24,436	0.0056
971.40	143,505	52,088	0.0081
971.50	148,893	66,708	0.0092
971.70	159,200	97,517	0.0109
972.00 (HWL)	169,320	146,795	0.0131

The future stormwater management system was modeled using both the single event design storm with the XPSWMM computer model and continuous simulation using the QUALHYMO computer model.

Single Event Simulation

Table 6-22 summarizes the results of the computer simulation for 1:100 year design storm for the key ponds for the future condition.

Table 6-22 Future Condition Pond Summary

Pond ID	Design HWL (m)	Simulated 1:100 HWL (m)	Simulated Peak Inflow (m^3/s)	Simulated Maximum Outflow (m^3/s)	Simulated 1:100 Year Storage Volume (m^3)
1	971.70	971.304	5.096	0.0068	38,815
2	971.40	970.813	4.634	0.143	21,204
3	971.30	970.882	7.088	0.530	13,823
4B	966.70	966.636	4.004	3.189	30,586
4A	965.50	965.077	10.625	4.783	15,440
6	955.70	955.362	13.744	4.634	65,253
E1	955.65 (NWL)	955.862	1.080	1.080	14,282
E2	955.30	955.569	6.786	2.258	15,000
E3	953.60	953.720	2.258	0.528	45,828
7	951.70	950.938	5.162	0.0873	340,433

The single event simulations show that the outflow from Pond 1 has been reduced but the simulated HWL of 971.304 m in the pond has not increased much over the existing condition (elevation 971.25 m, **Table 6-12**). Therefore, there would be no benefit to raising the berm of Pond 1. Reducing the outflow out of Pond 1 has marginally reduced the outflow out of Pond 2 to 0.143 m^3/s versus 0.190 m^3/s for the existing condition, however, there is no further impact downstream because the outflow out of Pond 3 has not changed from the existing condition. The simulated HWL for Pond 4A is now acceptable because of the upgrade that is proposed to Pond 4B.

It is proposed that Pond 4B be increased in size. The proposed rating data for Pond 4B is provided in **Table 6-23**.

Table 6-23 Stage-Storage-Discharge Rating for the Future Condition Scenario for Pond 4B

Elevation (m)	Area (m^2)	Total Volume (m^3)	Discharge (m^3/s)
963.20 (Bottom)	4,000	0.0	0.0
964.70 (NWL)	8,000	9,000	0.0
966.70 (HWL)	14,300	31,300	3.248
967.00 (Freeboard)	15,100	35,710	3.483

In addition, it is proposed that the outflow out of Pond 4B be controlled with an orifice with a diameter of 1.25 m with its invert set at the NWL elevation of 964.70 m. It is noted that Pond 4B will be subject to backwater conditions from Pond 4A.

The maximum water level that was simulated in Pond 6 for the 1:100 year design storm event is now acceptable because of the upgrade that is proposed for Pond 4B, and the discharge rating of Pond 6 was improved by providing a 1.20 m wide rectangular weir with a crest elevation set at the NWL elevation of 953.634 m. **Table 6-24** provides the rating data for Pond 6 for the future condition scenario.

Table 6-24 Stage-Storage-Discharge Rating for the Future Condition Scenario for Pond 6

Elevation (m)	Area (m^2)	Total Volume (m^3)	Discharge (m^3/s)
952.00	8,826	0.0	0.0
953.634 (NWL)	15,822	20,976	0.0
954.00	17,389	25,675	0.452
954.20	20,239	29,438	0.869
954.40	22,163	33,678	1.368
954.60	25,296	38,424	1.937
954.80	28,945	43,848	2.569
955.00	33,177	50,060	3.257
955.20	42,949	57,673	3.998
955.40	50,635	67,031	4.788
955.60	56,477	77,742	5.624
955.70 (HWL)	62,860	83,709	6.058

Pond E3 discharges a small amount of flow into Pond 7 for the 1:100 year design storm event. The maximum water level that was simulated in Pond 7 is 950.938 m which is below the design HWL, and the maximum outflow that was simulated is 87 L/s.

The maximum flow rate that was simulated in the Unnamed Watercourse (A) for the 1:100 year design storm event is 289 L/s with the proposed stormwater storage facilities implemented as indicated in **Table 6-20**. When the simulated flow in the Unnamed Watercourse (A) is combined with the simulated outflow from Pond 7 the resulting maximum flow rate in the Eagle Lake Ditch is computed to be 369 L/s which is less than the maximum allowable discharge rate of 1,700 L/s.

Continuous Simulation

Continuous simulation was conducted with the QUALHYMO computer model to assess the long term operation of the stormwater storage facilities and to determine the average annual runoff volume for the 50 years of historic data that was simulated. There was no overflow from Pond E3 in the continuous simulation. Thus, the continuous simulation shows that Ponds E2 and E3 are effective in removing the stormwater runoff from the stormwater management system that is tributary to Ponds E1 and E2 by infiltration, assuming an infiltration rate of 30 mm/hr. The continuous simulation indicates that Ponds E2 and E3 are effective in providing the stipulated CSMI volume control, and therefore volume control would not need to be implemented in Catchments W6, W5, W7 and E1 since it is accomplished with Ponds E2 and E3. Rate control would need to be implemented in Catchments W6, W5, W7 and E1 by implementing stormwater storage facilities as indicated in **Table 6-15**.

The maximum depth that was computed in Pond 7 was 4.75 m (water level elevation of 951.75 m) compared to a design HWL depth of 4.70 m (HWL 951.70 m). Further investigation would be required to determine if single event analysis or continuous simulation governs the sizing of Pond 7. Continuous simulation involves computing a time series of storage volumes for Pond 7 and fitting a number of frequency distributions to the time series and computing the 1:100 year volume from the best fitting distribution. The method that computes the most conservative volume governs the size of the pond.

As stated previously, the site area at the proposed location of the regional stormwater storage facility was maximized to assess the capability of the proposed regional stormwater storage facility in achieving the average annual runoff volume target of 20 mm for the lands that are tributary to the regional stormwater storage facility in the annexation areas, and in contributing to achieving a maximum flow rate of 1,700 L/s in the Eagle Lake Ditch for the 1:100 year design storm event. Thus, further analysis will be required to optimize the proposed regional pond.

6.7 Summary of Conclusions and Recommendations

6.7.1 Concerns

The primary concerns for the Town of Strathmore are:

- Areas within the Town discharging directly to the WID 'A' Canal.
- Areas within the Town discharging directly to the WID 'A' North Canal.
- Excessive amount of stormwater currently being discharged into the Eagle Lake Ditch.
- A maximum allowable unit area release rate of 0.8 L/s/ha for lands that the Town has annexed as recommended by the CSMI report.
- An average annual runoff volume of 40 mm for lands that drain to Serviceberry Drainage as recommended by the CSMI report.
- An average annual runoff volume of 20 mm for annexed lands that drain into the Eagle Lake drainage system as recommended by the CSMI report.
- A computer simulation of the 1:100 year design storm with the XPSWMM computer model of the existing condition for 2016 indicates the following:
    - The Town's stormwater management system currently does not meet the criteria of a maximum discharge of 1700 L/s to Eagle Lake Ditch. The maximum discharge out of Pond 6 is 4,935 L/s.
    - The Town does not meet the criteria of a maximum discharge of 1415 L/s to the WID 'A' Canal. The maximum discharge of stormwater runoff from all of the catchments that are tributary to the WID 'A' Canal is 4,793 L/s.
    - The Town does not meet the criteria of a maximum discharge of 141 L/s to the WID 'A' North Canal. The maximum discharge of stormwater runoff from all of the catchments that are tributary to the WID 'A' North Canal is 1,766 L/s.
- The Town has observed that the Strathmore Lakes Estates Stormwater Pond has flooded over the adjacent pathway in the last few years even during relative minor storm events. An investigation was conducted to assess why the flooding was occurring. The outlet system from the pond was surveyed and input into the XPSWMM computer model. The computer simulation for the 1:100 year design storm indicates that the pond performs acceptably for the 1:100 year design storm event. Thus, it is concluded that there is an issue with the outlet system and it should be upgraded and replaced before any future development areas are permitted to discharge additional stormwater runoff to it.

