Lincoln Ranch Revised Stormwater Management Report

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Sign-off Sheet

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1.0 Introduction

This stormwater management report (SWMR) was prepared on behalf of 1510060 AB Ltd. o/a Lincoln Developments, in accordance with the requirements of the County of Lacombe Design Guidelines. It will serve as a supplement to the engineering design drawings prepared by Stantec Consulting Ltd. for the Lincoln Ranch subdivision. Lincoln Ranch is in Lacombe County 20 km northwest of the City of Lacombe and 11 km north of the Village of Gull Lake. as shown on **Figure 1.1**.

The objective of this study is to demonstrate that the proposed stormwater management facilities will meet Alberta Environment and Parks (AEP) criteria for permissible release rate and water quality improvement. It will also outline the proposed configuration for the drainage systems within the residential development.

Figure 1.2 shows the lands within the Lincoln Ranch study area. The existing land surrounding the development site was reviewed to gain understanding of where existing and future drainage was/is going.

2.0 Site Description

2.1 DRAINAGE AREA

The Lincoln Ranch development will be a residential community of 64.44 ha. There is also 10.58 ha of offsite lands that drain through this proposed development, which is included in the drainage model. The development is located within the following legal land parcel:

NW¼ 14-41-28-W4M

Figure 2.1 illustrates the locations of the primary land uses that are relevant to this SWMR as presented in the Area Structure Plan (ASP).

The nature of this development necessitates that the study area be divided into drainage subcatchment areas for the purpose of the hydrologic analysis which is described later in section 4.0. The drainage subcatchments are established on the basis of areas that drain to the stormwater management facilities (SWMF's). The drainage subcatchment areas are shown on **Figure 2.2** and described in **Table 2.1.**

Table 2.1 Drainage Subcatchment Areas

Subcatchment	Description	Area (ha)
16	Offsite – Pasture land (undeveloped)	2.65
10	Row houses, Road, Golf course (Proposed)	5.83
	Total to Lincoln Ranch Pond 1	**8.48**
11	Small acreage lots, Road, Golf course (Proposed)	22.94
	Total to Lincoln Ranch Pond 2	**22.94**
19	½ of Rge. Rd. 282 and ditch (Existing)	0.88
15	Farm residence (Existing)	1.97
12	Small acreage lots, Row houses, Road, Golf course (Proposed)	15.78
	Total to Lincoln Ranch Pond 3	**18.63**
18	Offsite – Pasture land (undeveloped)	0.78
13	Small acreage lots, Road, Golf course (Proposed)	15.39
	Total to Lincoln Ranch Pond 4	**16.17**
17	Offsite – Pasture land (undeveloped)	4.3
14	Golf course (Proposed)	4.5
	Total to Lincoln Ranch Pond 5	**8.8**
	Total Lincoln Ranch Development	**75.02**

All drainage from Lincoln Ranch goes to Gull Lake. About 30% of the site currently drains to the east into Wilson Creek which drains to the south and then west into Gull Lake. The remaining portion drains to the southwest corner of the site into the ditch of Rge Rd. 282 and through two 600mm culverts under Rge Rd. 282 and into Gull Lake. The post-development cuts off the drainage to Wilson Creek and will be directed to the west and will be discharge to Gull Lake through an adequate outlet via existing culverts and a ditch.

2.2 TOPOGRAPHY

The site topography consists of gentle sloping terrain with a highpoint that runs relatively from northwest down to the center of the ¼ section in the south. The general direction of the west half of the quarter slopes from the north to the south with the low points being near the southwest corner. The east portion of the site also drains from the north to the south and drains offsite into Wilson creek which is a small tributary that drains to Gull Lake.

2.3 PRE-DEVEOPMENT

Predevelopment was analyzed in order to determine if there would be a net loss of stormwater runoff to Gull Lake on an annual basis. **Figure 2.3** shows the existing contours and where the surface water is draining to. When analyzing the pre-development runoff volume that drains to Gull Lake the updated 50-percent Agri-Foods Canada basin yield for this region was considered. Based on this study it shows that 28 dam^3/km^2 (28 mm) of runoff is expected in this region based on pre-development conditions. Applying this to the site of 75.02 ha, this results in an annual runoff volume of 21,006 m^3. later in section 5.6 it will be shown how the pre-development model relates to this number.

3.0 Stormwater Management Concepts

3.1 DRAINAGE CONCEPTS

Lincoln Ranch will be a Golf Course community, which incorporates standard stormwater management features that have been utilized throughout the County of Lacombe as well as irrigation that utilizes treated wastewater and stormwater runoff. In accordance with the Red Deer Regional Stormwater Runoff Chart (preliminary), the Lincoln Ranch study site is in between the 2 L/s/ha and 3 L/s/ha. See **Appendix C** for more info.

Drainage from Lincoln Ranch is to be in accordance with the provincial's objectives. The following targets are applicable for the Lincoln Ranch lands:

- Discharges to the road ditch are to be limited to a Unit Area Release Rate (UARR) of 2.5 L/s/ha for the 100-year service level.
- Storm ponds within the development area are to meet current regulatory requirements; removing 85% of Total Suspended Solids for particles greater than or equal to 75 microns in diameter.
- Storm ponds will contain a permanent pool with a volume equal to or greater than the runoff generated from a 25 mm rainfall event.
- No net loss of surface water entering Gull Lake as a result of the proposed development as per the Gull Lake Interim Water Rights Administrative Guideline dated March 1, 1994.

The runoff to the drainage channel will occur by storm sewer and overland ditch drainage, with discharges regulated so that the peak flow does not exceed the above mentioned UARR. The Stormwater management facilities (SWMF's) shown on **Figure 2.2** as Lincoln Ranch Ponds 1-5 will be incorporated into the development to contain the excess flows. The Lincoln Ranch Pond 5 is the treated wastewater pond. This pond will capture treated effluent from the Lincoln Ranch homes as well as the Degraff's RV resort. Information on this will be explained later in section 4.6.4.

The stormwater runoff will be conveyed from the ponds via pipe or overland, this will be finalized at detail design. Each of the storm ponds can spill/drain down to pond 3 which is the lowest pond on the site at which point this pond 3 will discharge to Gull Lake.

The treated wastewater pond will be lined and have no direct discharge to the storm system. This pond will be monitored and strictly used as irrigation. If the pond reaches high levels and irrigation cannot use the water, emergency pumping to an offsite location will take place in order to lower the pond without the pond discharging into the storm system and ultimately to Gull Lake.

3.2 STORMWATER REUSE AND TREATED WASTEWATER BY IRRIGATION

The treated wastewater in Pond 5 along with stormwater collected in Pond 3 will be used to irrigate the golf course. **Figure 3.2**, Irrigated Areas shows the lands that are proposed for this irrigation, which comprise the following:

Subcatchment 10	2.75 ha
Subcatchment 11	10.18 ha
Subcatchment 12	7.25 ha
Subcatchment 13	5.87 ha
Total	**26.05 ha**

As per Dave Moroz, who instructs a golf course design/irrigation program at Olds College in Alberta, a typical golf course needs about 450 mm of mean annual irrigation/precipitation. This is usually applied from May 1 – to middle of September. This results in about 25 mm of water applied weekly to the golf course. Due to constraints in the model, irrigation was applied till the end of September for simplicity.

The combination of pond size and irrigation demand are integral to each other in balancing the amount of irrigation withdrawal and storage capacity. Factors for consideration are as follows:

- Water for irrigation is pumped from the permanent storage capacity of the SWMF below the normal water level (NWL). The amount of water available is thus determined by the pond area and allowable drawdown below the NWL. The upper normal water level (UNWL) represents the level that is controlled by the outlet to while the lower normal water level (LNWL) is the lowest level allowed for irrigation withdrawals.

- The allowable drawdown of water for irrigation will influence the visual appearance of the pond and extent of slope treatment. A drawdown depth of 1.0 m is proposed for the Lincoln Ranch SWMF.

- A certain depth of permanent water is desirable to ensure submergence of sediments that have collected in the pond bottom. For the Lincoln Ranch SWMF a minimum depth of 2.0 m below the LNWL is used.

- Irrigation demand is a function of irrigated area and application depth.

The stormwater will be used as a supplement to the treated wastewater and not as a replacement of the treated wastewater supply. Therefore stormwater will be pumped to Pond 5 (treated wastewater) on a needed basis when there is not enough treated wastewater available for irrigation.

3.3 WATER QUALITY IMPROVEMENT

Alberta Environment and Parks requires that at least 85 % of the sediment contained in the stormwater that is greater than or equal to 75 microns (≥ 75 μm) is to be removed prior to discharging to receiving watercourses.

The SWMF's will be the primary water quality treatment mechanisms for Lincoln Ranch. The overland drainage ditches within the site will also aid in treatment. Based on past experiences, the size of SWMFs being required for the Lincoln Ranch area (see Section 5.0) will remove more than 85% of the sediments that wash off the catchment areas.

In addition to the above quality control, it is equally important to practice temporary sediment and erosion controls during construction of the new developments. Erosion control measures will also be implemented during construction.

3.4 OVERLAND DRAINAGE SYSTEMS

The Lincoln Ranch development will consist of an overland drainage network. The proposed development shall be graded such that most the development can have the overland flows drain\spill to the proposed stormwater management facilities by roadway ditches, grass ditches and culverts.

Previsions will be made and detailed design will be done in order to route all of the off-site drainage (from the north) through the golf course without causing flooding issues for the lots and roads.

All runoff within the site location will flow overland via roadways, swales, ditches and culverts. It is important that developments have a properly designed overland drainage system because poorly designed developments will still experience overland drainage, but often with consequences. In Alberta, overland drainage systems are typically designed such that property will not experience flood damage for storms up to and including the 1:100-year return period, and this is the standard that the Lincoln ranch development will be designed to.

Overland drainage shall conform to the County of Lacombe Design Guidelines, and also the water velocity and depth relations as outlined in the AEP Stormwater Management Guidelines.

4.0 Post-Development Analysis Methodology

A post-development hydrologic-hydraulic analysis was performed to provide the following information based on the stormwater management concepts and principles discussed in Section 3.0:

- Sizing of the SWMF's;
- Stormwater retention using source control measures;
- Water balance computations for irrigation use and the inflows from the treated wastewater.
- Post Development volumes are greater than or equal to pre-development volumes to Gull Lake.

4.1 PRECIPITATION-RUNOFF ANALYSIS

4.1.1 Single Storm Event

The 1:100-year design storm is used as standard practice in the County of Lacombe for design of major drainage systems and to verify the sizing of stormwater management facilities. Single event simulation was therefore performed using the 100-year Chicago design storm to confirm the storage volume requirements for the SWMFs compared to that of the continuous simulation analysis (described in next section). Of the two methods, the higher storage volume requirement is used for design purposes.

The single event analysis utilizes a single storm event which may be either a historic storm or a theoretical design storm. For this Lincoln Ranch development, a 1:100-year design storm event of the Chicago distribution was used for this study.

A total storm duration of 24 hours with 5-minute rainfall increments was used for this study. The Rainfall intensities for the Chicago distribution are determined from an *intensity-duration-frequency* (IDF) relationship. The following parameters were used to derive the rainfall intensities for this design storm as provided by AES for the City of Lacombe:

1:100-year: a = 1396.0 b = 7.03 c = 0.797 r = 0.3 (24-hour duration)

Table 4.1 lists the rainfall intensities for the design storm.

Table 4.1 24-hour, Chicago Design Storm IDF Values

1:100-year Storm Event	
Time (min)	**Intensity (mm/hr)**
5	192.00
10	150.60
15	121.20
30	74.80
60	43.10
120	25.75
360	11.48
720	6.70
1440	4.21

4.1.2 Continuous Simulation

Continuous simulation was the approach used to quantify catchment runoff and confirm the size of the SWMFs for the development. Key objectives of the post-development analysis is to also provide water balance computations to compare runoff volumes to Gull Lake and existing conditions as identified in the updated 50-percent yield Agri-food Canada basin yield for this region. This requires the continuous simulation approach.

Historic precipitation was used for the period 1964 to 2007 inclusive. This data includes both rainfall and snowfall. The precipitation data for the period 1964 to 2007 were obtained from Environment Canada and reformatted for use with the computer model by Stantec for this SWMR report.

Frequency analysis was performed of the peak annual storage volumes to determine the 100-year storage volume requirements for the SWMFs. This was undertaken using a frequency analysis Excel spreadsheet.

4.2 COMPUTER MODEL

The PCSWMM computer model software Version 6.1.2015 Professional 2D was used for this analysis. This software, which is developed by Computational Hydraulics International (CHI), is a GIS based interface which provides a front end pre and post processor for the USEPA SWMM5 model as the computational "engine", with no internal modifications.

The EPA SWMM5 model is a dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas. The runoff

component of SWMM operates on a collection of subcatchment areas that receive precipitation and generate runoff and pollutant loads. The routing portion of SWMM transports this runoff through a system of pipes, channels, storage/treatment devices, pumps, and regulators. SWMM tracks the quantity and quality of runoff generated within each subcatchment, and the flow rate, flow depth, and quality of water in each pipe and channel during a simulation period comprised of multiple time steps. It contains a flexible set of hydraulic modeling capabilities used to route runoff and external inflows through the drainage system network of pipes, channels, storage/treatment units and diversion structures.

The post-development drainage system was discretized into various elements which describe the components of the physical drainage system. **Figure 2.2** illustrates the post-development model elements in terms of subcatchments and SWMFs while **Figure 4.1** is a schematic representation.

The various model elements are discussed further in the following sections.

4.3 RUNOFF COMPUTATION

Computation of runoff by SWMM5 is based on several physical parameters which includes catchment area, length/width, slope, imperviousness, Manning 'n', depression storage and infiltration. Summaries of the parameter values that were used are provided in **Appendix A**. The following sub-sections describe some of the key parameters used for catchment runoff.

4.3.1 Imperviousness

Catchment runoff is a direct function of the amount of land surface that is impervious surface coverage which depends on the land use characteristics. The imperviousness for the various catchments are based on the proposed land uses as represented by the Lincoln Ranch Area Structure Plan (ASP). The parameter values for imperviousness that were input into the PCSWMM models are listed in **Appendix A**. These values are based on the various land uses and assignment of imperviousness for each land use.

4.3.2 Length

Catchment length is not a sensitive parameter in-so-far as pond storage requirement is concerned because storm pond sizing is not sensitive to peak runoff due to the relatively small UARR from the SWMF (i.e. 2.5 L/s/ha). But catchment length will affect peak overland flows which can affect the routing of street trap-low storage and overland flows. Generally, a catchment length of 150-300 m was used for the larger residential subcatchments.

4.3.3 Slope

As with catchment length, catchment slope is not critical for detention storage whereas it is more relevant to overland flow rates. A slope of 2% was generally used for the residential areas.

4.3.4 Infiltration

The Horton method was used for calculating infiltration by the PCSWMM model. The Horton parameters were chosen based on the surrounding soil conditions. Since there are no guidelines locally for the Horton parameters, The City of Calgary parameters were modified to calibrate the pre-development runoff volumes when compared to the updated 50-percent yield Agri-food Canada basin yield for this region. The Horton infiltration equation defines the infiltration capacity of the soil by using an initial infiltration rate that decays to a lower rate with time. This is a more accurate representation then using the Curve Number (CN) method that is commonly used in the Red Deer Area.

4.3.5 Snow Melt

The PCSWMM model has the capability to simulate snowmelt using a Snow Pack routine along with temperature, evaporation, and wind data. Snowmelt was incorporated in the continuous simulation analysis using maximum and minimum temperature data that was obtained from Alberta Environment. The various parameters that were specified for Snow Pack and snowmelt are listed in **Appendix A**.

4.4 EVAPORATION LOSSES

The PCSWMM model computes evaporation losses from two sources; depression storage on the catchment surface and the water surface in storage locations. Monthly evaporation obtained from Evaporation and Evapotranspiration in Alberta (April 2013) for Lacombe Lake was converted to daily evaporation for use in the PCSWMM model. The evaporation data is summarized in **Appendix A**.

4.5 MAJOR-MINOR DRAINAGE

The PCSWMM model developed for Lincoln Ranch was not specifically developed as a major-minor system model because the emphasis is placed on the receiving SWMFs and storm outlet rather than the internal conveyance system.

4.6 STORAGE ROUTING

4.6.1 Storage Rating Relationship

Storage routing was performed to simulate the Lincoln Ranch SWMFs. The SWMFs storage are represented by a depth - area relationship which is based on the layouts and preliminary grading contours that were developed for this SWMR and which are presented in Section 5.0.

Evaporation can occur at the SWMFs using a factor of 1.0 times the evaporation rates that are input into the model (see Section 5.5).

The SWMFs are going to be lined with native clays to prevent infiltration into the sub soil. Infiltration was therefore turned off in the PCSWMM model for the SWMF.

The storage rating data for the SWMFs are provided in **Tables 4.2 – 4.6**. The data used in the PCSWMM model for the storage location is provided in **Appendix A**.

4.6.2 Discharge Relationship

The controlled discharge from the SWMFs were facilitated in the PCSWMM model as outlet rating curves which were computed using orifice control.

The detailed outlet rating data for the SWMFs controlled discharges are provided in **Appendix A**. **Tables 4.2 – 4.6** summarize the discharge rates for the SWMFs.

Table 4.2 Storage Rating Data for Lincoln Ranch Pond 1

Elevation (m)	Area (m^2)	Storage (m^3)		Discharge Rate (m^3/s)
		Permanent	Active	Pond 1
906.0 BOTTOM	225	0	0	0
908.0 NWL	1,412	1,385	0	0
908.5	1,882	2,209	824	0.111
909.0	2,392	3,277	1,892	0.173
909.5 HWL	2,943	4,611	3,226	0.218

Table 4.3 Storage Rating Data for Lincoln Ranch Pond 2

Elevation (m)	Area (m^2)	Storage (m^3)		Discharge Rate (m^3/s)
		Permanent	Active	Pond 2
905.0 BOTTOM	4,442	0	0	0
907.0 NWL	7,152	11,194	0	0
907.5	8,801	15,002	3,808	0.007
908.0	9,049	19,284	8,091	0.010
908.5	10,058	24,061	12,868	0.012
909.0 HWL	11,106	29,352	18,159	0.014

Table 4.4 Storage Rating Data for Lincoln Ranch Pond 3

Elevation (m)	Area (m^2)	Storage (m^3)		Discharge Rate (m^3/s)
		Permanent	Active	Pond 3
902.0 BOTTOM	2,990	0	0	0
904.0 LNWL	5,281	7,924	0	0
904.5	6,079	10,764	0	0
905.0 UNWL	6,915	14,013	0	0
905.5	7,791	17,689	3,677	0.120
906.0 HWL	8,705	21,813	7,801	0.188

Table 4.5 Storage Rating Data for Lincoln Ranch Pond 4

Elevation (m)	Area (m^2)	Storage (m^3)		Discharge Rate (m^3/s)
		Permanent	Active	Pond 4
906.0 BOTTOM	1,583	0	0	0
908.0 NWL	4,787	6,163	0	0
908.5	5,747	8,796	2,634	0.0013
909.0	6,746	11,919	5,756	0.0019
909.5	7,781	15,550	9,387	0.0023
910.0 HWL	8,858	19,709	13,547	0.0026

Table 4.6 Storage Rating Data for Lincoln Ranch Pond 5 (Treated Wastewater)

Elevation (m)	Area (m^2)	Storage (m^3)		Discharge Rate (m^3/s)
		Permanent	Active	Pond 5
914.3 BOTTOM	4,900	0	0	0
914.8 NWL	5,625	2,631	0	0
917.0	8,836	18,538	0	0
917.1	8,911	19,426	0	0
917.3 HWL	9,025	21,229	0	0

4.6.3 Sediment removal analysis

Water quality modeling was performed by the PCSWMM model for sediment removal from the SWMFs. This requires input data for pollutant *build-up*, pollutant *washoff* and pond *settling velocities* which was based on data provided in the City of Calgary guidelines.; which is the closest City that has these type of guidelines.

