SHEPARD INDUSTRIAL AREA STRUCTURE PLAN:

STORMWATER MANAGEMENT STUDY

ROCKY VIEW COUNTY, ALBERTA

Prepared for:

Shepard Development Corporation

Prepared by:

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1. INTRODUCTION

This stormwater servicing study is provided in support of the Shepard Industrial Area Structure Plan (ASP). This study does not provide a detailed stormwater servicing plan for the ASP area as it is not at the detailed stage in planning process, this study provides an high level overview and analysis of the pre-development stormwater flow volumes, pre-development catchment areas, post-development stormwater retention and release options, and the location and size of stormwater retention ponds and stormwater mains. As part of the subsequent planning process more detailed stormwater management analysis and reports will be submitted in accordance with County planning application requirements as market forces and development phasing details are determined.

2. STUDY AREA

2.1. SITE LOCATION AND ADJACENT AREA

The ASP are includes approximately 773 hectares (1910 acres) of land and proposes a mix of industrial and commercial uses located in Rocky View County, AB. The ASP lands are located east of the City of Calgary within the future growth corridor for industrial development in the Intermunicipal Development Plan (IDP) between Rocky View County and the City of Calgary. The ASP lands are bound by the CP Rail mainline right of way to the south, the abandoned CP railway right of way, approximately one-half mile north of Township Road 232 to the north, Range Road 284 to the west and the undeveloped Range Road 282 AR/W Plan 1112369 to the east. The total area amounts to 773 hectares (1910 acres). The ASP lands are shown in Drawing SK-00, the ASP lands are inclusive of the below legal parcels:

- NW¼-3-23-28-W4, NE¼-3-23-28-W4, SE¼-9-23-28-W4 and SW¼-9-23-28-W4 north of the Canadian Pacific Railway
- NW¼-9-23-28-W4
- NE¼-9-23-28-W4
- SE¼-16-23-28-W4, SW¼-16-23-28-W4, NE¼-15-23-28-W4 and SW¼-15-23-28-W4
- south of the Canadian Pacific Railway
- SE¼-15-23-28-W4
- 10-23-28-W4

2.2. PRE-DEVELOPMENT CATCHMENT AREAS

The pre-development storm catchment area is divided into 2 distinct catchments areas. The catchment areas are separated by a ridge that divides the ASP area approximately in half.

The catchment areas will be referred to as the *Shepard* wetland catchment area and the *Bow River* catchment area in this study. The *Shepard* wetland catchment area drains to the *Shepard* existing wetland on the west side of the ASP area and the *Bow River* drains to the Bow River. The *Bow River* catchment area, includes drainage area that is outside of the ASP area and has a total area of 934.39 ha and are comprised of catchment areas EX 1 and EX 6 as shown on Drawing SK-01. Catchment area EX 6 has natural depression area which provide sufficient volumes to self-contain the 1:100 year storm event. Catchment area EX 1 in the SE quadrant of the ASP area is assumed to be a zero-discharge area, all stormwater flows to an existing low spot (a slough).

The *Shepard* wetland catchment area has a total area 430.01 ha and is comprised of catchment areas EX 5 and EX 7. Catchment areas EX 5 and EX 7 pre-development flows are not contained within the ASP site. Stormwater, sheet flows from catchment area EX 5 and spills to the north of the ASP area at a pre-development peak flow rate for a 1:100 year event of 3.8 L/s/ha (1,572 L/s). The stormwater from this area continues to sheet flow until reaching the existing Shepard wetland system located west of the ASP area. Catchment area EX 7 sheet flows to west to the same Shepard wetland system at 18.75 L/s/ha (246 L/s). Water from this wetland make its way into the City of Calgary's Ralph Klein Park, ultimately discharging into the Bow River via the Shepard Ditch.

2.3. POST-DEVELOPMENT CATCHMENT AREAS

As shown on Drawing SK-02, the ASP areas existing drainage topography will generally remain consistent with the pre-development drainage pattern through the post development drainage pattern, where the post development *Bow River* catchment area include catchment areas PR 1, EX 6 and EX 8. The post development *Bow River* catchment area is 905.10 ha. The *Shepard* wetland catchment areas include PR 5, PR 9 and PR 10, the post development *Shepard* wetland catchment area is 442.50 ha.

3. PREVIOUS STUDIES AND PLANNING DOCUMENTS

The *Shepard Regional Drainage Plan* (SRDP) prepared by AECOM in November 2011 has been reviewed by IDEA Group Inc. and the findings have been taken into account for this ASP stormwater study The design targets in this ASP stormwater study are compliant with the SRDP. The Bow River is the receiving water body for the SRDP. A previous analysis had set a 2.5L/s/ha release rate to Bow River from SRDP area. However, the Shepard Ditch did not meet this capacity and as a result of the analysis conducted for the SRDP, AECOM reset the Unit Area Release Rate target to 0.8L/s/ha for the area to ensure the Shepard Ditch would have sufficient capacity to convey the stormwater to the Bow River. It is also

stipulated that 0.8L/s/ha is recommended for all sub-catchments within the study area in SRDP.

The SRDP also mentions that the Bow Basin Watershed Management Plan (BBWMP) does not indicate specific runoff volume control targets for the Shepard Study Area. However, the SRDP stipulates interim targets of effective imperviousness between 10%-20% for new development in support of the BBWMP. The 10%-20% effective imperviousness is equivalent to an annual runoff volume in the range of 40mm-90mm according to SRDP. The low impact development (LID) has been analyzed in the SRDP, in two scenarios, to reduce the volume release. LID scenario 1 in the report reached 87 mm total annual release volume. The following Table 1 shows the annual runoff for each sub-catchment area within the SRDP in relation to the ASP area.

Name of sub-catchment area in Shepard Regional Drainage Plan	Name of catchment area in our Report	Runoff Volume (mm)
Bow-Sh-S-P4-6	PR 5, PR 9, PR 10	113
Bow-Sh-S-P10-12	PR 1 & EX 8 (Part)	52
Bow-Sh-S-P10-10	PR 1 & EX 8 (Part)	159

Table 1. Shepard Regional Drainage Plan LID Scenario #1

Based on portions of catchment areas PR 1 & EX 8 falling within Bow-Sh-S-P10-12 and Bow-Sh-S-P10-10, the annual volume release target for PR 1 & EX 8 has been set to 100 mm. The annual volume release target for PR 5, PR 9 and PR 10 has been set to 113 mm for the purposes of this report and as stipulated within the SRDP.

3.1. STORMWATER MANAGEMENT OPTIONS:

The 2 catchment areas will require two different stormwater management systems, as their pre-development conditions vary.

3.1.1. SHEPARD WETLAND CATCHMENT AREA

The Shepard wetland catchment area is naturally flowing offsite into the wetland west of the ASP boundary. Post-development flows will continue to flow into the wetland. However, the site will increase in overall imperviousness due to development, increasing the stormwater runoff in the catchment areas. A storm pond system will be required to provide sufficient

storage to decrease the post-development peak flow rate to 0.8 L/s/ha as stipulated in AECOM, 2011, *Shepard Regional Drainage Plan.*

3.1.2. BOW RIVER CATCHMENT AREA

The existing Bow River catchment area are self-contained and assumed to be zero discharge. As the catchment area EX 6 shown on Drawing SK-02 will not be disturbed under the proposed development, and it has sufficient natural depression storage to accommodate the peak flow of a 1:100 year event; catchment area EX 6 is not considered to contribute stormwater to the proposed ASP area. The catchment area EX 8 will not be disturbed by proposed development either, but the stormwater runoff of this area will continue flowing to the ASP area post-development. Thus, the proposed stormwater management system should provide enough capacities for runoff from catchment area PR 1 and EX 8. A storm pond system is required to collect the stormwater at the natural low-lying area, and a storm trunk will be required to convey stormwater at a peak flow rate of 0.546 L/s/ha (494 L/s) from the pond system to the Bow River.

4. COMPUTE MODELS

EPA SWMM was used to analyze a single 1:100 year storm event and City of Calgary Water Balance Sheet (WBSCC) was used for the continuous simulation of the proposed catchment areas.

4.1. EPA SWMM

Created by the United States Environmental Protection Agency (EPA), the Stormwater Management Model (SWMM) has been utilized since 1971. It has been updated through several programming languages, and IDEA Group is using release 5.1.010 for the purpose of the stormwater modelling. It has a significant variety of capabilities for single-event and continuous modelling, as well as scaling for study areas of any size. The EPA SWMM input and output files are included in Appendix A of this report. Additionally, Figure 1 is a schematic guide for the pre-development sub-catchments, junctions and link parameters used in the model. Figure 2 is a schematic guide for the post-development sub-catchments, junctions and link parameters used in the model.

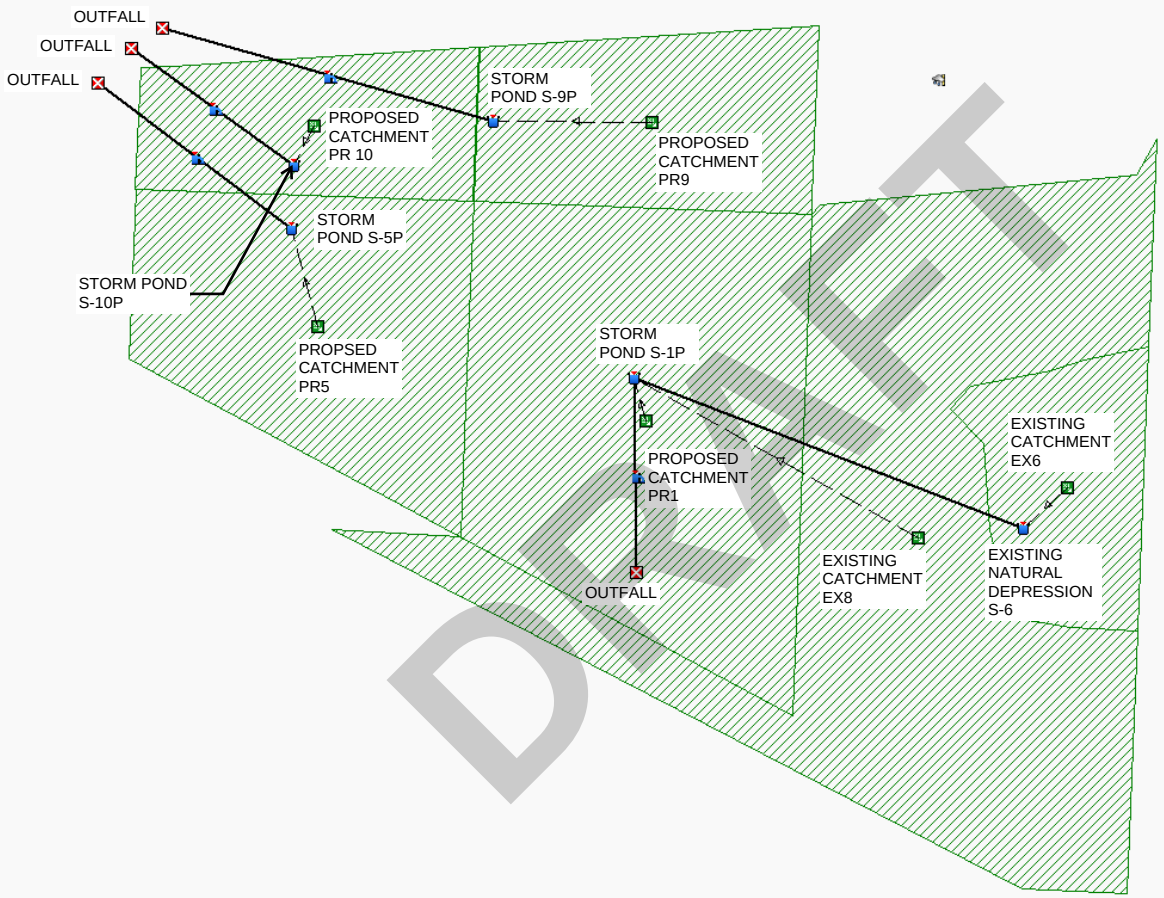
4.1.1. PROJECT OPTIONS AND ANALYSIS OPTIONS

The following parameters are utilized within the EPA SWMM model files:

Flow Units: LPS (Litres per Second)

EPA SWMM Infiltration Method: SCS Curve Number

Consultant	Project	Drawing Title	Project Lead	Scale	Issued For/Revisions			Drawing
4034 4th Street SE Calgary, AB T2G2W3 (t)403.274.4556 (f)403.206.7295	SHEPARD INDUSTRIAL ASP	FIGURE 1	JEFF BEATON Project # 18073	N.T.S. Date (YY-MM-DD)	No.	Description	Date YY.MM.DD	FIGURE 1
					1	ISSUED FOR REPORT	20.09.28	
					.	.	.	
					.	.	.	



Consultant	Project	Drawing Title	Project Lead	Scale	Issued For/Revisions		Drawing
4034 4th Street SE Calgary, AB T2G2W3 (t)403.274.4556 (f)403.206.7295	SHEPARD INDUSTRIAL ASP	FIGURE 2	JEFF BEATON Project # 18073	N.T.S. Date (YY-MM-DD)	No. / Description / Date YY.MM.DD 1 / ISSUED FOR REPORT / 20.09.28		FIGURE 2

An adaption from the NRCS (SCS) Curve Number method for estimating runoff. It assumes that the total infiltration capacity of a soil can be found from the soil's tabulated Curve Number.

Link Routing Method: Hydrodynamic Wave Routing

The most sophisticated routing method with the capabilities to represent pressurized flow, channel storage, backwater, and entrance/exit losses by solving the complete *Saint Venant* flow equations.

Analysis Duration: 24 hours

4.1.2. RAIN GAUGES

The City of Calgary Stormwater Management & Design Guidelines (SMDG) were referenced for the 1:100 year 24-hour design storm based on the Calgary IDF Curves and Chicago distribution. The 5-minute intervals shown in the EPA SWMM input file correspond with that of Appendix K in the SMDG. 24 hours has been used in the EPA SWMM model to allow for the full contribution of upstream areas.

4.1.3.CATCHMENT AREAS AND PARAMETERS

As the proposed development is at preliminary stages, and consequently site-specific drainage patterns have not been determined. The delineation of the catchment areas was completed using pre-development LIDAR data, and the existing drainage topography is anticipated to generally remain through post development within in the ASP area. The pre-development catchment areas are shown on Drawing SK-01, and the post-development catchment areas are shown on Drawing SK-02.

It should be noted that in pre-development conditions areas EX 2, EX 3, EX 4 and EX 6 do not contribute stormwater to the ASP area. In post-development conditions, areas EX 2, EX 3, EX 4, EX 6 and EX 7 do not contribute stormwater to the ASP area.

Pre-development

As shown in Drawing SK-01, Shepard existing wetland sits west of catchment areas EX 4 and EX 7. Catchment areas EX 5 and EX 7 are within the ASP area boundary. Catchment area EX 7 drains west to the Shepard existing wetland, and catchment area EX 5 will drain north via a natural depression area, spilling north to catchment area EX 4, ultimately, draining into the Shepard existing wetland.

The stretch along RR 281 is considered a high point dividing drainage east and west. The east side of RR 281 is sitting lower than the road, and the water is assumed to flow into the creek east of RR 275. As shown in Drawing SK-01, catchment areas EX 6 and EX 1 are west

of RR 281 and the elevation generally falls from east to west. Catchment area EX 6 has sufficient natural trap low storage to consider it self-contained under a 1:100 year event. Catchment area EX 1 is assumed to be a zero-discharge area, all stormwater flows to a low spot (a slough) in the SE quadrant of the ASP area.

Post-development

As shown in Drawing SK-02, catchment area PR 1 and PR 5 are inside of the ASP area, and they are proposed light industrial area. Catchment areas EX 8 sit outside of the ASP area and are assumed to remain undeveloped. Under post-development condition, EX 8 will flow to catchment area PR 1.

One storm pond will be required in each proposed catchment area which are within Shepard wetland catchment area (PR 5, PR 9, and PR 10). Each storm pond will be located in the natural low lying area within the catchment area as shown on Drawing SK-02. A peak release rate of 0.8 L/s/ha (in accordance with the SRDP) is stipulated for each pond totalling 354 L/s through a regional storm trunk draining west towards the Shepard existing wetland.

Another storm pond will be required in PR 1 to service catchment area PR 1 and EX 8 with a peak release rate of 0.546 L/s/ha (494 L/s) through a storm trunk draining south to the Bow River.

The imperviousness of the site was calculated based on the ratios of landscaping (C=0.10), pavement (C=0.9), roof (C=0.9) and waterbody (C=1.0). Equivalent width is used by EPA SWMM to approximate time of concentration, using Area divided by the Maximum-Average-Overland-Flow Length. The industrial area uses C=0.85, refer to SMDG. Table 2 and Table 3 show the parameters used in the model.

Impervious Surfaces (Sheet Flow)		Pervious Surfaces (Sheet Flow)	
Initial Abstraction (mm)	Manning's Roughness	Initial Abstraction (mm)	Manning's Roughness
1.6	0.013	3.2	0.25

Table 2. EPA SWMM Common Catchment Area Parameters (All Areas)

The Initial Abstraction values used for this model of 3.2mm for pervious surfaces, and 1.6mm for impervious surfaces, were selected from Section 3.2.5.2 of the SMDG. For the lots, a Weighted Curve Number is calculated by using curve numbers of 74 for natural grass areas, and 98 for impervious areas (paved roads and water bodies). The typical imperviousness of an industrial site is 85%. Only grass and pavement are assumed to be

present in the area. The areas of grass and the pavement area are calculated to have weighted imperviousness equal to the total site imperviousness of 85%. The calculated grass and pavement areas are used to calculate the Weighted Curve Number (CN). Manning's roughness values were selected for sheet-flow on asphalt/concrete and light turf.

Catchment Area	Area (ha)	Imperviousness (%)	Weighted CN	Equivalent Width (m)	Average Slope (%)
Pre-development					
EX 1	840.27	5	74	2972	0.4
EX 5	416.89	5	74	2473	0.7
EX 6	94.12	5	74	1188	0.3
EX 7	13.12	5	74	1017	0.7
Post-development					
PR 1	329.05	85	94	2902	0.3
PR 5	198.75	85	94	1207	0.7
PR 9	135.37	85	94	872	0.6
PR 10	108.38	85	94	989	0.6
EX 6	94.12	5	74	1188	0.3
EX 8	481.93	5	74	2545	0.4

Table 3. EPA SWMM Sub-Catchment Parameters

Equivalent Width is calculated by dividing the Area by the Maximum-Average-Overland-Flow Length. This value is used to approximate the time of concentration within EPA SWMM.