6.7.2 Evaluation Criteria

The underlying criterion used in this study for sizing of stormwater facilities is as follows:

- The maximum allowable stormwater release rate to Eagle Lake Ditch is 1700 L/s.
- The maximum allowable stormwater release rate to WID 'A' North Canal is 141 L/s.
- The maximum allowable stormwater release rate to the WID 'A' Canal is 1415 L/s.
- A maximum allowable unit area release rate of 0.8 L/s/ha for lands the Town has annexed.
- A maximum allowable unit area release rate of 0.8 L/s/ha plus a flow-through of 0.766 m^3/s for proposed stormwater storage facilities located in Catchments W7 and E1 to accommodate runoff from Catchment 67 as shown in **Figure 6-10**.
- A maximum allowable unit area release rate of 0.8 L/s/ha for catchments that are tributary to Unnamed Watercourse A, as shown in **Figure 6-10**.
- A maximum allowable unit area release rate of 0.67 L/s/ha for catchments that are tributary to Unnamed Watercourse B, as shown in **Figure 6-10**.
- The historic precipitation data from the Calgary International Airport should be adjusted to 6% less precipitation for the Serviceberry drainage basin and 8% less precipitation for the Eagle Lake drainage basin for continuous simulation of the historic precipitation data.

6.7.3 Conclusions

- The study recommended modifications to the proposed stormwater management systems for the WID 'A' Canal and the WID 'A' North Canal that were simulated with the XPSWMM computer model for the 1:100 year design storm with the following results:
    - The stormwater runoff from Catchments W6, W5, 67 and W7 would be diverted underneath the WID 'A' Canal and would be conveyed to a proposed regional stormwater storage facility, as shown in **Figure 6-10**. With these modifications implemented the maximum discharge of stormwater runoff from all of the catchments that are tributary to the WID 'A' Canal is 1415 L/s which meets the criteria for the allowable maximum discharge to the WID 'A' Canal.
    - The stormwater runoff from Catchments W4 and W3 would be diverted north to Serviceberry Drainage and no longer contribute stormwater runoff to the WID 'A' North Canal, as shown in **Figure 6-10**. With these modifications implemented, the maximum discharge of stormwater runoff from all of the catchments that are tributary to the WID 'A' North Canal is 131 L/s, which meets the criteria for the allowable maximum discharge to the WID 'A' North Canal.
- A regional stormwater storage facility is proposed within the Eagle Lake drainage system to accommodate development in the annexed areas on the east side of the Town, meets CSMI's criteria of 20 mm of average runoff volume for the annexed areas based on the simulation of the historic record of precipitation data from the Calgary International Airport which is reduced by 8% less precipitation, and to address the maximum allowable discharge rate of 1700 L/s to the Eagle Lake Ditch. The proposed regional, stormwater storage facility, shown in **Figure 6-12**, would consist of a series of ponds as follows:
    - Pond E1 which is a forebay to capture coarse sediments.
    - Pond E2 which would be an infiltration area to infiltrate stormwater runoff. The infiltration rate for Pond E2 has been estimated as 30 mm/hr.

  - Pond E3 which would be an infiltration area to infiltrate stormwater runoff. The infiltration rate for Pond E3 has been estimated as 30 mm/hr as well.
  - Pond 7 which is a proposed wet pond.
  - Pond E1 outflows to Pond E2, Pond E2 outflows to Pond E3, and Pond E3 outflows to Pond 7. Pond 7 also receives stormwater outflow from Pond 6.
- The future condition stormwater management system within the Eagle Lake drainage system that was modeled consisted of the following:
  - The series of existing ponds, Ponds 1, 2, 3, 4B, 4A and 6, and their tributary areas. These ponds are tributary to Pond 7.
  - The proposed stormwater storage facilities indicated in **Table 6-15** that are tributary to Pond E1 and their tributary areas.
  - Ponds E1, E2 and its tributary areas, and Ponds E3 and 7.
  - The proposed stormwater storage facilities indicated in **Table 6-20** that are tributary to Unnamed Watercourse (A) and their tributary areas. The total stormwater flow in the Unnamed Watercourse (A) resulting from the 1:100 year design storm is a combination of the stormwater storage facilities discharging controlled stormwater runoff to the watercourse and uncontrolled stormwater runoff from Catchment 71. The combined peak outflow rate from Pond 7 and the peak discharge rate in the Unnamed Watercourse (A) resulting from the 1:100 year design storm should not exceed 1700 L/s.
- The single event simulation of the future condition stormwater management system for the 1:100 year design storm event within the Eagle Lake drainage system indicated the following:
  - The maximum flow rate that was simulated in the Unnamed Watercourse (A) for the 1:100 year design storm event is 289 L/s with the proposed stormwater storage facilities implemented as shown in **Table 6-20**.
  - The maximum outflow rate that was simulated from Pond 7 was 87 L/s.
  - When the simulated flow in the Unnamed Watercourse (A) is combined with the simulated outflow from Pond 7, the resulting maximum flow rate in Eagle Lake Ditch is computed to be 369 L/s, which is less than the maximum allowable discharge rate of 1700 L/s.
- The continuous simulation of the future condition stormwater management system within the Eagle Lake drainage system indicated the following:
  - Ponds E2 and E3 are effective in removing the stormwater runoff by infiltration, assuming an infiltration rate of 30 mm/hr. There was minimal outflow from Pond E3 in the continuous simulation.
  - Ponds E2 and E3 are effective in providing the stipulated CSMI volume control, and therefore volume control would not need to be implemented in Catchments W6, W5, W7 and E1 since it is accomplished with Ponds E2 and E3.
  - Rate control would need to be implemented in Catchments W6, W5, W7 and E1 by implementing stormwater storage facilities as indicated in **Table 6-15.** The maximum depth that was computed in Pond 7 was 4.75 m (water level elevation of 951.75 m) compared to a design HWL depth of 4.70 m (HWL 951.70 m). The return period of this maximum depth would need to be determined using various frequency distributions. If the return period of this maximum depth is less than 100 years, then the outflow from Pond 7 would need to be

increased so that the computed water depths in Pond 7 would decrease, and the maximum computed depth from the continuous simulation falls within a return period of 100 years or greater.

Preliminary indications are that the proposed regional stormwater storage facility is effective in controlling the discharge rate to Eagle Lake Ditch and meeting the average annual runoff volume target of 20 mm for annexed lands that drain into the Eagle Lake drainage system.

6.7.4 Recommendations

The allowable release rate for the Town of Strathmore to Eagle Lake Ditch is 1700 L/s. The proposed total catchment area for the Town's stormwater management system that is tributary to Eagle Lake and not subject to the 0.8 L/s/ha release rate is 1037 ha, and therefore, the allowable release rate for discharge of stormwater to the Eagle Lake Ditch is 1.09 L/s/ha for these areas. The SMS in 2006 recommended a UARR of 1.28 L/s/ha for the catchment areas that are tributary to Eagle Lake. The east side annexation areas have a total area of 417 ha and a UARR of 0.8 L/s/ha that results in an allowable discharge rate of 334 L/s. The catchment areas that are tributary to the Unnamed Watercourse (A) and are subject to a UARR of 0.8 L/s/ha have a total area of 299 ha which results in an allowable discharge rate of 240 L/s. **Table 6-25** summarizes the allowable UARR for the Town.