The procedure used in the PCSWMM model for pollutant simulation is as follows:

- Pollutants are identified and given certain attributes. For this sediment simulation modelling TSS was listed for five size ranges as noted in the City of Calgary manual; (1) 0-10 µm, (2) 10-20 µm, (3) 20-50 µm, (4) 50-150 µm and (5) > 150 µm.
- A fraction of total sediment is assigned to these sediment sizes as noted in the City of Calgary manual.
- Land uses are identified, each with a set of buildup and washoff parameters. For this study the land uses identified included (1) residential and (2) undeveloped areas.
- Removal efficiencies for source control BMPs can be assigned for each land use, but for this SWMR study an efficiency of 0 % was used as a conservative assumption.
- Removal of TSS in the SWMF is simulated by turning on the Treatment flag and assigning a removal expression based on the settling velocities for each of the TSS particle sizes as provided in the City of Calgary guidelines.

4.7 REUSE WITHDRAWALS - IRRIGATION

As noted in Section 3.2, reuse of the treated wastewater and stormwater for irrigation will be a key component of the Lincoln Ranch Development. This was simulated using the PCSWMM model's pump routine using a constant pumping rate. The treated wastewater (pond 5) will be the primary discharge point for irrigation. If this pond does not have adequate water, then water will be pumped from Pond 3 (stormwater) to Pond 5. This pumping occurs from the storage node that represents Pond 5.

Pond 5 will have a pump that will turn on when the water level is at 0.55 m and it will turn off when the water level reaches 0.5m. This will prevent the pond from completely being pumped dry.

Pond 3 will have a pump that will turn on when the water level is at 2.05m and it will turn off when the water level reaches 2.0m. This will ensure that there is at least 2.0m of water in the pond to properly function as a wet pond for quality reasons.

The Control Rules feature that is included in the PCSWMM model was used to control the pumping to simulate an irrigation schedule. The following rules were used:

1. The irrigation pumping is turned off for the months of October through to April; and
2. A dummy rain gauge is created as a storage node which receives the same precipitation as all the subcatchments. The rain gauge node has a fixed surface area of 10 m² with a storage depth of 25 mm. This depth corresponds with the weekly crop ET. Water is depleted from this node as infiltration using a rate of 0.125 mm/hr (hydraulic conductivity) which represents the crop use of 25 mm over a one-week period.

3. A storage node is used to represent the irrigation areas to which the pumping is directed. The storage is simulated with a Functional storage rating using a fixed area of 260,500 m² for the normal landscaped areas which equals the total irrigated area of 26.05 ha. If the depth of water in the node is > 28.40 mm (25 mm divided by 88 % efficiency), the pump is turned off. This prevents unlimited pumping during prolonged dry periods.

4. Water is discharged from the irrigation storage node by outlet links and reapplied back onto the corresponding subcatchments that represent the irrigated areas. Using a Functional discharge rating, a fixed discharge rate is assigned to each outlet that equates to a water depth of 28.4 mm per week over the corresponding irrigated area.

5. Calgary Parks has set rainfall sensors at 6.35 mm (0.25 inches) to trigger automated control of irrigation systems. Irrigation is maintained so long as the amount of rainfall is less than 6.35 mm. For this analysis a precipitation depth of 6 mm was used. If the depth of water in the rain gauge exceeds 6 mm the pump is turned off.

The reason that the irrigation water is reapplied onto the land surface is to properly reflect the soil moisture conditions and runoff as a result of the irrigation water and natural precipitation. This is a feature of PCSWMM which is facilitated by having the pumped water directed to an outfall which is designated a FREE type, with the water being routed to the appropriate subcatchment. The portion of pumped water that represents efficiency loss (i.e. 22 %) is also directed to a FREE outfall without an assigned routing location.

4.8 TREATED WASTEWATER ANALYSIS

The Lincoln Ranch pond 5 (treated wastewater) is receiving treated water from the Degraffs's RV park as well as the Lincoln Ranch subdivision. Based on other correspondence with similar developments, the following data was used for the inflow:

Table 4.7 Treated Wastewater inflows

	Summer Months (May – September)			Winter Months (October – April)		
	# of Units	Capita/unit	L/day/capita	# of Units	Capita/unit	L/day/capita
Lincoln Ranch	100	2	125	100	2	125
Degraff's RV	400	2	125	40	2	125
Total	**500**	**2**	**125**	**140**	**2**	**125**

This results in a total of 125 m³/day in the summer months and 35 m³/day in the winter months flowing into pond 5. This flow was added into the model as a base flow. This will be the primary source for irrigation with the stormwater runoff being used when there is insufficient treated wastewater.

For the model, the base flow of 0.001447 m³/s was used for the summer months with the winter months receiving a base flow of 0.000405 m³/s.

5.0 Stormwater Management Facilities

5.1 DESCRIPTION

Four detention storage facilities and one treated wastewater pond are proposed for Lincoln Ranch at the location shown on **Figure 2.2**. The stormwater Ponds are going to be constructed as wet storm ponds in accordance to the County of Lacombe and Alberta Environment guidelines. **Figures 5.1, 5.3, 5.5, 5.7 & 5.9**, shows the layouts, design grades and associated storm infrastructure while **Figures 5.2, 5.4, 5.6, 5.8 & 5.10** show the designated cross sections for the Lincoln Ranch Ponds. **Table 5.1** summarizes the preliminary design data for the Lincoln Ranch Ponds based on the concepts shown on the Figures. This table shows how the Lincoln Ranch Ponds will function.

Table 5.1 Design Data for Lincoln Ranch Storm Ponds

	Pond 1	Pond 2	Pond 3*	Pond 4	Pond 5
Contributing Drainage Area	8.48 ha	22.94 ha	18.63 ha	16.17 ha	8.80 ha
Bottom Elevation	906.0	905.0	902.0	906.0	914.3
NWL/LNWL Elevation	908.0	907.0	904.0	908.0	914.8
UNWL Elevation	-	-	905.0	-	-
HWL Elevation	909.5	909.0	906.0	910.0	917.3
Area at NWL/LNWL	0.14 ha	0.72 ha	0.53 ha	0.48 ha	0.56 ha
Area at HWL	0.29 ha	1.11 ha	0.87 ha	0.89 ha	0.90 ha
Storage Volume Below the NWL/LNWL	1,385 m^3	11,194 m^3	7,924 m^3	6,163 m^3	2,631 m^3
Storage Volume between LNWL and UNWL	-	-	6,089 m^3	-	-
Active Storage Volume at the HWL	3,226 m^3	18,159 m^3	7,801 m^3	13,547 m^3	19,012 m^3
Total Volume at the HWL	4,611 m^3	29,352 m^3	21,813 m^3	19,709 m^3	21,229 m^3
Max Side Slopes Below the NWL/LNWL	3H:1V	3H:1V	3H:1V	3H:1V	5H:1V
Max Side Slopes Between the NWL and HWL	5H:1V	5H:1V	5H:1V	5H:1V	5H:1V
Max Side Slopes Above the HWL	5H:1V	5H:1V	5H:1V	5H:1V	5H:1V
Allowable Discharge Rate at the HWL	218 L/s	19 L/s	188 L/s	2.6 L/s	-
1:100 Total Volume, Continuous Simulation	3,912 m^3	25,829 m^3	20,742 m^3	14,538 m^3	21,057 m^3
1:100 Total Volume, Single Event	4,398 m^3	26,401 m^3	21,506 m^3	14,696 m^3	7,432 m^3
Governing 1:100 Elevation	909.43 m	908.81 m	905.96 m	909.39 m	917.30 m
Governing 1:100 Peak Discharge	83 L/s	13 L/s	184 L/s	4 L/s	-
Freeboard Elevation	910.1	909.6	906.6	910.6	917.6

* Note: Pond 3 is the only pond that discharges to Gull Lake, the other storm ponds drain to Pond 3 by gravity through a pipe and or overland ditch flows. Pond 5 is not connected to the storm drainage system.

The High Water Level (HWL) is the design maximum operating level, which contains (at least) the 1:100-year event storage volume. As mentioned previously in Section 4.1, the maximum discharge rate for the 100-year level is 2.5 L/s/ha for the Lincoln Ranch development (Pond 3 discharges to Gull Lake). As noted in **Table 5.1**, the 100-year discharge rate from this Pond 3 facility is less than the target.

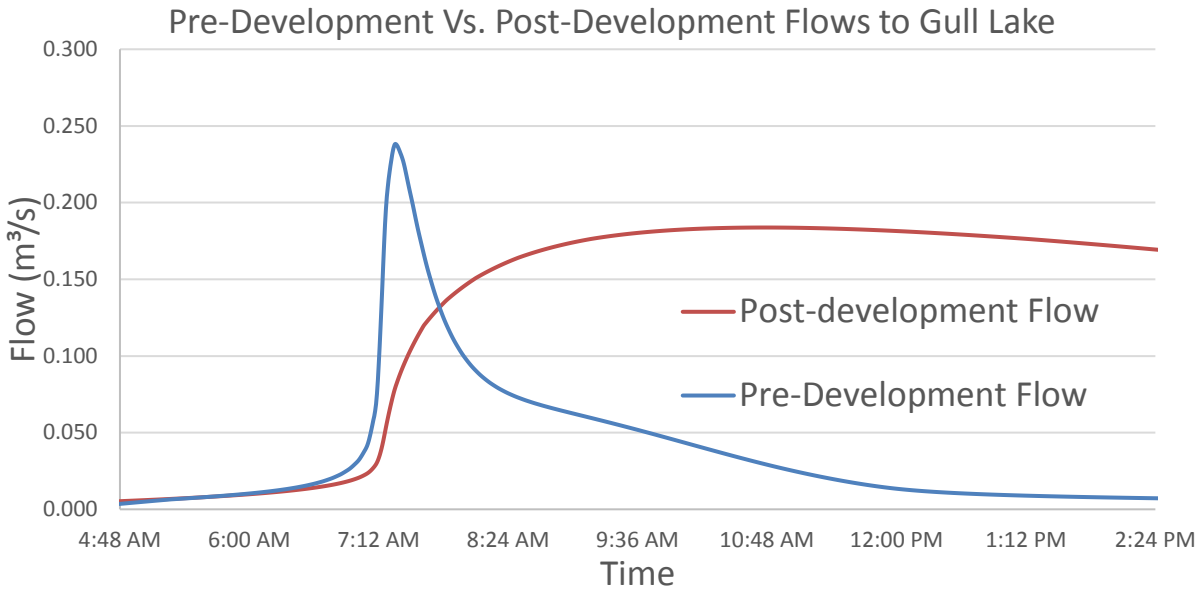
The storage volume below the NWL is not available for discharge rate (quantity) control. This storage is significant only in terms of water quality with respect to turnover rate and the pond's ability to improve the quality of the receiving stormwater. The storage volume above the NWL is the available capacity for control of discharges to the receiving outlet. This storage is referred to as *active* storage.

5.2 DISCHARGES TO GULL LAKE

Discharges from Lincoln Ranch Pond 3 will be made by storm sewer that will daylight to the road ditch which will drain under Rge Rd. 282. This is the same water course that the pre-development drainage is discharging to. The Lincoln Ranch Pond 3 will be controlled by an orifice in a manhole and a concrete weir that incorporates two levels of operation:

- An ICD will provide normal unregulated control using orifice flow principles. The ICD will be sized to pass the target flow of 188 L/s (75.02 ha @ 2.5 L/s/ha) based on water levels in the storage facilities at HWL.
- An overflow weir will accommodate increased flows when water levels rise above the HWL (i.e. > 100-year event).

Figure 5.5 provides preliminary details for the ICD and weir that will be used for Lincoln Ranch Pond 3.



5.3 EMERGENCY OVERFLOW

Based on the design of the Lincoln Ranch storm pond 3, the concrete weir will act as an emergency overflow that will allow the pond to discharge down the ditch towards the drainage course at levels above the HWL (i.e. > 100-year event).

5.4 FREQUENCIES OF STORAGE

Figure 5.11 illustrates the frequency of storage volume for the Lincoln Ranch Pond 3 based on the frequency analysis of the continuous simulation results.

Table 5.2 provides the 100-year storage volumes for the Lincoln Ranch Pond 3 as determined by the frequency analysis of the continuous simulation results. These results are less than the volumes determined by the 100-year single storm event and so the single event will govern for design purposes.

Table 5.2 Frequency Analysis for Lincoln Ranch Pond 3

Return Period (years)	Total Volume (m)	Active Volume (m)	Depth Above UNWL (m)	Elevation
2	15,039	1,027	0.14	905.14
5	16,240	2,227	0.30	905.30
10	17,206	3,193	0.43	905.43
20	18,587	4,574	0.61	905.61
50	19,722	5,709	0.75	905.75
100	20,944	6,931	0.89	905.89

5.5 SEDIMENT REMOVAL

Table 5.3 summarizes the results of sediment washoff and final loadings that are ultimately discharged to Gull Lake. These results demonstrate that the target efficiency of 85 % removal of ≥ 75 µm particle sizes is being met.

Table 5.3 Sediment Loadings for the Lincoln Ranch Development

Sediment Size (µm)	Lincoln Ranch SW Pond	
	Catchment Washoff (kg)	Discharges at Outfall (kg)
< 10	23,977	79
10-20	3,723	1
20-50	46,406	0
50-150	9,159	0
> 150	26,080	0
Totals	**109,345**	**80.0**
Total Percent removal	**100 %**	

5.6 IRRIGATION USAGE

PCSWMM determined the mean annual surface water supply and golf course water demand based on the inputs and are presented in this section as well as the overall results of water diversions for irrigation reuse.

Table 5.4 Irrigation demand Summary for Summer Months (May 1 – Sept. 30)

	Irrigated Area (ha)	Annual Precipitation (mm)	Irrigated Annually (mm)	Total annual water applied (mm)	Total Annual water demand (mm)[1]
10	2.75	348	135	483	543
11	10.18	348	135	483	543
12	7.25	348	135	483	543
13	5.87	348	135	483	543

1. *As noted in section 3.2, irrigation was applied at 25mm/week for 5 months for simplicity reasons, which is different than the 25mm/week suggested for the 18 weeks' irrigation schedule. This gives the higher demand (543 mm) compared to the 450mm, so the annual water applied in this scenario of 483mm is relatively close even though it is applied over 21.7 weeks versus 18 weeks.*

Table 5.5 Water Balance Summary for Lincoln Ranch

	Catchment Area (ha)	Annual Runoff (m^3)[1]	Annual Evaporation (m^3)	Annual Inflow (m^3)	Annual discharge to Gull Lake (m^3)	Annual Irrigation (m^3)[2] applied to subcatchment
PRE-DEVELOPMENT						
Lincoln Ranch	75.02	16,334	-	-	16,334	-
POST-DEVELOPMENT						
10,16 / Pond 1	8.48	4,725	815	-	-	3,707
11 / Pond 2	22.94	14,955	4,668	-	-	13,718
12,15,19 / Pond 3	18.63	15,455	2,370	-	17,686	9,770
13,18 / Pond 4	16.17	8,718	5,007	-	-	7,911
14,17 / Pond 5	8.80	3,148	2,305	26,464	-	0
Total	**75.02**	**47,001**	**15,165**	**26,464**	**17,686**	**40,614**

1. *The annual Runoff includes the water that was re-applied to the catchment areas*
2. *The annual irrigation includes the losses due to sprinkling/pumping efficiency (88% efficiency) This adds 4,786 m^3 annually.*

Water Balance: = Runoff – Evaporation + Inflow – Discharge – Irrigation = 0
= 47,000 m^3 – 15,165 m^3 + 26,464 m^3 – 17,686 m^3 – 40,614 m^3 = 0 m^3

As shown in the above table the pre-development runoff rate that was calculated is 16,334 m^2 compared to the 21,006 m^3 estimated from the updated 50-percent Agri-Foods Canada basin yield. Since the 21,006 m^3 is estimated from a basin study for a much larger area, localized runoff rates will vary depending on the landscape of the study area. The main reason for the pre-development runoff rates and volumes is to determine no net loss going to Gull Lake. Since the same infiltration parameters were used in the pre-development as in the Post-development, the no net loss that the computer model shows for the post-development compared to pre-development can be confirmed.

6.0 Conclusions

The Lincoln Ranch development and storm drainage system are in the NW$^1/_4$ 14-41-28-W4M. Four constructed wet storm ponds will be used on site to control the discharge rate for Lincoln Ranch as well as a constructed treated wastewater pond.