4.1.4. 1:100 YEAR SINGLE STORM EVENT RESULTS

The model was run as described above and the storage results of the pond of 1:100 year event are shown in Table 4 below. These values can be found in Appendix A. The schematic representing the pre-development model has been included in Figure 1.0, and the schematic post-development model has been included in Figure 2.0.

Pre-Development

Catchment Area	Storage Node	Volume (m3)	Available Volume (m3)	Release Rate (L/s)
EX 1	S-1	117,835	1,800,394	0
EX 5	S-5	58,105	58,105	1,572
EX 6	S-6	24,369	90,621	0
EX 7	NA	NA	NA	246

Post-Development

Catchment Area	Storage Node	Required Volume (m3)	Release Rate (L/s)
PR 1	S-1P	340,514	494
PR 5	S-5P	154,755	159
PR 9	S-9P	106,055	108
PR 10	S-10P	85,610	87
EX 6	S-6	0	0
EX 8	NA	NA	Flow to S-1P

Table 4. 1:100 Year Single Event Storage Results

4.2. WATER BALANCE SHEET

As the release rates of the post-development catchment areas are relatively low, continuous models are suggested to be used to confirm the required storage to ensure the onsite pond have sufficient storage. The continuous modelling requirement is being satisfied using the Water Balance Spreadsheet for the City of Calgary (WBSCC). This modelling tool was prepared by Westhoff Engineering Resources on behalf of the City of Calgary. It was originally developed in support of the Theoretical Residential Low Impact Development Subdivision Project for the City of Calgary. Excerpts from the spreadsheet have been included below, and the complete sheets are provided in Appendix B.

4.2.1. WBSCC MODELING PARAMETERS

Area: Total Site Area for the WBSCC model for PR 1 and EX 8 is 810.98 ha, for PR 5 and PR 10 is 307.13 ha, and for PR 9 is 135.37 ha.

Impervious Surface: Representing the small amounts of buildings and asphalt. 80% of light industrial site has been set to be impervious surface.

Pervious Surface: No pervious surfaces have been used in the analysis.

Absorbent Landscaping: This heading is being used to represent the loamed areas.

Media Depth: 300 mm was used for Landscaped areas.

Porosity, Field Capacity, Wilting Point, Saturated Conductivity: Values have been taken from Table 1 Appendix C of the *User Manual for Water Balance Sheet (UM-WBS) (Westoff Engineering Resources, Inc., 2011)* for Loam.

Sub-soil Hydraulic Conductivity: Soil Type has been selected as Clay Loam and relevant saturated conductivity was used.

Evaporation Pond:

Pond 1 Parameters: The ponds are to build at 5:1 slope from the bottom to HWL. The length: width ratio is set to be 3:1 for all the ponds. UNWL is set to be 2 m above the pond bottom, and HWL is set to be 3 m above the UNWL. All the pond parameters are compliant with *Stormwater Management Guidelines for the Province of Alberta (1999).* A geosynthetic liner will be required from the pond bottom to NWL; therefore, no seepage rate,has been used in calculations.

Bed Soil Parameters: As no seepage rate has been assigned to the model, no bed soil parameters have been considered.

Starting Water Elevation: Starting water elevation is the average water level over the period of record computed by WBSCC.

PR 1 & EX 8

WBSCC - PROJECT DATA SHEET - Sub-Catchment 1: Parameters, Runoff Allocation

Usage: PR 1

Sub-catchment Parameters		Cover Type				
		Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Medium
Area (Total: 317.33)	(ha)	255.22		63.81	0	0
Depression Loss	(mm)	1.6				
Soil Type: Sand			20	20	100	90
Silt			65	65	0	10
Clay			15	15		
Custom						
Unassigned			0	0	0	0
Soil or Media Depth	(mm)		150	300	200	600
Porosity			0.46	0.46	0.512	0.469
Field Capacity			0.271	0.271	0.132	0.092
Wilting Point			0.126	0.126	0.057	0.038
Saturated Hydraulic Conductivity	(m/s)		5.00E-06	5.00E-06	2.50E-05	3.50E-05
Sub-soil Hydraulic Conductivity	(m/s)		1.00E-08	1.00E-08		5.00E-08
Ponding Depth	(mm)		0	0	0	300
Inv. Slope of Log. Tension Moisture Curve			4.98	4.98	4.55	4.32
Subdrain Invert (above bottom of media)	(mm)					0
Subdrain Capacity	(m^3/s)					0

Table 5. WBSCC Catchment Area PR 1 Parameters

WBSCC - PROJECT DATA SHEET - Sub-Catchment 2: Parameters, Runoff Allocation

Usage: EX 8

Sub-catchment Parameters		Cover Type				
		Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Medium
Area (Total: 481.93)	(ha)	0	0	481.93	0	0
Depression Loss	(mm)	1.6				
Soil Type: Sand			20	10	100	90
Silt			65	45	0	10
Clay			15	45		
Custom						
Unassigned			0	0	0	0
Soil or Media Depth	(mm)		150	300	200	600
Porosity			0.46	0.46	0.512	0.469
Field Capacity			0.271	0.271	0.132	0.092
Wilting Point			0.126	0.126	0.057	0.038
Saturated Hydraulic Conductivity	(m/s)		5.00E-06	5.00E-06	2.50E-05	3.50E-05
Sub-soil Hydraulic Conductivity	(m/s)		1.00E-08	1.00E-08		5.00E-08
Ponding Depth	(mm)		0	0	0	300
Inv. Slope of Log. Tension Moisture Curve			4.98	4.98	4.55	4.32
Subdrain Invert (above bottom of media)	(mm)					0
Subdrain Capacity	(m^3/s)					0

Table 6. WBSCC Catchment Area EX 8 Parameters

PR 1 Pond Parameters		Values
Base Elevation	(m)	100.00
Starting Water Elevation	(m)	102.00
Starting Discharge Elevation (UNWL)	(m)	102.00
High Water Level (HWL)	(m)	105.00
Lower Normal Water Level (LNWL)	(m)	102.00
Seepage Rate	(mm/hr)	0.00
Discharge and Overflow Routed to:		OUTFALL

Elevation (m)	**Area (m^2)**	**Discharge (m^3/s)**
100.00	70227	0
101.90	82216	0.494
102.00	82867	0.494
105.00	103327	0.494

Table 7. WBSCC Catchment Area PR 1 Pond Parameters

PR 5 & PR 10

WBSCC - PROJECT DATA SHEET - Sub-Catchment 1: Parameters, Runoff Allocation

Usage: PR 5

Sub-catchment Parameters		Cover Type				
		Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Medium
Area (Total: 429.69)	(ha)	154.14		38.53	0	0
Depression Loss	(mm)	1.6				
Soil Type: Sand			20	20	100	90
Silt			65	65	0	10
Clay			15	15		
Custom						
Unassigned			0	0	0	0
Soil or Media Depth	(mm)		150	300	200	600
Porosity			0.46	0.46	0.512	0.469
Field Capacity			0.271	0.271	0.132	0.092
Wilting Point			0.126	0.126	0.057	0.038
Saturated Hydraulic Conductivity	(m/s)		5.00E-06	5.00E-06	2.50E-05	3.50E-05
Sub-soil Hydraulic Conductivity	(m/s)		1.00E-08	1.00E-08		5.00E-08
Ponding Depth	(mm)		0	0	0	300
Inv. Slope of Log. Tension Moisture Curve			4.98	4.98	4.55	4.32
Subdrain Invert (above bottom of media)	(mm)					0
Subdrain Capacity	(m^3/s)					0

Table 8. WBSCC Catchment Area PR 5 Parameters

WBSCC - PROJECT DATA SHEET - Sub-Catchment 2: Parameters, Runoff Allocation

Usage: PR 10

Sub-catchment Parameters		Cover Type				
		Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Medium
Area (Total: 429.69)	(ha)	83.95		20.99	0	0
Depression Loss	(mm)	1.6				
Soil Type: Sand			20	20	100	90
Silt			65	65	0	10
Clay			15	15		
Custom						
Unassigned			0	0	0	0
Soil or Media Depth	(mm)		150	300	200	600
Porosity			0.46	0.46	0.512	0.469
Field Capacity			0.271	0.271	0.132	0.092
Wilting Point			0.126	0.126	0.057	0.038
Saturated Hydraulic Conductivity	(m/s)		5.00E-06	5.00E-06	2.50E-05	3.50E-05
Sub-soil Hydraulic Conductivity	(m/s)		1.00E-08	1.00E-08		5.00E-08
Ponding Depth	(mm)		0	0	0	300
Inv. Slope of Log. Tension Moisture Curve			4.98	4.98	4.55	4.32
Subdrain Invert (above bottom of media)	(mm)					0
Subdrain Capacity	(m^3/s)					0

Table 9. WBSCC Catchment Area PR 10 Parameters

PR 5 Pond Parameters		Values
Base Elevation	(m)	100.00
Starting Water Elevation	(m)	102.00
Starting Discharge Elevation (UNWL)	(m)	102.00
High Water Level (HWL)	(m)	105.00
Lower Normal Water Level (LNWL)	(m)	102.00
Seepage Rate	(mm/hr)	0.00
Discharge and Overflow Routed to:		OUTFALL

Elevation (m)	Area (m^2)	Discharge (m^3/s)
100.00	36300	0
101.90	45021	0
102.00	45500	0.159
105.00	60800	0.159

Table 10. WBSCC Area PR 5 Pond Parameters

PR 10 Pond Parameters		Values
Base Elevation	(m)	100.00
Starting Water Elevation	(m)	102.00
Starting Discharge Elevation (UNWL)	(m)	102.00
High Water Level (HWL)	(m)	105.00
Lower Normal Water Level (LNWL)	(m)	102.00
Seepage Rate	(mm/hr)	0.00
Discharge and Overflow Routed to:		OUTFALL

Elevation (m)	Area (m^2)	Discharge (m^3/s)
100.00	16875	0
101.90	22936	0
102.00	23275	0.087
105.00	34375	0.087

Table 11. WBSCC Area PR 10 Pond Parameters

PR 9

WBSCC - PROJECT DATA SHEET - Sub-Catchment 1: Parameters, Runoff Allocation

Usage: PR 9

Sub-catchment Parameters		Cover Type				
		Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Medium
Area (Total: 429.69)	(ha)	104.71		26.18	0	0
Depression Loss	(mm)	1.6				
Soil Type: Sand			20	20	100	90
Silt			65	65	0	10
Clay			15	15		
Custom						
Unassigned			0	0	0	0
Soil or Media Depth	(mm)		150	300	200	600
Porosity			0.46	0.46	0.512	0.469
Field Capacity			0.271	0.271	0.132	0.092
Wilting Point			0.126	0.126	0.057	0.038
Saturated Hydraulic Conductivity	(m/s)		5.00E-06	5.00E-06	2.50E-05	3.50E-05
Sub-soil Hydraulic Conductivity	(m/s)		1.00E-08	1.00E-08		5.00E-08
Ponding Depth	(mm)		0	0	0	300

Inv. Slope of Log. Tension Moisture Curve			4.98	4.98	4.55	4.32
Subdrain Invert (above bottom of media)	(mm)					0
Subdrain Capacity	(m^3/s)					0

Table 12. WBSCC Catchment Area PR 9 Parameters

PR 9 Pond Parameters		Values
Base Elevation	(m)	100.00
Starting Water Elevation	(m)	102.00
Starting Discharge Elevation (UNWL)	(m)	102.00
High Water Level (HWL)	(m)	105.00
Lower Normal Water Level (LNWL)	(m)	102.00
Seepage Rate	(mm/hr)	0.00
Discharge and Overflow Routed to:		OUTFALL

Elevation (m)	Area (m^2)	Discharge (m^3/s)
100.00	24300	0
101.90	31501	0
102.00	31900	0.108
105.00	44800	0.108

Table 13. WBSCC Area PR 9 Pond Parameters

4.2.2. WBSCC RESULTS

Catchment Area	Storage Node	Release Rate (L/s/ha)	Release Rate (L/s)	Required Volume (m3)
PR 1 & EX 8	S-1P	0.546	494	431,653
PR 5	S-5P	0.800	159	240,529
PR 9	S-9P	0.800	108	170,537
PR 10	S-10P	0.800	87	125,920

Table 14. Continuous Simulation Storage Results

4.2.3. POND STAGED STORAGE

	Elevation (m)	Area (m2)	Volume (m3)
Bottom of the Pond	100	70,227	0
Upper Normal Water Level (UNWL)	102	82,867	152,925
High Water Level	105	103,327	431,653

Note: No re-use water is used to analyze. Lower Normal Water Level (LNWL) is equal to UNWL.
UNWL is the starting discharge elevation.

Table 15. S-1P Staged Storage Analyzed in WBSCC

	Elevation (m)	Area (m2)	Volume (m3)
Bottom of the Pond	100	36,300	0
Upper Normal Water Level (UNWL)	102	45,500	81,632
High Water Level	105	60,800	240,529

Note: No re-use water is used to analyze. Lower Normal Water Level (LNWL) is equal to UNWL.
UNWL is the starting discharge elevation.

Table 16. S-5P Staged Storage Analyzed in WBSCC

	Elevation (m)	Area (m2)	Volume (m3)
Bottom of the Pond	100	24,300	0
Upper Normal Water Level (UNWL)	102	31,900	56,033
High Water Level	105	44,800	170,537

Note: No re-use water is used to analyze. Lower Normal Water Level (LNWL) is equal to UNWL.
UNWL is the starting discharge elevation.

Table 17. S-9P Staged Storage Analyzed in WBSCC

	Elevation (m)	Area (m2)	Volume (m3)
Bottom of the Pond	100	16,875	0
Upper Normal Water Level (UNWL)	102	23,275	39,984
High Water Level	105	34,375	125,920

Note: No re-use water is used to analyze. Lower Normal Water Level (LNWL) is equal to UNWL.
UNWL is the starting discharge elevation.

Table 18. S-10P Staged Storage Analyzed in WBSCC

4.3. 1:100 YEAR EVENT RESULTS AND CONTINUOUS SIMULATION RESULTS COMPARISON

Table 19 shows the results of both WBSCC and EPA SWMM. By comparing the results of both WBSCC and EPA SWMM, the required storage analyzed by WBSCC is greater than the required storage analyzed by EPA SWMM for all the ponds and alternatives. The pond release rate is relatively low and continuous simulation is considered to be more accurate than 1:100 year single event. Thus, the WBSCC results are chosen to be used.

Pond	Release Rate (L/s)	WBSCC Required Storage (m3)	EPA SWMM Required Storage (m3)
S-1P	494	431,653	340,514
S-5P	159	240,529	154,755
S-9P	87	125,920	106,055
S-10P	108	170,537	85,610

Table 19. WBSCC VS EPA SWMM

5. VOLUME ANALYSIS

As per Table 1, the average annual release target stipulated by SRDP for PR 1, EX 6 and EX 8 is 100 mm, and the target for PR 5, PR 9, and PR 10 is 113 mm. Based on the results from WBSCC, the annual volume release of PR 1, EX 6 and EX 8 is 50 mm, which meets the target. The annual average volume release of PR 5, PR 9 and PR 10 is calculated based on the proportionate volume release for each catchment areas. The average annual volume release for PR 5 and PR 10 is 138 mm, and the average annual volume release for PR 9 is 137 mm. The average total annual volume release for PR 5, PR 9 and PR 10 is 138 mm. The 113mm average annual release target for PR 5, PR9 & PR10 is exceeded by 25%. Additional Low Impact Development will be required in the areas as they develop to reduce the annual release volume to 113 mm, in accordance with the SRDP. The following lists the LID Scenario #1 practices referenced within the SRDP.

- Absorbent Landscaping Type A2.

Feature	Landscape Type A2
Surface Ponding Depth	50 mm
Silt Clay Loam (topsoil) Depth	300 mm
Conductivity	50 mm/hr
Porosity	40%
Field Capacity	13%
Total Depth	350 mm
Scarified Subgrade Conductivity	5 mm/hr
ET (average for 150 days)	4.5 mm/day
Vegetative Cover	Grass-Trees

- Rain Gardens.

Feature	Minor Rain Gardens	Major Rain Gardens
Surface Ponding Depth	300 mm	450 mm
Silt Clay Loam (topsoil) Depth	450 mm	600 mm
Conductivity	80 mm/hr	100 mm/hr
Porosity	43%	43%
Field Capacity	13%	13%

Total Depth	850 mm	1350 mm
Scarified Subgrade Conductivity	5 mm/hr	5 mm/hr
ET (average for 150 days)	4.5 mm/day	4.5 mm/day
Vegetative Cover	Grass & Forbes	Grass & Forbes
Underdrain	100 mm perforated pipe (1/ garden)	100 mm perforated pipe (1/ garden)
Overflow	Direct discharge to storm system	Direct discharge to storm system

- Cistern

Feature	Value/Condition
Maximum Storage Volume	5.36 m3
Water Use (Average for 150 days)	25 mm/week
Overflow	To rain garden or pond

The following are some additional design options to meet the volume control, but which are not limited to this sample listing.

- Directing impervious surfaces over pervious surfaces
- Water re-use, by way of industrial use or irrigation;
- Underground soil cells, soil cell technology or any other form of infiltration system or tanks;
- Bio-retention swales or rain gardens;
- Evaporation ponds, fire ponds or low slope flooded site areas.

The above mentioned LID options are not mandatory as long as the volume control target are met.

6. WATER QUALITY

All wet ponds are required to provide enhanced water quality and to provide a minimum 85% removal of TSS for practical sizes greater than, or equal to 50 um, refer to SMDG. Sediment forebays, sedimentation vaults and oil/grit separator may be required to minimize the pollution and achieve the satisfactory water quality.

According to Alberta Environment, the total phosphorus (TP) concentration limits for protection of aquatic life is 0.05 mg/L, refer to SMDG. In order to mitigate the water quality with respect to phosphorus, a variety of solutions can be implemented in the future storm pond designs, such as :

- A Bio-filtration system consisting of trees and shrubs with emergent vegetation to maximize phosphorus removal
- Regular maintenance and removal of sediment and settled pollutants within in the pond

Individual developments with irregular water quality concerns would be required to provide additional controls to the satisfactory of the County.

7. PHASING

Phasing has been reviewed in conjunction with all servicing requirements for the ASP, inclusive of stormwater management, sanitary and water servicing concepts, and a potential phasing option is presented in Drawing SK-06. The first phase is governed by the proximity to TWP 232, the proposed alignments for the SFM the WTM, and the stormwater trunk for Shepard wetland catchment area. Subsequent Phases 4 and 5 are presumed to make use of/expand the infrastructure within Phase 1, i.e. Lift Station #1, Water Reservoir and Stormwater Trunk #1. While Phase 3 is presumed to make use of/expand on the infrastructure within Phase 2.