Table 6-25 Allowable Unit Area Release Rates

Unit Area Release Rate (L/s/ha)	Catchment ID
1.09	1, 2, 3, 4, 5, 6, 7A, 7B, 8A, 8B, 8C, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19A, 19B, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 59, 60, 62, 63, 68, 70, 71, 201
N/A	16, 36, 37A, 37B (built out)
0.8	38, 39, 74, C1, C2, C3, X5, W2, W3, W4, W5, W6, W7, E1, 50, C7, C8, C9, C10, R1, R2, X1, X2, X3, X4
0.67	E2, 73
Pre-development	77

A geotechnical study to investigate the soils at the proposed location of the regional stormwater storage facility is recommended. The study should include groundwater monitoring and percolation tests to verify the infiltration rates that have been assumed in this study.

It is recommended that preliminary and detailed engineering design be undertaken for the proposed regional stormwater storage facility where further optimization of the facility can be carried out. The preliminary and detailed design of the proposed regional stormwater storage facility should be carried out using the City of Calgary's sizing methodology using single event analysis and continuous simulation.

It is recommended that a groundwater mounding analysis be undertaken for the proposed infiltration facilities designated as Ponds E2 and E3.

Appendix A Range of Hydraulic Conductivity of Natural Soils

Table 3.5 Range of Hydraulic Conductivity of Natural Soils

Soil type	Hydraulic conductivity range gpd/ft^2 (m/sec)	Permeability description
Openwork gravel (GP)	20,000 (1×10^{-2}) or higher	Very high
Uniform gravel (GP)	4000 to 20,000 (2×10^{-3} to 1×10^{-2})	High
Well-graded gravel (GW)	1000 to 6000 (5×10^{-4} to 3×10^{-3})	Moderate to high
Uniform sand (SP)	100 to 4000 (5×10^{-5} to 2×10^{-3})	Moderate to high
Well-graded sand (SW)	20 to 2000 (1×10^{-5} to 1×10^{-3})	Low to moderate
Silty sand (SM)	20 to 100 (1×10^{-5} to 5×10^{-5})	Low
Clayey sand (SC)	2 to 20 (1×10^{-6} to 1×10^{-5})	Low to very low
Silt (ML)	1 to 2 (5×10^{-7} to 1×10^{-6})	Very low
Clay (CL)	2×10^{-4} to 0.2 (1×10^{-10} to 1×10^{-7})	Very low to practically impermeable

Powers, J. P., Corwin, A. B., Schmall, P. C., & Kaeck, W. E. (2007). *Construction dewatering and groundwater control: New methods and applications* (3rd ed.). Hoboken, NJ: John Wiley & Sons.

Town of Strathmore SWMP – Recommended Allowable Unit Area Release Rates

300-8 Manning Close NE, Calgary, AB T2E 7N5 Phone: 403-717-2370			
Date:	November 29, 2019	Project Number:	19CG0000 (*for 16CG0023*)
Attention:	Freda Isaac, MSc, P. Eng.	Project Description:	Recommended Allowable UARR
Company:	Town of Strathmore	File Number:	
Phone:	403 934 3133 Ext 265	Prepared by:	Alex Mutasingwa, PhD, P. Eng
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Copy To:	Catherine Boddington (Town of Strathmore); Raul Morales (Allnorth); Mirren Turnbull (Allnorth)		

The Town of Strathmore (The Town) requested Allnorth to review and update the allowable release rates recommendations in the Town of Strathmore Stormwater Master Servicing Study (2018). These updates will provide the Town's with a quick guide for planning purposes, specifically for improvements and new development so that the existing and proposed stormwater system meet the current objectives of the Town, the Western Irrigation District (WID), Co-operative Stormwater Management Initiative (CSMI), and Alberta Environment and Parks (AEP).

1 ASSUMPTIONS

In updating the Table 6-25 of the allowable unit area release rates in the Town of Strathmore Stormwater Master Servicing Study report (2018), the following methodology and assumptions were made:

- The XPSWMM stormwater model for Town of Strathmore Stormwater Master Servicing Study was used for this purpose, and assumed to be correct. The current version 2019.1 was utilized.
- Many of the Town's existing and future drainage systems drain into the WID irrigation system. The main criteria is to discharges to the three Strathmore drainage courses of the Eagle Lake Ditch, WID 'A' Main Canal, and WID 'A' North Canal at a maximum allowable outflow discharge as summarized in **Table 1-1**. The Town has in addition to the WID sources, Eagle Lake drainage easement with a flow capacity of 85 L/s that drains south of Town into Eagle Lake, known as Unnamed Water Course B (Allnorth, 2018). The presented modelled outflow rate is based on the XPSWMM model.

Table 1-1: Maximum Allowable Release Rate to WID Irrigation System

ID	Total Area (ha)	Max. Allowable Outflow (m^3/s)	Modelled Maximum Outflow (m^3/s)	Remarks
Eagle Lake Ditch	2139.33	1.700	0.370	
WID 'A' Main Canal	49.54	1.415	0.434	
WID 'A' North Canal	39.52	0.141	0.152	
Unnamed Water Course B		0.085		No catchment area defined
Notes: • The modelled maximum outflow rate is based on XPSWMM model results.				

- The proposed maximum allowable UARR of 1.09 L/s/ha, 0.8 L/s/ha and 0.67 L/s/ha recommended in Town of Strathmore Stormwater Master Servicing Study (Allnorth 2018) is very conservative, it excluded the attenuation effects of the ponds, lakes and natural water bodies. The Town is concerned that developers may struggle to accommodate such low allowable UARR within a reasonable budget for stormwater infrastructure.
- Allnorth has taken a balanced approach to revising the allowable unit area release rate (Allowable UARR), maintaining the conservative requirement that developers preserve the pre-development UARR, but obtaining a higher Allowable UARR by considering the attenuation effects of the existing ponds, lakes, natural water bodies, and proposed ponds. The general methodology was to divide the study area into catchment areas for each pond (existing pond, lake, natural water body or proposed pond). Catchment areas with existing developments are also considered to be the pre-development condition, when considering future development. This assumption should be acceptable, as the existing developments and undeveloped lands do not exceed the maximum allowable outflows at the receiving water bodies, and the revised Allowable UARRs for future areas will maintain the pre-development. This approach of defining the allowable UARR upstream of each pond and defining the designed pond parameters that will maintain the overall actual outflow rate as summarized in **Table 1-1**.

2 REVISED ALLOWABLE UNIT AREA RELEASE RATES

The revised allowable unit area release rates (Allowable UARRs) were based on the modelled maximum inflow to the pond, as summarized in **Table 2-1**. Allowable UARRs were computed by taking the sum of modelled maximum inflow to each engineered pond, subtracting any flow resulting from upstream ponds, and dividing by the catchment area for each pond. Flows from upstream ponds were excluded to avoid double-counting, as the Allowable UARRs for the areas contributing to any upstream ponds were computed with the upstream pond.

The UARR was also computed using the catchment maximum outflows. This value is supplied for reference only, and Allnorth does not recommend using it as the Allowable UARR. The reasoning is that the catchment maximum outflows UARR assumes the modelled attenuation between the catchment and the downstream pond can be relied upon as part of the stormwater design. Given that the structures contributing to this attenuation are not necessarily designed, this is not a reliable assumption. It is also seen from the results in **Table 2-1**, the sum of pond maximum inflows is less than the sum of catchment maximum outflows this can be explained by catchment losses and channel routing before reaching the pond.