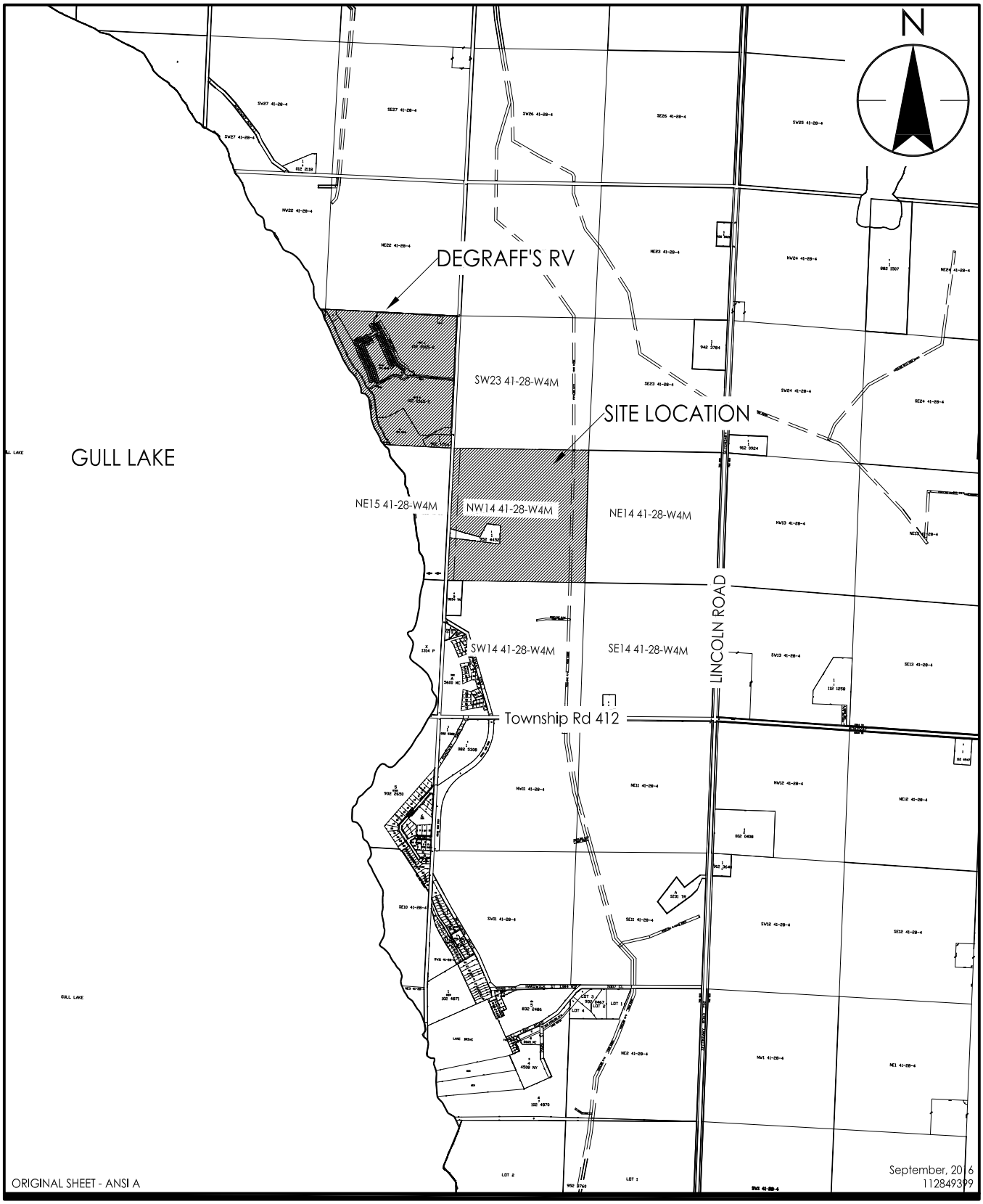
Discharges to Gull Lake will meet the unit area release rate (UARR) of 2.5 L/s/ha. The allowable discharge from this development is 188 L/s (75.02 @ 2.5 L/s/ha). Discharges from Lincoln Ranch will also be limited to achieve no net loss of annual average runoff volume to Gull Lake.

The residential golf course community development draining to the Lincoln Ranch Ponds will have an overland drainage storm system with culverts, swales, and ditches. Overland drainage shall conform to the County of Lacombe Design Guidelines, and the water velocity and depth relations as outlined in the Alberta Environment (AEP) Stormwater Management Guidelines.

The SWMF's that are proposed for Lincoln Ranch will provide high levels of water quality improvement prior to discharges being made to Gull Lake. Sediment simulation has demonstrated that nearly all the sediment that is washed off the development areas; will be removed by the ditches and the SWMF's.

The ponds will be controlled by an orifice at NWL and a spillway at HWL in order to accommodate levels in the ponds greater than the 1:100-year storm event.

The PCSWMM Single Event modeling and the continuous modeling demonstrates that the Lincoln Ranch Ponds have adequate live storage to attenuate the peak flows resulting from a 24-hour duration, 1:100-year design storm event and 44 years' worth of precipitation data along with a frequency analysis. This model also shows that the available active storage and discharge rate demonstrates that the facilities will provide a detention time of greater than 24 hours.



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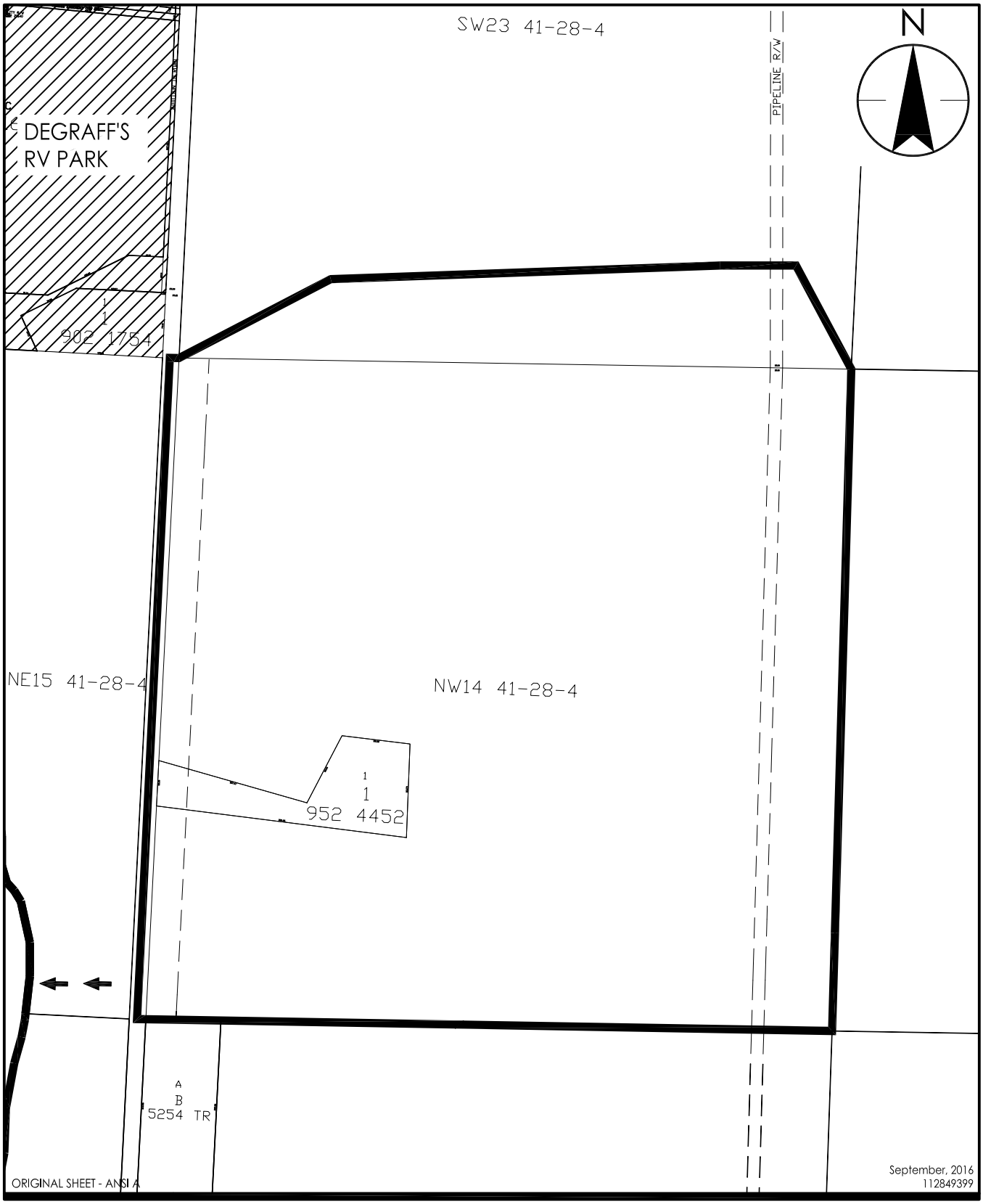
Lincoln Ranch

Figure No.
1.1

Title
SITE LOCATION



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Study Catchment Area

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Lincoln Ranch

Figure No.
1.2

Title
STUDY
AREA

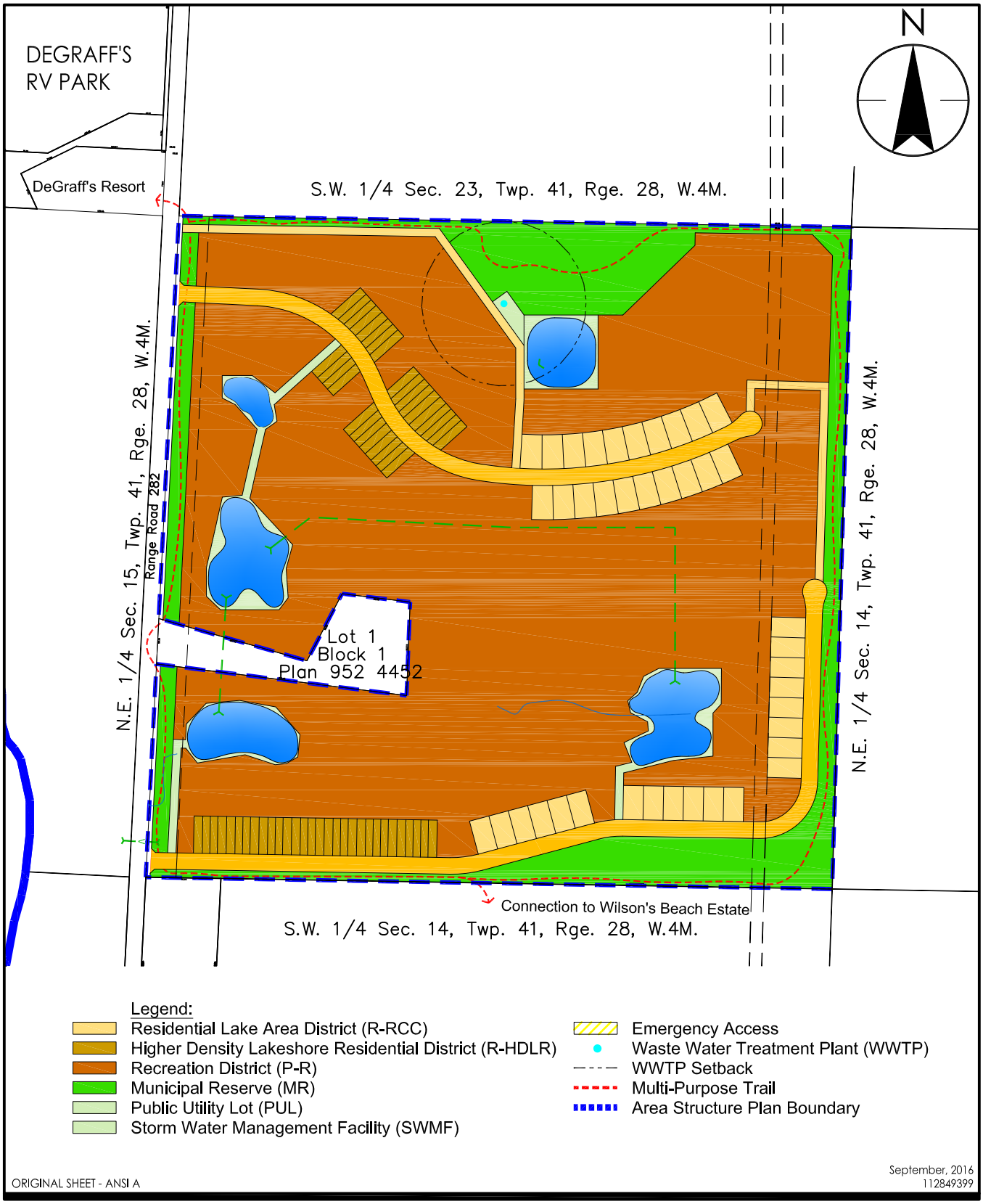

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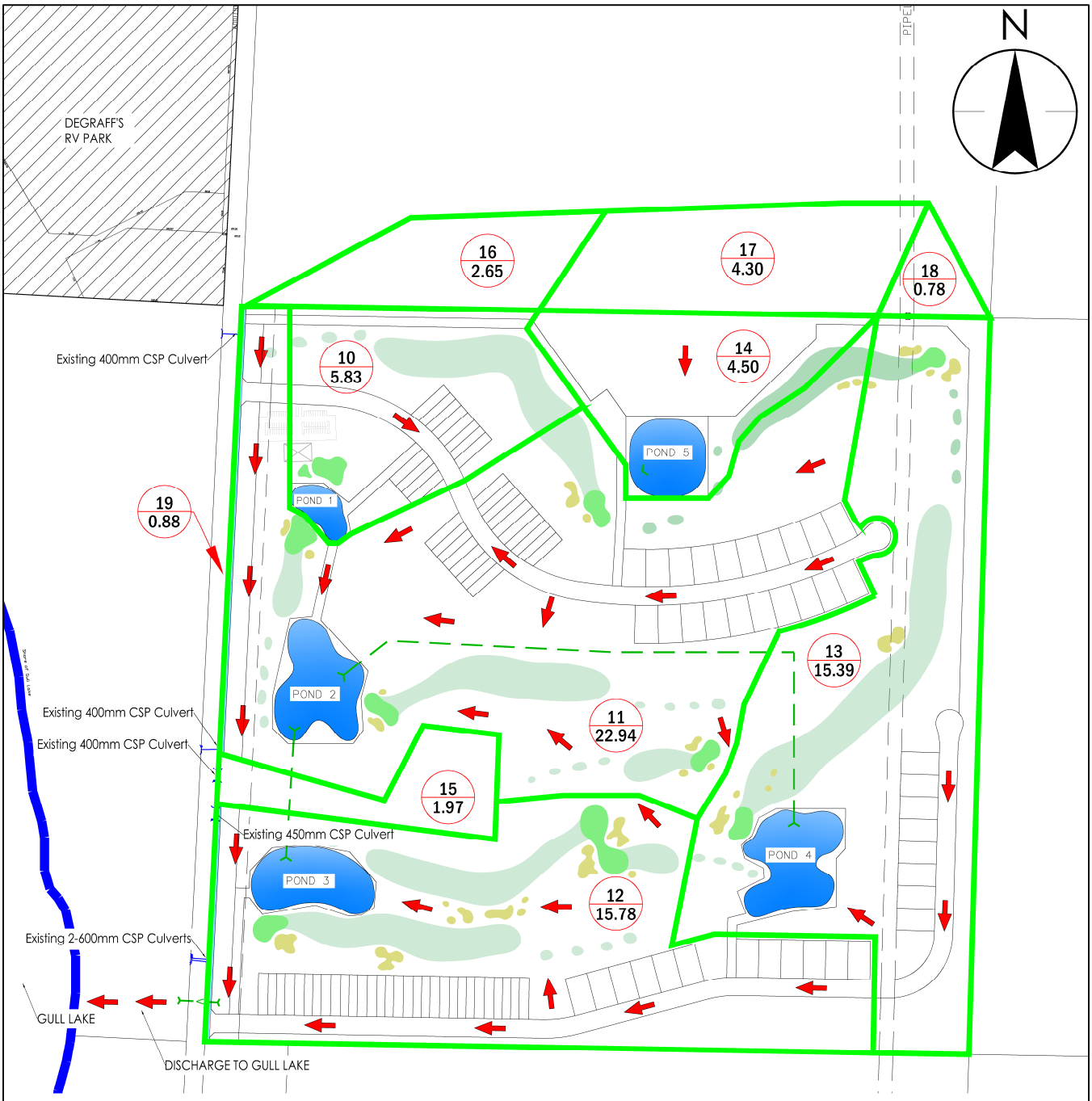
Figure No.
2.1

Title
CONCEPT
PLAN



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Subcatchments (SUB# AREA(HA))
Site Boundary
Drainage Direction
Subcatchments
Gull Lake
Storm Pipe

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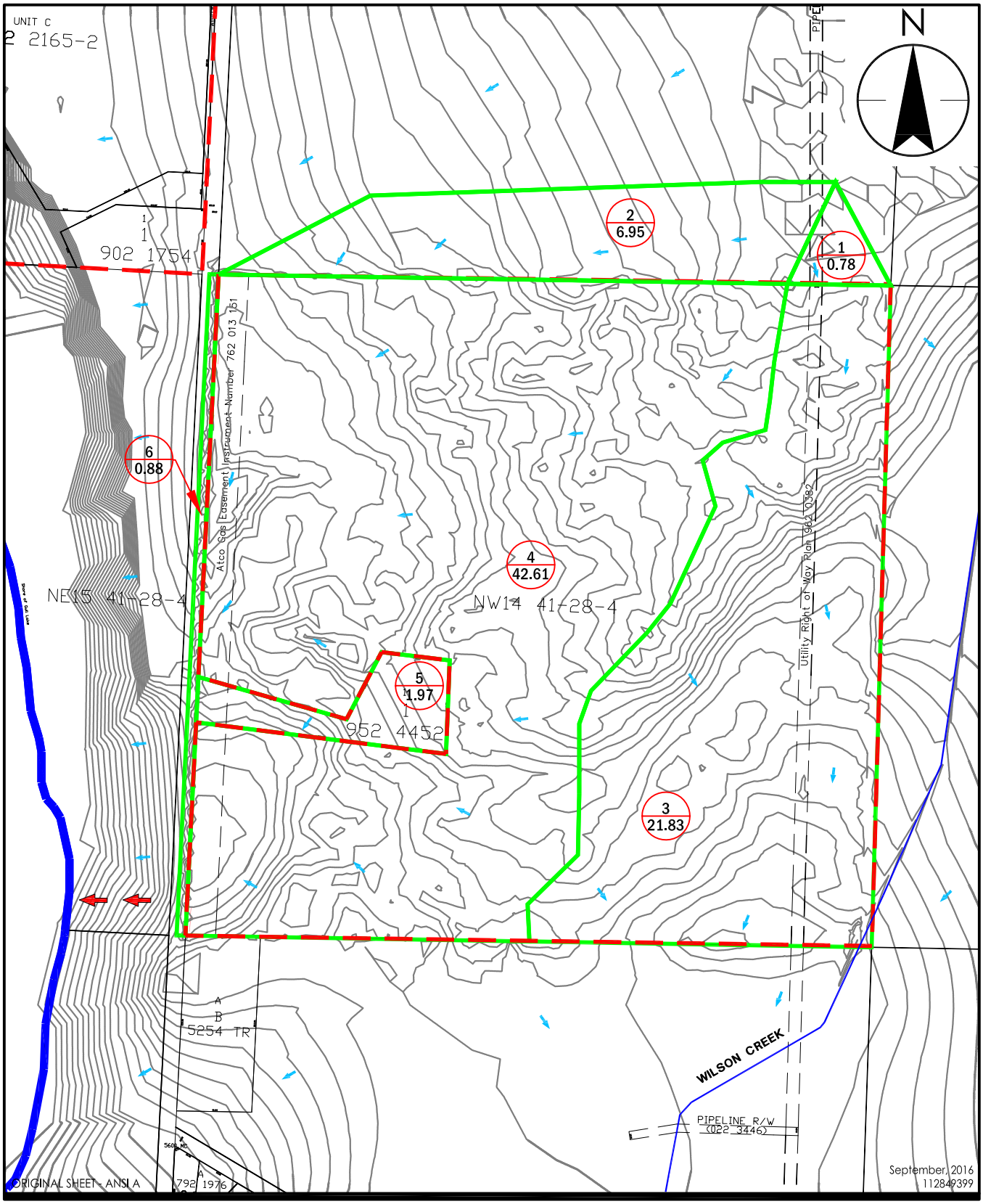
Lincoln Developments
Lincoln Ranch