While a phasing schematic has been presented in this study, considerations should be given to the fact that phasing is wholly dependant on market conditions, and as such, the proposed phasing plan requires flexibility as project details progress

8. OPINION OF PROBABLE COST

The section reviewed the capital cost of associated with providing stormwater management solutions within in the ASP area. The pipes, pipe placing, manholes and manhole placing cost are based on the City of Calgary’s 2019 Master Development Agreement. As shown on Drawing SK-02, a storm trunk is required to release stormwater from PR 5 to the existing Shepard wetland system along Township Road 232. A second storm trunk is required from PR 1 to CN railway, and north-west on CN railway to Range Road 284. The storm trunk continuous on Range Road 284 south to Township 232, and east on Township 232 to Range Road 285. It eventually connects the Bow River along Range Road 285. Table 20 shows the cost summary of the storm trunks.

	Area (ha)	Cost of Storm Trunk ($)	Total Cost Including 25% Contingency ($)	Cost/ha ($/ha)
Draining to Existing Shepard Wetland	442.80	1,081,000	1,352,000	3,055
Draining to the Bow River	810.98	11,825,000	14,782,000	18,227

Table 20. Stormwater Trunk Cost

A breakdown of the pipeline cost is found in Appendix C.

9. CONCLUSION AND RECOMMENDATION

This study provides the preliminary design of stormwater management for the proposed ASP area. As the proposed development is divided into Shepard wetland catchment area and Bow River catchment area by a ridge running from the SW to the NE, 2 different stormwater management solutions are required for the Shepard wetland catchment area and the Bow River catchment area. 3 storm ponds are required in catchment area PR 5, PR 9 and PR 10 to collect stormwater runoff from the Shepard wetland catchment area. A storm trunk is required for the stormwater release from the pond to the nearby Shepard existing wetland at 354 L/s to adhere to the unit area release rate of 0.8 L/s/ha stipulated by *SRDP*. The required storages of the each pond are calculated by continuous simulations.

In the Bow River catchment area, another storm pond is required to collect the stormwater runoff of the area. By increasing the release rate would reduce the required size of the pond. However, by increasing the release rate, the size of the storm trunk is also required to be increased, which would increase the cost of pipe installation. Therefore, a cost analysis has been done by comparing the value of land loss for building the ponds and cost of installing the storm trunk in few scenarios. The release rate of 494 L/s is determined to be the most cost-efficient alternative. The cost analysis is included in Appendix D in the report. Thus, a storm trunk is required for the stormwater release from the pond system to the Bow River at 0.546 L/s/ha (494 L/s). As confirmed within the provided EPA SWMM and WBSCC, the required storage of the Bow River catchment area pond system (S-1P) is 431,653 m3 calculated by continuous simulation.

REFERENCES

- Alberta Environment Protection; *Stormwater Management Guidelines for the Province of Alberta*; January 1999
- Alberta Government; *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems*; March 2012
- City of Calgary; *Stormwater Management &Design Manual*; December 2011
- J.F Sabourin and Associates Inc.; *SYMHYMO Stormwater Management Hydrologic Model Example Guide*; May 2000
- Chow, Ven Te, Maidment, David R. and Mays, Larry W.; *Applied Hydrology;* McGraw-Hill Book Co.; 1988
- C.D Smith; *Hydraulic Structures;* 1995
- USDA Soil Conservation Service; *SCS National Engineering Handbook – Section 4: Hydrology*; March, 1985
- AutoDesk; Autodesk Storm and Sanitary Analysis 2013 Users Guide; 2013
- AECOM; Shepard Regional Drainage Plan; November 2011
- City of Calgary; *Master Development Agreement*; 2019

CORPORATE AUTHORIZATION

PERMIT TO PRACTICE
IDEA GROUP INC.
Signature
Date FEB 17, 2021
PERMIT NUMBER: P 7711
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

CORPORATE AUTHORIZATION

PROFESSIONAL ENGINEER ALBERTA
MARTHA TINOCO LANDERO
February 17, 2021

RESPONSIBLE ENGINEER

Yulin Zhu, E.I.T

REPORT AUTHOR AND MODELLER

APPENDIX 'A' - EPA SWMM Input and Output File – 24 hour

Pre-development

```
  EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.007)
  --------------------------------------------------------------

  J:\18\18073
SdcS9&10Ind\1.0-Planning\3.0-CAD\1.0-C3D\3.0-PipeNetworks\18073-CatchmentAreas.dwg

  ***********************************************************
  NOTE: The summary statistics displayed in this report are
  based on results found at every computational time step,
  not just on results from each reporting time step.
  ***********************************************************

  ****************
  Analysis Options
  ****************
  Flow Units ............... LPS
  Process Models:
    Rainfall/Runoff ........ YES
    RDII ................... NO
    Snowmelt ............... NO
    Groundwater ............ NO
    Flow Routing ........... YES
    Ponding Allowed ........ YES
    Water Quality .......... NO
  Infiltration Method ...... CURVE_NUMBER
  Flow Routing Method ...... DYNWAVE
  Starting Date ............ SEP-25-2020 00:00:00
  Ending Date .............. SEP-26-2020 00:00:00
  Antecedent Dry Days ...... 0.0
  Report Time Step ......... 00:05:00
  Wet Time Step ............ 00:05:00
  Dry Time Step ............ 01:00:00
  Routing Time Step ........ 30.00 sec
  Variable Time Step ....... YES
  Maximum Trials ........... 8
  Head Tolerance ........... 0.005000 m


  *************
  Element Count
  *************
  Number of rain gages ...... 1
  Number of subcatchments ... 4
  Number of nodes ........... 6
  Number of links ........... 3
  Number of pollutants ...... 0
  Number of land uses ....... 0
```

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
Rain&#65533;Gage-01	TS-01	INTENSITY	5 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
{Site&#65533;1}.EX&#65533;1	840.26	2972.00	5.00	0.4000	Rain&#65533;Gage-01	S-1
{Site&#65533;1}.EX&#65533;5	416.89	2425.00	5.00	0.7000	Rain&#65533;Gage-01	S-5
{Site&#65533;1}.EX&#65533;6	94.12	1188.00	5.00	0.3000	Rain&#65533;Gage-01	S-6
{Site&#65533;1}.EX&#65533;7	13.12	1017.00	5.00	0.7000	Rain&#65533;Gage-01	Out-05

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
Out-01	OUTFALL	0.00	0.50	0.0	
Out-04	OUTFALL	0.00	0.50	0.0	
Out-05	OUTFALL	0.00	0.00	0.0	
S-1	STORAGE	0.00	0.60	0.0	
S-5	STORAGE	0.00	0.60	0.0	
S-6	STORAGE	0.00	0.60	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
Link-01	S-1	Out-04	CONDUIT	20.0		

2.5008 0.0250
Link-02 S-6 S-1 CONDUIT 20.0
2.5008 0.0250
Link-03 S-5 Out-01 CONDUIT 20.0
2.3006 0.0250

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
Link-01	RECT_OPEN	0.50	25.00	0.50	50.00	1	98968.38
Link-02	RECT_OPEN	0.50	15.00	0.49	30.00	1	59121.15
Link-03	RECT_OPEN	0.50	25.00	0.50	50.00	1	94924.85

****
Control Actions Taken
****

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	122.344	89.670
Evaporation Loss	0.000	0.000
Infiltration Loss	57.975	42.492
Surface Runoff	25.135	18.422
Final Surface Storage	39.325	28.822
Continuity Error (%)	-0.074	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	24.953	249.530
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000

External Outflow	4.347	43.471
Internal Outflow	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	20.606	206.064
Continuity Error (%)	-0.002	

****
Time-Step Critical Elements
****
None

****
Highest Flow Instability Indexes
****
All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	30.00 sec
Average Time Step	:	29.99 sec
Maximum Time Step	:	30.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.00
Percent Not Converging	:	0.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff
{Site1}.EX1	89.67	0.00	0.00	42.49	14.76	123.99	2340.95	0.165

```
  {Site¤1}.EX¤5             89.67       0.00       0.00      42.49      23.19
96.67  1808.54   0.259
  {Site¤1}.EX¤6             89.67       0.00       0.00      42.49      26.99
25.40   500.03   0.301
  {Site¤1}.EX¤7             89.67       0.00       0.00      42.49      40.36
 5.29   265.95   0.450


  ******************
  Node Depth Summary
  ******************

  ---------------------------------------------------------------------
                                Average  Maximum  Maximum  Time of Max
                                  Depth    Depth      HGL   Occurrence
  Node                 Type      Meters   Meters   Meters  days hr:min
  ---------------------------------------------------------------------
  Out-01               OUTFALL     0.01     0.04     0.04     0  19:12
  Out-04               OUTFALL     0.00     0.00     0.00     0  00:00
  Out-05               OUTFALL     0.00     0.00     0.00     0  00:00
  S-1                  STORAGE     0.01     0.03     0.03     1  00:00
  S-5                  STORAGE     0.24     0.50     0.50     0  19:12
  S-6                  STORAGE     0.05     0.14     0.14     1  00:00


  ******************
  Node Inflow Summary
  ******************


-------------------------------------------------------------------------------
-------------
                                Maximum  Maximum                  Lateral
Total        Flow
                                Lateral    Total  Time of Max      Inflow
Inflow     Balance
                                 Inflow   Inflow   Occurrence      Volume
Volume       Error
  Node                 Type         LPS      LPS  days hr:min    10^6 ltr    10^6
ltr     Percent

-------------------------------------------------------------------------------
-------------
  Out-01               OUTFALL      0.00  1631.66     0  19:12           0
38.2       0.000
  Out-04               OUTFALL      0.00     0.00     0  00:00           0
 0       0.000 ltr
  Out-05               OUTFALL    265.95   265.95     0  07:50        5.28
5.28       0.000
  S-1                  STORAGE   2340.95  2340.95     0  19:40         123
```

```
123       0.019
  S-5                  STORAGE    1808.54  1808.54     0  13:30        96.1
96       0.020
  S-6                  STORAGE     500.03   500.03     0  11:50        25.3
25.3       0.011


  **********************
  Node Surcharge Summary
  **********************

  No nodes were surcharged.


  **********************
  Node Flooding Summary
  **********************

  No nodes were flooded.


  **********************
  Storage Volume Summary
  **********************


-------------------------------------------------------------------------------
--------------
                         Average     Avg  Evap Exfil       Maximum     Max    Time
of Max    Maximum
                          Volume    Pcnt  Pcnt  Pcnt        Volume    Pcnt
Occurrence    Outflow
  Storage Unit          1000 m3    Full  Loss  Loss       1000 m3    Full    days
hr:min        LPS

-------------------------------------------------------------------------------
--------------
  S-1                      38.603       2     0     0       122.946       6       1
00:00       0.00
  S-5                      27.425      40     0     0        58.219      84       0
19:12    1631.66
  S-6                       9.106       8     0     0        25.256      23       1
00:00       0.00


  **********************
  Outfall Loading Summary
  **********************

  ------------------------------------------------------------
```

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
Out-01	31.41	1407.48	1631.66	38.191
Out-04	0.00	0.00	0.00	0.000
Out-05	71.43	85.51	265.95	5.279
System	34.28	1492.99	1675.47	43.471

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
Link-01	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
Link-02	CONDUIT	0.00	0 00:00	0.00	0.00	0.03
Link-03	CONDUIT	1631.66	0 19:12	0.74	0.02	0.09

****
Flow Classification Summary
****

Inlet Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
Link-01	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Link-02	1.00	0.30	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Link-03	1.00	0.69	0.00	0.00	0.02	0.30	0.00	0.00	0.00	0.00

****

Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Fri Jan 22 15:12:22 2021
Analysis ended on: Fri Jan 22 15:12:22 2021
Total elapsed time: < 1 sec

Post-development

```
  EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.007)
  --------------------------------------------------------------

  \\Mac\Shared\18\18073
SdcS9&10Ind\1.0-Planning\3.0-CAD\1.0-C3D\3.0-PipeNetworks\18073-CatchmentAreas (Post
development).dwg

  ***********************************************************
  NOTE: The summary statistics displayed in this report are
  based on results found at every computational time step,
  not just on results from each reporting time step.
  ***********************************************************

  ****************
  Analysis Options
  ****************
  Flow Units ............... LPS
  Process Models:
    Rainfall/Runoff ........ YES
    RDII ................... NO
    Snowmelt ............... NO
    Groundwater ............ NO
    Flow Routing ........... YES
    Ponding Allowed ........ YES
    Water Quality .......... NO
  Infiltration Method ...... CURVE_NUMBER
  Flow Routing Method ...... DYNWAVE
  Starting Date ............ FEB-12-2021 00:00:00
  Ending Date .............. FEB-13-2021 00:00:00
  Antecedent Dry Days ...... 0.0
  Report Time Step ......... 00:05:00
  Wet Time Step ............ 00:05:00
  Dry Time Step ............ 01:00:00
  Routing Time Step ........ 30.00 sec
  Variable Time Step ....... YES
  Maximum Trials ........... 8
  Head Tolerance ........... 0.005000 m


  *************
  Element Count
  *************
  Number of rain gages ...... 1
  Number of subcatchments ... 6
  Number of nodes ........... 9
  Number of links ........... 5
  Number of pollutants ...... 0
  Number of land uses ....... 0
```

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
Rain&#65533;Gage-01	TS-01	INTENSITY	5 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
{Site&#65533;1}.PR&#65533;1	329.05	2899.00	85.00	0.3000	Rain&#65533;Gage-01	S-1P
{Site&#65533;1}.PR&#65533;10	108.38	989.00	85.00	0.6000	Rain&#65533;Gage-01	S-10P
{Site&#65533;1}.PR&#65533;5	198.75	1207.00	85.00	0.7000	Rain&#65533;Gage-01	S-5P
{Site&#65533;1}.PR&#65533;6	94.12	1188.00	5.00	0.3000	Rain&#65533;Gage-01	S-6
{Site&#65533;1}.PR&#65533;8	481.93	2848.00	5.00	0.4000	Rain&#65533;Gage-01	S-1P
{Site&#65533;1}.PR&#65533;9	135.37	872.00	85.00	0.6000	Rain&#65533;Gage-01	S-9P

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
Out-01	OUTFALL	0.00	0.00	0.0	
Out-02	OUTFALL	0.00	0.00	0.0	
Out-03	OUTFALL	0.00	0.00	0.0	
Out-04	OUTFALL	0.00	0.00	0.0	
S-10P	STORAGE	0.00	6.00	0.0	
S-1P	STORAGE	0.00	5.00	0.0	
S-5P	STORAGE	0.00	6.00	0.0	
S-6	STORAGE	5.00	1.00	0.0	
S-9P	STORAGE	0.00	6.00	0.0	

****

Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
Link-01	S-6	S-1P	CONDUIT	20.0	2.5008	0.0250
Orifice-01	S-5P	Out-04	ORIFICE			
Orifice-02	S-10P	Out-01	ORIFICE			
Orifice-03	S-9P	Out-03	ORIFICE			
Orifice-04	S-1P	Out-02	ORIFICE			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
Link-01	RECT_OPEN	0.50	15.00	0.49	30.00	1	59121.15

****
Control Actions Taken
****

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	120.838	89.670
Evaporation Loss	0.000	0.000
Infiltration Loss	25.970	19.271
Surface Runoff	74.062	54.958
Final Surface Storage	20.928	15.530
Continuity Error (%)	-0.101	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000

Wet Weather Inflow	73.857	738.578
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	2.390	23.900
Internal Outflow	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	71.459	714.602
Continuity Error (%)	0.010	

****
Time-Step Critical Elements
****
None

****
Highest Flow Instability Indexes
****
All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	30.00 sec
Average Time Step	:	29.99 sec
Maximum Time Step	:	30.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.00
Percent Not Converging	:	0.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff LPS	Runoff Coeff

```
--------------------------------------------------------------------------------
--------------------
  {Site1}.PR1              89.67       0.00       0.00       1.94      79.78
262.53 18353.29   0.890
  {Site1}.PR10             89.67       0.00       0.00       1.94      81.17
87.97  7641.70   0.905
  {Site1}.PR5              89.67       0.00       0.00       1.94      79.99
158.99 11457.81   0.892
  {Site1}.PR6              89.67       0.00       0.00      42.49      26.99
25.40   500.03   0.301
  {Site1}.PR8              89.67       0.00       0.00      42.49      20.24
97.55  1797.19   0.226
  {Site1}.PR9              89.67       0.00       0.00       1.94      79.92
108.19  7712.42   0.891


  ******************
  Node Depth Summary
  ******************

  ---------------------------------------------------------------
                               Average  Maximum  Maximum  Time of Max
                                 Depth    Depth      HGL   Occurrence
  Node                 Type      Meters   Meters   Meters  days hr:min
  ---------------------------------------------------------------
  Out-01               OUTFALL     0.00     0.00     0.00     0  00:00
  Out-02               OUTFALL     0.00     0.00     0.00     0  00:00
  Out-03               OUTFALL     0.00     0.00     0.00     0  00:00
  Out-04               OUTFALL     0.00     0.00     0.00     0  00:00
  S-10P                STORAGE     1.37     2.50     2.50     1  00:00
  S-1P                 STORAGE     2.00     4.13     4.13     1  00:00
  S-5P                 STORAGE     1.36     2.55     2.55     1  00:00
  S-6                  STORAGE     0.05     0.14     5.14     1  00:00
  S-9P                 STORAGE     1.26     2.37     2.37     1  00:00


  ******************
  Node Inflow Summary
  ******************


--------------------------------------------------------------------------------
-------------
                               Maximum  Maximum                  Lateral
Total        Flow
                               Lateral    Total  Time of Max      Inflow
Inflow     Balance
                                Inflow   Inflow   Occurrence      Volume
Volume       Error
  Node                 Type        LPS      LPS  days hr:min    10^6 ltr    10^6
```

```
ltr     Percent

--------------------------------------------------------------------------------
-------------
  Out-01               OUTFALL       0.00    87.53     1  00:00           0
1.95       0.000
  Out-02               OUTFALL       0.00   496.47     1  00:00           0
16.8       0.000
  Out-03               OUTFALL       0.00   109.93     1  00:00           0
1.62       0.000
  Out-04               OUTFALL       0.00   160.80     1  00:00           0
3.48       0.000
  S-10P                STORAGE    7641.61  7641.61     0  07:45        87.8
87.8       0.011
  S-1P                 STORAGE   19278.82 19278.82     0  08:00         359
359        0.010
  S-5P                 STORAGE   11457.74 11457.74     0  07:55         159
159        0.011
  S-6                  STORAGE     500.03   500.03     0  11:50        25.3
25.3        0.011
  S-9P                 STORAGE    7712.40  7712.40     0  07:55         108
108        0.011


  **********************
  Node Surcharge Summary
  **********************

  Surcharging occurs when water rises above the top of the highest conduit.
  -------------------------------------------------------------------
                                                Max. Height   Min. Depth
                                  Hours       Above Crown    Below Rim
  Node                 Type      Surcharged         Meters       Meters
  -------------------------------------------------------------------
  S-10P                STORAGE         6.21          0.237        3.503
  S-5P                 STORAGE         5.15          0.203        3.447
  S-9P                 STORAGE         1.21          0.037        3.626


  **********************
  Node Flooding Summary
  **********************

  No nodes were flooded.


  **********************
  Storage Volume Summary
  **********************
```