Some of these pond catchments areas are at buildout condition, with exception of Pond X, A17, Pond4A, Pond 4B, AW5, AW7, A1, A17, Pond E2, AE2, A73, P39, AC1, AX5, A71, AC2 and AC3, ass presented in italic in **Table 2-1**.

Figure 6-10 shows the watershed areas for the future condition, and **Figure 6-10A** shows the watershed areas for the future condition and the network layout of catchments and ponds as they drain downstream, and reflects the layout used within the with the XPSWMM model.

Table 2-1: Maximum Allowable Unit Area Release Rates

Model Pond ID	Pond Description (Existing / Proposed)	Excluding Contributions from Upstream Ponds			UARR based Catchment Max. Outflows (L/s/ha)	Allowable UARR for Pond Max. Inflow (L/s/ha)	Contributing Nodes (Excluding Upstream Ponds)
		Sum of Catchment Max. Outflows (m^3/s)	Sum of Pond Max. Inflows (m^3/s)	Sum of Contributing Areas (ha)			
A13	existing	2.00	2.00	13.28	150.9	150.9	A13
POND-X	existing	8.57	7.13	91.63	93.5	77.8	*A10*, A11, A12, A14 (A14A and A14B)
A17	existing	0.72	0.68	61.55	11.6	11.0	*A15, A17; undeveloped areas*
POND-Z	existing	1.48	1.46	58.51	25.2	25.0	*A18; undeveloped areas*
F1	existing	0.92	0.89	41.43	22.1	21.4	A19A, A59, *A60*
F2	existing	5.15	5.12	39.62	130.0	129.3	A19B
POND1	existing	0.93	0.93	25.4	36.6	36.7	A20
POND2	existing	5.95	4.60	53.11	112.0	86.6	A21, A22, A62
POND3	existing	7.02	7.09	39.25	178.7	180.6	A23
Pond 4B	*proposed*	16.90	1.07	168.71	100.2	6.4	*A2, A201*, A5, A63, A6 (A6a and A6b), *A7A*, A8A, A8B, A8C, A9
POND4A	existing	8.95	7.44	67.67	132.3	110.0	A24, *A30*, A68
Pond 6	existing	19.04	8.98	151.34	125.8	59.3	A26, A27, A28, A29, A31, A32, A33
Pond 7	existing	0.00	0.00	0	N/A	N/A	*No upstream catchments draining directly*
A3x	existing	2.71	2.12	33.23	81.6	63.8	A1, A3
A4	*proposed*	0.53	0.53	3.66	143.7	143.7	A4
A66	*existing*	2.37	2.37	17.86	132.7	132.7	A66
P4	existing	2.61	2.57	27.06	96.5	94.9	A7B
AW5	*proposed*	16.24	15.31	116.7	139.2	131.2	*AW5, AW6; undeveloped areas*
AW7	existing slough	15.68	15.57	137.52	114.0	113.2	A67, *AW7; undeveloped areas*
AE1	*proposed*	17.89	17.89	169.99	105.3	105.3	*AE1; undeveloped areas*
A77	*proposed*	8.13	8.13	57.54	141.3	141.3	*A77; undeveloped areas*
Pond E1	*proposed*	0.00	0.38	0	N/A	N/A	*No upstream catchments draining directly*
Pond E2	*proposed*	10.49	7.90	134.6	77.9	58.7	*A34 - green space A35 - undeveloped areas*
Pond E3	*proposed*	0.00	0.00	0	N/A	N/A	*No upstream catchments draining directly*
AE2	*proposed*	8.95	8.95	65.41	136.8	136.8	*AE2; undeveloped areas*
A73	*proposed*	8.62	8.62	62.25	138.5	138.5	*A73; undeveloped areas*

Model Pond ID	Pond Description (Existing / Proposed)	Excluding Contributions from Upstream Ponds			UARR based Catchment Max. Outflows (L/s/ha)	Allowable UARR for Pond Max. Inflow (L/s/ha)	Contributing Nodes (Excluding Upstream Ponds)
		Sum of Catchment Max. Outflows (m^3/s)	Sum of Pond Max. Inflows (m^3/s)	Sum of Contributing Areas (ha)			
P23	*proposed*	8.23	3.18	60.37	136.3	52.7	A16, A36, A37B
P39	*proposed*	14.53	8.99	79.7	182.3	112.9	*A37A, A38, A39; partially developed areas*
AC1	*proposed*	0.64	0.64	68.78	9.3	9.3	*AC1; undeveloped areas*
AX5	*proposed*	1.88	1.88	52.45	35.7	35.7	*AX5; undeveloped areas*
A74	*proposed*	5.07	5.07	29.62	171.2	171.2	*A74; undeveloped areas*
AC2	*proposed*	0.62	0.62	66.72	9.3	9.3	*AC2; undeveloped areas*
AC3	*proposed*	0.34	0.34	32.43	10.6	10.6	*AC3; undeveloped areas*

Notes:

- Contributions from upstream ponds has been excluded.
- Contributing nodes exclude upstream ponds.
- For Pond 7, Pond E1 and Pond E3 there are no upstream catchments draining directly to the pond.
- Contributing areas presented in italic are green space, undeveloped or partially developed.
- Pond 4A and Pond 4B can be assumed to be one pond since they are hydraulically connected. Similarly Pond 6 and Pond 7
- UARR based catchment maximum outflows is provided for reference only, allowable UARR is based on the modelled maximum inflow to the pond.

3 STORMWATER PONDS

To ensure the allowable UARRs are controlled adequately at each pond, the ponds must meet the design specifications used in the XPSWMM model. These specifications are summarized in **Table 3-1**.

The 1-in-100 year high water level (HWL) and maximum outflow rate are presented for each pond. In this assignment it is assumed all the ponds information and the outlet controls in the XPSWMM were verified during the Town of Strathmore Stormwater Master Servicing Study (2018). Therefore, the XPSWMM model information and the recommended allowable unit area release rates in **Table 2-1** are valid. For the undeveloped areas identified, the proposed pond stage – storage curves, and outflow rates should be used.

Table 3-1: Pond Volume Information

POND-X				
Data Point	**Elevation (m)**	**Depth (m)**	**Surface Area (m^2)**	**Volume (m^3)**
1	966.58	0.00	49685	0
2	971.88	5.30	74503	326882
3	972.33	5.75	84605	362657
4	973.08	6.50	84606	426110
5	973.83	7.25	84607	489565
6	974.25	7.67	97671	527810
7	974.30	7.72	98645	532718
8	974.50	7.92	100645	552646
Notes: Model HWL 973.612 m; Model maximum outflow 0.0179 m^3/s				
POND-A17				
Data Point	**Elevation (m)**	**Depth (m)**	**Surface Area (m^2)**	**Volume (m^3)**
1	970.00	0.00	10080	0
2	971.00	1.00	40400	23553
3	972.00	2.00	80900	83042
Notes: Model HWL 972.309 m; Model maximum outflow 0.0216 m^3/s; Pond A17 and Pond-Z work together.				
POND-Z				
Data Point	**Elevation (m)**	**Depth (m)**	**Surface Area (m^2)**	**Volume (m^3)**
1	972.00	0.00	154948	0
2	972.50	0.50	159228	78541
3	973.00	1.00	163549	159232
Notes: Model HWL 972.309 m; Model maximum outflow 0.0194 m^3/s				

POND-F1				
Data Point	**Elevation (m)**	**Depth (m)**	**Surface Area (m^2)**	**Volume (m^3)**
1	969.50	0.00	1743	0
2	970.00	0.50	2406	1033
3	970.50	1.00	3109	2408
4	971.00	1.50	3851	4144
5	971.50	2.00	4632	6262
6	971.60	2.10	4793	6733
7	971.70	2.20	4956	7221
8	971.80	2.30	5120	7725
Notes: Model HWL 971.560 m; Model maximum outflow 0.399 m^3/s				