Figure No.
2.2

Title
POST-DEVELOPMENT
SUBCATCHMENTS



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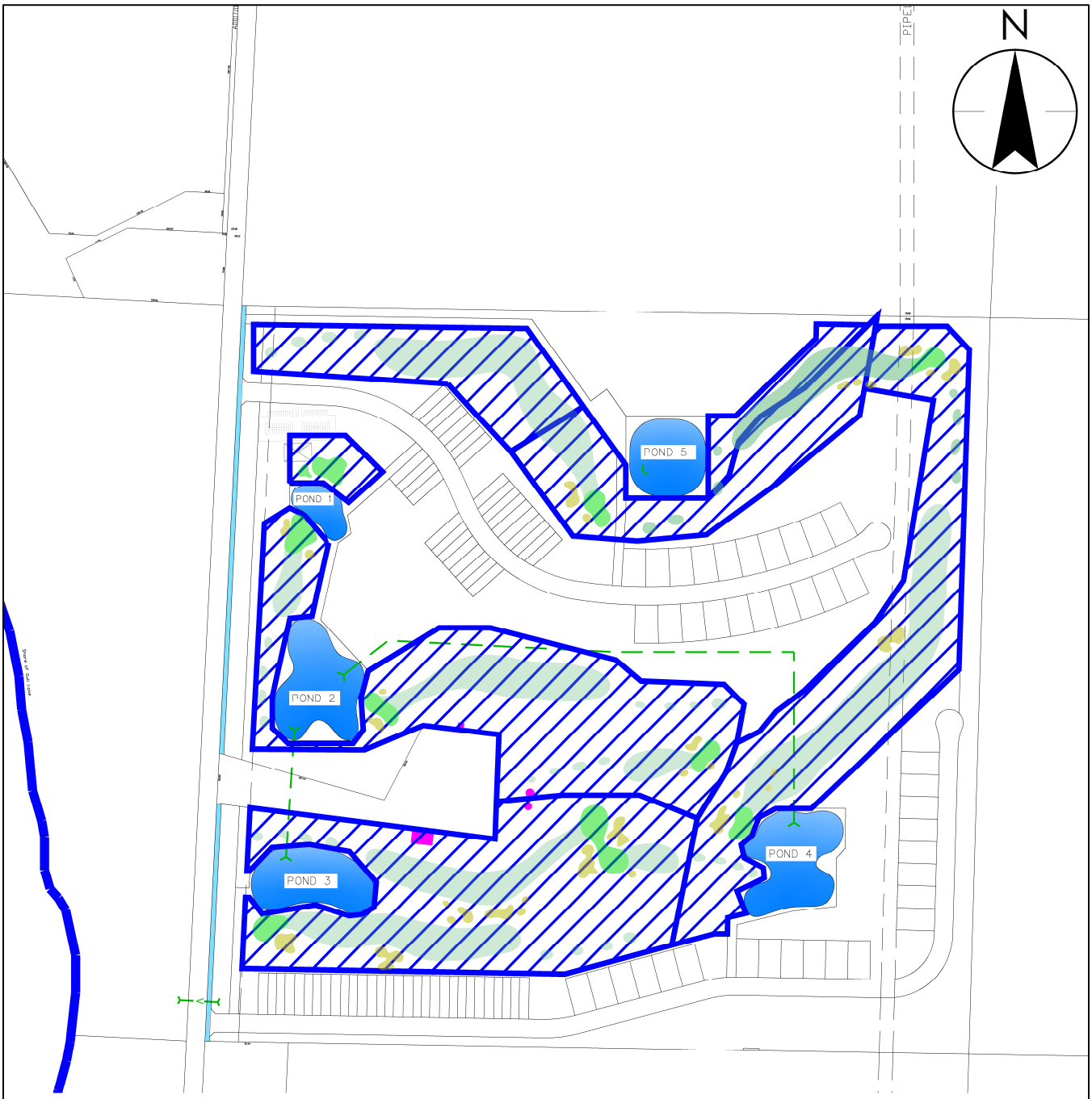
Subcatchments SUB# AREA(HA)
Site Boundary
Drainage Direction
Subcatchments
Gull Lake

Client/Project
Lincoln Developments
Lincoln Ranch

Figure No.
2.3

Title
PRE-DEVELOPMENT SUBCATCHMENTS



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Irrigated Areas

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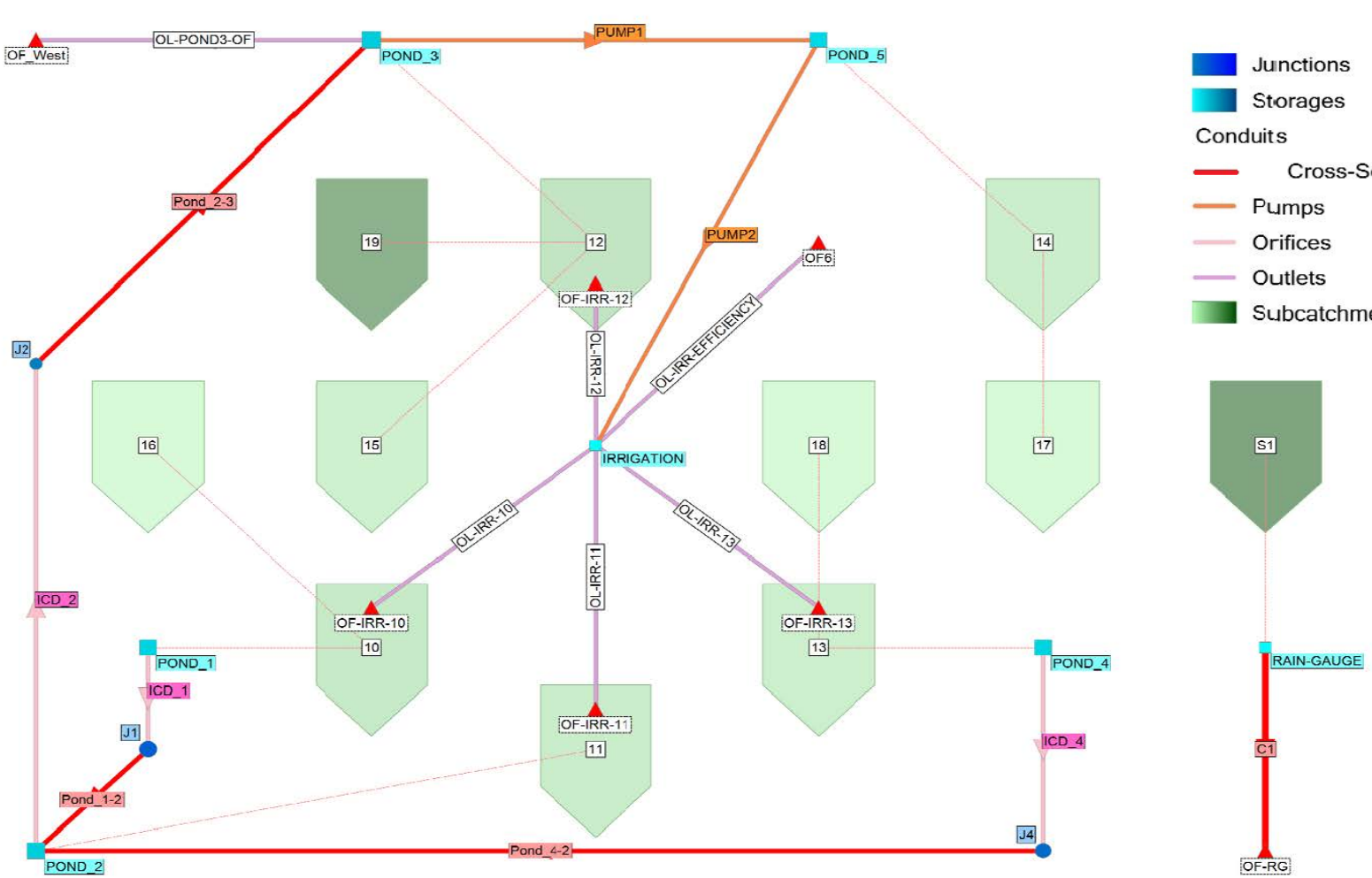
Lincoln Developments
Lincoln Ranch

Figure No.
3.2

Title
IRRIGATED AREAS



Legend

- Junctions
- Storages
- Conduits
  - Cross-Section = CIRCULAR
  - Pumps
  - Orifices
  - Outlets
- Subcatchments

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Lincoln Developments
Lincoln Ranch

Figure No.

4.1

Title

SCHEMATIC

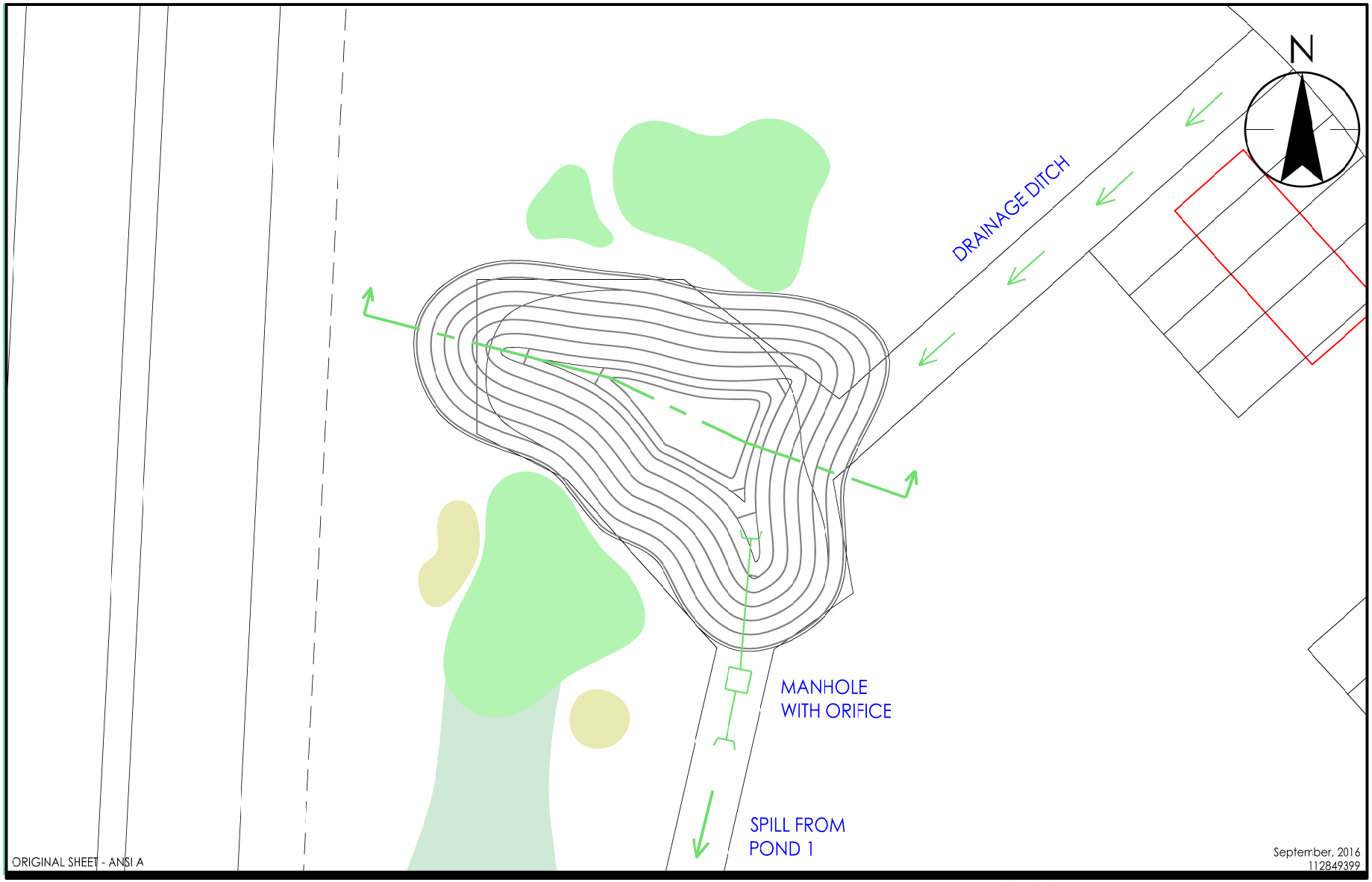

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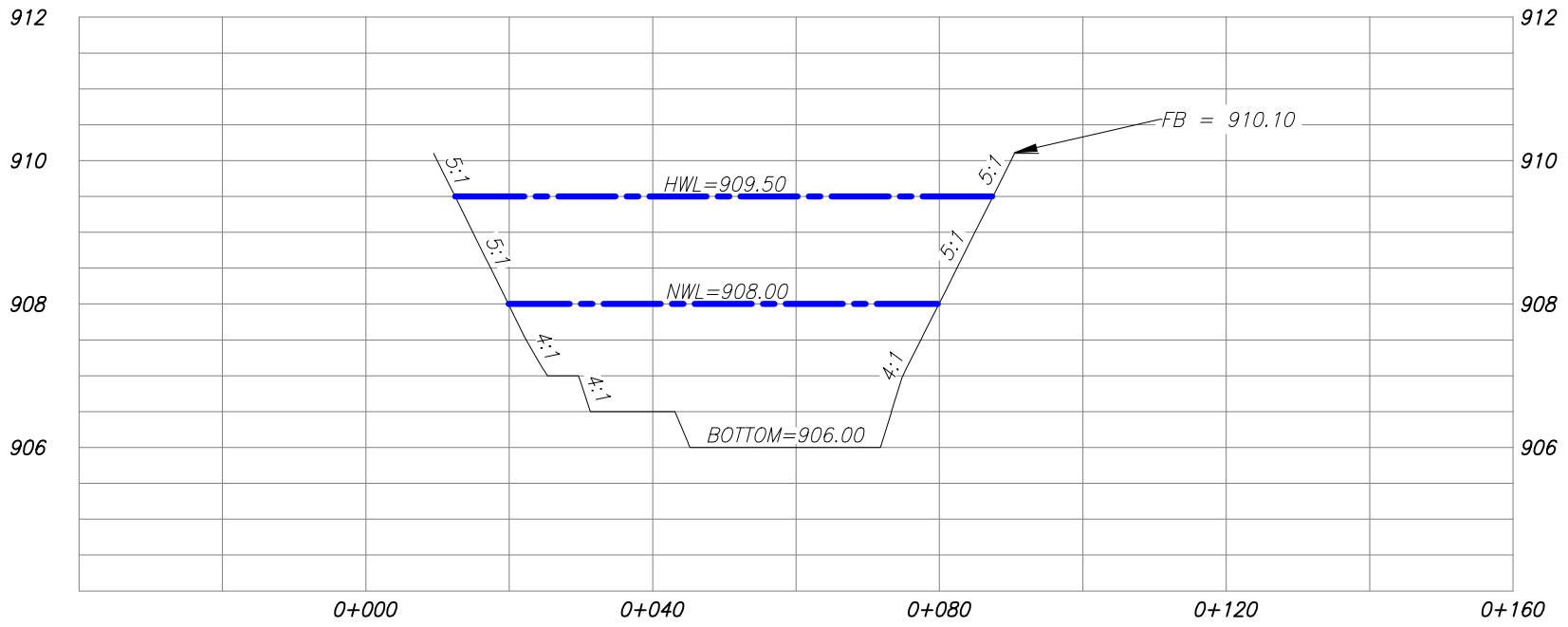
Figure No.
5.1