	Average	Avg	Evap	Exfil	Maximum	Max	Time of Max	Maximum
	Volume	Pcnt	Pcnt	Pcnt	Volume	Pcnt	Occurrence	Outflow
Storage Unit	1000 m3	Full	Loss	Loss	1000 m3	Full	days hr:min	LPS
S-10P	47.042	23	0	0	85.851	42	1 00:00	87.53
S-1P	165.610	40	0	0	342.014	83	1 00:00	496.47
S-5P	82.973	23	0	0	155.201	43	1 00:00	160.80
S-6	9.106	5	0	0	25.256	14	1 00:00	0.00
S-9P	56.548	21	0	0	106.352	40	1 00:00	109.93

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
Out-01	42.10	53.73	87.53	1.954
Out-02	56.16	347.21	496.47	16.846
Out-03	34.12	55.14	109.93	1.624
Out-04	42.35	95.03	160.80	3.476
System	43.68	551.11	854.74	23.900

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth

Link-01	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
Orifice-01	ORIFICE	160.80	1	00:00			1.00
Orifice-02	ORIFICE	87.53	1	00:00			1.00
Orifice-03	ORIFICE	109.93	1	00:00			1.00
Orifice-04	ORIFICE	496.47	1	00:00			1.00

****
Flow Classification Summary
****

	Adjusted	---------- Fraction of Time in Flow Class ----------							
	/Actual		Up	Down	Sub	Sup	Up	Down	Norm
Inlet Conduit	Length	Dry	Dry	Dry	Crit	Crit	Crit	Crit	Ltd Ctrl
Link-01	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Wed Feb 17 10:40:57 2021
Analysis ended on: Wed Feb 17 10:40:57 2021
Total elapsed time: < 1 sec

APPENDIX 'B' - WBSCC Data File

PR 1 & EX 8

WBSCC

Water Balance Spreadsheet for the City of Calgary
Version 1.2

PROJECT SUMMARY SHEET

Project Name:	Shepard Industrial ASP Storm Study
Project Description:	Water Balance Model for continuous simulation of Potential Pond in PR 1 and EX 8
Location:	Rocky View County
Date:	Februray, 2021
Designed by:	YZ
Company Name:	IDEA Group Inc.
Reviewed by:	JB

WBSCC - PROJECT DATA SHEET - Environmental Information

Minimum Temperature to Trigger Runoff (^{o}C)	0
Sublimation Losses (%)	0
Precipitation Multiplication Factor (% Decrease)	0

Month	Is Winter or Summer?	Crop Water Requirement (mm/month)			
		KENTUCKY BLUE GRASS	SAGE BRUSH	Barley	Alfalfa Hay
January	Winter	0	0	0	0
February	Winter	0	0	0	0
March	Winter	0	0	0	0
April	Summer	0	0	0	0
May	Summer	110	50	35	70
June	Summer	110	50	135	175
July	Summer	110	60	200	175
August	Summer	110	50	110	110
September	Summer	110	50	0	110
October	Summer	0	20	0	0
November	Winter	0	0	0	0
December	Winter	0	0	0	0

Catchment Area Data

Sub-Catchment	Description of Sub-catchment Use	Area (ha)
Sub-Catchment 1	PR 1	319.03
Sub-Catchment 2	EX 8	481.93
Sub-Catchment 3		
Sub-Catchment 4		
Sub-Catchment 5		
Total		800.96

Pond Area Data

Pond	Description of Pond	Pond Area (m^2)
Pond 1		103327
Pond 2		0

WBSCC - PROJECT DATA SHEET - Environmental Information (Cont'd.)

Actual to Potential Evapotranspiration Modification Factors

Sand		Silt		Clay		Customized Media	
AW/AWC	F	AW/AWC	F	AW/AWC	F	AW/AWC	F
0	0	0	0	0	0	0	0
0.2	1	0.2	0.1	0.2	0.05	0.2	0.1
0.4	1	0.4	0.8	0.4	0.3	0.4	0.5
0.6	1	0.6	1	0.6	0.6	0.6	0.7
0.8	1	0.8	1	0.8	0.95	0.8	0.9
1	1	1	1	1	1	1	1
50	1	50	1	50	1	50	1
100	1	100	1	100	1	100	1

AW: Available Water Content (mm)
AWC: Available Water Capacity (mm)

WBSCC - PROJECT DATA SHEET - Sub-Catchment 1: Parameters, Runoff Allocation

Usage: PR 1

Sub-catchment Parameters		Cover Type					
		Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Medium	Unassigned Area
Area (Total: 319.03)	(ha)	255.22		63.81	0	0	0
Depression Loss	(mm)	1.6					
Soil Type: Sand			20	20	100	90	
Silt			65	65	0	10	
Clay			15	15			
Custom							
Unassigned			0	0	0	0	
Soil or Media Depth	(mm)		150	300	200	600	
Porosity			0.46	0.46	0.512	0.469	
Field Capacity			0.271	0.271	0.132	0.092	
Wilting Point			0.126	0.126	0.057	0.038	
Saturated Hydraulic Conductivity	(m/s)		5.00E-06	5.00E-06	2.50E-05	3.50E-05	
Sub-soil Hydraulic Conductivity	(m/s)		1.00E-08	1.00E-08		5.00E-08	
Ponding Depth	(mm)		0	0	0	300	
Inv. Slope of Log. Tension Moisture Curve			4.98	4.98	4.55	4.32	
Subdrain Invert (above bottom of media)	(mm)					0	
Subdrain Capacity	(m^3/s)					0	

% of Runoff Allocated To:	Runoff Allocated from Cover Type/ Facility:						
	Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Media	Storage/ Reuse Tank	Discharge
Pervious Surface	0			0			
Absorbent Landscaping	80	80		0			
Green Roof Media	0						
Storage/ Reuse Tank	0	0	0	0			
Bioretention/Bioswale Media	0	0	0	0			
Discharge	20	20	100	100	100	100	
Pond 1/Pond 2							POND #1

WBSCC - PROJECT DATA SHEET - Sub-Catchment 1: Crops, Irrigation, Storage/Reuse Tank

Storage/ Reuse Tank Parameters		Values
Tank Water Surface Area (assumed bath tub)	(m^2)	0
Spill Crest Elevation, above Tank Floor	(m)	0
Starting Water Level	(m)	0
Minimum Tank Water Elevation for Recharge	(m)	0
Maximum Tank Water Elevation for Recharge	(m)	1
Use Recharge from Storm Ponds		No
Recharge Source		POND #1
Additional Non-Potable Demand	(l/s)	0
Municipal Supply Available		No

Ground Cover Crop-Mix Profiles (Mix as %)

Crops	Profile #1	Profile #2	Profile #3
KENTUCKY BLUE GRASS	90	100	50
SAGE BRUSH	10	0	50
Barley	0	0	0
Alfalfa Hay	0	0	0
Unassigned	0	0	0

Irrigation Crop Profile or Scheduling Assignment:

Pervious Surface Cover Type			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	1
Absorbent Landscaping Cover Type			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	1
Green Roof Media			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	1

WBSCC - PROJECT DATA SHEET - Sub-Catchment 2: Parameters, Runoff Allocation

Usage: EX 8

Sub-catchment Parameters		Cover Type					
		Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Medium	Unassigned Area
Area (Total: 481.93)	(ha)	0	0	481.93	0	0	0
Depression Loss	(mm)	1.6					
Soil Type: Sand			20	10	100	90	
Silt			65	45	0	10	
Clay			15	45			
Custom							
Unassigned			0	0	0	0	
Soil or Media Depth	(mm)		150	300	200	600	
Porosity			0.46	0.46	0.512	0.469	
Field Capacity			0.271	0.271	0.132	0.092	
Wilting Point			0.126	0.126	0.057	0.038	
Saturated Hydraulic Conductivity	(m/s)		5.00E-06	5.00E-06	2.50E-05	3.50E-05	
Sub-soil Hydraulic Conductivity	(m/s)		1.00E-08	1.00E-08		5.00E-08	
Ponding Depth	(mm)		0	0	0	300	
Inv. Slope of Log. Tension Moisture Curve			4.98	4.98	4.55	4.32	
Subdrain Invert (above bottom of media)	(mm)					0	
Subdrain Capacity	(m^3/s)					0	

% of Runoff Allocated To:	Runoff Allocated from Cover Type/ Facility:						
	Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Media	Storage/ Reuse Tank	Discharge
Pervious Surface	0			0			
Absorbent Landscaping	0	100		0			
Green Roof Media	0						
Storage/ Reuse Tank	0	0	100	0			
Bioretention/Bioswale Media	0	0	0	0			
Discharge	100	0	0	100	100	100	
Pond 1/Pond 2							POND #1

WBSCC - PROJECT DATA SHEET - Sub-Catchment 2: Crops, Irrigation, Storage/Reuse Tank

Storage/ Reuse Tank Parameters		Values
Tank Water Surface Area (assumed bath tub)	(m^2)	0
Spill Crest Elevation, above Tank Floor	(m)	0
Starting Water Level	(m)	0
Minimum Tank Water Elevation for Recharge	(m)	0
Maximum Tank Water Elevation for Recharge	(m)	0
Use Recharge from Storm Ponds		No
Recharge Source		POND #1
Additional Non-Potable Demand	(l/s)	0.00E+00
Municipal Supply Available		No

Ground Cover Crop-Mix Profiles (Mix as %)

Crops	Profile #1	Profile #2	Profile #3
KENTUCKY BLUE GRASS	90	0	50
SAGE BRUSH	10	0	50
Barley	0	0	0
Alfalfa Hay	0	100	0
Unassigned	0	0	0

Irrigation Crop Profile or Scheduling Assignment:

Pervious Surface Cover Type			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	2
Absorbent Landscaping Cover Type			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	1
Green Roof Media			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	1

WBSCC - PROJECT DATA SHEET - Pond 1: Parameters, Elevation-Area-Discharge-Volume Relationship

Pond 1 Parametrs		Values
Base Elevation	(m)	100.00
Starting Water Elevation	(m)	102.00
Starting Discharge Elevation (UNWL)	(m)	102.00
High Water Level (HWL)	(m)	105.00
Lower Normal Water Level (LNWL)	(m)	102.00
Seepage Rate	(mm/hr)	0.00
Discharge and Overflow Routed to:		OUTFALL

Pond 1 Pertinent Volumes (m^3)	Values
Volume at Base Elevation	0
Volume at Stating Water Elevation	152925
Volume at LNWL	152925
Volume at UNWL	152925
Volume at HWL	431653

Pond 1 Bed Soil Parameters		
Soil Type: Sand		0
Silt		0
Clay		100
Custom		
Unassigned		0
Soil or Media Depth	(mm)	50
Porosity		0.46
Field Capacity		0.28
Wilting Point		0.14
Saturated Hydraulic Conductivity	(m/s)	1.00E-06
Sub-soil Hydraulic Conductivity	(m/s)	0.00E+00
Ponding Depth	(mm)	0
Inv. Slope of Log. Tension Moisture Curve		5.51

Elevation (m)	Area (m^2)	Discharge (m^3/s)
100.00	70227	0
101.90	82216	0
102.00	82867	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494
105.00	103327	0.494

POND 1 **POND #1** **CATCHMENT AREA SIZE**

DISCHARGES TO OUTFALL 801.0 ha - DIRECT

801.0 ha - TOTAL

	MAX	MIN	AVG	MEDIAN
VOLUME (m3)	428083.5	123485.1	151296.7	151536.0
LEVEL (m)	105.0	101.6	102.0	102.0

UNIT AREA RESULTS BASED ON TOTAL CATCHMENT SIZE

	MAX	TOTAL	AVG	MEDIAN		MAX	TOTAL	AVG	MEDIAN
INFLOW (m3)	1061606.8	24539695.7	481170.5	481620.3	(mm)	132.5	3063.8	60.1	60.1
DIRECT PRECIPITATION (m3)	49371.4	1741168.6	34140.6	33716.7	(mm)	6.2	217.4	4.3	4.2
EVAPORATION LOSS (m3)	68765.3	3191079.1	62570.2	62560.1	(mm)	8.6	398.4	7.8	7.8
SEEPAGE LOSS (m3)	0.0	0.0	0.0	0.0	(mm)	0.0	0.0	0.0	0.0
DISCHARGE (m3)	1057124.3	23089805.5	452741.3	454311.4	(mm)	132.0	2882.8	56.5	56.7
OVERFLOW (m3)	0.0	0.0	0.0	0.0	(mm)	0.0	0.0	0.0	0.0
MAKE-UP WATER (m3)	0.0	0.0	0.0	0.0	(mm)	0.0	0.0	0.0	0.0
DEMAND (m3)	0.0	0.0	0.0	0.0	(mm)	0.0	0.0	0.0	0.0
WATER BALANCE (m3)		0.0							

ANNUAL SUMMARIES

YEAR	POND #1 VOLUME MAX (m3)	VOLUME MIN (m3)	LEVEL MAX (m)	LEVEL MIN (m)	Inflow (m3)	Direct Precipitation (m3)	Evaporation (m3)	Seepage (m3)	Discharge (m3)	Overflow (m3)	Make-Up Water (m3)	Demand (m3)	
1960	205967.7	145467.5	102.6	101.9	326515.5	30857.4	62547.1	0.0	295152.9	0.0	0.0	0.0	0.0
1961	238419.7	135135.1	102.9	101.8	526803.8	32692.5	63345.1	0.0	495824.1	0.0	0.0	0.0	0.0
1962	152925.5	145658.8	102.0	101.9	170935.5	23600.6	58652.0	0.0	140974.4	0.0	0.0	0.0	0.0
1963	213757.8	141815.5	102.7	101.9	513005.9	35370.3	64110.5	0.0	479694.5	0.0	0.0	0.0	0.0
1964	243489.2	137010.8	103.0	101.8	484174.7	32824.0	59639.4	0.0	456840.0	0.0	0.0	0.0	0.0
1965	251802.8	145349.3	103.1	101.9	1061606.8	49371.4	53853.9	0.0	1057124.3	0.0	0.0	0.0	0.0
1966	241670.2	141354.9	103.0	101.9	541762.4	33716.7	59087.6	0.0	516391.5	0.0	0.0	0.0	0.0
1967	179019.4	123485.1	102.3	101.6	289079.8	21127.7	61391.9	0.0	269270.9	0.0	0.0	0.0	0.0
1968	204711.2	132515.9	102.6	101.7	361628.2	29765.0	56568.6	0.0	314370.1	0.0	0.0	0.0	0.0
1969	202769.4	142149.7	102.5	101.9	588831.5	35630.8	62018.7	0.0	563222.4	0.0	0.0	0.0	0.0
1970	312551.3	140310.0	103.7	101.8	450350.8	33701.9	66996.2	0.0	418223.5	0.0	0.0	0.0	0.0
1971	191503.6	142469.0	102.4	101.9	404732.2	32573.0	68765.3	0.0	366593.8	0.0	0.0	0.0	0.0
1972	204942.5	145211.1	102.6	101.9	677760.0	40127.9	60616.7	0.0	657266.4	0.0	0.0	0.0	0.0
1973	165938.6	145496.5	102.1	101.9	373479.8	29918.4	66770.7	0.0	336655.8	0.0	0.0	0.0	0.0
1974	194747.2	140211.9	102.5	101.8	395782.5	28815.0	63317.4	0.0	361876.1	0.0	0.0	0.0	0.0
1975	167354.6	145665.7	102.2	101.9	240440.7	30554.7	62192.0	0.0	208255.6	0.0	0.0	0.0	0.0
1976	182620.0	145145.8	102.3	101.9	383411.9	33635.4	67256.6	0.0	349768.4	0.0	0.0	0.0	0.0
1977	170179.0	142081.2	102.2	101.9	462561.7	34825.6	65592.1	0.0	431771.9	0.0	0.0	0.0	0.0
1978	257539.2	146943.5	103.1	101.9	775456.3	44589.3	59184.5	0.0	760873.1	0.0	0.0	0.0	0.0
1979	152925.5	142670.2	102.0	101.9	173213.5	23567.0	62866.1	0.0	134939.8	0.0	0.0	0.0	0.0
1980	183812.1	139892.0	102.3	101.8	528329.6	37054.7	64409.7	0.0	499946.9	0.0	0.0	0.0	0.0
1981	241261.3	144434.4	103.0	101.9	672462.1	42329.3	64376.7	0.0	650956.3	0.0	0.0	0.0	0.0
1982	197621.2	142780.3	102.5	101.9	481620.3	34864.8	61913.5	0.0	454311.4	0.0	0.0	0.0	0.0
1983	159048.6	141913.7	102.1	101.9	208903.2	24396.5	62318.6	0.0	172297.4	0.0	0.0	0.0	0.0
1984	184267.2	138218.2	102.3	101.8	399978.2	30478.3	62104.5	0.0	366737.8	0.0	0.0	0.0	0.0
1985	428083.5	140722.5	105.0	101.8	492882.8	33114.1	63706.9	0.0	462386.6	0.0	0.0	0.0	0.0
1986	351810.1	143057.5	104.1	101.9	736847.2	39118.1	62035.7	0.0	714232.1	0.0	0.0	0.0	0.0
1987	169594.7	137303.5	102.2	101.8	422046.3	29113.9	67232.2	0.0	388545.2	0.0	0.0	0.0	0.0
1988	281434.3	136153.6	103.4	101.8	521074.7	33934.9	66969.6	0.0	483561.7	0.0	0.0	0.0	0.0
1989	152914.0	147701.5	102.0	101.9	222158.4	32071.7	62020.8	0.0	191708.1	0.0	0.0	0.0	0.0
1990	156459.4	146229.8	102.0	101.9	340788.3	32964.1	61188.0	0.0	312551.3	0.0	0.0	0.0	0.0
1991	198363.9	142350.1	102.5	101.9	500594.4	33795.6	63745.1	0.0	473673.4	0.0	0.0	0.0	0.0
1992	309548.4	145875.5	103.7	101.9	620046.3	41488.5	58727.1	0.0	599741.2	0.0	0.0	0.0	0.0
1993	218703.8	146290.4	102.7	101.9	632165.0	37420.0	57608.5	0.0	613679.3	0.0	0.0	0.0	0.0
1994	180079.1	143319.8	102.3	101.9	263462.9	29422.4	64317.2	0.0	226894.0	0.0	0.0	0.0	0.0
1995	187894.4	148029.8	102.4	101.9	457682.8	34366.5	59457.2	0.0	432551.9	0.0	0.0	0.0	0.0
1996	165068.3	140527.7	102.1	101.8	385444.3	31164.7	58761.6	0.0	357870.8	0.0	0.0	0.0	0.0
1997	256142.5	143780.4	103.1	101.9	681257.3	35571.6	63648.2	0.0	654917.2	0.0	0.0	0.0	0.0
1998	278560.1	140808.0	103.4	101.8	849897.8	44985.0	64706.2	0.0	828433.8	0.0	0.0	0.0	0.0
1999	242280.1	146203.9	103.0	101.9	655892.7	38385.7	59487.9	0.0	638227.7	0.0	0.0	0.0	0.0
2000	167835.8	144069.7	102.2	101.9	403525.1	34194.8	65775.1	0.0	370617.5	0.0	0.0	0.0	0.0
2001	189606.0	137369.9	102.4	101.8	273257.3	26359.3	67952.2	0.0	233990.3	0.0	0.0	0.0	0.0
2002	152841.2	141590.2	102.0	101.9	220819.1	28487.2	62466.6	0.0	182578.3	0.0	0.0	0.0	0.0
2003	189001.3	144348.3	102.4	101.9	521190.4	35700.3	62560.1	0.0	494446.7	0.0	0.0	0.0	0.0
2004	208120.3	148005.6	102.6	101.9	263759.0	32124.5	62638.9	0.0	232954.1	0.0	0.0	0.0	0.0
2005	419709.5	144967.7	104.9	101.9	1029777.8	46213.1	63085.9	0.0	1013445.5	0.0	0.0	0.0	0.0
2006	211879.3	141930.4	102.6	101.9	494808.8	34933.5	62543.3	0.0	466704.4	0.0	0.0	0.0	0.0
2007	342232.8	145795.0	104.0	101.9	700520.0	43223.9	62836.9	0.0	681172.2	0.0	0.0	0.0	0.0
2008	200895.0	146244.3	102.5	101.9	511678.8	41826.6	62677.2	0.0	490515.9	0.0	0.0	0.0	0.0
2009	197484.9	142815.1	102.5	101.9	330687.1	27121.3	62462.5	0.0	295345.7	0.0	0.0	0.0	0.0
2010	186731.4	146388.4	102.4	101.9	514604.6	37679.0	62573.1	0.0	489721.2	0.0	0.0	0.0	0.0