POND-F2				
Data Point	**Elevation (m)**	**Depth (m)**	**Surface Area (m^2)**	**Volume (m^3)**
1	969.40	0.00	3035	0
2	969.90	0.50	3859	1719
3	970.40	1.00	4722	3861
4	970.90	1.50	5625	6444
5	971.40	2.00	6567	9489
6	971.50	2.10	6760	10156
7	971.60	2.20	6955	10841
8	971.70	2.30	7151	11547
Notes: Model HWL 971.690 m; Model maximum outflow 3.782 m^3/s				

POND 3				
Data Point	**Elevation (m)**	**Depth (m)**	**Area (m^2)**	**Volume (m^3)**
1	970.20	0.00	5380	0
2	970.40	0.20	18986	2298
3	970.60	0.40	23434	6532
4	970.80	0.60	25617	11436
5	971.00	0.80	29004	16894
6	971.20	1.00	36424	23423
7	971.30	1.10	41002	27292
Notes: Model HWL 970.883 m; Model maximum outflow 0.5317 m^3/s				

POND A3x				
Data Point	**Elevation (m)**	**Depth (m)**	**Surface Area (m^2)**	**Volume (m^3)**
1	973.00	0.00	1	0
2	973.20	0.20	1050	72
3	973.40	0.40	2013	373
4	973.60	0.60	3028	874
5	973.80	0.80	5433	1708
6	974.00	1.00	7271	2974
7	974.20	1.20	8497	4550
8	974.40	1.40	9296	6328
9	974.60	1.60	9854	8243
10	974.80	1.80	9854	10214
11	975.00	2.00	11029	12301
12	975.20	2.20	11861	14589
Notes: Model HWL 974.880 m; Model maximum outflow 0.0850 m^3/s				

POND P4				
Data Point	**Elevation (m)**	**Depth (m)**	**Surface Area (m^2)**	**Volume (m^3)**
1	972.73	0.00	1	0
2	974.50	1.77	2	3
3	975.00	2.27	1645	287
4	976.00	3.27	7408	4468
Notes: Model HWL 974.781 m; Model maximum outflow 2.1642 m^3/s				

POND 4B				
Data Point	**Elevation (m)**	**Depth (m)**	**Surface Area (m^2)**	**Volume (m^3)**
1	963.20	0.00	4000	0
2	964.70	1.50	8000	8828
3	966.70	3.50	14300	30825
4	967.00	3.80	15100	35235

Notes: Model HWL 966.641 m; Model maximum outflow 3.1953 m^3/s

POND 4A				
Data Point	**Elevation (m)**	**Depth (m)**	**Surface Area (m^2)**	**Volume (m^3)**
1	961.00	0.00	1400	0
2	963.36	2.36	3900	6007
3	965.50	4.50	6800	17313
4	968.00	7.00	6800	34313
Notes: Model HWL 965.082 m; Model maximum outflow 4.7957 m^3/s				

POND 6				
Data Point	**Elevation (m)**	**Depth (m)**	**Surface Area (m^2)**	**Volume (m^3)**
1	952.00	0.00	8286	0
2	954.00	2.00	17389	25119
3	954.20	2.20	20239	28878
4	954.40	2.40	22163	33117
5	954.60	2.60	25296	37859
6	954.80	2.80	28945	43279
7	955.00	3.00	33177	49486
8	955.20	3.20	42949	57078
9	955.40	3.40	50635	66426
10	955.60	3.60	56477	77131
Notes: Model HWL 955.362 m; Model maximum outflow 4.6356 m^3/s				

POND 7				
Data Point	**Elevation (m)**	**Depth (m)**	**Surface Area (m^2)**	**Volume (m^3)**
1	947.00	0.00	35800	0
2	949.00	2.00	46500	82066
3	950.00	3.00	148500	174765
4	951.00	4.00	194000	345507
5	951.70	4.70	245000	498809
6	952.00	5.00	264000	575140
Notes: Model HWL 950.967 m; Model maximum outflow 0.0881 m^3/s				

POND A13				
Data Point	**Elevation (m)**	**Depth (m)**	**Area (m^2)**	**Volume (m^3)**
1	979.70	0.00	580	0
2	980.10	0.40	1750	445
3	980.30	0.60	1960	816
4	980.50	0.80	2240	1235
5	980.70	1.00	2430	1702
6	980.90	1.20	2710	2216
7	981.10	1.40	2920	2779
8	981.20	1.50	3080	3079
9	981.80	2.10	3727	5118
Notes: Model HWL 980.735 m; Model Max. Outflow 0.3618 m^3/s				

POND 1				
Data Point	**Elevation (m)**	**Depth (m)**	**Area (m^2)**	**Volume (m^3)**
1	971.00	0.00	111351	0
2	971.20	0.20	133010	24404
3	971.40	0.40	143505	52048
4	971.50	0.50	148893	66667
5	971.70	0.70	159200	97471
6	972.00	1.00	169320	146740
Notes: Model HWL 971.309 m; Model Max. Outflow 0.0069 m^3/s				

POND 2				
Data Point	**Elevation (m)**	**Depth (m)**	**Area (m^2)**	**Volume (m^3)**
1	970.40	0.00	24067	0
2	970.60	0.20	54594	7661
3	970.80	0.40	67994	19895
4	971.00	0.60	98021	36405
5	971.20	0.80	111544	57347
6	971.40	1.00	124860	80974
Notes: Model HWL 970.814 m; Model Max. Outflow 0.1438 m^3/s				

POND AW7				
Data Point	**Elevation (m)**	**Depth (m)**	**Area (m^2)**	**Volume (m^3)**
1	963.60	0.00	28420	0
2	964.20	0.60	30990	17817
3	964.80	1.20	33620	37195
4	965.20	1.60	35420	51001
5	965.60	2.00	37250	65533
6	965.80	2.20	38180	73076
7	966.30	2.70	40530	92750
8	966.90	3.30	43420	117930
9	967.30	3.70	45390	135691
10	967.60	4.00	46880	149530
11	967.90	4.30	48390	163820
Notes: Model HWL 966.699 m; Model Max. Outflow 0.6815 m^3/s				

4 CONCLUSIONS AND RECOMMENDATIONS

In this assignment it is assumed all the ponds design information and the outlet controls in the XPSWMM model were verified during the Town of Strathmore Stormwater Master Servicing Study (2018). Therefore, the XPSWMM model information and the recommended allowable unit area release rates in **Table 2-1** are valid.

The revised allowable unit area release rates as presented in **Table 2-1**. The revised outflow rates meets the discharge rates to the drainage courses of the Eagle Lake Ditch, WID 'A' Main Canal, and WID 'A' North Canal as summarized in **Table 1-1**.

To meet the allowable unit area release rates the pond information in **Table 3-1** as used in the XPSWMM model should be maintained.

We recommend the Town to inspect and verify all the existing and proposed ponds information and the outlet controls to ensure the model information and the recommended allowable unit area release rates in **Table 2-1** are valid. For the undeveloped areas identified, the proposed pond volume and outflow rates should be used.

REFERENCES

Allnorth, July 2018, Town of Strathmore Stormwater Master Servicing Study, prepared for the Town of Strathmore, July 06, 2018

Allnorth, 2018, XPSWMM models for Town of Strathmore Stormwater Master Servicing Study (Future Town, FutureWID and FutureWIDNorthA)

We trust this memorandum satisfies your requirements at this time and thank you for the opportunity to work with you on the project. If you have questions or concerns do not hesitate to contact our office.