Title
CONCEPTUAL
POND 1



POND 1 CROSS SECTION A

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Figure No.
5.2

Title
LINCOLN RANCH
POND 1 CROSS SECTION

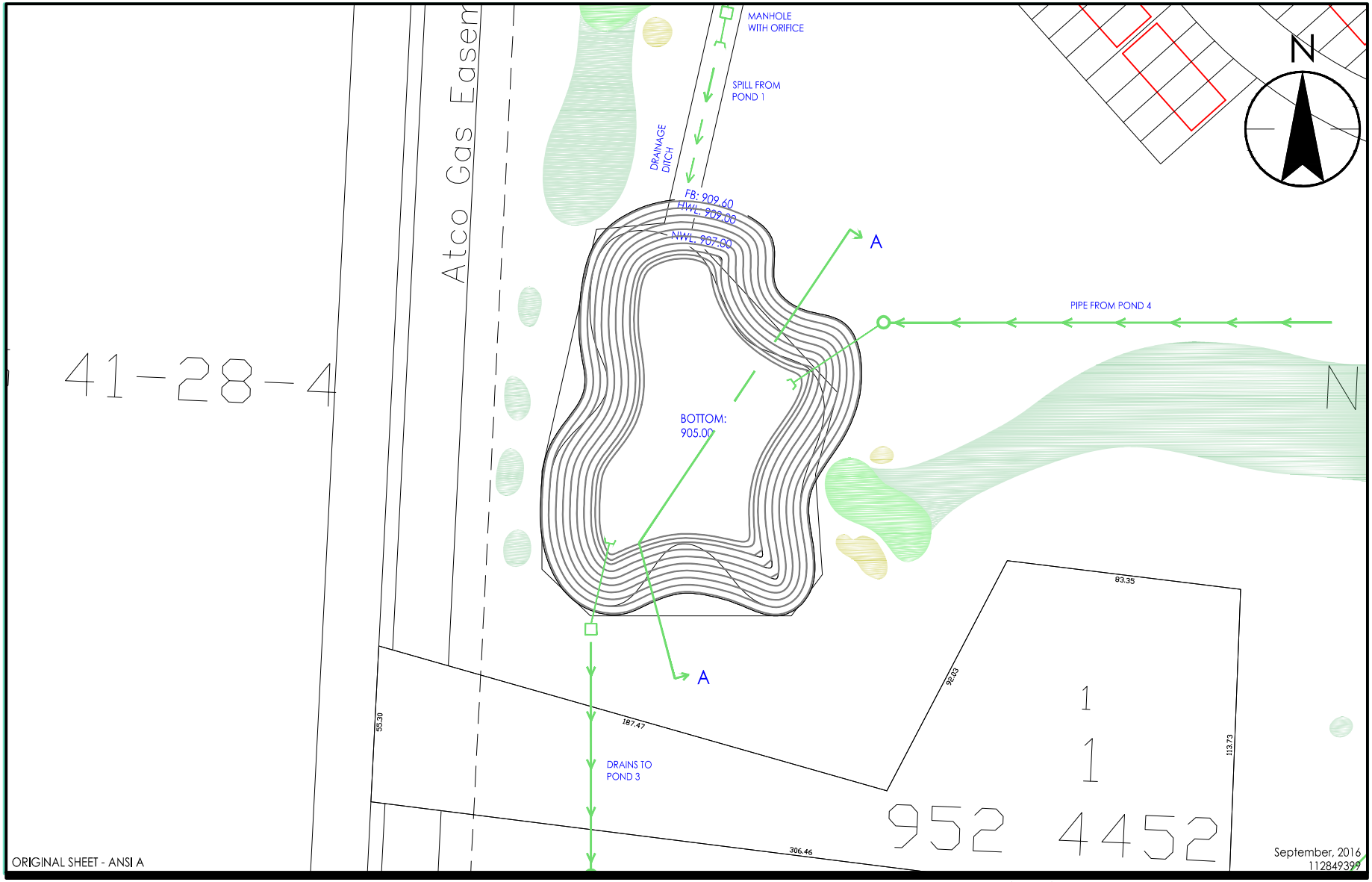

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Figure No.
5.3

Title
CONCEPTUAL
POND 2

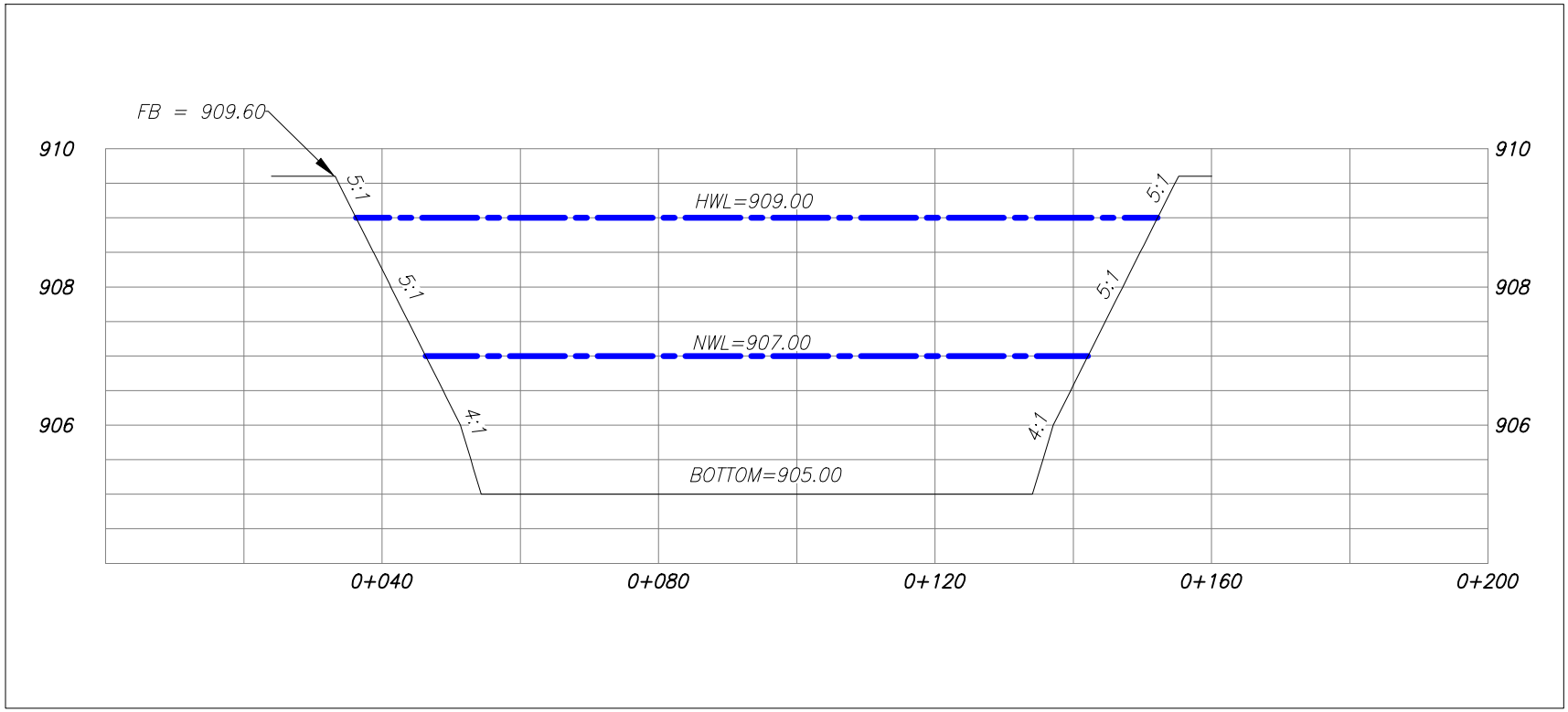

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Figure No.
5.4

Title
LINCOLN RANCH
POND 2 CROSS SECTION

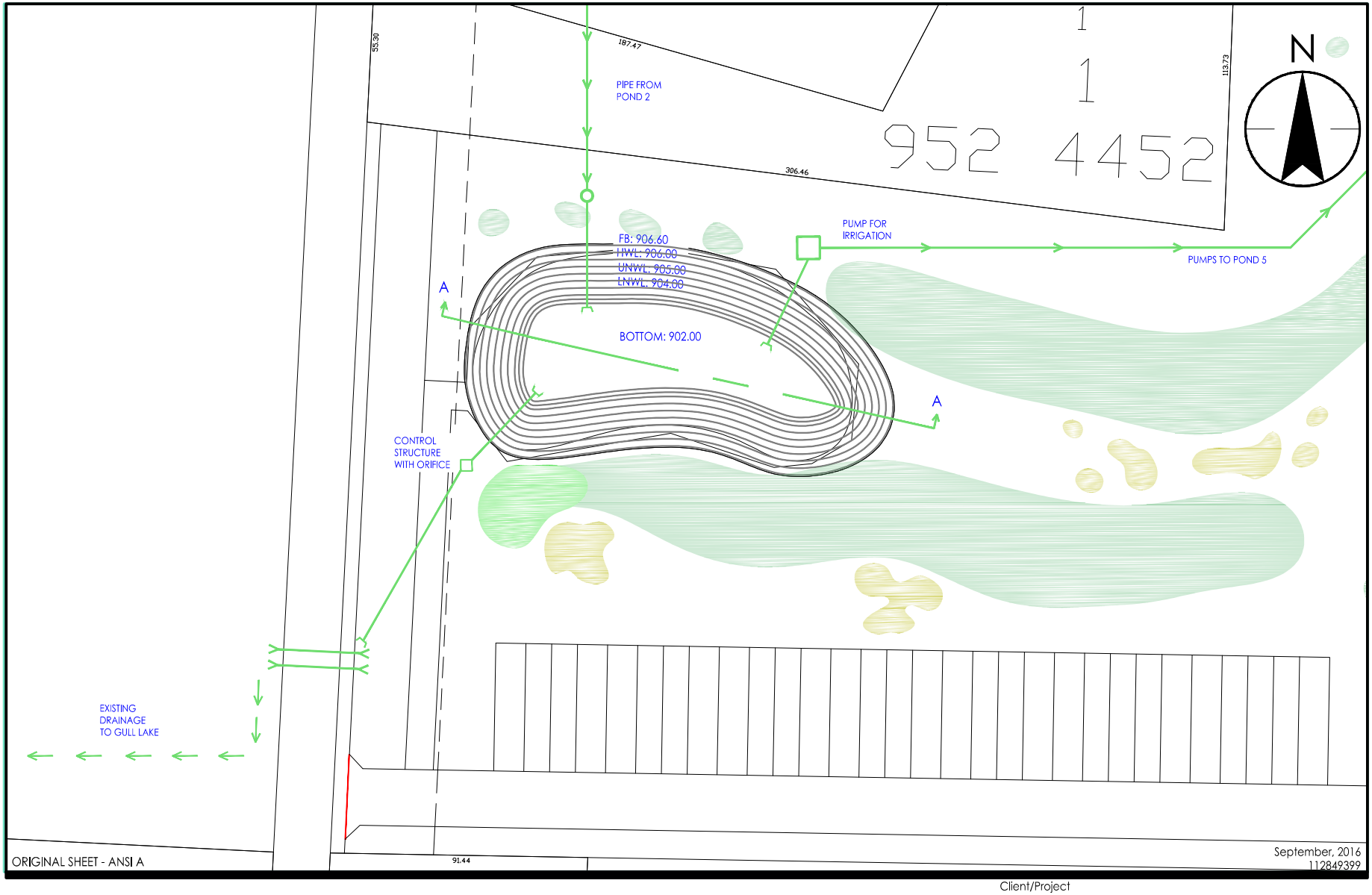

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Figure No.
5.5

Title
CONCEPTUAL
POND 3

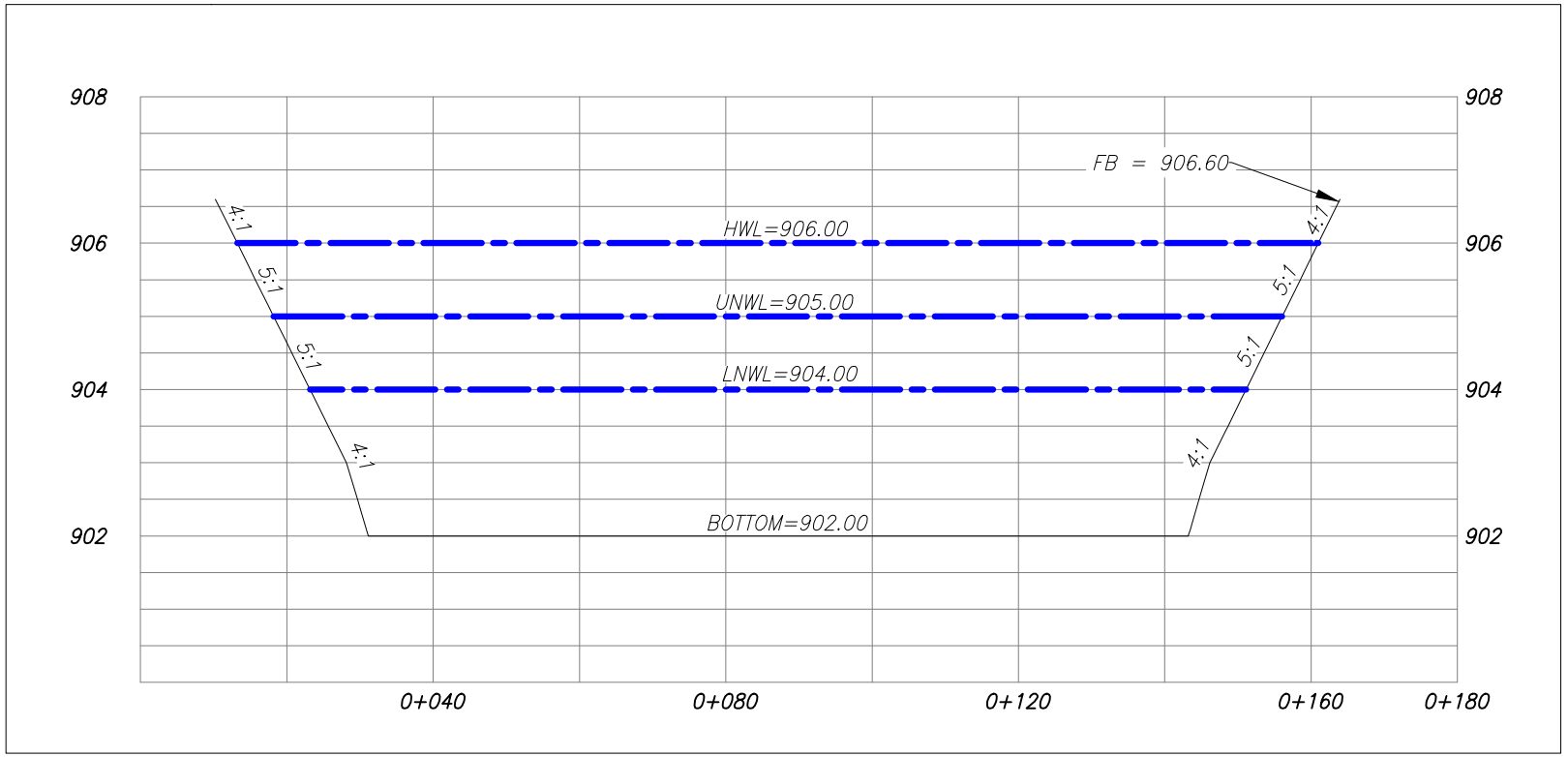

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Figure No.
5.6

Title
LINCOLN RANCH
POND 3 CROSS SECTION

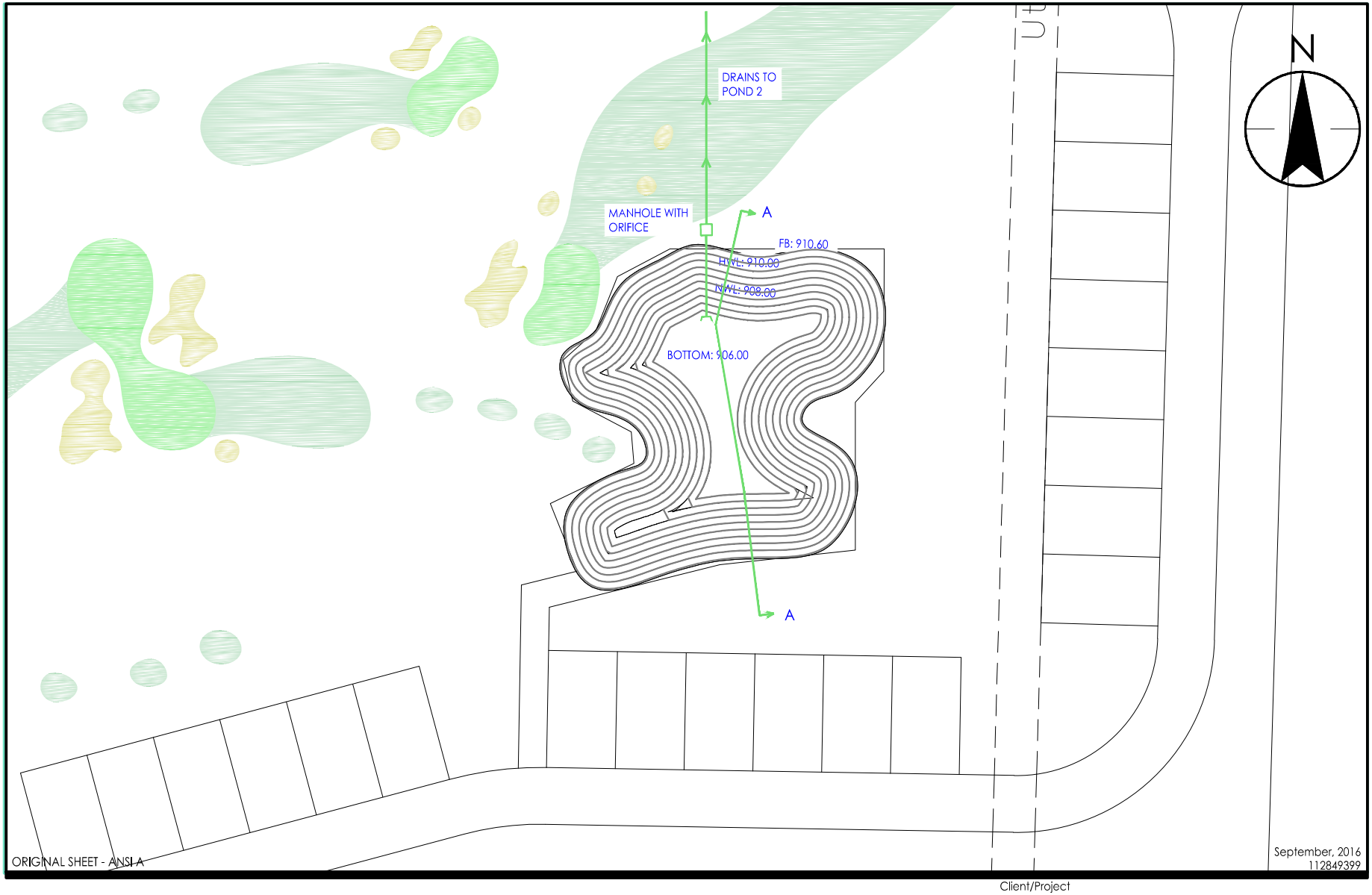

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Figure No.
5.7

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CONCEPTUAL
POND 4

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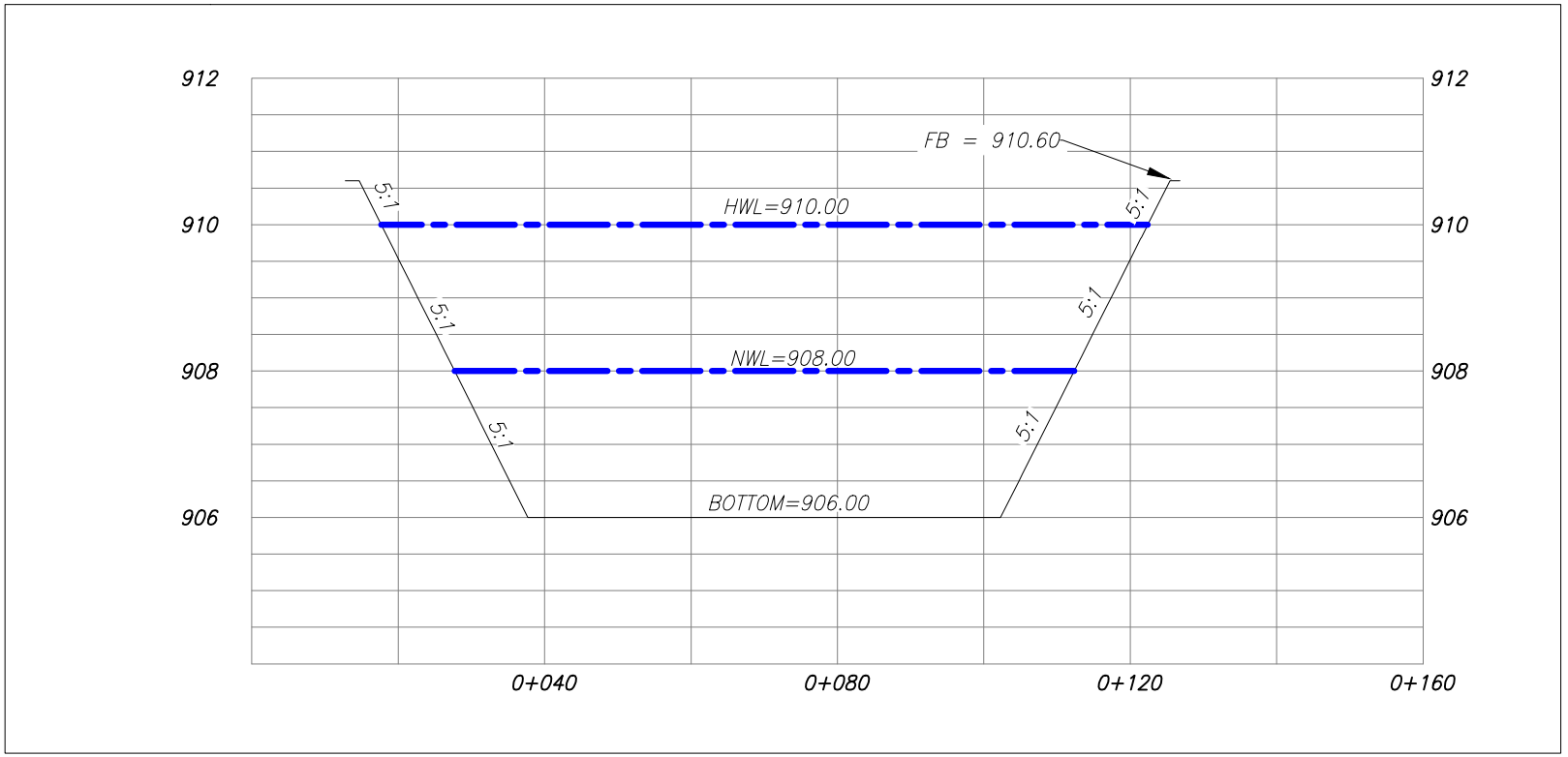