OUTFALL

801.0 ha - TOTAL

Pond #1 10.3 ha

Pond #2 0.0 ha

811.3 ha - Including Ponds

	MAX	TOTAL	AVG	MEDIAN		UNIT AREA RESULTS BASED ON TOTAL CATCHMENT SIZE MAX	TOTAL	AVG	MEDIAN		UNIT AREA RESULTS BASED ON TOTAL CATCHMENT + POND SIZE MAX	TOTAL	AVG	MEDIAN
PRECIPITATION (m3)					(mm)		20897.0	409.7	404.7	(mm)		20897.0	409.7	404.7
DISCHARGE (m3)	1057124.3	23089805.5	452741.3	454311.4	(mm)	132.0	2882.8	56.5	56.7	(mm)	130.3	2846.1	55.8	56.0
RATIO (%)							13.8	13.8	14.0			13.6	13.6	13.8

PR 5 & PR 10

WBSCC

Water Balance Spreadsheet for the City of Calgary
Version 1.2

PROJECT SUMMARY SHEET

Project Name:	Shepard Industrial ASP Storm Study
Project Description:	Water Balance Model for continuous simulation of Catchment PR 5 and PR 10
Location:	Rocky View County
Date:	Februray, 2021
Designed by:	YZ
Company Name:	IDEA Group Inc.
Reviewed by:	JB

WBSCC - PROJECT DATA SHEET - Environmental Information

Minimum Temperature to Trigger Runoff (^{o}C)	0
Sublimation Losses (%)	0
Precipitation Multiplication Factor (% Decrease)	0

Month	Is Winter or Summer?	Crop Water Requirement (mm/month)			
		KENTUCKY BLUE GRASS	SAGE BRUSH	Barley	Alfalfa Hay
January	Winter	0	0	0	0
February	Winter	0	0	0	0
March	Winter	0	0	0	0
April	Summer	0	0	0	0
May	Summer	110	50	35	70
June	Summer	110	50	135	175
July	Summer	110	60	200	175
August	Summer	110	50	110	110
September	Summer	110	50	0	110
October	Summer	0	20	0	0
November	Winter	0	0	0	0
December	Winter	0	0	0	0

Catchment Area Data

Sub-Catchment	Description of Sub-catchment Use	Area (ha)
Sub-Catchment 1	PR 5	192.67
Sub-Catchment 2	PR 10	104.94
Sub-Catchment 3		
Sub-Catchment 4		
Sub-Catchment 5		
Total		297.61

Pond Area Data

Pond	Description of Pond	Pond Area (m^2)
Pond 1		60800
Pond 2		34375

WBSCC - PROJECT DATA SHEET - Environmental Information (Cont'd.)

Actual to Potential Evapotranspiration Modification Factors

Sand		Silt		Clay		Customized Media	
AW/AWC	F	AW/AWC	F	AW/AWC	F	AW/AWC	F
0	0	0	0	0	0	0	0
0.2	1	0.2	0.1	0.2	0.05	0.2	0.1
0.4	1	0.4	0.8	0.4	0.3	0.4	0.5
0.6	1	0.6	1	0.6	0.6	0.6	0.7
0.8	1	0.8	1	0.8	0.95	0.8	0.9
1	1	1	1	1	1	1	1
50	1	50	1	50	1	50	1
100	1	100	1	100	1	100	1

AW: Available Water Content (mm)
AWC: Available Water Capacity (mm)

WBSCC - PROJECT DATA SHEET - Sub-Catchment 1: Parameters, Runoff Allocation

Usage: PR 5

Sub-catchment Parameters		Cover Type					
		Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Medium	Unassigned Area
Area (Total: 192.67)	(ha)	154.14		38.53	0	0	0
Depression Loss	(mm)	1.6					
Soil Type: Sand			20	20	100	90	
Silt			65	65	0	10	
Clay			15	15			
Custom							
Unassigned			0	0	0	0	
Soil or Media Depth	(mm)		150	300	200	600	
Porosity			0.46	0.46	0.512	0.469	
Field Capacity			0.271	0.271	0.132	0.092	
Wilting Point			0.126	0.126	0.057	0.038	
Saturated Hydraulic Conductivity	(m/s)		5.00E-06	5.00E-06	2.50E-05	3.50E-05	
Sub-soil Hydraulic Conductivity	(m/s)		1.00E-08	1.00E-08		5.00E-08	
Ponding Depth	(mm)		0	0	0	300	
Inv. Slope of Log. Tension Moisture Curve			4.98	4.98	4.55	4.32	
Subdrain Invert (above bottom of media)	(mm)					0	
Subdrain Capacity	(m^3/s)					0	

% of Runoff Allocated To:	Runoff Allocated from Cover Type/ Facility:						
	Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Media	Storage/ Reuse Tank	Discharge
Pervious Surface	0			0			
Absorbent Landscaping	80	80		0			
Green Roof Media	0						
Storage/ Reuse Tank	0	0	0	0			
Bioretention/Bioswale Media	0	0	0	0			
Discharge	20	20	100	100	100	100	
Pond 1/Pond 2							POND #1

WBSCC - PROJECT DATA SHEET - Sub-Catchment 1: Crops, Irrigation, Storage/Reuse Tank

Storage/ Reuse Tank Parameters		Values
Tank Water Surface Area (assumed bath tub)	(m^2)	0
Spill Crest Elevation, above Tank Floor	(m)	0
Starting Water Level	(m)	0
Minimum Tank Water Elevation for Recharge	(m)	0
Maximum Tank Water Elevation for Recharge	(m)	1
Use Recharge from Storm Ponds		No
Recharge Source		POND #1
Additional Non-Potable Demand	(l/s)	0
Municipal Supply Available		No

Ground Cover Crop-Mix Profiles (Mix as %)

Crops	Profile #1	Profile #2	Profile #3
KENTUCKY BLUE GRASS	90	100	50
SAGE BRUSH	10	0	50
Barley	0	0	0
Alfalfa Hay	0	0	0
Unassigned	0	0	0

Irrigation Crop Profile or Scheduling Assignment:

Pervious Surface Cover Type			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	1
Absorbent Landscaping Cover Type			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	1
Green Roof Media			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	1

WBSCC - PROJECT DATA SHEET - Sub-Catchment 2: Parameters, Runoff Allocation

Usage: PR 10

Sub-catchment Parameters		Cover Type					
		Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Medium	Unassigned Area
Area (Total: 104.94)	(ha)	83.95	0	20.99	0	0	0
Depression Loss	(mm)	1.6					
Soil Type: Sand			20	10	100	90	
Silt			65	45	0	10	
Clay			15	45			
Custom							
Unassigned			0	0	0	0	
Soil or Media Depth	(mm)		150	300	200	600	
Porosity			0.46	0.46	0.512	0.469	
Field Capacity			0.271	0.271	0.132	0.092	
Wilting Point			0.126	0.126	0.057	0.038	
Saturated Hydraulic Conductivity	(m/s)		5.00E-06	5.00E-06	2.50E-05	3.50E-05	
Sub-soil Hydraulic Conductivity	(m/s)		1.00E-08	1.00E-08		5.00E-08	
Ponding Depth	(mm)		0	0	0	300	
Inv. Slope of Log. Tension Moisture Curve			4.98	4.98	4.55	4.32	
Subdrain Invert (above bottom of media)	(mm)					0	
Subdrain Capacity	(m^3/s)					0	

% of Runoff Allocated To:	Runoff Allocated from Cover Type/ Facility:						
	Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Media	Storage/ Reuse Tank	Discharge
Pervious Surface	0			0			
Absorbent Landscaping	80	80		0			
Green Roof Media	0						
Storage/ Reuse Tank	0	0	100	0			
Bioretention/Bioswale Media	0	0	0	0			
Discharge	20	20	0	100	100	100	
Pond 1/Pond 2							POND #2

WBSCC - PROJECT DATA SHEET - Sub-Catchment 2: Crops, Irrigation, Storage/Reuse Tank

Storage/ Reuse Tank Parameters		Values
Tank Water Surface Area (assumed bath tub)	(m^2)	0
Spill Crest Elevation, above Tank Floor	(m)	0
Starting Water Level	(m)	0
Minimum Tank Water Elevation for Recharge	(m)	0
Maximum Tank Water Elevation for Recharge	(m)	0
Use Recharge from Storm Ponds		No
Recharge Source		POND #1
Additional Non-Potable Demand	(l/s)	0.00E+00
Municipal Supply Available		No

Ground Cover Crop-Mix Profiles (Mix as %)

Crops	Profile #1	Profile #2	Profile #3
KENTUCKY BLUE GRASS	90	0	50
SAGE BRUSH	10	0	50
Barley	0	0	0
Alfalfa Hay	0	100	0
Unassigned	0	0	0

Irrigation Crop Profile or Scheduling Assignment:

Pervious Surface Cover Type			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	2
Absorbent Landscaping Cover Type			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	1
Green Roof Media			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	1

WBSCC - PROJECT DATA SHEET - Pond 1: Parameters, Elevation-Area-Discharge-Volume Relationship

Pond 1 Parametrs		Values
Base Elevation	(m)	100.00
Starting Water Elevation	(m)	102.00
Starting Discharge Elevation (UNWL)	(m)	102.00
High Water Level (HWL)	(m)	105.00
Lower Normal Water Level (LNWL)	(m)	102.00
Seepage Rate	(mm/hr)	0.00
Discharge and Overflow Routed to:		OUTFALL

Pond 1 Pertinent Volumes (m^3)	Values
Volume at Base Elevation	0
Volume at Stating Water Elevation	81632
Volume at LNWL	81632
Volume at UNWL	81632
Volume at HWL	240529

Pond 1 Bed Soil Parameters		
Soil Type: Sand		0
Silt		0
Clay		100
Custom		
Unassigned		0
Soil or Media Depth	(mm)	50
Porosity		0.46
Field Capacity		0.28
Wilting Point		0.14
Saturated Hydraulic Conductivity	(m/s)	1.00E-06
Sub-soil Hydraulic Conductivity	(m/s)	0.00E+00
Ponding Depth	(mm)	0
Inv. Slope of Log. Tension Moisture Curve		5.51

Elevation (m)	Area (m^2)	Discharge (m^3/s)
100.00	36300	0
101.90	45021	0
102.00	45500	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159
105.00	60800	0.159

WBSCC - PROJECT DATA SHEET - Pond 2: Parameters, Elevation-Area-Discharge Relationship

Pond 2 Parametrs		Values
Base Elevation	(m)	100.00
Starting Water Elevation	(m)	102.00
Starting Discharge Elevation (UNWL)	(m)	102.00
High Water Level (HWL)	(m)	105.00
Lower Normal Water Level (LNWL)	(m)	102.00
Seepage Rate	(mm/hr)	0.00
Discharge and Overflow Routed to:		OUTFALL

Pond 2 Pertinent Volumes (m^3)	Values
Volume at Base Elevation	0
Volume at Stating Water Elevation	39984
Volume at LNWL	39984
Volume at UNWL	39984
Volume at HWL	125920

Pond 2 Bed Soil Parameters		
Soil Type: Sand		
Silt		100
Clay		
Custom		
Unassigned		0
Soil or Media Depth	(mm)	50
Porosity		0.46
Field Capacity		0.28
Wilting Point		0.14
Saturated Hydraulic Conductivity	(m/s)	1.00E-06
Sub-soil Hydraulic Conductivity	(m/s)	0.00E+00
Ponding Depth	(mm)	0
Inv. Slope of Log. Tension Moisture Curve		5.51

Elevation (m)	Area (m^2)	Discharge (m^3/s)
100.00	16875	0
101.90	22936	0
102.00	23275	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087
105.00	34375	0.087

POND 1 **POND #1** **CATCHMENT AREA SIZE**

DISCHARGES TO OUTFALL 192.7 ha - DIRECT

297.6 ha - TOTAL

	MAX	MIN	AVG	MEDIAN
VOLUME (m3)	238190.6	66806.3	81543.5	81007.6
LEVEL (m)	105.0	101.6	102.0	102.0

	MAX	TOTAL	AVG	MEDIAN
INFLOW (m3)	641761.3	14720028.6	288628.0	279622.3
DIRECT PRECIPITATION (m3)	27542.6	963752.6	18897.1	18689.4
EVAPORATION LOSS (m3)	37796.8	1755867.6	34428.8	34399.5
SEEPAGE LOSS (m3)	0.0	0.0	0.0	0.0
DISCHARGE (m3)	639499.9	13927922.9	273096.5	262920.4
OVERFLOW (m3)	0.0	0.0	0.0	0.0
MAKE-UP WATER (m3)	0.0	0.0	0.0	0.0
DEMAND (m3)	0.0	0.0	0.0	0.0
WATER BALANCE (m3)		0.0		

UNIT AREA RESULTS BASED ON TOTAL CATCHMENT SIZE

		MAX	TOTAL	AVG	MEDIAN
INFLOW	(mm)	215.6	4946.1	97.0	94.0
DIRECT PRECIPITATION	(mm)	9.3	323.8	6.3	6.3
EVAPORATION LOSS	(mm)	12.7	590.0	11.6	11.6
SEEPAGE LOSS	(mm)	0.0	0.0	0.0	0.0
DISCHARGE	(mm)	214.9	4679.9	91.8	88.3
OVERFLOW	(mm)	0.0	0.0	0.0	0.0
MAKE-UP WATER	(mm)	0.0	0.0	0.0	0.0
DEMAND	(mm)	0.0	0.0	0.0	0.0