Yours truly,

ALLNORTH CONSULTANTS LIMITED

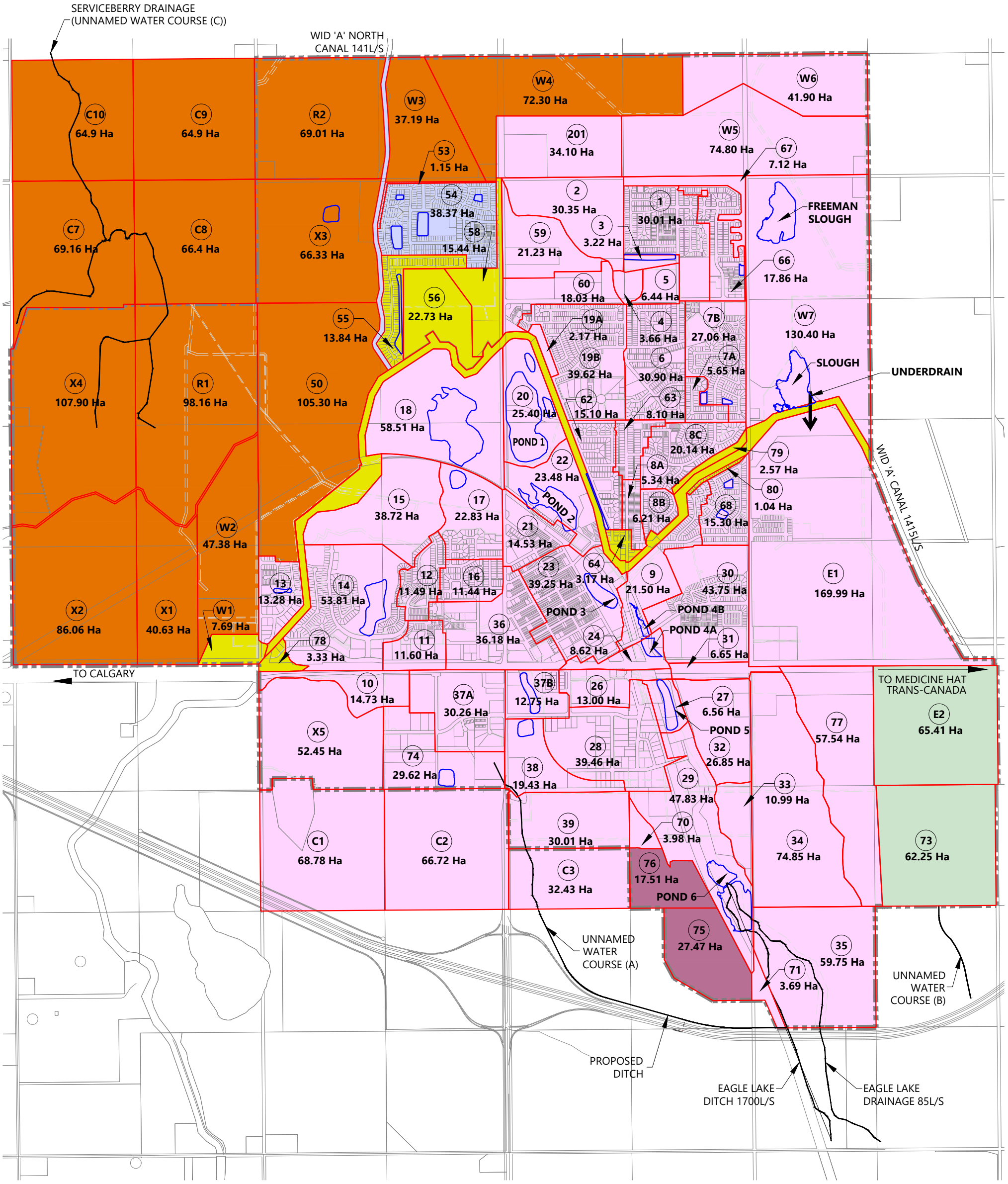
Allnorth Permit to Practice/Certificate of Authorization #: 6366

Prepared By:

Alex Mutasingwa, PhD, P. Eng
Senior Water Resources Engineer

ATTACHMENTS

Date: 2019/08/15 | User: Annie Xu | File: P:\CG\2016\0-99\16CG0023 - Town of Strathmore - Master Plan Update - Storm Water\1000-Drawings\1011 Civil\01-Production\16CG0023_Figure 6-10 | Layout: Areas | Paper Size: 431.8mm x 558.8mm



Legend

- CATCHMENT BOUNDARY
- TOWN BOUNDARY
- UNNAMED WATER COURSE
- WID 'A' NORTH CANAL
- SERVICEBERRY DRAINAGE
- WID 'A' CANAL
- UNNAMED WATER COURSE (B) /EAGLE LAKE DRAINAGE
- NO DRAINAGE
- EAGLE LAKE DITCH DRAINAGE
- R1 SUBCATCHMENT AREA LABEL

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
D	18/05/10	ISSUED FOR REPORT	HL	-
C	18/04/13	ISSUED FOR REPORT	HL	-
B	17/01/10	ISSUED FOR REPORT	LX	-
A	16/11/09	ISSUED FOR REVIEW	LX	-

CLIENT: Strathmore — Where Quality of Life is a Way of Life

Allnorth

TITLE: **Watershed Areas Future Condition**

CLIENT NO:	-	DRWN:	LX	DATE: 16/11/09
PROJECT NO:	16CG0023	DSGN:	JB	DATE: -
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE: -
SCALE:	1:25000	APVD:	-	DATE: -

PROJECT: **Town of Strathmore Stormwater Master Study**

DWG NO: **Figure 6-10**

REV: **D**

Date: 2019/08/21 | User: Annie Xu | File: P:\CG\2016\0-99\16CG0023 - Town of Strathmore - Master Plan Update - Storm Water\1000-Drawings\1011 Civil\01-Production\16CG0023_Figure 6-10A | Layout: Areas | Paper Size: 431.8mm x 558.8mm

WID 'A' NORTH CANAL 141L/S

R2 69.01 Ha

W3 37.19 Ha

W4 72.30 Ha

W6 41.90 Ha

W5 74.80 Ha

201 34.10 Ha

X3 66.33 Ha

53 1.15 Ha

54 38.37 Ha

2 30.35 Ha

67 7.12 Ha

1 30.01 Ha

FREEMAN SLOUGH

66 17.86 Ha

59 21.23 Ha

POND A3X

3 3.22 Ha

5 3.66 Ha

4 6.44 Ha

60 18.03 Ha

58 15.44 Ha

56 22.73 Ha

POND A66

W7 130.40 Ha

7B 27.06 Ha

55 13.84 Ha

19A 2.17 Ha

19B 39.62 Ha

6 30.90 Ha

SLOUGH

UNDERDRAIN

50 105.30 Ha

POND F1

7A

P4

20 25.40 Ha

POND F2

5.65 Ha

18 58.51 Ha

POND Z

15.10 Ha

8.10 Ha

8C 20.14 Ha

62

63

POND 1

22 23.48 Ha

79 2.57 Ha

80 1.04 Ha

15.30 Ha

68

8A 5.34 Ha

8B 6.21 Ha

15 38.72 Ha

17 22.83 Ha

POND 2

21 14.53 Ha

64 3.17 Ha

WID 'A' CANAL 1415L/S

53.81 Ha

13 13.28 Ha

14

12 11.49 Ha

16 11.44 Ha

23 39.25 Ha

9 21.50 Ha

30 43.75 Ha

E1 169.99 Ha

POND A13

POND X

36.18 Ha

36

POND 3

POND 4B

POND 4A

11 11.60 Ha

78 3.33 Ha

24 8.62 Ha

31

TO MEDICINE HAT TRANS-CANADA

POND 23

37B

10 14.73 Ha

37A 30.26 Ha

12.75 Ha

26 13.00 Ha

27 6.56 Ha

POND 6

57.54 Ha

E2 65.41 Ha

77

X5 52.45 Ha

74 29.62 Ha

28 39.46 Ha

32 26.85 Ha

38 19.43 Ha

29 47.83 Ha

33 10.99 Ha

74.85 Ha

POND E1

39 30.01 Ha

34

73 62.25 Ha

C1 68.78 Ha

C2 66.72 Ha

C3 32.43 Ha

76 17.51 Ha

POND 7

75 27.47 Ha

59.75 Ha

35

UNNAMED WATER COURSE (A)