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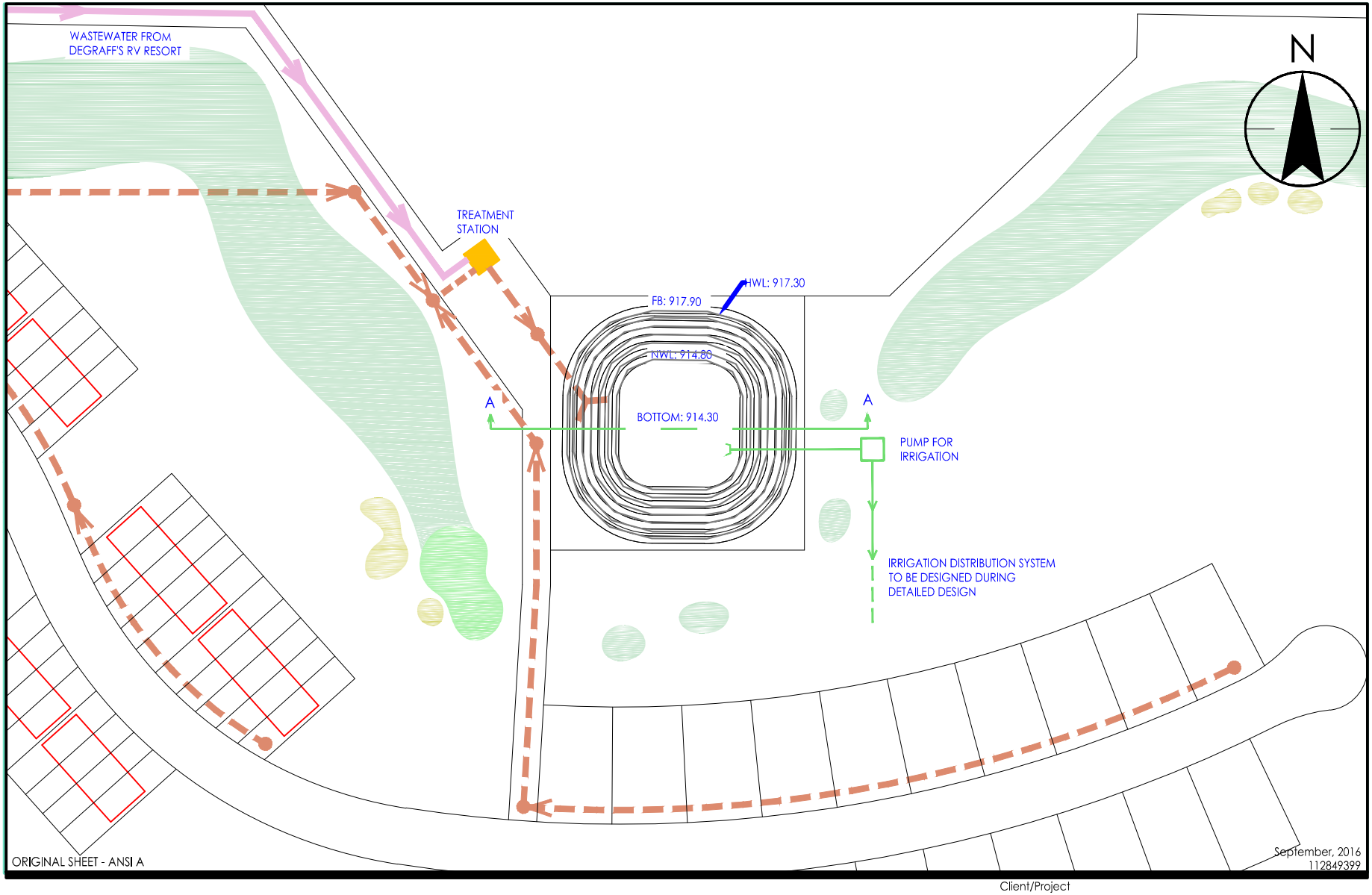
Lincoln Ranch

Figure No.
5.8

Title
LINCOLN RANCH
POND 4 CROSS SECTION



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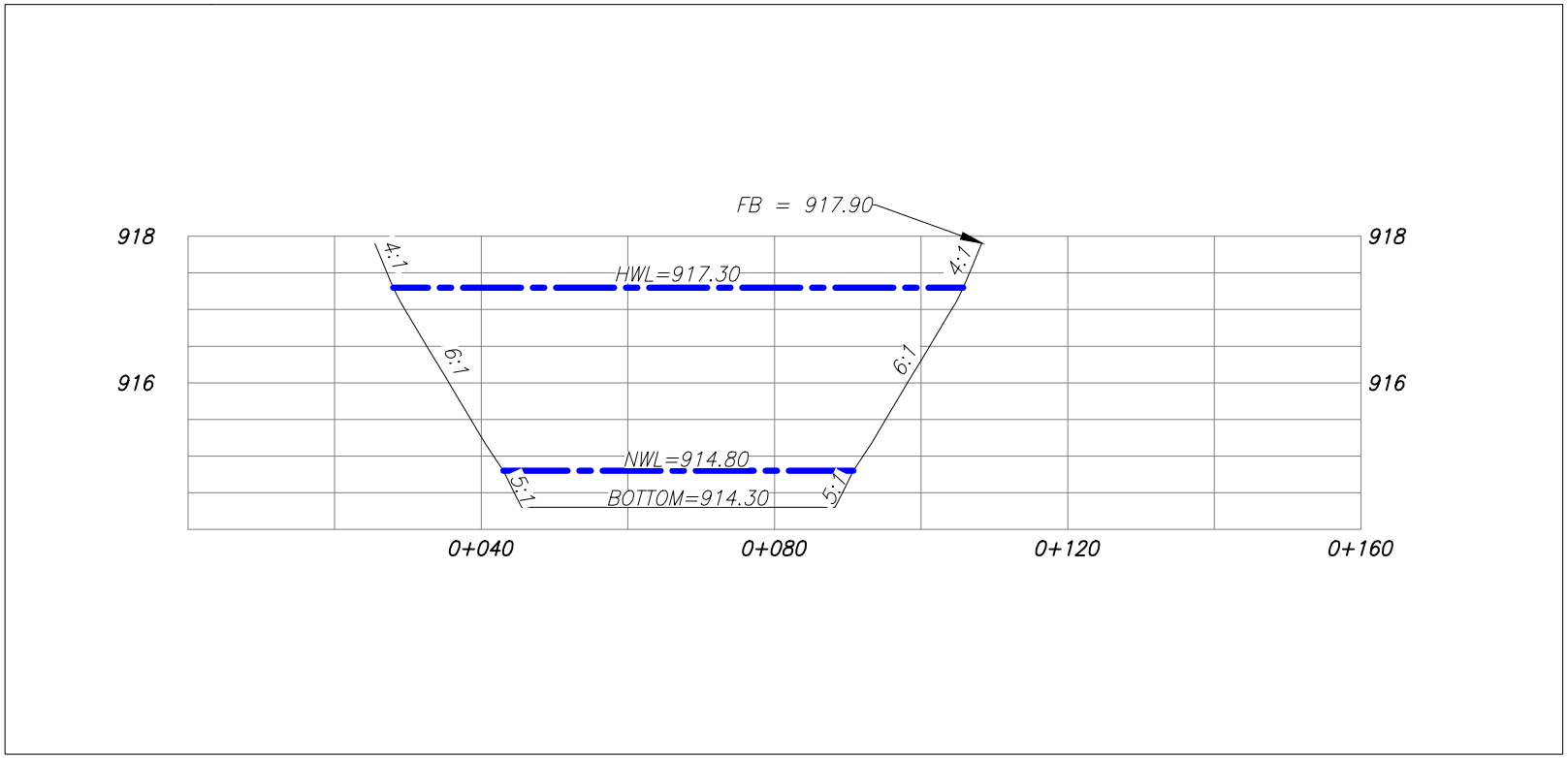
Lincoln Ranch

Figure No.
5.9

Title
CONCEPTUAL
POND 5



POND 5 CROSS SECTION A

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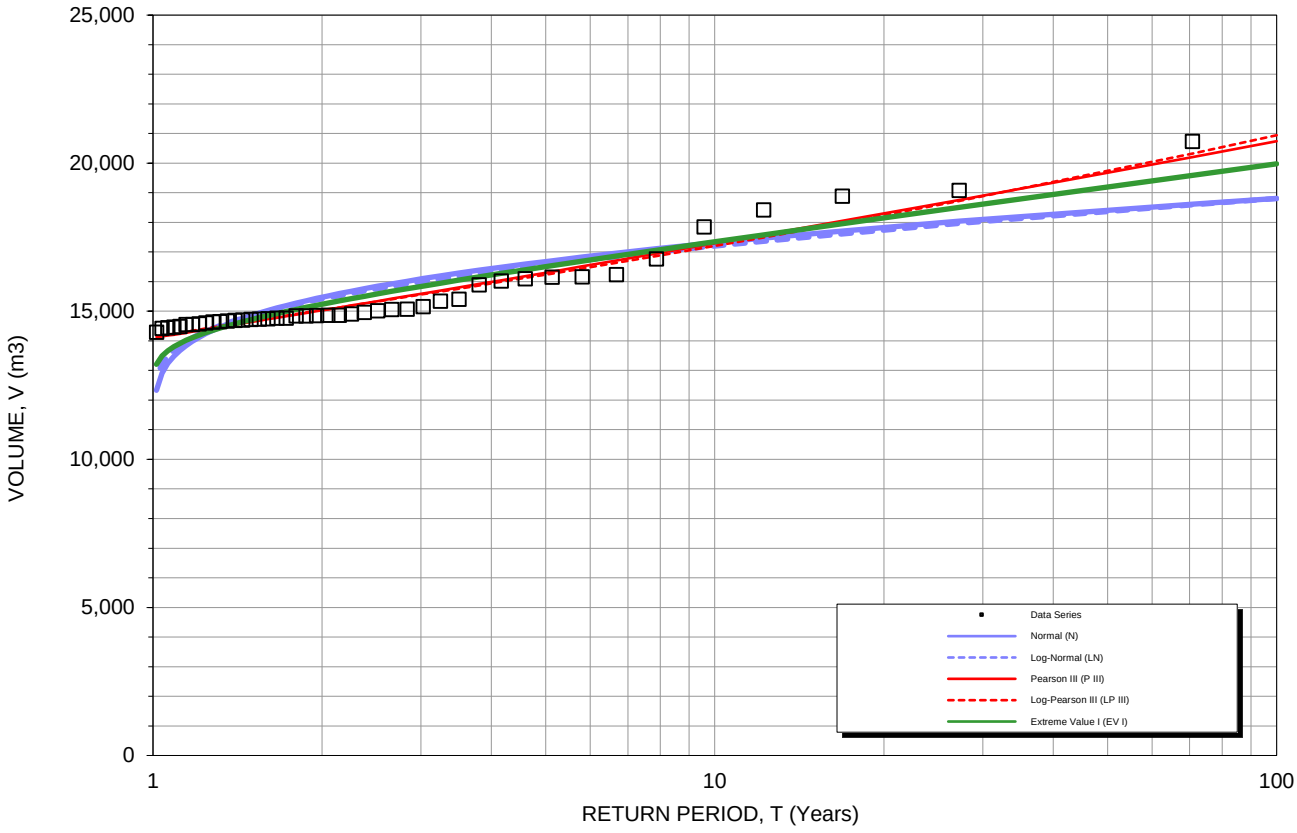
Client/Project
Lincoln Developments
Lincoln Ranch

Figure No.
5.10

Title
LINCOLN RANCH
POND 5 CROSS SECTION



Summary of Results

T (Years)	Total Volume, Including Permanent (m3)					Active Volume
	N	LN	P III	LP III	EV I	for LP III (m3)
2	15,475	15,417	15,032	15,039	15,240	7,115
5	16,681	16,566	16,303	16,240	16,509	8,316
10	17,313	17,201	17,291	17,206	17,349	9,282
25	17,985	17,904	18,634	18,587	18,410	10,663
50	18,420	18,374	19,676	19,722	19,197	11,798
100	18,811	18,807	20,742	20,944	19,978	13,020
Correlation	0.834	0.860	0.975	0.977	0.926	
Std. Error	784	670	298	285	526	

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Client/Project
Lincoln Developments
Lincoln Ranch

Figure No.
5.11

Title
Frequency Distributions
Lincoln Ranch Pond 3
Post Development Condition

REFERENCES

1. Alberta Environmental Protection; Stormwater Management Guidelines for the Province of Alberta; January, 1999

2. County of Lacombe; Minimum Design Standards for Development; January 2011

3. City of Calgary; Stormwater Management & Design Manual; 2011

4. Computational Hydraulics International; Users' Guide to SWMM5; 2010

5. Alberta Environmental Protection; Municipal Policies and Procedures Manual; April, 2001

Appendix A

PCSWMM COMPUTER MODEL DATA

September, 2016

Iron Gate SWMR
PCSWMM POST-DEVELOPMENT MODEL INPUT DATA

Subcatchment Parameters

Catchment	Area (ha)	Length (m)	Slope (%)	Impervious (%)	Manning 'n'		Depression Storage (mm)		Zero Imperv. (%)	Subarea Routing	Amount Routed (%)	Horton Parameters			
					Imperv.	Perv.	Imperv.	Perv.				Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
10	5.83	220	2.0	23	0.015	0.25	1.6	3.2	0	OUTLET	100	75	2.5	4.14	7
11	22.94	350	2.0	20	0.015	0.25	1.6	3.2	0	OUTLET	100	75	2.5	4.14	7
12	15.78	350	2.0	28	0.015	0.25	1.6	3.2	0	OUTLET	100	75	2.5	4.14	7
13	15.39	350	2.0	17	0.015	0.25	1.6	3.2	0	OUTLET	100	75	2.5	4.14	7
14	4.50	200	2.0	18	0.015	0.25	1.6	3.2	0	OUTLET	100	75	2.5	4.14	7
15	1.97	20	2.0	15	0.015	0.25	1.6	3.2	0	OUTLET	100	75	2.5	4.14	7
16	2.65	120	2.0	5	0.015	0.25	1.6	3.2	0	OUTLET	100	75	2.5	4.14	7
17	4.30	12	2.0	5	0.015	0.25	1.6	3.2	0	OUTLET	100	75	2.5	4.14	7
18	0.78	80	2.0	5	0.015	0.25	1.6	3.2	0	OUTLET	100	75	2.5	4.14	7
19	0.88	5	1.5	85	0.015	0.25	1.6	3.2	0	OUTLET	100	75	2.5	4.14	7
S1	0.001	3.16	10.0	100	0.015	0.25	1.6	3.2	0	OUTLET	100	75	2.5	4.14	7

Chicago Design Storm

Time (H:M)	Intensity (mm/hr)	Time (H:M)	Intensity (mm/hr)	Time (H:M)	Intensity (mm/hr)	Time (H:M)	Intensity (mm/hr)	Time (H:M)	Intensity (mm/hr)	Time (H:M)	Intensity (mm/hr)
0:00	2.25										
0:05	2.26	4:05	3.17	8:05	13.10	12:05	4.67	16:05	3.22	20:05	2.60
0:10	2.28	4:10	3.20	8:10	15.90	12:10	4.62	16:10	3.20	20:10	2.59
0:15	2.29	4:15	3.24	8:15	21.91	12:15	4.57	16:15	3.18	20:15	2.58
0:20	2.30	4:20	3.27	8:20	61.27	12:20	4.52	16:20	3.17	20:20	2.57
0:25	2.31	4:25	3.31	8:25	45.71	12:25	4.47	16:25	3.15	20:25	2.56
0:30	2.32	4:30	3.34	8:30	26.26	12:30	4.43	16:30	3.13	20:30	2.55
0:35	2.34	4:35	3.38	8:35	20.28	12:35	4.38	16:35	3.12	20:35	2.54
0:40	2.35	4:40	3.42	8:40	17.09	12:40	4.34	16:40	3.10	20:40	2.54
0:45	2.36	4:45	3.46	8:45	15.04	12:45	4.30	16:45	3.08	20:45	2.53
0:50	2.38	4:50	3.50	8:50	13.58	12:50	4.25	16:50	3.07	20:50	2.52
0:55	2.39	4:55	3.54	8:55	12.47	12:55	4.21	16:55	3.05	20:55	2.51
1:00	2.40	5:00	3.59	9:00	11.59	13:00	4.18	17:00	3.04	21:00	2.50
1:05	2.42	5:05	3.64	9:05	10.87	13:05	4.14	17:05	3.02	21:05	2.49
1:10	2.43	5:10	3.68	9:10	10.27	13:10	4.10	17:10	3.01	21:10	2.49
1:15	2.45	5:15	3.73	9:15	9.76	13:15	4.06	17:15	2.99	21:15	2.48
1:20	2.46	5:20	3.79	9:20	9.32	13:20	4.03	17:20	2.98	21:20	2.47
1:25	2.48	5:25	3.84	9:25	8.93	13:25	4.00	17:25	2.97	21:25	2.46
1:30	2.49	5:30	3.90	9:30	8.59	13:30	3.96	17:30	2.95	21:30	2.45
1:35	2.51	5:35	3.96	9:35	8.28	13:35	3.93	17:35	2.94	21:35	2.44
1:40	2.52	5:40	4.02	9:40	8.00	13:40	3.90	17:40	2.93	21:40	2.44
1:45	2.54	5:45	4.09	9:45	7.75	13:45	3.87	17:45	2.91	21:45	2.43
1:50	2.56	5:50	4.15	9:50	7.52	13:50	3.84	17:50	2.90	21:50	2.42
1:55	2.57	5:55	4.23	9:55	7.31	13:55	3.81	17:55	2.89	21:55	2.41
2:00	2.59	6:00	4.30	10:00	7.12	14:00	3.78	18:00	2.87	22:00	2.41
2:05	2.61	6:05	4.38	10:05	6.94	14:05	3.75	18:05	2.86	22:05	2.40
2:10	2.63	6:10	4.47	10:10	6.77	14:10	3.72	18:10	2.85	22:10	2.39
2:15	2.64	6:15	4.56	10:15	6.62	14:15	3.70	18:15	2.84	22:15	2.38
2:20	2.66	6:20	4.65	10:20	6.47	14:20	3.67	18:20	2.82	22:20	2.38
2:25	2.68	6:25	4.75	10:25	6.34	14:25	3.64	18:25	2.81	22:25	2.37
2:30	2.70	6:30	4.86	10:30	6.21	14:30	3.62	18:30	2.80	22:30	2.36
2:35	2.72	6:35	4.98	10:35	6.09	14:35	3.59	18:35	2.79	22:35	2.36
2:40	2.74	6:40	5.10	10:40	5.97	14:40	3.57	18:40	2.78	22:40	2.35