ANNUAL SUMMARIES

YEAR	POND #1 VOLUME MAX (m3)	VOLUME MIN (m3)	LEVEL MAX (m)	LEVEL MIN (m)	Inflow (m3)	Direct Precipitation (m3)	Evaporation (m3)	Seepage (m3)	Discharge (m3)	Overflow (m3)	Make-Up Water (m3)	Demand (m3)	
1960	125164.3	77947.0	102.8	101.9	197389.4	16965.5	34359.3	0.0	180153.2	0.0	0.0	0.0	0.0
1961	159708.7	72142.3	103.5	101.8	318421.3	18151.8	34874.5	0.0	301528.1	0.0	0.0	0.0	0.0
1962	87698.2	77694.7	102.1	101.9	103346.4	12964.7	32198.1	0.0	86556.8	0.0	0.0	0.0	0.0
1963	129342.7	75625.1	102.9	101.9	310234.4	19555.2	35271.2	0.0	292127.7	0.0	0.0	0.0	0.0
1964	159644.0	73415.5	103.5	101.8	292684.2	18221.4	32869.9	0.0	277995.4	0.0	0.0	0.0	0.0
1965	152155.1	77612.2	103.3	101.9	641761.3	27542.6	29804.1	0.0	639499.9	0.0	0.0	0.0	0.0
1966	156823.9	75429.7	103.4	101.9	327572.0	18676.9	32555.0	0.0	313693.9	0.0	0.0	0.0	0.0
1967	109501.8	66806.3	102.5	101.6	174745.6	11605.3	33655.7	0.0	162117.2	0.0	0.0	0.0	0.0
1968	121042.7	72235.6	102.7	101.8	218706.5	16415.2	31091.7	0.0	194608.4	0.0	0.0	0.0	0.0
1969	130414.9	76310.4	102.9	101.9	355963.2	19747.3	34149.6	0.0	341976.1	0.0	0.0	0.0	0.0
1970	200323.2	74821.8	104.2	101.8	272219.7	18807.7	37030.9	0.0	254535.7	0.0	0.0	0.0	0.0
1971	125948.3	75920.9	102.8	101.9	244689.0	17976.8	37796.8	0.0	223914.3	0.0	0.0	0.0	0.0
1972	129622.0	77497.0	102.9	101.9	409743.0	22202.8	33379.7	0.0	398557.3	0.0	0.0	0.0	0.0
1973	101534.6	77696.9	102.4	101.9	225800.4	16464.8	36680.4	0.0	205595.3	0.0	0.0	0.0	0.0
1974	118931.1	74803.4	102.7	101.8	239309.4	15888.9	34766.7	0.0	220766.5	0.0	0.0	0.0	0.0
1975	101680.2	77678.8	102.4	101.9	145361.6	16779.7	34144.8	0.0	127696.5	0.0	0.0	0.0	0.0
1976	123271.0	77643.1	102.8	101.9	231762.2	18549.5	36956.3	0.0	213345.3	0.0	0.0	0.0	0.0
1977	102993.3	75782.0	102.4	101.9	279622.3	19168.9	36025.8	0.0	262744.3	0.0	0.0	0.0	0.0
1978	165119.3	78498.2	103.6	101.9	468791.2	24734.2	32612.9	0.0	460925.9	0.0	0.0	0.0	0.0
1979	88899.5	76592.6	102.1	101.9	104706.7	12949.2	34522.8	0.0	83569.8	0.0	0.0	0.0	0.0
1980	133868.0	74491.8	103.0	101.8	319353.2	20530.2	35429.2	0.0	304017.3	0.0	0.0	0.0	0.0
1981	155118.7	77172.9	103.4	101.9	406465.7	23435.1	35444.6	0.0	394673.1	0.0	0.0	0.0	0.0
1982	120681.3	76309.6	102.7	101.9	291081.9	19250.3	34044.6	0.0	276160.8	0.0	0.0	0.0	0.0
1983	96823.9	75861.5	102.3	101.9	126309.2	13425.8	34224.5	0.0	106153.4	0.0	0.0	0.0	0.0
1984	115030.8	74272.0	102.6	101.8	241802.5	16811.2	34099.2	0.0	223772.9	0.0	0.0	0.0	0.0
1985	238190.6	75236.9	105.0	101.9	276879.4	18437.1	35030.0	0.0	260339.6	0.0	0.0	0.0	0.0
1986	198290.9	76282.4	104.2	101.9	417958.9	21825.4	34173.2	0.0	405732.0	0.0	0.0	0.0	0.0
1987	107339.5	73345.9	102.5	101.8	255096.4	16061.9	36922.0	0.0	236709.8	0.0	0.0	0.0	0.0
1988	168517.2	72553.2	103.6	101.8	314990.3	18842.7	36867.0	0.0	294585.2	0.0	0.0	0.0	0.0
1989	81626.2	78766.6	102.0	101.9	134262.6	17605.5	34034.5	0.0	117587.1	0.0	0.0	0.0	0.0
1990	96232.6	77984.6	102.3	101.9	206011.7	18149.8	33603.8	0.0	190542.7	0.0	0.0	0.0	0.0
1991	120729.0	75929.2	102.7	101.9	302599.3	18689.4	35051.1	0.0	287870.0	0.0	0.0	0.0	0.0
1992	199111.3	78597.8	104.2	101.9	374807.3	23064.5	32443.2	0.0	363783.4	0.0	0.0	0.0	0.0
1993	130729.3	78051.3	102.9	101.9	382136.9	20727.6	31722.8	0.0	372068.1	0.0	0.0	0.0	0.0
1994	108982.1	76445.1	102.5	101.9	159288.9	16193.4	35320.7	0.0	139250.9	0.0	0.0	0.0	0.0
1995	114799.5	79083.6	102.6	101.9	276675.9	18946.8	32675.5	0.0	262920.4	0.0	0.0	0.0	0.0
1996	101046.5	74890.4	102.4	101.8	233012.5	17125.4	32251.4	0.0	217904.1	0.0	0.0	0.0	0.0
1997	167126.6	76949.5	103.6	101.9	411835.1	19789.3	35087.6	0.0	397480.6	0.0	0.0	0.0	0.0
1998	181293.9	75177.2	103.9	101.9	511405.5	25044.1	35771.4	0.0	499730.4	0.0	0.0	0.0	0.0
1999	157609.7	78046.6	103.4	101.9	396530.4	21369.9	32801.7	0.0	386922.8	0.0	0.0	0.0	0.0
2000	101262.8	76873.4	102.4	101.9	243932.2	18841.7	36136.8	0.0	225760.2	0.0	0.0	0.0	0.0
2001	135337.3	73399.3	103.0	101.8	165143.9	14575.7	37328.6	0.0	143481.4	0.0	0.0	0.0	0.0
2002	89276.5	75973.3	102.1	101.9	133475.7	15652.3	34298.5	0.0	112888.1	0.0	0.0	0.0	0.0
2003	121910.7	77037.9	102.8	101.9	315022.6	19736.0	34399.5	0.0	300422.5	0.0	0.0	0.0	0.0
2004	124325.4	78939.1	102.8	101.9	159451.7	17675.1	34401.7	0.0	142565.6	0.0	0.0	0.0	0.0
2005	231353.5	77330.5	104.8	101.9	558726.4	26205.6	35114.1	0.0	550090.1	0.0	0.0	0.0	0.0
2006	130556.6	76585.8	102.9	101.9	299145.8	19388.9	34449.9	0.0	283838.1	0.0	0.0	0.0	0.0
2007	217950.5	77814.2	104.6	101.9	423476.5	24119.8	34782.9	0.0	412950.1	0.0	0.0	0.0	0.0
2008	140535.6	78007.1	103.1	101.9	309276.1	23196.1	34526.9	0.0	297782.7	0.0	0.0	0.0	0.0
2009	120632.5	76129.5	102.7	101.9	199905.8	14903.2	34294.4	0.0	180514.4	0.0	0.0	0.0	0.0
2010	114122.3	78527.4	102.6	101.9	311138.4	20764.2	34389.5	0.0	297517.1	0.0	0.0	0.0	0.0

POND 2 **POND #2** **CATCHMENT AREA SIZE**

DISCHARGES TO OUTFALL 104.9 ha - DIRECT

297.6 ha - TOTAL

	MAX	MIN	AVG	MEDIAN
VOLUME (m3)	125423.5	32605.4	39998.0	39673.2
LEVEL (m)	105.0	101.6	102.0	102.0

UNIT AREA RESULTS BASED ON TOTAL CATCHMENT SIZE

	MAX	TOTAL	AVG	MEDIAN		MAX	TOTAL	AVG	MEDIAN
INFLOW (m3)	351216.2	8102804.9	158878.5	153806.9	(mm)	118.0	2722.6	53.4	51.7
DIRECT PRECIPITATION (m3)	14241.2	496024.5	9726.0	9628.4	(mm)	4.8	166.7	3.3	3.2
EVAPORATION LOSS (m3)	19330.6	898559.8	17618.8	17595.0	(mm)	6.5	301.9	5.9	5.9
SEEPAGE LOSS (m3)	0.0	0.0	0.0	0.0	(mm)	0.0	0.0	0.0	0.0
DISCHARGE (m3)	350150.3	7700273.9	150985.8	146315.6	(mm)	117.7	2587.4	50.7	49.2
OVERFLOW (m3)	0.0	0.0	0.0	0.0	(mm)	0.0	0.0	0.0	0.0
MAKE-UP WATER (m3)	0.0	0.0	0.0	0.0	(mm)	0.0	0.0	0.0	0.0
DEMAND (m3)	0.0	0.0	0.0	0.0	(mm)	0.0	0.0	0.0	0.0
WATER BALANCE (m3)		0.0							

POND #2

VOLUME MAX (m3)	VOLUME MIN (m3)	LEVEL MAX (m)	LEVEL MIN (m)	Inflow (m3)	Direct Precipitation (m3)	Evaporation (m3)	Seepage (m3)	Discharge (m3)	Overflow (m3)	Make-Up Water (m3)	Demand (m3)	
63734.0	38160.1	102.8	101.9	109303.7	8679.1	17562.0	0.0	100495.8	0.0	0.0	0.0	
82480.1	35239.1	103.5	101.8	174195.1	9356.4	17843.4	0.0	165626.0	0.0	0.0	0.0	
43927.4	37988.6	102.1	101.9	57396.9	6631.7	16453.0	0.0	48776.3	0.0	0.0	0.0	
66046.7	36924.5	102.9	101.9	171599.5	10054.3	18050.3	0.0	162428.2	0.0	0.0	0.0	
82465.4	35850.4	103.5	101.8	161493.9	9404.6	16831.2	0.0	154048.8	0.0	0.0	0.0	
78441.5	37931.8	103.3	101.9	351216.2	14241.2	15307.1	0.0	350150.3	0.0	0.0	0.0	
81503.8	36864.5	103.4	101.9	181398.9	9628.4	16676.5	0.0	174350.7	0.0	0.0	0.0	
55197.0	32605.4	102.5	101.6	95447.4	5926.8	17139.6	0.0	88677.4	0.0	0.0	0.0	
61899.6	35553.9	102.8	101.8	121181.3	8423.9	15900.0	0.0	109262.5	0.0	0.0	0.0	
66479.6	37338.2	102.9	101.9	195995.5	10164.3	17483.4	0.0	188882.5	0.0	0.0	0.0	
105383.9	36542.5	104.3	101.8	150005.5	9786.2	19006.0	0.0	141025.7	0.0	0.0	0.0	
64741.1	37075.7	102.9	101.9	135030.8	9227.3	19330.6	0.0	124481.3	0.0	0.0	0.0	
66867.4	37907.8	102.9	101.9	224949.2	11418.6	17096.1	0.0	219267.0	0.0	0.0	0.0	
50838.3	38004.0	102.4	101.9	125303.7	8429.2	18751.8	0.0	114986.7	0.0	0.0	0.0	
60335.7	36538.7	102.7	101.8	131418.9	8147.6	17764.6	0.0	121972.5	0.0	0.0	0.0	
51462.1	37973.8	102.4	101.9	81129.3	8580.7	17454.1	0.0	72102.7	0.0	0.0	0.0	
62601.8	38049.2	102.8	101.9	128695.7	9510.4	18899.3	0.0	119302.1	0.0	0.0	0.0	
51579.7	37033.0	102.4	101.9	153806.9	9815.9	18414.3	0.0	145197.4	0.0	0.0	0.0	
86363.0	38436.9	103.6	101.9	256757.2	12763.6	16715.7	0.0	252812.1	0.0	0.0	0.0	
44518.1	37416.3	102.2	101.9	58458.0	6621.2	17633.8	0.0	47648.7	0.0	0.0	0.0	
68733.6	36343.4	103.0	101.8	175617.9	10556.9	18123.4	0.0	167848.6	0.0	0.0	0.0	
80652.7	37757.2	103.4	101.9	222743.8	12070.7	18148.1	0.0	216771.0	0.0	0.0	0.0	
61258.5	37283.1	102.7	101.9	160295.2	9871.2	17412.1	0.0	152692.0	0.0	0.0	0.0	
48247.4	37109.7	102.3	101.9	69634.2	6873.8	17488.8	0.0	59309.6	0.0	0.0	0.0	
58156.5	36326.3	102.6	101.8	133248.8	8625.6	17421.9	0.0	124115.8	0.0	0.0	0.0	
125423.5	36809.0	105.0	101.9	151800.5	9598.4	17920.3	0.0	143505.8	0.0	0.0	0.0	
103573.9	37272.7	104.2	101.9	229217.1	11342.4	17509.4	0.0	223110.6	0.0	0.0	0.0	
53910.0	35859.6	102.5	101.8	139721.3	8232.2	18865.6	0.0	130320.6	0.0	0.0	0.0	
87775.5	35391.7	103.7	101.8	173387.9	9739.5	18871.4	0.0	163061.6	0.0	0.0	0.0	
39980.8	38520.0	102.0	101.9	74998.0	9002.7	17395.3	0.0	66489.5	0.0	0.0	0.0	
47975.2	38123.8	102.3	101.9	114033.6	9296.6	17181.7	0.0	106139.9	0.0	0.0	0.0	
61264.1	37089.3	102.7	101.9	166599.6	9606.6	17930.4	0.0	159103.0	0.0	0.0	0.0	
104272.7	38454.4	104.2	101.9	205731.6	11921.1	16647.1	0.0	200172.8	0.0	0.0	0.0	
66849.8	38166.1	102.9	101.9	209038.7	10664.7	16244.4	0.0	203929.6	0.0	0.0	0.0	
54883.7	37352.9	102.5	101.9	88540.1	8293.2	18055.7	0.0	78314.8	0.0	0.0	0.0	
58940.4	38719.1	102.7	101.9	153329.9	9712.7	16712.6	0.0	146315.6	0.0	0.0	0.0	
50569.7	36560.4	102.4	101.8	128065.2	8762.6	16477.4	0.0	120360.2	0.0	0.0	0.0	
86552.5	37625.2	103.6	101.9	225675.9	10223.3	17977.6	0.0	218400.8	0.0	0.0	0.0	
94285.4	36709.0	103.9	101.9	280027.8	12939.6	18356.3	0.0	274129.8	0.0	0.0	0.0	
81593.9	38154.7	103.5	101.9	217775.4	11045.4	16813.7	0.0	212933.8	0.0	0.0	0.0	
51271.3	37566.6	102.4	101.9	135350.5	9658.5	18479.3	0.0	126039.2	0.0	0.0	0.0	
69744.1	35799.1	103.0	101.8	90655.9	7481.8	19069.5	0.0	79571.0	0.0	0.0	0.0	
44101.9	37104.1	102.1	101.9	74523.4	8005.0	17525.9	0.0	64112.9	0.0	0.0	0.0	
61900.8	37660.9	102.8	101.9	173235.5	10134.7	17597.1	0.0	165805.4	0.0	0.0	0.0	
64004.5	38610.0	102.8	101.9	88008.2	9061.5	17595.0	0.0	79393.1	0.0	0.0	0.0	
121557.1	37810.4	104.8	101.9	306723.4	13768.7	18118.1	0.0	302510.5	0.0	0.0	0.0	
67105.9	37432.1	102.9	101.9	165271.5	9990.7	17636.7	0.0	157502.2	0.0	0.0	0.0	
114371.2	38045.5	104.6	101.9	231635.7	12525.8	17875.1	0.0	226353.1	0.0	0.0	0.0	
71993.9	38146.9	103.1	101.9	170003.5	11938.4	17684.0	0.0	164178.0	0.0	0.0	0.0	
61260.3	37185.1	102.7	101.9	110253.0	7622.6	17522.6	0.0	100352.9	0.0	0.0	0.0	
58166.8	38411.2	102.6	101.9	172878.2	10646.2	17590.4	0.0	165935.7	0.0	0.0	0.0	

OUTFALL

297.6 ha - TOTAL

Pond #1 6.1 ha

Pond #2 3.4 ha

307.1 ha - Including Ponds

	MAX	TOTAL	AVG	MEDIAN		UNIT AREA RESULTS BASED ON TOTAL CATCHMENT SIZE MAX	TOTAL	AVG	MEDIAN		UNIT AREA RESULTS BASED ON TOTAL CATCHMENT + POND SIZE MAX	TOTAL	AVG	MEDIAN
PRECIPITATION (m3)					(mm)		20897.0	409.7	404.7	(mm)		20897.0	409.7	404.7
DISCHARGE (m3)	639499.9	21628196.9	424082.3	262920.4	(mm)	214.9	7267.5	142.5	88.3	(mm)	208.2	7042.7	138.1	85.6
RATIO (%)							22.4	22.4	21.8			21.7	21.7	21.2

PR 9

WBSCC

Water Balance Spreadsheet for the City of Calgary
Version 1.2

PROJECT SUMMARY SHEET

Project Name:	Shepard Industrial ASP Storm Study
Project Description:	Water Balance Model for continuous simulation of Catchment PR 9
Location:	Rocky View County
Date:	February, 2021
Designed by:	YZ
Company Name:	IDEA Group Inc.
Reviewed by:	JB

WBSCC - PROJECT DATA SHEET - Environmental Information

Minimum Temperature to Trigger Runoff (^{o}C)	0
Sublimation Losses (%)	0
Precipitation Multiplication Factor (% Decrease)	0

Month	Is Winter or Summer?	Crop Water Requirement (mm/month)			
		KENTUCKY BLUE GRASS	SAGE BRUSH	Barley	Alfalfa Hay
January	Winter	0	0	0	0
February	Winter	0	0	0	0
March	Winter	0	0	0	0
April	Summer	0	0	0	0
May	Summer	110	50	35	70
June	Summer	110	50	135	175
July	Summer	110	60	200	175
August	Summer	110	50	110	110
September	Summer	110	50	0	110
October	Summer	0	20	0	0
November	Winter	0	0	0	0
December	Winter	0	0	0	0

Catchment Area Data

Sub-Catchment	Description of Sub-catchment Use	Area (ha)
Sub-Catchment 1	PR 9	130.89
Sub-Catchment 2		
Sub-Catchment 3		
Sub-Catchment 4		
Sub-Catchment 5		
Total		130.89

Pond Area Data

Pond	Description of Pond	Pond Area (m^2)
Pond 1		44800
Pond 2		0

WBSCC - PROJECT DATA SHEET - Environmental Information (Cont'd.)