PROPOSED DITCH

71 3.69 Ha

UNNAMED WATER COURSE (B)

POND E3

EAGLE LAKE DITCH 1700L/S

EAGLE LAKE DRAINAGE 85L/S

Legend

- CATCHMENT BOUNDARY
- TOWN BOUNDARY
- UNNAMED WATER COURSE
- WID 'A' NORTH CANAL
- SERVICEBERRY DRAINAGE
- WID 'A' CANAL
- UNNAMED WATER COURSE (B) /EAGLE LAKE DRAINAGE
- NO DRAINAGE
- EAGLE LAKE DITCH DRAINAGE
- R1 SUBCATCHMENT AREA LABEL

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
A	19/08/15	ISSUED FOR REVIEW	LX	AM

CLIENT: Strathmore — Where Quality of Life is a Way of Life

Allnorth

TITLE: **Watershed Areas Future Condition & Network Layout**

CLIENT NO:	-	DRWN:	LX	DATE: 16/11/09
PROJECT NO:	16CG0023	DSGN:	JB	DATE: -
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE: -
SCALE:	1:25000	APVD:	-	DATE: -

PROJECT: **Town of Strathmore Stormwater Master Study**

DWG NO: **Figure 6-10A**

REV: **A**

#300 - 8 Manning Close NE
Calgary, AB T2E 7N5
Phone: 403-717-2370
Fax: 403-717-2363

Cost Estimate

Client	Strathmore , AB	**Date**	15 Sep, 2019
Subject	Strathmore Stormwater Master Plan Cost Estimate	**Project No.**	16CG0023
		By:	CC

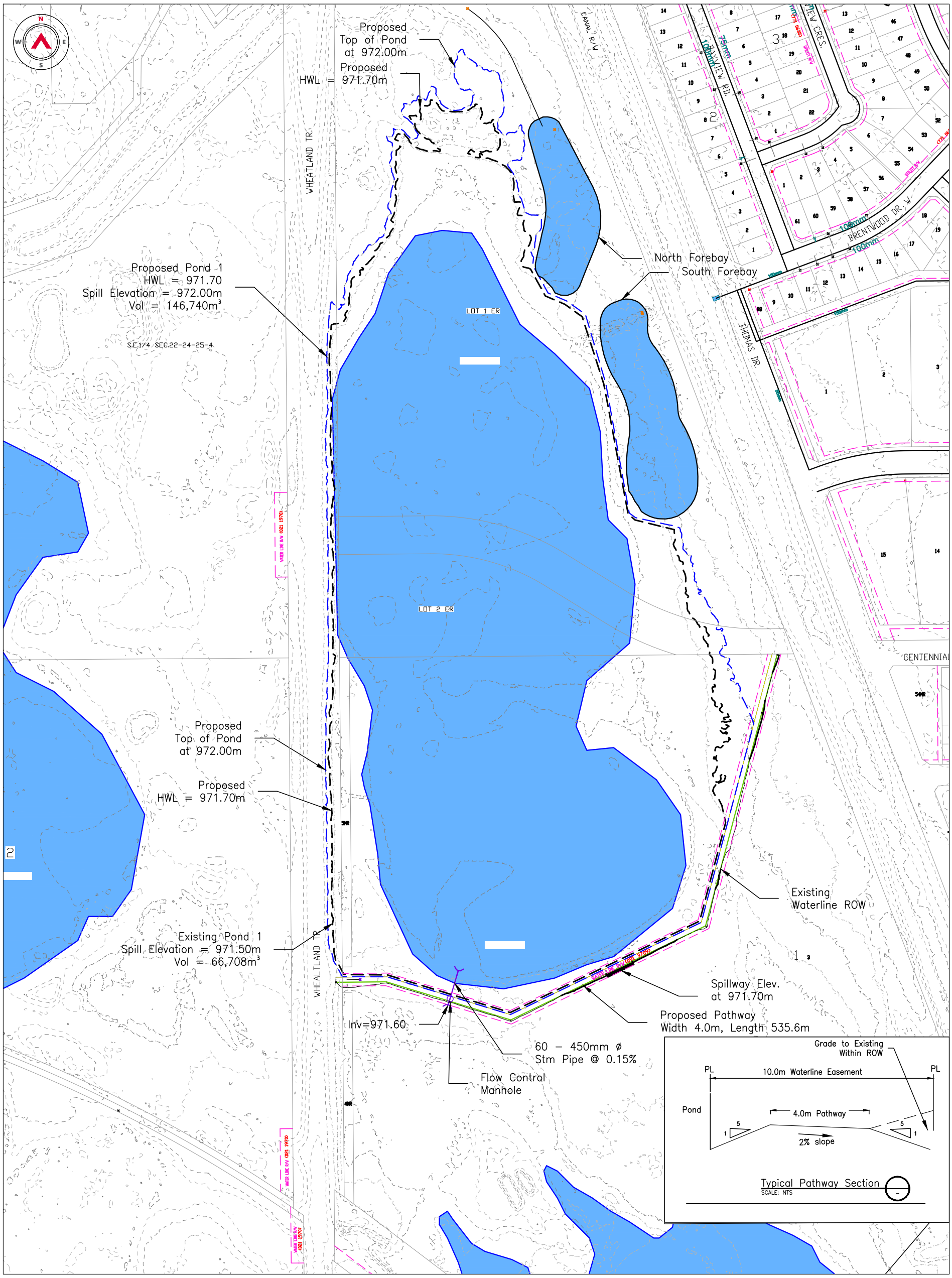
SCHEDULE A -EXISTING POND 1 IMPROVEMENTS

ITEM NO.	DESCRIPTION OF WORK	UNIT	EST. QTY.	UNIT PRICE	EXT. AMT
1	Top soil Stripping (assume 0.15m depth)	cu.m	8396	$10	$83,958
2	Common Excavation	cu.m	80032	$15	$1,200,480
3	Riprap (assume 1m depth)	cu.m	60	$300	$18,000
4	Filter Fabric	sq.m	60	$4	$240
5	Top soil and Seeding	sq.m	3200	$5	$16,000
6	Storm Pipe - 450mm	l.m.	60	$270	$16,200
7	Storm Manhole	unit	1	$3,500	$3,500
8	Outlet Control Structure	unit	1	$5,000	$5,000
				SUBTOTAL	$1,343,378
	35% Engineering / Contingency				$1,813,560
				TOTAL - SCHEDULE A	**$1,813,560**

SCHEDULE B - PATHWAY SOUTH OF POND 1

ITEM NO.	DESCRIPTION OF WORK	UNIT	EST. QTY.	UNIT PRICE	EXT. AMT
1	Subgrade preparation	sq.m	2140	$10	$21,400
2	25mm Crushed Gravel 100mm lift	cu.m	214	$80	$17,120
3	Miscellanous signs	allow.	1	$5,000	$5,000
				SUBTOTAL	$43,520
	35% Engineering / Contingency				$58,752
				TOTAL - SCHEDULE B	**$58,752**