2:45	2.76	6:45	5.23	10:45	5.87	14:45	3.54	18:45	2.77	22:45	2.34
2:50	2.78	6:50	5.38	10:50	5.76	14:50	3.52	18:50	2.75	22:50	2.33
2:55	2.80	6:55	5.54	10:55	5.67	14:55	3.50	18:55	2.74	22:55	2.33
3:00	2.83	7:00	5.71	11:00	5.57	15:00	3.48	19:00	2.73	23:00	2.32
3:05	2.85	7:05	5.90	11:05	5.49	15:05	3.45	19:05	2.72	23:05	2.31
3:10	2.87	7:10	6.11	11:10	5.40	15:10	3.43	19:10	2.71	23:10	2.31
3:15	2.90	7:15	6.34	11:15	5.32	15:15	3.41	19:15	2.70	23:15	2.30
3:20	2.92	7:20	6.60	11:20	5.24	15:20	3.39	19:20	2.69	23:20	2.29
3:25	2.95	7:25	6.89	11:25	5.17	15:25	3.37	19:25	2.68	23:25	2.29
3:30	2.97	7:30	7.23	11:30	5.10	15:30	3.35	19:30	2.67	23:30	2.28
3:35	3.00	7:35	7.62	11:35	5.03	15:35	3.33	19:35	2.66	23:35	2.28
3:40	3.03	7:40	8.08	11:40	4.97	15:40	3.31	19:40	2.65	23:40	2.27
3:45	3.05	7:45	8.64	11:45	4.90	15:45	3.29	19:45	2.64	23:45	2.26
3:50	3.08	7:50	9.33	11:50	4.84	15:50	3.27	19:50	2.63	23:50	2.26
3:55	3.11	7:55	10.21	11:55	4.78	15:55	3.25	19:55	2.62	23:55	2.25
4:00	3.14	8:00	11.39	12:00	4.73	16:00	3.24	20:00	2.61	24:00:00	0.00

Evaporation

Month	Monthly (mm)	Daily (mm)
January	-2.0	-0.06
February	0.0	0.00
March	21.0	0.66
April	70.0	2.35
May	115.0	3.72
June	132.0	4.40
July	147.0	4.76
August	117.0	3.79
September	63.0	2.12
October	27.0	0.87
November	2.0	0.07
December	-3.0	-0.10

Wind Speed

Month	Average Monthly Speed (km/hr)
January	10.4
February	10.3
March	11.3
April	13.3
May	13.8
June	12.2
July	10.4
August	9.8
September	11.1
October	11.7
November	10.4
December	10.4

Time Patterns Multiplier

Month	Hydraulic Conductivity	Initial Deficit
January	0.05	0.05
February	0.05	0.05
March	0.05	0.05
April	0.05	0.05
May	1.0	1.0
June	1.0	1.0
July	1.0	1.0
August	1.0	1.0
September	1.0	1.0
October	1.0	1.0
November	0.05	0.05
December	0.05	0.05

Snow Melt

Dividing temperature between snow & rain (C^o)	0
Fraction ATI weight	0.5
Fraction negative melt ratio	0.6
Elevation above MSL (m)	905
Latitude (degrees)	52
Longitude correction (± minutes)	0

Area Depletion

Depth Ratio	Impervious	Pervious
0	1.0	0.10
0.1	1.0	0.35
0.2	1.0	0.53
0.3	1.0	0.66
0.4	1.0	0.75
0.5	1.0	0.82
0.6	1.0	0.87
0.7	1.0	0.92
0.8	1.0	0.95
0.9	1.0	0.98

Snow Pack

Snowpack Parameters			
	Plowable	Impervious	Pervious
Min. Melt Coeff. (mm/hr/C^o)	0.05	0.05	0.05
Max. Melt Coeff. (mm/hr/C^o)	5	5	5
Base Temp. (C^o)	0	0	0
Fraction Free Water Capacity	0.1	0.1	0.1
Initial Snow Depth (mm)	0	0	0
Initial Free Water (mm)	0	0	0
Depth at 100% Cover (mm)	-	15	100
Impervious Area Plowable (%)	0		

Snow Removal Parameters	
Depth at which snow removal begins (mm)	10
Fraction Transferred out of watershed	0
Fraction transferred to Impervious Area	0
Fraction transferred to pervious area	1
Fraction converted to immediate melt	0
Fraction moved to another subcatchment	0

TSS Buildup & Washoff

Residential Land Use										
Parameter	Particle Size (µm)	Fraction (%)	Buildup				Washoff			
			Function	Max. (kg/m^2)	Rate (kg/ha)	Power/Sat. Constant	Function	Coefficient (mg/L)	Exponent	BMP Effic. (%)
TSS010	< 10	23	POW	460	1.26	0.95	EMC	102	1	0
TSS020	10-20	9	POW	180	0.493	0.95	EMC	40	1	0
TSS050	20-50	13	POW	260	0.712	0.95	EMC	58	1	0
TSS150	50-150	23	POW	460	1.26	0.95	EMC	102	1	0
TSS150+	> 150	32	POW	640	1.753	0.95	EMC	142	1	0
Undeveloped Land Use										
Parameter	Particle Size (µm)	Fraction (%)	Buildup				Washoff			
			Function	Max. (kg/m^2)	Rate (kg/ha)	Power/Sat. Constant	Function	Coefficient (mg/L)	Exponent	BMP Effic. (%)
TSS010	< 10	4	POW	4.8	0.0132	0.95	EMC	8	1	0
TSS020	10-20	2	POW	2.4	0.00658	0.95	EMC	4	1	0
TSS050	20-50	33	POW	39.6	0.1085	0.95	EMC	66	1	0
TSS150	50-150	50	POW	60	0.1644	0.95	EMC	100	1	0
TSS150+	> 150	11	POW	13.2	0.0362	0.95	EMC	22	1	0

TSS Removal from Storage

Parameter	Particle Size (µm)	Settling Velocity (m/s)	Treatment Expression
TSS010	< 10	0.00000592	R = 0.00000592*AREA/FLOW
TSS020	10-20	0.0000473	R = 0.0000473*AREA/FLOW
TSS050	20-50	0.000283	R = 0.000283*AREA/FLOW
TSS150	50-150	0.00195	R = 0.00195*AREA/FLOW
TSS150+	> 150	0.0124	R = 0.0124*AREA/FLOW

Surface Roughness

Description	Manning 'n'
Pervious Areas	0.25
Impervious Areas	0.015

Storage Ratings

Pond 1		Pond 2		Pond 3		Pond 4		Pond 5	
Invert Elev. =	906.00	Invert Elev. =	905.00	Invert Elev. =	902.00	Invert Elev. =	906.00	Invert Elev. =	914.30
Depth (m)	Area (m2)	Depth (m)	Area (m2)	Depth (m)	Area (m2)	Depth (m)	Area (m2)	Depth (m)	Area (m2)
0.00	225	0.00	4442	0.00	2990	0.00	1583	0.00	4900
0.50	372	0.50	4912	0.50	3389	0.50	2244	0.50	5625
1.00	596	1.00	5416	1.00	3802	1.00	3019	2.70	8836
1.50	984	1.50	6262	1.50	4522	1.50	3877	2.80	8911
2.00	1412	2.00	7152	2.00	5281	2.00	4787	3.00	9120
2.50	1882	2.50	8081	2.50	6079	2.50	5747		LNWL
3.00	2392	3.00	9049	3.00	6915	3.00	6743		UNWL
3.50	2943	3.50	10058	3.50	7791	3.50	7781		HWL
4.10	3659	4.00	11106	4.00	8705	4.00	8858		
	NWL	4.60	12417	4.60	9854	4.60	10208		
	HWL		NWL		LNWL		NWL		
			HWL		UNWL		HWL		
					HWL				

Pond Discharge Outlet Ratings

Pond 1		Pond 2		Pond 3		Pond 4		Pond 5	
Invert Elev. =	908.00	Invert Elev. =	907.00	Invert Elev. =	904.00	Invert Elev. =	908.00	Invert Elev. =	914.80
Depth (m)	Rate (m^2/s)	Depth (m)	Rate (m^2/s)	Depth (m)	Rate (m^2/s)	Depth (m)	Rate (m^2/s)	Depth (m)	Rate (m^2/s)
0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.0000	0.00	0.000
0.50	0.111	0.50	0.007	0.30	0.078	0.50	0.0013	2.20	0.000
1.00	0.173	1.00	0.010	0.50	0.120	1.00	0.0019	2.30	0.120
1.50	0.218	1.50	0.012	0.60	0.136	1.50	0.0023	2.50	0.188
	NWL	2.00	0.014	0.70	0.151	2.00	0.0026		LNWL
	HWL		NWL	0.80	0.164		NWL		UNWL
			HWL	0.90	0.176		HWL		HWL
				1.00	0.188				
				1.60	0.246				
					UNWL				
					HWL				

Pump Curves

Irrigation		Storm_Pump	
Start up depth (m)	0.55	Start up depth (m)	2.05
Shutoff Depth (m)	0.50	Shutoff Depth (m)	2.00
Depth (m)	Flow (m²/s)	Depth (m)	Flow (m²/s)
0.00	0	0.00	0
0.49	0	1.99	0
0.50	0.05879	2.00	0.05879
7.50	0.05879	7.50	0.05879