Actual to Potential Evapotranspiration Modification Factors

Sand		Silt		Clay		Customized Media	
AW/AWC	F	AW/AWC	F	AW/AWC	F	AW/AWC	F
0	0	0	0	0	0	0	0
0.2	1	0.2	0.1	0.2	0.05	0.2	0.1
0.4	1	0.4	0.8	0.4	0.3	0.4	0.5
0.6	1	0.6	1	0.6	0.6	0.6	0.7
0.8	1	0.8	1	0.8	0.95	0.8	0.9
1	1	1	1	1	1	1	1
50	1	50	1	50	1	50	1
100	1	100	1	100	1	100	1

AW: Available Water Content (mm)
AWC: Available Water Capacity (mm)

WBSCC - PROJECT DATA SHEET - Sub-Catchment 1: Parameters, Runoff Allocation

Usage: PR 9

Sub-catchment Parameters		Cover Type					
		Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Medium	Unassigned Area
Area (Total: 130.89)	(ha)	104.71		26.18	0	0	0
Depression Loss	(mm)	1.6					
Soil Type: Sand			20	20	100	90	
Silt			65	65	0	10	
Clay			15	15			
Custom							
Unassigned			0	0	0	0	
Soil or Media Depth	(mm)		150	300	200	600	
Porosity			0.46	0.46	0.512	0.469	
Field Capacity			0.271	0.271	0.132	0.092	
Wilting Point			0.126	0.126	0.057	0.038	
Saturated Hydraulic Conductivity	(m/s)		5.00E-06	5.00E-06	2.50E-05	3.50E-05	
Sub-soil Hydraulic Conductivity	(m/s)		1.00E-08	1.00E-08		5.00E-08	
Ponding Depth	(mm)		0	0	0	300	
Inv. Slope of Log. Tension Moisture Curve			4.98	4.98	4.55	4.32	
Subdrain Invert (above bottom of media)	(mm)					0	
Subdrain Capacity	(m^3/s)					0	

% of Runoff Allocated To:	Runoff Allocated from Cover Type/ Facility:						
	Impervious Surface	Pervious Surface	Absorbent Landscaping	Green Roof Media	Bioretention/ Bioswale Media	Storage/ Reuse Tank	Discharge
Pervious Surface	0			0			
Absorbent Landscaping	80	80		0			
Green Roof Media	0						
Storage/ Reuse Tank	0	0	0	0			
Bioretention/Bioswale Media	0	0	0	0			
Discharge	20	20	100	100	100	100	
Pond 1/Pond 2							POND #1

WBSCC - PROJECT DATA SHEET - Sub-Catchment 1: Crops, Irrigation, Storage/Reuse Tank

Storage/ Reuse Tank Parameters		Values
Tank Water Surface Area (assumed bath tub)	(m^2)	0
Spill Crest Elevation, above Tank Floor	(m)	0
Starting Water Level	(m)	0
Minimum Tank Water Elevation for Recharge	(m)	0
Maximum Tank Water Elevation for Recharge	(m)	1
Use Recharge from Storm Ponds		No
Recharge Source		POND #1
Additional Non-Potable Demand	(l/s)	0
Municipal Supply Available		No

Ground Cover Crop-Mix Profiles (Mix as %)

Crops	Profile #1	Profile #2	Profile #3
KENTUCKY BLUE GRASS	90	100	50
SAGE BRUSH	10	0	50
Barley	0	0	0
Alfalfa Hay	0	0	0
Unassigned	0	0	0

Irrigation Crop Profile or Scheduling Assignment:

Pervious Surface Cover Type			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	1
Absorbent Landscaping Cover Type			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	1
Green Roof Media			
Use Irrigation Schedule	No	Schedule Number	1
Use Crop Demand Profile	No	Profile Number	1

WBSCC - PROJECT DATA SHEET - Pond 1: Parameters, Elevation-Area-Discharge-Volume Relationship

Pond 1 Parametrs		Values
Base Elevation	(m)	100.00
Starting Water Elevation	(m)	102.00
Starting Discharge Elevation (UNWL)	(m)	102.00
High Water Level (HWL)	(m)	105.00
Lower Normal Water Level (LNWL)	(m)	102.00
Seepage Rate	(mm/hr)	0.00
Discharge and Overflow Routed to:		OUTFALL

Pond 1 Pertinent Volumes (m^3)	Values
Volume at Base Elevation	0
Volume at Stating Water Elevation	56033
Volume at LNWL	56033
Volume at UNWL	56033
Volume at HWL	170537

Pond 1 Bed Soil Parameters		
Soil Type: Sand		0
Silt		0
Clay		100
Custom		
Unassigned		0
Soil or Media Depth	(mm)	50
Porosity		0.46
Field Capacity		0.28
Wilting Point		0.14
Saturated Hydraulic Conductivity	(m/s)	1.00E-06
Sub-soil Hydraulic Conductivity	(m/s)	0.00E+00
Ponding Depth	(mm)	0
Inv. Slope of Log. Tension Moisture Curve		5.51

Elevation (m)	Area (m^2)	Discharge (m^3/s)
100.00	24300	0
101.90	31501	0
102.00	31900	0.108
105.00	44800	0.108
105.00	44800	0.108
105.00	44800	0.108
105.00	44800	0.108
105.00	44800	0.108
105.00	44800	0.108
105.00	44800	0.108
105.00	44800	0.108
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105.00	44800	0.108
105.00	44800	0.108
105.00	44800	0.108
105.00	44800	0.108
105.00	44800	0.108

POND 1 **POND #1** **CATCHMENT AREA SIZE**

DISCHARGES TO OUTFALL 130.9 ha - DIRECT

130.9 ha - TOTAL

	MAX	MIN	AVG	MEDIAN
VOLUME (m3)	162750.9	45593.4	55942.5	55591.7
LEVEL (m)	104.8	101.6	102.0	102.0

	MAX	TOTAL	AVG	MEDIAN
INFLOW (m3)	436514.2	10010303.3	196280.5	190125.2
DIRECT PRECIPITATION (m3)	19375.8	676846.3	13271.5	13122.1
EVAPORATION LOSS (m3)	26489.0	1230807.8	24133.5	24111.1
SEEPAGE LOSS (m3)	0.0	0.0	0.0	0.0
DISCHARGE (m3)	434968.8	9456348.5	185418.6	178487.3
OVERFLOW (m3)	0.0	0.0	0.0	0.0
MAKE-UP WATER (m3)	0.0	0.0	0.0	0.0
DEMAND (m3)	0.0	0.0	0.0	0.0
WATER BALANCE (m3)		0.0		

UNIT AREA RESULTS BASED ON TOTAL CATCHMENT SIZE

	MAX	TOTAL	AVG	MEDIAN
(mm)	333.5	7647.9	150.0	145.3
(mm)	14.8	517.1	10.1	10.0
(mm)	20.2	940.3	18.4	18.4
(mm)	0.0	0.0	0.0	0.0
(mm)	332.3	7224.7	141.7	136.4
(mm)	0.0	0.0	0.0	0.0
(mm)	0.0	0.0	0.0	0.0
(mm)	0.0	0.0	0.0	0.0

ANNUAL SUMMARIES

YEAR	POND #1 VOLUME MAX (m3)	VOLUME MIN (m3)	LEVEL MAX (m)	LEVEL MIN (m)	Inflow (m3)	Direct Precipitation (m3)	Evaporation (m3)	Seepage (m3)	Discharge (m3)	Overflow (m3)	Make-Up Water (m3)	Demand (m3)	
1960	85646.1	53405.6	102.8	101.9	134202.6	11892.2	24075.9	0.0	122133.2	0.0	0.0	0.0	0.0
1961	109232.5	49344.0	103.4	101.8	216536.3	12753.6	24440.6	0.0	204726.3	0.0	0.0	0.0	0.0
1962	60158.7	53266.2	102.1	101.9	70279.9	9086.4	22559.1	0.0	58548.3	0.0	0.0	0.0	0.0
1963	88554.6	51824.3	102.9	101.9	211043.6	13729.6	24725.9	0.0	198344.4	0.0	0.0	0.0	0.0
1964	109188.0	50254.5	103.4	101.8	199048.0	12808.5	23042.9	0.0	188784.3	0.0	0.0	0.0	0.0
1965	104082.2	53216.4	103.3	101.9	436514.2	19375.8	20921.2	0.0	434968.8	0.0	0.0	0.0	0.0
1966	107294.1	51664.5	103.3	101.9	222824.4	13122.1	22826.6	0.0	213119.9	0.0	0.0	0.0	0.0
1967	75029.6	45593.4	102.5	101.6	118819.6	8126.6	23535.9	0.0	110174.5	0.0	0.0	0.0	0.0
1968	82864.2	49286.5	102.7	101.8	148797.2	11516.0	21789.9	0.0	131759.3	0.0	0.0	0.0	0.0
1969	89327.0	52287.4	102.9	101.9	242067.0	13870.0	23942.0	0.0	232286.4	0.0	0.0	0.0	0.0
1970	136943.5	51247.4	104.1	101.8	185119.2	13251.3	25977.5	0.0	172792.5	0.0	0.0	0.0	0.0
1971	86230.9	52030.4	102.8	101.9	166424.4	12613.2	26489.0	0.0	151857.6	0.0	0.0	0.0	0.0
1972	88731.2	53115.9	102.9	101.9	278658.3	15589.7	23406.7	0.0	270835.3	0.0	0.0	0.0	0.0
1973	69596.6	53247.2	102.4	101.9	153556.3	11543.5	25705.3	0.0	139401.7	0.0	0.0	0.0	0.0
1974	81433.2	51226.7	102.7	101.8	162794.2	11144.5	24356.4	0.0	149817.5	0.0	0.0	0.0	0.0
1975	69676.7	53258.5	102.4	101.9	98837.4	11761.2	23928.4	0.0	86459.9	0.0	0.0	0.0	0.0
1976	84411.3	53175.6	102.7	101.9	157577.9	13011.8	25900.9	0.0	144681.5	0.0	0.0	0.0	0.0
1977	70586.7	51915.4	102.4	101.9	190125.2	13441.2	25244.5	0.0	178307.3	0.0	0.0	0.0	0.0
1978	112920.9	53803.4	103.5	101.9	318830.1	17385.5	22874.3	0.0	313350.6	0.0	0.0	0.0	0.0
1979	60986.2	52500.7	102.1	101.9	71172.1	9073.9	24182.5	0.0	56390.6	0.0	0.0	0.0	0.0
1980	91570.0	51035.0	102.9	101.8	217152.0	14413.2	24831.4	0.0	206406.5	0.0	0.0	0.0	0.0
1981	106151.2	52879.6	103.3	101.9	276365.9	16463.2	24852.9	0.0	268132.4	0.0	0.0	0.0	0.0
1982	82604.2	52296.3	102.7	101.9	197886.7	13504.7	23861.6	0.0	187437.8	0.0	0.0	0.0	0.0
1983	66403.6	51946.6	102.3	101.9	85888.6	9411.7	23976.6	0.0	71798.6	0.0	0.0	0.0	0.0
1984	78784.9	50740.7	102.6	101.8	164430.9	11793.0	23884.3	0.0	151794.6	0.0	0.0	0.0	0.0
1985	162750.9	51504.4	104.8	101.9	188337.3	12996.1	24546.2	0.0	176824.4	0.0	0.0	0.0	0.0
1986	135558.3	52274.6	104.1	101.9	284279.7	15376.2	23964.3	0.0	275777.1	0.0	0.0	0.0	0.0
1987	73573.9	50173.3	102.5	101.8	173450.5	11263.8	25861.0	0.0	160606.2	0.0	0.0	0.0	0.0
1988	115240.0	49659.5	103.6	101.8	214201.7	13249.2	25838.9	0.0	199929.8	0.0	0.0	0.0	0.0
1989	56028.8	54025.3	102.0	101.9	91237.3	12339.3	23849.6	0.0	79547.7	0.0	0.0	0.0	0.0
1990	66002.3	53477.9	102.3	101.9	140062.9	12726.8	23551.2	0.0	129229.2	0.0	0.0	0.0	0.0
1991	82661.2	52030.5	102.7	101.9	205759.0	13119.5	24568.2	0.0	195455.2	0.0	0.0	0.0	0.0
1992	136083.7	53897.2	104.1	101.9	254901.4	16221.9	22763.9	0.0	247204.3	0.0	0.0	0.0	0.0
1993	89495.5	53518.4	102.9	101.9	259855.1	14557.7	22245.1	0.0	252818.5	0.0	0.0	0.0	0.0
1994	74658.7	52390.7	102.5	101.9	108319.3	11354.9	24750.7	0.0	94283.8	0.0	0.0	0.0	0.0
1995	78642.5	54223.8	102.6	101.9	188119.5	13289.6	22903.2	0.0	178487.3	0.0	0.0	0.0	0.0
1996	69264.8	51306.0	102.3	101.8	158444.2	12005.0	22595.6	0.0	147865.8	0.0	0.0	0.0	0.0
1997	114291.3	52734.4	103.5	101.9	280121.5	13915.3	24605.5	0.0	270094.7	0.0	0.0	0.0	0.0
1998	123967.5	51504.2	103.8	101.9	347775.0	17612.8	25098.9	0.0	339622.7	0.0	0.0	0.0	0.0
1999	107821.7	53520.9	103.4	101.9	269693.9	15030.1	23009.4	0.0	262995.4	0.0	0.0	0.0	0.0
2000	69390.4	52693.9	102.3	101.9	165844.0	13215.1	25327.2	0.0	153149.4	0.0	0.0	0.0	0.0
2001	92662.0	50266.4	103.0	101.8	112294.2	10224.7	26146.2	0.0	97156.9	0.0	0.0	0.0	0.0
2002	61237.2	52065.6	102.1	101.9	90712.6	10969.6	24029.6	0.0	76237.6	0.0	0.0	0.0	0.0
2003	83484.7	52802.0	102.7	101.9	214196.2	13851.8	24111.1	0.0	203981.4	0.0	0.0	0.0	0.0
2004	85120.6	54145.1	102.8	101.9	108418.3	12398.0	24112.9	0.0	96591.6	0.0	0.0	0.0	0.0
2005	158098.0	53005.7	104.7	101.9	380041.8	18532.1	24682.9	0.0	374083.5	0.0	0.0	0.0	0.0
2006	89354.8	52484.9	102.9	101.9	203460.1	13620.3	24150.9	0.0	192754.8	0.0	0.0	0.0	0.0
2007	148939.0	53351.8	104.4	101.9	288028.6	16991.6	24419.3	0.0	280698.8	0.0	0.0	0.0	0.0
2008	96190.2	53484.9	103.1	101.9	210276.2	16293.4	24213.2	0.0	202240.3	0.0	0.0	0.0	0.0
2009	82590.4	52177.4	102.7	101.9	135935.7	10444.8	24026.3	0.0	122354.0	0.0	0.0	0.0	0.0
2010	78152.3	53849.6	102.6	101.9	211585.3	14564.6	24104.8	0.0	202048.1	0.0	0.0	0.0	0.0

OUTFALL

130.9 ha - TOTAL

Pond #1 4.5 ha

Pond #2 0.0 ha

135.4 ha - Including Ponds

	MAX	TOTAL	AVG	MEDIAN		UNIT AREA RESULTS BASED ON TOTAL CATCHMENT SIZE MAX	TOTAL	AVG	MEDIAN		UNIT AREA RESULTS BASED ON TOTAL CATCHMENT + POND SIZE MAX	TOTAL	AVG	MEDIAN
PRECIPITATION (m3)					(mm)		20897.0	409.7	404.7	(mm)		20897.0	409.7	404.7
DISCHARGE (m3)	434968.8	9456348.5	185418.6	178487.3	(mm)	332.3	7224.7	141.7	136.4	(mm)	321.3	6985.6	137.0	131.9
RATIO (%)							34.6	34.6	33.7			33.4	33.4	32.6

APPENDIX 'C' - Preliminary Stormwater Management Facilities

IDEA GROUP INC

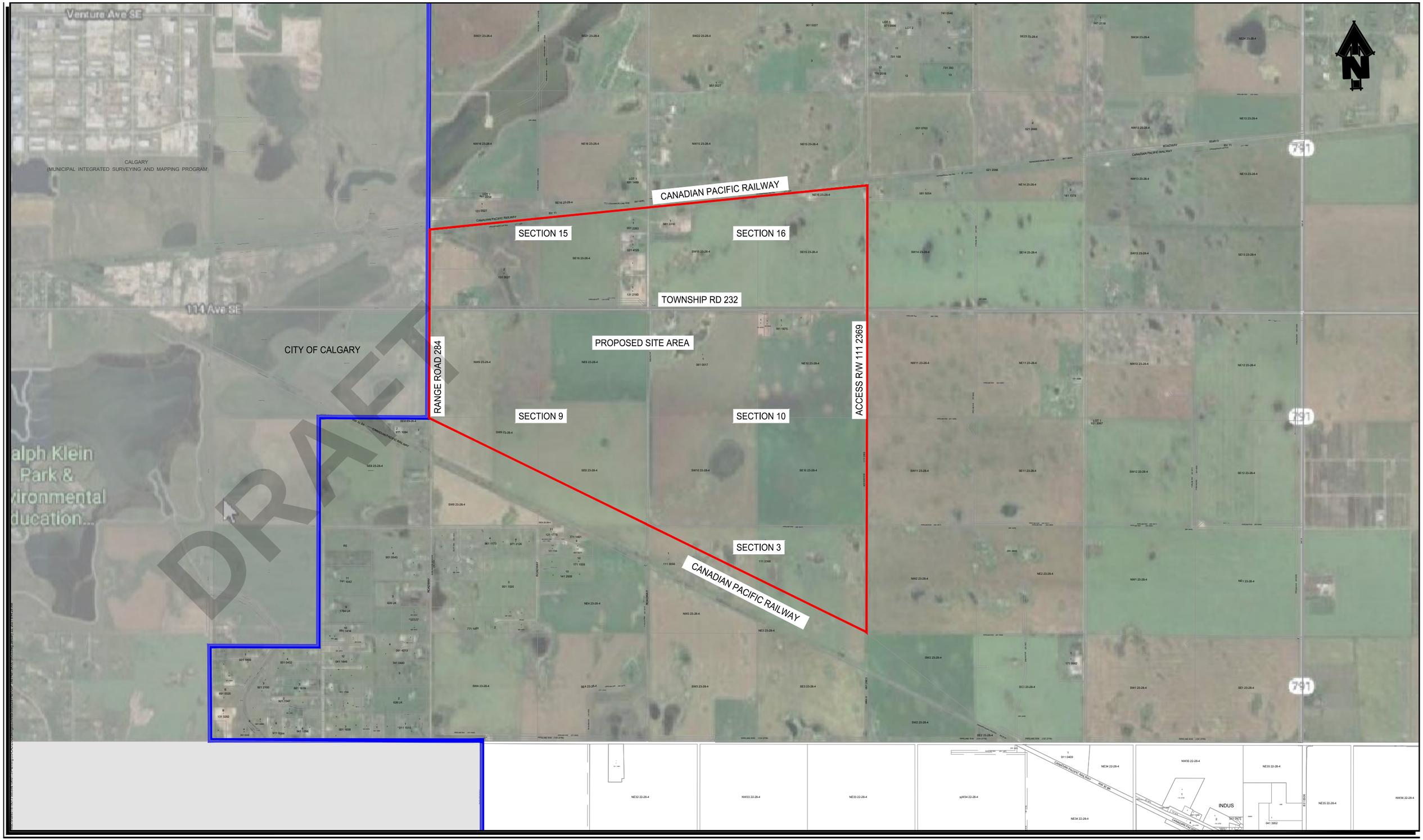
Preliminary Budget Amounts

Item	Description	Unit	Budget Unit Price	Shepard Wetland Catchment Area Budget Quantity	Shepard Wetland Catchment Area Budget Amount	Bow River Catchment Area Budget Quantity	Shepard Wetland Catchment Area Budget Amount	Total
	Storm Sewer							
01	750mm CLASS IV (4.0-4.5m) On Public Rd	M	$ 777.00	1,300	$ 1,011,000.00		$ 0.00	
02	900mm CLASS IV (4.0-4.5m)	M	$ 811.00	0	$ 0.00	3,100	$ 2,515,000.00	
03	900mm CLASS IV (4.0-4.5m On Public Rd	M	$ 931.00		$ 0.00	9,400	$ 8,752,000.00	
05	Type 5A Manholes (c/w frame and cover)(4.0-4.5m)	EA	$ 6,155.00	8	$ 50,000.00	60	$ 370,000.00	
06	Video and Deflection Test	M	$ 15.00	1,300	$ 20,000.00	12,500	$ 188,000.00	
			Sub Total:		**$ 1,081,000.00**		**$ 11,825,000.00**	**$ 12,906,000.00**
07	Contingency 25%				**$ 271,000.00**		**$ 2,957,000.00**	**$ 3,227,000.00**
			Total:		**$ 1,352,000.00**		**$ 14,782,000.00**	**$ 16,133,000.00**