OVERALL TOTAL	**$1,872,312**



Legend

- EXISTING POND EXTENT
- PROPOSED POND EXTENT
- PROPOSED INLET/ OUTLET
- PROPOSED STORM PIPE/ CULVERT
- PROPOSED STORM MANHOLE
- PROPOSED PATHWAY

REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
B	19/09/18	ISSUED FOR REVIEW	LX	AM
A	16/09/28	ISSUED FOR REVIEW	LX	-

CLIENT:

Allnorth

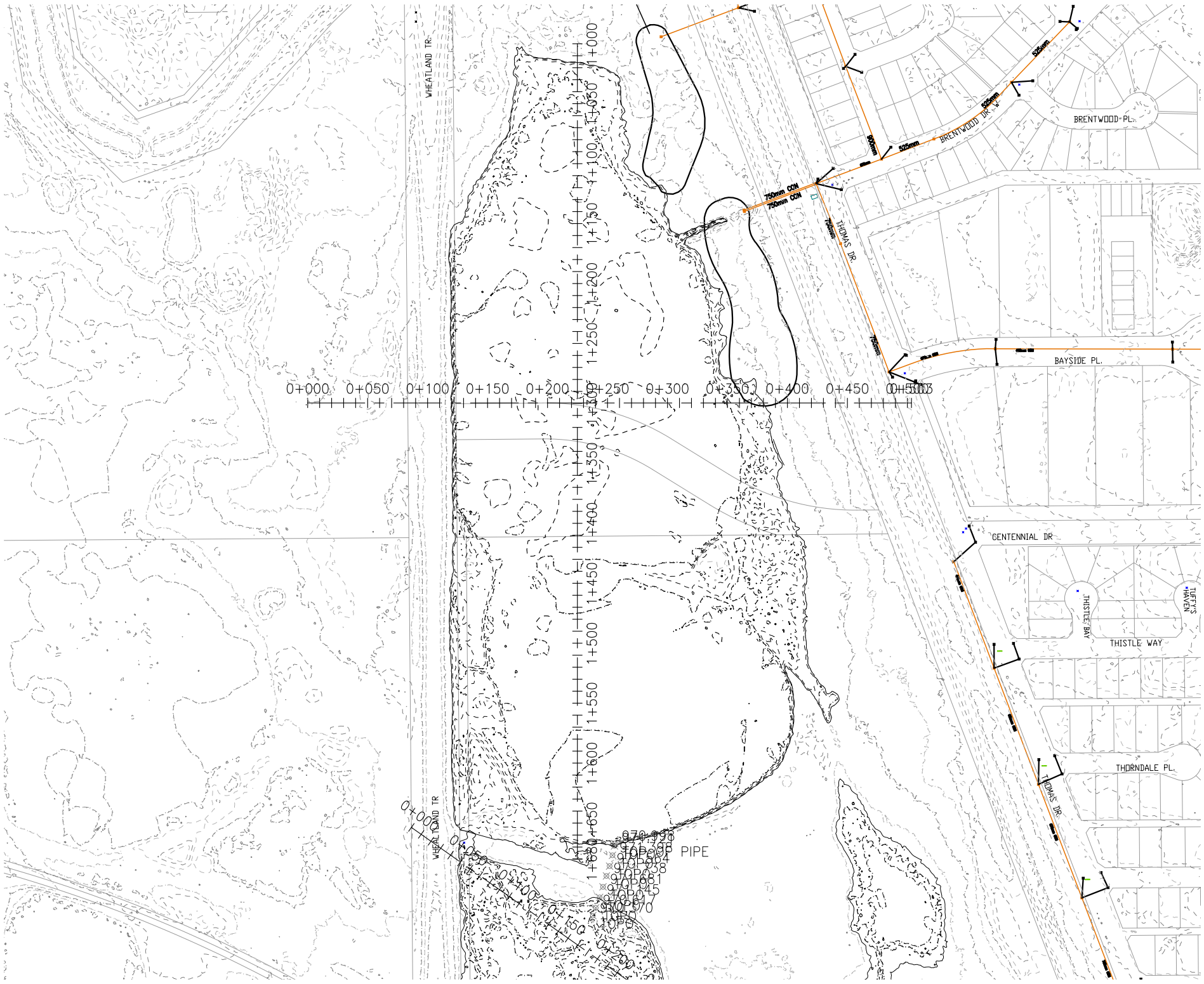
TITLE: **Pond 1 Storage Update**

CLIENT NO:	16CG0023	DRWN: -	DATE: 16/11/30
PROJECT NO:	-	DSGN: FI	DATE: -
DRAWING SIZE:	ANSI "B"	CHKD: -	DATE: -
SCALE:	1:2500	APVD: -	DATE: -

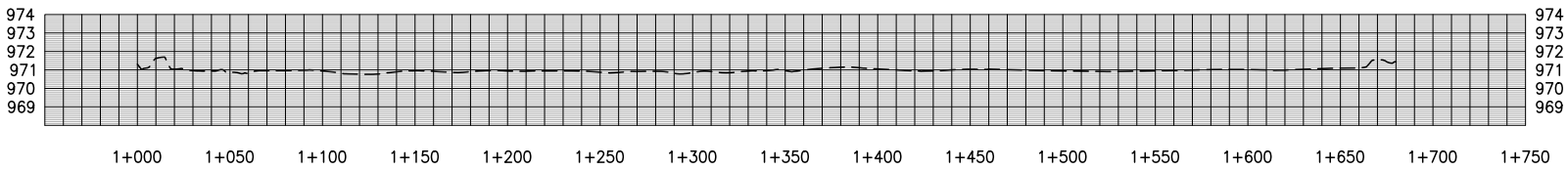
PROJECT: **Town of Strathmore Stormwater Master Plan Update**

DWG NO: **POND 1**

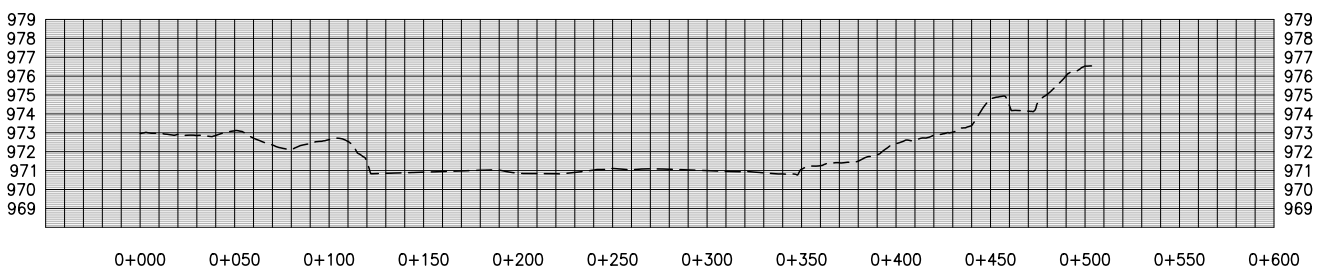
REV: **B**



PROFILE VIEW: POND 1 SECTION A



PROFILE VIEW: POND 1 SECTION B



REV	YY/MM/DD	DESCRIPTION	DRWN	APVD
-	-	-	-	-

CLIENT:

TITLE: -

CLIENT NO:	-	DRWN:	-	DATE: -
PROJECT NO:	-	DSGN:	-	DATE: -
DRAWING SIZE:	ANSI "B"	CHKD:	-	DATE: -
SCALE:	AS NOTED	APVD:	-	DATE: -

PROJECT: **Strathmore Storm Ponds Stage Storage**

DWG NO: **POND 1**

REV: -