APPENDIX 'D' - Cost Analysis

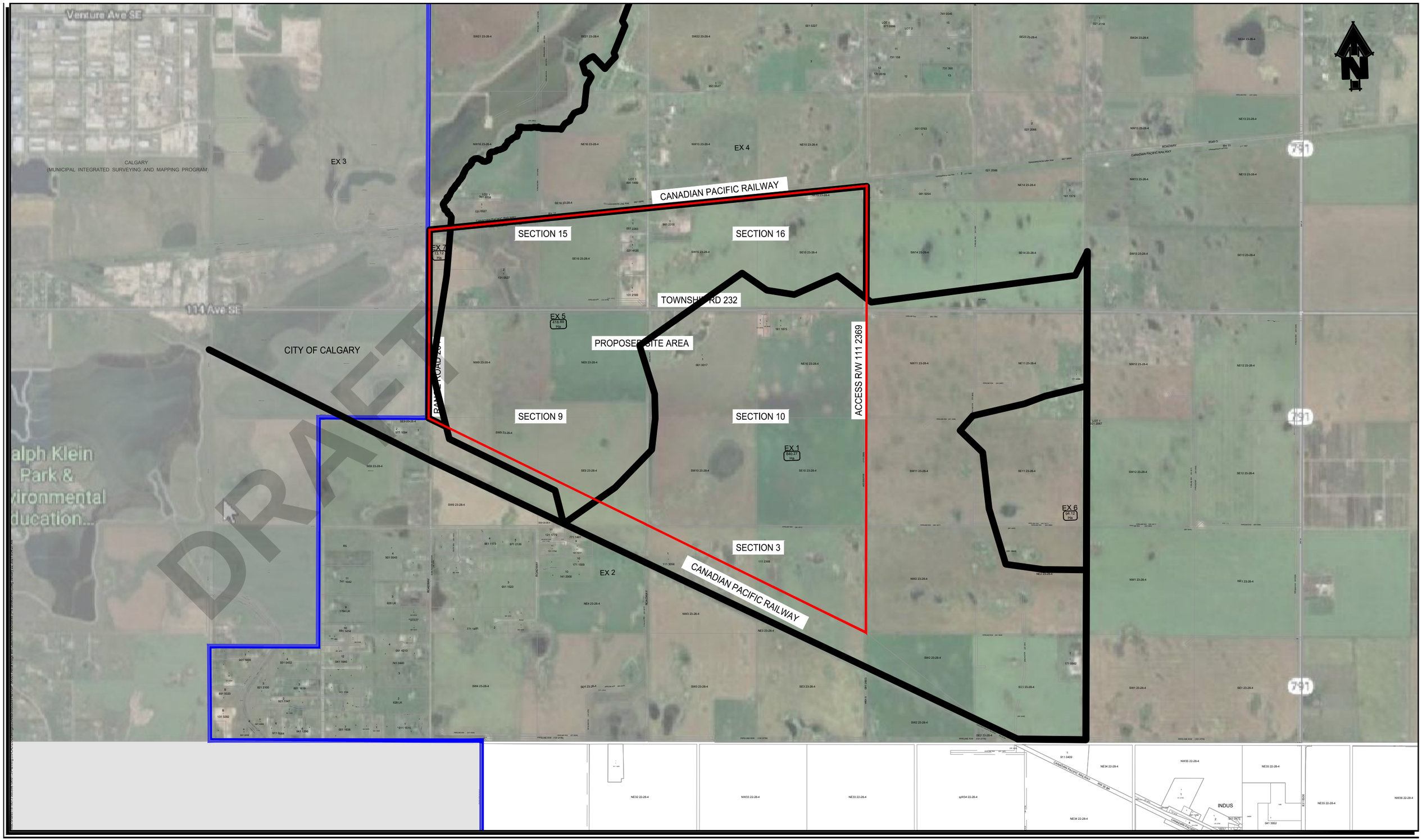
DESIGN DRAWINGS

Drawing SK-00 - Site Location Plan



Owner SHEPARD	Consultant IDEA INNOVATION ENGINEERING DESIGN BUILD ARCHITECTURE GROUP	Legend CITY OF CALGARY LIMITS PROPOSED SITE AREA	Project SHEPARD INDUSTRIAL ASP	Drawing Title PROPOSED SITE	Project Lead JB Project # 18073	Scale 1:25,000 Date (YY-MM-DD) 20-10-29	Issued For/Revisions No. Description — Date YY.MM.DD 1 ISSUED FOR INFORMATION — 20.10.29	Drawing SK-00

Drawing SK-001 - Aerial Image with Catchment Boundaries (Pre-development)



Owner

SHEPARD

Consultant

IDEA GROUP — INNOVATION ENGINEERING DESIGN BUILD ARCHITECTURE

Legend

- CITY OF CALGARY LIMITS
- PROPOSED SITE AREA
- PROPOSED DRAINAGE BOUNDARY

Project

SHEPARD INDUSTRIAL ASP

Drawing Title

PRE DEVELOPMENT CATCHMENT AREAS (AERIAL IMAGE)

Project Lead

JB

Project #

18073

Scale

1:25,000

Date (YY-MM-DD)

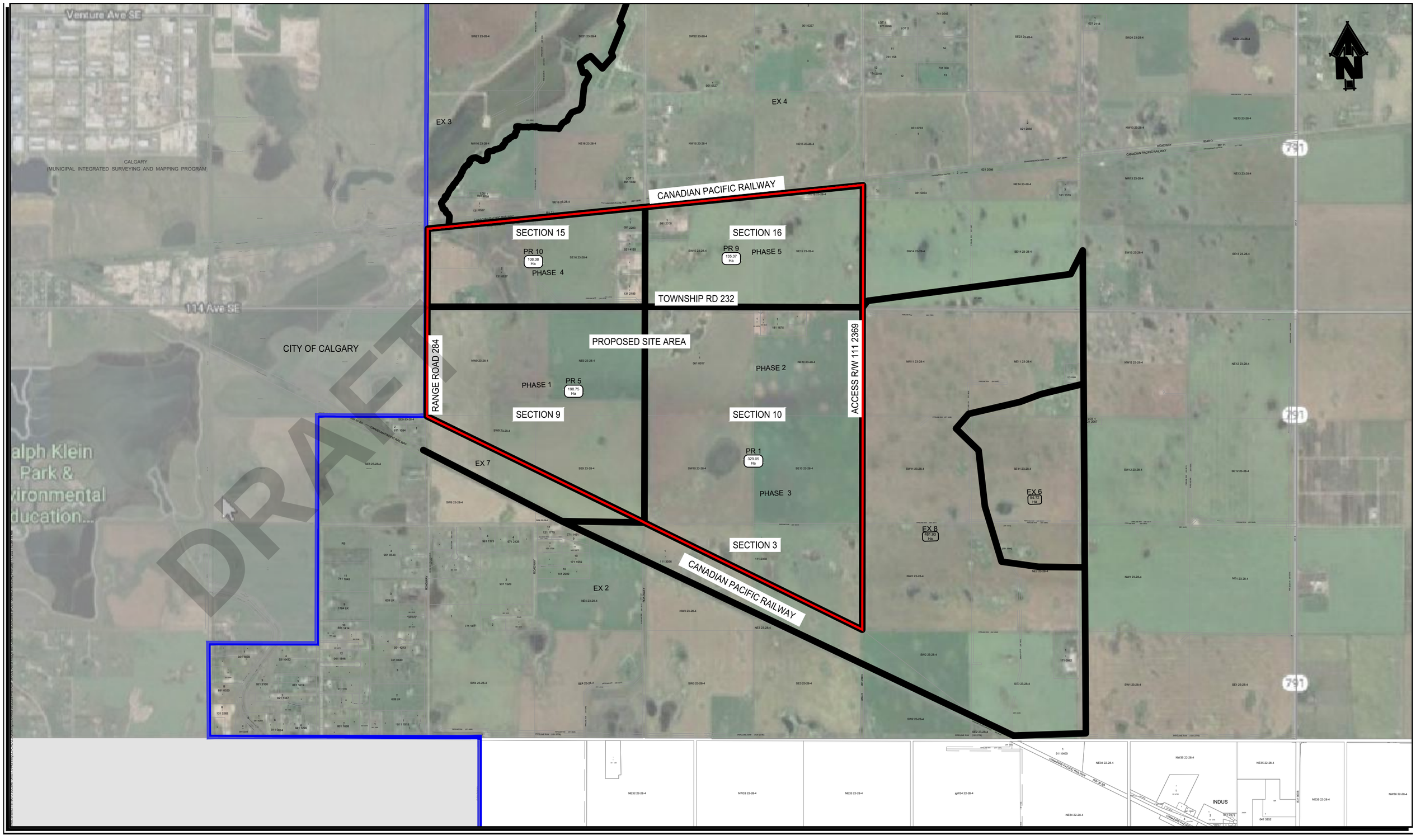
20-10-29

No.	Issued For/Revisions	Date YY.MM.DD
2	ISSUED FOR COUNTY REVIEW	21.01.21
1	ISSUED FOR INFORMATION	20.10.29

Drawing

SK-001

Drawing SK-002 - Aerial Image with Catchment Boundaries (Post-development)



Owner

SHEPARD

Consultant

IDEA GROUP — Innovation Engineering Design Build Architecture

Legend

- CITY OF CALGARY LIMITS
- PROPOSED SITE AREA
- PROPOSED DRAINAGE BOUNDARY

Project

SHEPARD INDUSTRIAL ASP

Drawing Title

POST DEVELOPMENT CATCHMENT AREAS (AERIAL IMAGE)

Project Lead

JB

Project #

18073

Scale

1:25,000

Date (YY-MM-DD)

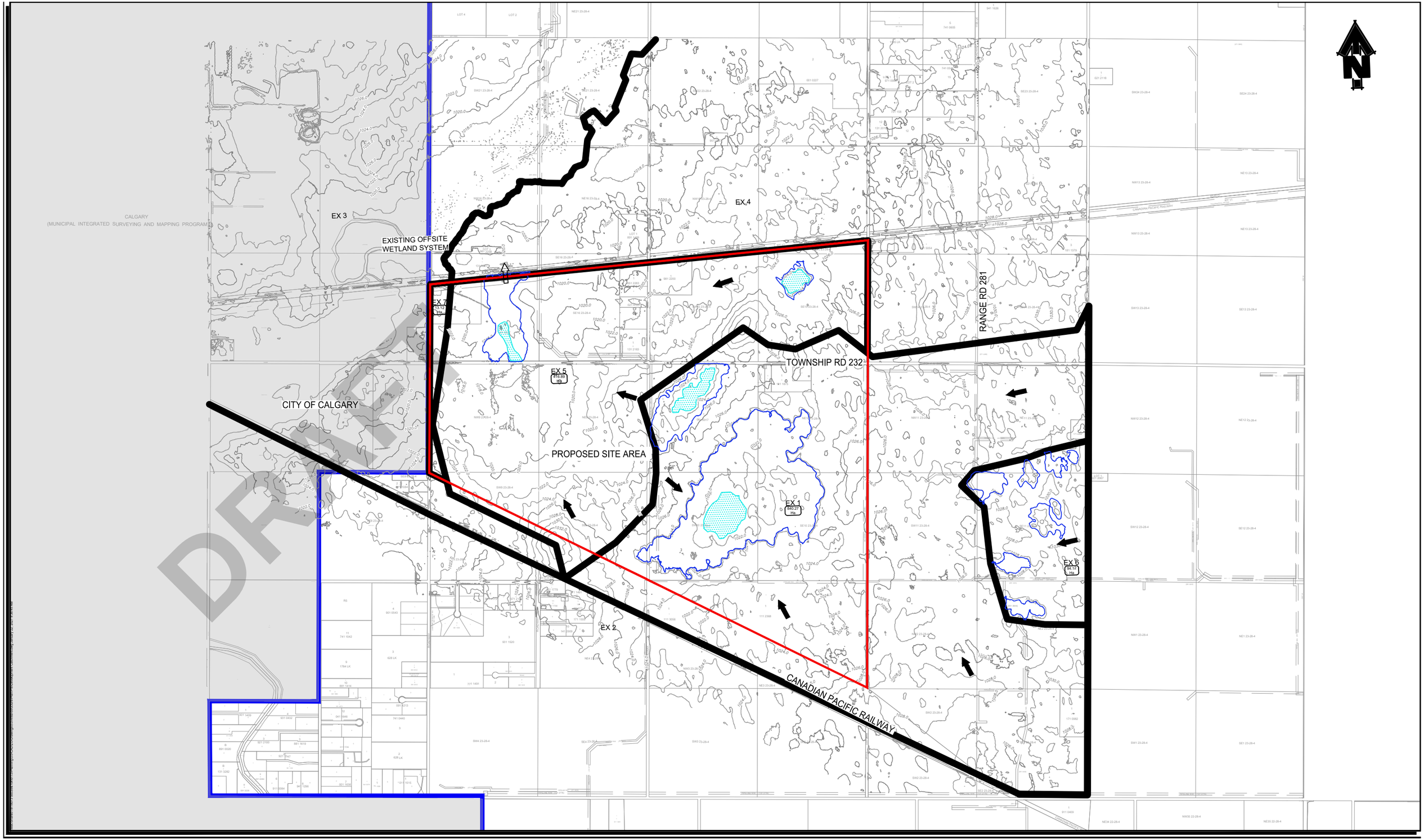
21-02-17

No.	Issued For/Revisions	Date YY.MM.DD
2	ISSUED FOR COUNTY REVIEW	21.02.17
1	ISSUED FOR INFORMATION	20.10.29

Drawing

SK-002

Drawing SK-01 - Pre-development Drainage Areas



Owner

SHEPARD

Consultant

IDEA GROUP — INNOVATION ENGINEERING DESIGN BUILD ARCHITECTURE

Legend

- CITY OF CALGARY LIMITS
- PROPOSED SITE AREA
- EXISTING DRAINAGE BOUNDARY
- OVERLAND DRAINAGE
- EXISTING WATERBODY
- NATURAL DEPRESSION AREA

Project
SHEPARD INDUSTRIAL ASP

Drawing Title
PRE - DEVELOPMENT

Project Lead
JB

Project #
18073

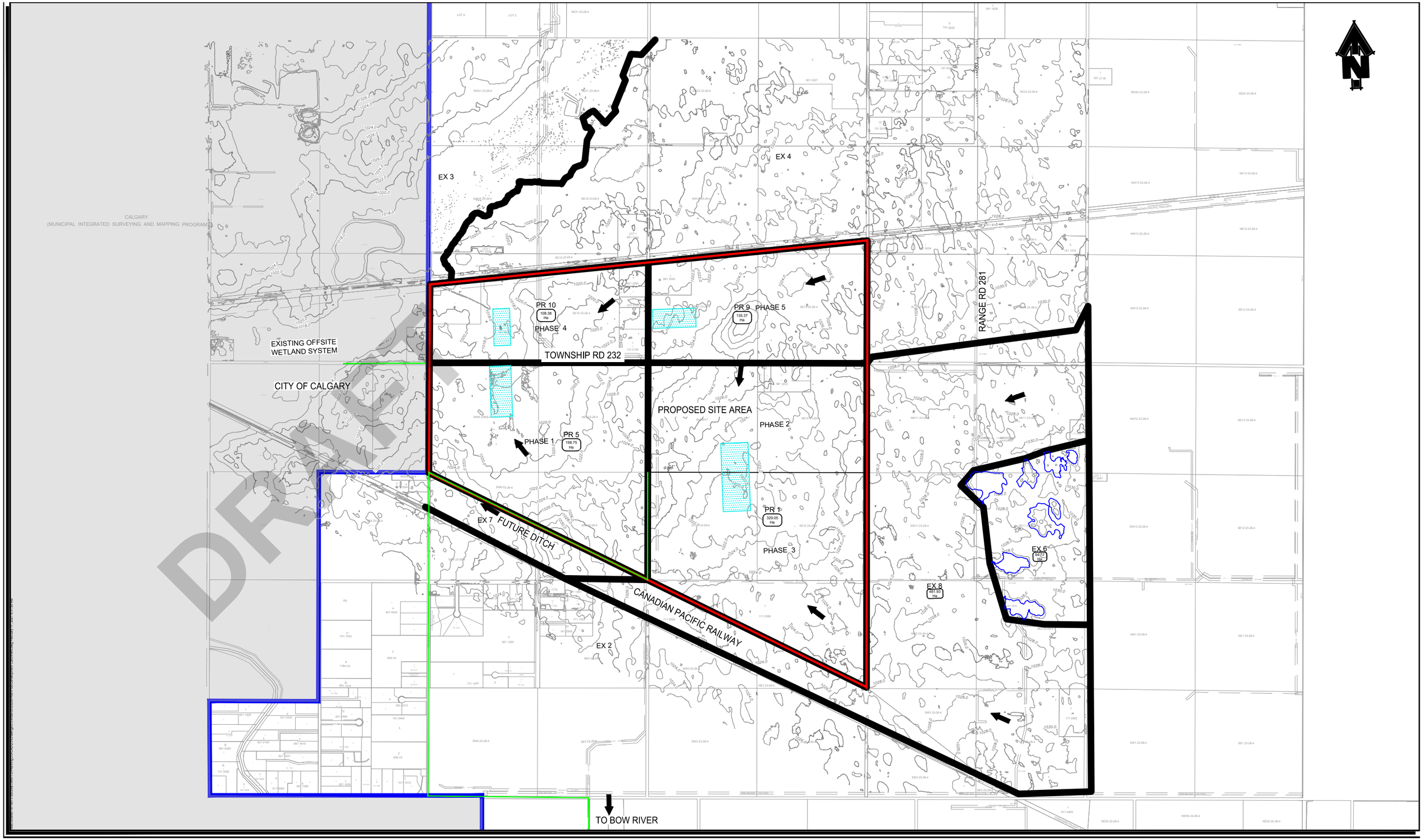
Scale
1:25,000

Date (YY-MM-DD)
20-10-30

	Issued For/Revisions	
No.	Description	Date YY.MM.DD
2	ISSUED FOR COUNTY REVIEW	21.01.22
1	ISSUED FOR INFORMATION	20.10.30

Drawing
SK-01

Drawing SK-02 - Post Development Drainage Areas



Owner

SHEPARD

Consultant

IDEA GROUP
INNOVATION ENGINEERING
DESIGN BUILD ARCHITECTURE

Legend

- CITY OF CALGARY LIMITS
- PROPOSED SITE AREA
- PROPOSED DRAINAGE BOUNDARY
- OVERLAND DRAINAGE
- PROPOSED STORM TRUNK
- PROPOSED POND
- NATURAL DEPRESSION AREA

Project
SHEPARD INDUSTRIAL ASP

Drawing Title
POST-DEVELOPMENT

Project Lead
JB

Project #
18073

Scale
1:25,000

Date (YY-MM-DD)
21-02-17

	Issued For/Revisions	
No.	Description	Date YY.MM.DD
2	ISSUED FOR COUNTY REVIEW	21.02.17
1	ISSUED FOR INFORMATION	20.09.25

Drawing

SK-02