Appendix B

COMPUTER MODEL INPUT & OUTPUT

September, 2016

Lincoln Ranch (Single Event).dat

B.1 INPUT DATA

```
[TITLE]

[OPTIONS]
;;Options            Value
;;------------------ ------------
FLOW_UNITS           CMS
INFILTRATION         HORTON
FLOW_ROUTING         DYNWAVE
START_DATE           06/01/2016
START_TIME           00:00:00
REPORT_START_DATE    06/01/2016
REPORT_START_TIME    00:00:00
END_DATE             06/03/2016
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:01:00
WET_STEP             00:05:00
DRY_STEP             00:05:00
ROUTING_STEP         3
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[EVAPORATION]
;;Type          Parameters
;;------------- ----------
MONTHLY      -0.06  0      0.66   2.35   3.72   4.40   4.76   3.79   2.12   0.87   0.07   -0.10
DRY_ONLY     NO

[RAINGAGES]
;;                  Rain      Time   Snow   Data
;;Name              Type      Intrvl Catch  Source
;;----------------- --------- ------ ------ ----------
Lacombe_1:100_24hr_2 INTENSITY 0:05   1.0    TIMESERIES Lacombe_1:100_24hr_2

[SUBCATCHMENTS]
;;                                                 Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
10               Lacombe_1:100_24hr_2 POND_1       5.83     23       265      2        0        Snowpack1
11               Lacombe_1:100_24hr_2 POND_2       22.94    20       655.429  2        0        Snowpack1
12               Lacombe_1:100_24hr_2 POND_3       15.78    28       450.857  2        0        Snowpack1
13               Lacombe_1:100_24hr_2 POND_4       15.39    17       439.714  2        0        Snowpack1
14               Lacombe_1:100_24hr_2 POND_5       4.5      18       225      2        0        Snowpack1
15               Lacombe_1:100_24hr_2 12           1.97     15       985      2        0        Snowpack1
16               Lacombe_1:100_24hr_2 10           2.65     5        220.833  2        0        Snowpack1
17               Lacombe_1:100_24hr_2 14           4.3      5        358.333  2        0        Snowpack1
18               Lacombe_1:100_24hr_2 13           0.78     5        97.5     2        0        Snowpack1
19               Lacombe_1:100_24hr_2 POND_3       0.88     85       1760     1.5      0        Snowpack1
S1               Lacombe_1:100_24hr_2 RAIN-GAUGE   0.001    100      3.165    10       0        Snowpack1

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
10               0.015      0.25       1.6        3.2        0          OUTLET
11               0.015      0.25       1.6        3.2        0          OUTLET
12               0.015      0.25       1.6        3.2        0          OUTLET
13               0.015      0.25       1.6        3.2        0          OUTLET
14               0.015      0.25       1.6        3.2        0          OUTLET
15               0.015      0.25       1.6        3.2        0          OUTLET
16               0.015      0.25       1.6        3.2        0          OUTLET
17               0.015      0.25       1.6        3.2        0          OUTLET
18               0.015      0.25       1.6        3.2        0          OUTLET
19               0.015      0.25       1.6        3.2        0          OUTLET
S1               0.015      0.25       0          3.2        100        OUTLET

[INFILTRATION]
```

```
;;Subcatchment   MaxRate    MinRate    Decay      DryTime    MaxInfil
;;-------------- ---------- ---------- ---------- ---------- ----------
10               75         2.5        4.14       7          0
11               75         2.5        4.14       7          0
12               75         2.5        4.14       7          0
13               75         2.5        4.14       7          0
14               75         2.5        4.14       7          0
15               75         2.5        4.14       7          0
16               75         2.5        4.14       7          0
17               75         2.5        4.14       7          0
18               75         2.5        4.14       7          0
19               75         2.5        4.14       7          0
S1               75         2.5        4.14       7          0

[SNOWPACKS]
Snowpack1        PLOWABLE   0.05       5          0.0        0.10       0.00       0.00       0.0
Snowpack1        IMPERVIOUS 0.05       5          0.0        0.10       0.00       0.00       15
Snowpack1        PERVIOUS   0.05       5          0.0        0.10       0.00       0.00       100
Snowpack1        REMOVAL    10         0.0        0.0        1          0.0        0.0

[JUNCTIONS]
;;               Invert     Max.       Init.      Surcharge  Ponded
;;Name           Elev.      Depth      Depth      Depth      Area
;;-------------- ---------- ---------- ---------- ---------- ----------
J1               908        2.1        0          0          0
J2               907        2.6        0          0          0
J4               908        2.6        0          0          0

[OUTFALLS]
;;               Invert     Outfall      Stage/Table      Tide
;;Name           Elev.      Type         Time Series      Gate Route To
;;-------------- ---------- ------------ ---------------- ---- ----------------
OF_West          905        FREE                          NO
OF6              902        FREE                          NO
OF-IRR-10        902        FREE                          NO   10
OF-IRR-11        902        FREE                          NO   11
OF-IRR-12        902        FREE                          NO   12
OF-IRR-13        902        FREE                          NO   13
OF-RG            1055       FREE                          NO

[STORAGE]
;;               Invert   Max.     Init.    Storage    Curve                    Ponded   Evap.
;;Name           Elev.    Depth    Depth    Curve      Params                   Area     Frac.
Infiltration parameters
;;-------------- -------- -------- -------- ---------- -------- -------- -------- -------- -------- -----------
------------
IRRIGATION       905      5        0        FUNCTIONAL 260500   0        0        0        0
POND_1           906      4.1      2        TABULAR    POND1                     0        1
POND_2           905      4.6      2        TABULAR    POND2                     0        1
POND_3           902      4.6      3        TABULAR    POND3                     0        1
POND_4           906      4.6      2        TABULAR    POND4                     0        1
POND_5           914.3    3.7      0.5      TABULAR    POND5                     0        1
RAIN-GAUGE       0        1        0        FUNCTIONAL 10       0        0        0        0        0
0.125    0

[CONDUITS]
;;               Inlet            Outlet                      Manning    Inlet      Outlet     Init.      Max.
;;Name           Node             Node             Length     N          Offset     Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- -----
-----
C1               RAIN-GAUGE       OF-RG            50         0.01       0.025      0          0          0
Pond_1-2         J1               POND_2           200        0.011      0          2          0          0
Pond_2-3         J2               POND_3           200        0.011      0          2          0          0
Pond_4-2         J4               POND_2           400        0.011      0          2          0          0

[PUMPS]
;;               Inlet            Outlet           Pump             Init.  Startup  Shutoff
;;Name           Node             Node             Curve            Status Depth    Depth
;;-------------- ---------------- ---------------- ---------------- ------ -------- --------
PUMP1            POND_3           POND_5           Storm_Pump       OFF    4        2
PUMP2            POND_5           IRRIGATION       Irrigation       OFF    3        0.5

[ORIFICES]
;;               Inlet            Outlet           Orifice      Crest      Disch.     Flap Open/Close
;;Name           Node             Node             Type         Height     Coeff.     Gate Time
;;-------------- ---------------- ---------------- ------------ ---------- ---------- ---- ----------
ICD_1            POND_1           J1               SIDE         2          0.6        NO   0
ICD_2            POND_2           J2               SIDE         2          0.6        NO   0
ICD_4            POND_4           J4               SIDE         2          0.6        NO   0

[OUTLETS]
;;               Inlet            Outlet           Outflow    Outlet           Qcoeff/                    Flap
;;Name           Node             Node             Height     Type             QTable           Qexpon    Gate
;;-------------- ---------------- ---------------- ---------- ---------------- ---------------- ---------- ----
OL-IRR-10        IRRIGATION       OF-IRR-10        0          FUNCTIONAL/DEPTH 0.001138         0          NO
OL-IRR-11        IRRIGATION       OF-IRR-11        0          FUNCTIONAL/DEPTH 0.004212         0          NO
OL-IRR-12        IRRIGATION       OF-IRR-12        0          FUNCTIONAL/DEPTH 0.003            0          NO
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OL-IRR-13        IRRIGATION       OF-IRR-13        0          FUNCTIONAL/DEPTH 0.002429         0          NO
OL-IRR-EFFICIENCY IRRIGATION      OF6              0          FUNCTIONAL/DEPTH 0.00147          0          NO
OL-POND3-OF      POND_3           OF_West          3          TABULAR/DEPTH    OL-POND3-TOTAL              NO

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels
;;-------------- ------------ ---------------- ---------- ---------- ---------- ----------
C1               CIRCULAR     0.5              0          0          0          1
Pond_1-2         CIRCULAR     0.299            0          0          0          1
Pond_2-3         CIRCULAR     0.299            0          0          0          1
Pond_4-2         CIRCULAR     0.299            0          0          0          1
ICD_1            CIRCULAR     0.3              0          0          0
ICD_2            CIRCULAR     0.07             0          0          0
ICD_4            CIRCULAR     0.03             0          0          0

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------

[CONTROLS]
RULE 1
IF SIMULATION MONTH < 5
OR SIMULATION MONTH > 9
THEN PUMP PUMP2 STATUS = OFF
PRIORITY 1
RULE 2
IF NODE RAIN-GAUGE DEPTH > .006
THEN PUMP PUMP2 STATUS = OFF
PRIORITY 2
RULE 3
IF NODE IRRIGATION DEPTH > 0.0284
THEN PUMP PUMP2 STATUS = OFF
PRIORITY 3
RULE 4
IF SIMULATION MONTH < 5
OR SIMULATION MONTH > 9
THEN PUMP PUMP1 STATUS = OFF
PRIORITY 1
RULE 5
IF NODE RAIN-GAUGE DEPTH > .006
THEN PUMP PUMP1 STATUS = OFF
PRIORITY 2
RULE 6
IF NODE IRRIGATION DEPTH > 0.0284
THEN PUMP PUMP1 STATUS = OFF
PRIORITY 3
RULE 7
IF NODE POND_5 DEPTH < .5
THEN PUMP PUMP1 STATUS = OFF
PRIORITY 1

[POLLUTANTS]
;;               Mass   Rain       GW         I&I        Decay      Snow  Co-Pollut.       Co-Pollut. DWF
Init.
;;Name          Units  Concen.    Concen.    Concen.    Coeff.     Only  Name             Fraction   Concen.
Concen.
;;-------------- ------ ---------- ---------- ---------- ---------- ----- ---------------- ---------- ---------
- ----------
TSS0_10          MG/L   0          0          0          0          NO    *                0.0        0
0
TSS10_20         MG/L   0          0          0          0          NO    *                0.0        0
0
TSS150_500       MG/L   0          0          0          0          NO    *                0.0        0
0
TSS20_50         MG/L   0          0          0          0          NO    *                0.0        0
0
TSS50_150        MG/L   0          0          0          0          NO    *                0.0        0
0

[LANDUSES]
;;               Cleaning   Fraction   Last
;;Name          Interval   Available  Cleaned
;;-------------- ---------- ---------- ----------
Landscaped       0          0          0
Pavement         0          0          0

[COVERAGES]
;;Subcatchment   Land Use         Percent
;;-------------- ---------------- ----------
10               Landscaped       77
10               Pavement         23
11               Landscaped       80
11               Pavement         20
12               Landscaped       72
12               Pavement         28
13               Landscaped       83
13               Pavement         17
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14              Landscaped      82
14              Pavement        18
15              Landscaped      85
15              Pavement        15
16              Landscaped      95
16              Pavement        5
17              Landscaped      95
17              Pavement        5
18              Landscaped      95
18              Pavement        5
19              Landscaped      15
19              Pavement        85

[LOADINGS]
;;Subcatchment   Pollutant       Loading
;;-------------- --------------- ----------

[BUILDUP]
;;LandUse        Pollutant       Function   Coeff1     Coeff2     Coeff3     Normalizer
;;-------------- --------------- ---------- ---------- ---------- ---------- ----------
Landscaped      TSS0_10         POW        460        1.265      0.95       AREA
Landscaped      TSS10_20        POW        180        0.495      0.95       AREA
Landscaped      TSS150_500      POW        640        1.76       0.95       AREA
Landscaped      TSS20_50        POW        260        0.715      0.95       AREA
Landscaped      TSS50_150       POW        460        1.265      0.95       AREA
Pavement        TSS0_10         POW        460        1.265      0.95       AREA
Pavement        TSS10_20        POW        180        0.495      0.95       AREA
Pavement        TSS150_500      POW        640        1.76       0.95       AREA
Pavement        TSS20_50        POW        260        0.715      0.95       AREA
Pavement        TSS50_150       POW        460        1.265      0.95       AREA

[WASHOFF]
;;                                                                 Cleaning   BMP
;;Land Use       Pollutant       Function   Coeff1     Coeff2     Effic.     Effic.
;;-------------- --------------- ---------- ---------- ---------- ---------- ----------
Landscaped      TSS0_10         EXP        0.00043    1.2        0.0        55
Landscaped      TSS10_20        EXP        0.00017    1.2        0.0        55
Landscaped      TSS150_500      EXP        0.0006     1.2        0.0        55
Landscaped      TSS20_50        EXP        0.00029    1.2        0.0        55
Landscaped      TSS50_150       EXP        0.00047    1.2        0.0        55
Pavement        TSS0_10         EXP        0.00086    1.2        0          55
Pavement        TSS10_20        EXP        0.00034    1.2        0.0        55
Pavement        TSS150_500      EXP        0.0012     1.2        0.0        55
Pavement        TSS20_50        EXP        0.00058    1.2        0.0        55
Pavement        TSS50_150       EXP        0.00093    1.2        0.0        55

[TREATMENT]
;;Node           Pollutant       Function
;;-------------- --------------- ----------
POND_1          TSS0_10         R=0.00000592*AREA/FLOW
POND_1          TSS10_20        R=0.0000473*AREA/FLOW
POND_1          TSS150_500      R=0.0124*AREA/FLOW
POND_1          TSS20_50        R=0.000283*AREA/FLOW
POND_1          TSS50_150       R=0.00195*AREA/FLOW
POND_2          TSS0_10         R=0.00000592*AREA/FLOW
POND_2          TSS10_20        R=0.0000473*AREA/FLOW
POND_2          TSS150_500      R=0.0124*AREA/FLOW
POND_2          TSS20_50        R=0.000283*AREA/FLOW
POND_2          TSS50_150       R=0.00195*AREA/FLOW
POND_3          TSS0_10         R=0.00000592*AREA/FLOW
POND_3          TSS10_20        R=0.0000473*AREA/FLOW
POND_3          TSS150_500      R=0.0124*AREA/FLOW
POND_3          TSS20_50        R=0.000283*AREA/FLOW
POND_3          TSS50_150       R=0.00195*AREA/FLOW
POND_4          TSS0_10         R=0.00000592*AREA/FLOW
POND_4          TSS10_20        R=0.0000473*AREA/FLOW
POND_4          TSS150_500      R=0.0124*AREA/FLOW
POND_4          TSS20_50        R=0.000283*AREA/FLOW
POND_4          TSS50_150       R=0.00195*AREA/FLOW

[INFLOWS]
;;                                                 Param    Units    Scale    Baseline Baseline
;;Node           Parameter       Time Series      Type     Factor   Factor   Value    Pattern
;;-------------- --------------- ---------------- -------- -------- -------- -------- --------
POND_5          FLOW            ""               FLOW     1.0      1        0.001447 Summer-winter

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
Irrigation      Pump2      0          0
Irrigation                 0.01       0.05879
Irrigation                 7.5        0.05879

Storm_Pump      Pump2      0          0
Storm_Pump                 1.99       0
Storm_Pump                 2.00       0.05879
Storm_Pump                 7.5        0.05879
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OL-POND3-TOTAL   Rating     0.000      0.0000
OL-POND3-TOTAL              0.300      0.0775
OL-POND3-TOTAL              0.500      0.1199
OL-POND3-TOTAL              0.600      0.1362
OL-POND3-TOTAL              0.700      0.1508
OL-POND3-TOTAL              0.800      0.1640
OL-POND3-TOTAL              0.900      0.1763
OL-POND3-TOTAL              1.000      0.1878
OL-POND3-TOTAL              1.600      0.2457

POND1            Storage    0.0        225
POND1                       0.5        372
POND1                       1.0        596
POND1                       1.5        984
POND1                       2.0        1412
POND1                       2.5        1882
POND1                       3.0        2392
POND1                       3.5        2943
POND1                       4.1        3659

POND2            Storage    0.0        4442
POND2                       0.5        4912
POND2                       1.0        5416
POND2                       1.5        6262
POND2                       2.0        7152
POND2                       2.5        8081
POND2                       3.0        9049
POND2                       3.5        10058
POND2                       4.0        11106
POND2                       4.6        12417

POND3            Storage    0.0        2990
POND3                       0.5        3389
POND3                       1.0        3802
POND3                       1.5        4522
POND3                       2.0        5281
POND3                       2.5        6079
POND3                       3.0        6915
POND3                       3.5        7791
POND3                       4.0        8705
POND3                       4.6        9854

POND4            Storage    0.0        1583
POND4                       0.5        2244
POND4                       1.0        3019
POND4                       1.5        3877
POND4                       2.0        4787
POND4                       2.5        5747
POND4                       3.0        6743
POND4                       3.5        7781
POND4                       4.0        8858
POND4                       4.6        10208

POND5            Storage    0.0        4900
POND5                       0.5        5625
POND5                       2.7        8836
POND5                       2.8        8911
POND5                       3.0        9120

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
;Chicago design storm, a = 1396, b = 7.03, c =
0.797, Duration = 1440 minutes, r = 0.3, rain units
= mm/hr.
Lacombe_1:100_24hr_2            0:00       0.878
Lacombe_1:100_24hr_2            0:05       0.887
Lacombe_1:100_24hr_2            0:10       0.895
Lacombe_1:100_24hr_2            0:15       0.904
Lacombe_1:100_24hr_2            0:20       0.913
Lacombe_1:100_24hr_2            0:25       0.922
Lacombe_1:100_24hr_2            0:30       0.932
Lacombe_1:100_24hr_2            0:35       0.941
Lacombe_1:100_24hr_2            0:40       0.951
Lacombe_1:100_24hr_2            0:45       0.961
Lacombe_1:100_24hr_2            0:50       0.971
Lacombe_1:100_24hr_2            0:55       0.982
Lacombe_1:100_24hr_2            1:00       0.993
Lacombe_1:100_24hr_2            1:05       1.004
Lacombe_1:100_24hr_2            1:10       1.015
Lacombe_1:100_24hr_2            1:15       1.027
Lacombe_1:100_24hr_2            1:20       1.039
Lacombe_1:100_24hr_2            1:25       1.051
Lacombe_1:100_24hr_2            1:30       1.064
Lacombe_1:100_24hr_2            1:35       1.077
Lacombe_1:100_24hr_2            1:40       1.09
Lacombe_1:100_24hr_2            1:45       1.104
Lacombe_1:100_24hr_2            1:50       1.118
Lacombe_1:100_24hr_2            1:55       1.132
Lacombe_1:100_24hr_2            2:00       1.147
Lacombe_1:100_24hr_2            2:05       1.163
Lacombe_1:100_24hr_2            2:10       1.178
Lacombe_1:100_24hr_2            2:15       1.195
Lacombe_1:100_24hr_2            2:20       1.212
Lacombe_1:100_24hr_2            2:25       1.229
Lacombe_1:100_24hr_2            2:30       1.247
Lacombe_1:100_24hr_2            2:35       1.266
Lacombe_1:100_24hr_2            2:40       1.285
Lacombe_1:100_24hr_2            2:45       1.305
Lacombe_1:100_24hr_2            2:50       1.325
Lacombe_1:100_24hr_2            2:55       1.347
Lacombe_1:100_24hr_2            3:00       1.369
Lacombe_1:100_24hr_2            3:05       1.392
Lacombe_1:100_24hr_2            3:10       1.416
Lacombe_1:100_24hr_2            3:15       1.44
Lacombe_1:100_24hr_2            3:20       1.466
Lacombe_1:100_24hr_2            3:25       1.493
Lacombe_1:100_24hr_2            3:30       1.521
Lacombe_1:100_24hr_2            3:35       1.55
Lacombe_1:100_24hr_2            3:40       1.581
Lacombe_1:100_24hr_2            3:45       1.613
Lacombe_1:100_24hr_2            3:50       1.646
Lacombe_1:100_24hr_2            3:55       1.681
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Lacombe_1:100_24hr_2	4:00	1.718	Lacombe_1:100_24hr_2	11:15	2.815
Lacombe_1:100_24hr_2	4:05	1.756	Lacombe_1:100_24hr_2	11:20	2.767
Lacombe_1:100_24hr_2	4:10	1.797	Lacombe_1:100_24hr_2	11:25	2.721
Lacombe_1:100_24hr_2	4:15	1.839	Lacombe_1:100_24hr_2	11:30	2.677
Lacombe_1:100_24hr_2	4:20	1.885	Lacombe_1:100_24hr_2	11:35	2.634
Lacombe_1:100_24hr_2	4:25	1.932	Lacombe_1:100_24hr_2	11:40	2.592
Lacombe_1:100_24hr_2	4:30	1.983	Lacombe_1:100_24hr_2	11:45	2.552
Lacombe_1:100_24hr_2	4:35	2.036	Lacombe_1:100_24hr_2	11:50	2.514
Lacombe_1:100_24hr_2	4:40	2.093	Lacombe_1:100_24hr_2	11:55	2.477
Lacombe_1:100_24hr_2	4:45	2.153	Lacombe_1:100_24hr_2	12:00	2.441
Lacombe_1:100_24hr_2	4:50	2.218	Lacombe_1:100_24hr_2	12:05	2.406
Lacombe_1:100_24hr_2	4:55	2.287	Lacombe_1:100_24hr_2	12:10	2.372
Lacombe_1:100_24hr_2	5:00	2.361	Lacombe_1:100_24hr_2	12:15	2.339
Lacombe_1:100_24hr_2	5:05	2.441	Lacombe_1:100_24hr_2	12:20	2.307
Lacombe_1:100_24hr_2	5:10	2.527	Lacombe_1:100_24hr_2	12:25	2.277
Lacombe_1:100_24hr_2	5:15	2.62	Lacombe_1:100_24hr_2	12:30	2.247
Lacombe_1:100_24hr_2	5:20	2.721	Lacombe_1:100_24hr_2	12:35	2.218
Lacombe_1:100_24hr_2	5:25	2.832	Lacombe_1:100_24hr_2	12:40	2.19
Lacombe_1:100_24hr_2	5:30	2.953	Lacombe_1:100_24hr_2	12:45	2.162
Lacombe_1:100_24hr_2	5:35	3.086	Lacombe_1:100_24hr_2	12:50	2.136
Lacombe_1:100_24hr_2	5:40	3.233	Lacombe_1:100_24hr_2	12:55	2.11
Lacombe_1:100_24hr_2	5:45	3.398	Lacombe_1:100_24hr_2	13:00	2.084
Lacombe_1:100_24hr_2	5:50	3.582	Lacombe_1:100_24hr_2	13:05	2.06
Lacombe_1:100_24hr_2	5:55	3.79	Lacombe_1:100_24hr_2	13:10	2.036
Lacombe_1:100_24hr_2	6:00	4.026	Lacombe_1:100_24hr_2	13:15	2.013
Lacombe_1:100_24hr_2	6:05	4.299	Lacombe_1:100_24hr_2	13:20	1.99
Lacombe_1:100_24hr_2	6:10	4.616	Lacombe_1:100_24hr_2	13:25	1.968
Lacombe_1:100_24hr_2	6:15	4.991	Lacombe_1:100_24hr_2	13:30	1.946
Lacombe_1:100_24hr_2	6:20	5.439	Lacombe_1:100_24hr_2	13:35	1.925
Lacombe_1:100_24hr_2	6:25	5.988	Lacombe_1:100_24hr_2	13:40	1.905
Lacombe_1:100_24hr_2	6:30	6.676	Lacombe_1:100_24hr_2	13:45	1.884
Lacombe_1:100_24hr_2	6:35	7.564	Lacombe_1:100_24hr_2	13:50	1.865
Lacombe_1:100_24hr_2	6:40	8.757	Lacombe_1:100_24hr_2	13:55	1.846
Lacombe_1:100_24hr_2	6:45	10.448	Lacombe_1:100_24hr_2	14:00	1.827
Lacombe_1:100_24hr_2	6:50	13.037	Lacombe_1:100_24hr_2	14:05	1.809
Lacombe_1:100_24hr_2	6:55	17.501	Lacombe_1:100_24hr_2	14:10	1.791
Lacombe_1:100_24hr_2	7:00	26.972	Lacombe_1:100_24hr_2	14:15	1.773
Lacombe_1:100_24hr_2	7:05	59.348	Lacombe_1:100_24hr_2	14:20	1.756
Lacombe_1:100_24hr_2	7:10	190.483	Lacombe_1:100_24hr_2	14:25	1.739
Lacombe_1:100_24hr_2	7:15	97.568	Lacombe_1:100_24hr_2	14:30	1.723
Lacombe_1:100_24hr_2	7:20	55.126	Lacombe_1:100_24hr_2	14:35	1.707
Lacombe_1:100_24hr_2	7:25	37.795	Lacombe_1:100_24hr_2	14:40	1.691
Lacombe_1:100_24hr_2	7:30	28.616	Lacombe_1:100_24hr_2	14:45	1.676
Lacombe_1:100_24hr_2	7:35	23.002	Lacombe_1:100_24hr_2	14:50	1.661
Lacombe_1:100_24hr_2	7:40	19.24	Lacombe_1:100_24hr_2	14:55	1.646
Lacombe_1:100_24hr_2	7:45	16.552	Lacombe_1:100_24hr_2	15:00	1.632
Lacombe_1:100_24hr_2	7:50	14.54	Lacombe_1:100_24hr_2	15:05	1.617
Lacombe_1:100_24hr_2	7:55	12.979	Lacombe_1:100_24hr_2	15:10	1.603
Lacombe_1:100_24hr_2	8:00	11.734	Lacombe_1:100_24hr_2	15:15	1.59
Lacombe_1:100_24hr_2	8:05	10.718	Lacombe_1:100_24hr_2	15:20	1.576
Lacombe_1:100_24hr_2	8:10	9.872	Lacombe_1:100_24hr_2	15:25	1.563
Lacombe_1:100_24hr_2	8:15	9.158	Lacombe_1:100_24hr_2	15:30	1.55
Lacombe_1:100_24hr_2	8:20	8.546	Lacombe_1:100_24hr_2	15:35	1.538
Lacombe_1:100_24hr_2	8:25	8.017	Lacombe_1:100_24hr_2	15:40	1.525
Lacombe_1:100_24hr_2	8:30	7.554	Lacombe_1:100_24hr_2	15:45	1.513
Lacombe_1:100_24hr_2	8:35	7.145	Lacombe_1:100_24hr_2	15:50	1.501
Lacombe_1:100_24hr_2	8:40	6.781	Lacombe_1:100_24hr_2	15:55	1.489
Lacombe_1:100_24hr_2	8:45	6.456	Lacombe_1:100_24hr_2	16:00	1.478
Lacombe_1:100_24hr_2	8:50	6.163	Lacombe_1:100_24hr_2	16:05	1.466
Lacombe_1:100_24hr_2	8:55	5.898	Lacombe_1:100_24hr_2	16:10	1.455
Lacombe_1:100_24hr_2	9:00	5.657	Lacombe_1:100_24hr_2	16:15	1.444
Lacombe_1:100_24hr_2	9:05	5.436	Lacombe_1:100_24hr_2	16:20	1.433
Lacombe_1:100_24hr_2	9:10	5.234	Lacombe_1:100_24hr_2	16:25	1.423
Lacombe_1:100_24hr_2	9:15	5.047	Lacombe_1:100_24hr_2	16:30	1.412
Lacombe_1:100_24hr_2	9:20	4.875	Lacombe_1:100_24hr_2	16:35	1.402
Lacombe_1:100_24hr_2	9:25	4.715	Lacombe_1:100_24hr_2	16:40	1.392
Lacombe_1:100_24hr_2	9:30	4.566	Lacombe_1:100_24hr_2	16:45	1.382
Lacombe_1:100_24hr_2	9:35	4.427	Lacombe_1:100_24hr_2	16:50	1.372
Lacombe_1:100_24hr_2	9:40	4.297	Lacombe_1:100_24hr_2	16:55	1.362
Lacombe_1:100_24hr_2	9:45	4.176	Lacombe_1:100_24hr_2	17:00	1.353
Lacombe_1:100_24hr_2	9:50	4.062	Lacombe_1:100_24hr_2	17:05	1.344
Lacombe_1:100_24hr_2	9:55	3.954	Lacombe_1:100_24hr_2	17:10	1.334
Lacombe_1:100_24hr_2	10:00	3.853	Lacombe_1:100_24hr_2	17:15	1.325
Lacombe_1:100_24hr_2	10:05	3.757	Lacombe_1:100_24hr_2	17:20	1.316
Lacombe_1:100_24hr_2	10:10	3.667	Lacombe_1:100_24hr_2	17:25	1.308
Lacombe_1:100_24hr_2	10:15	3.581	Lacombe_1:100_24hr_2	17:30	1.299
Lacombe_1:100_24hr_2	10:20	3.499	Lacombe_1:100_24hr_2	17:35	1.29
Lacombe_1:100_24hr_2	10:25	3.422	Lacombe_1:100_24hr_2	17:40	1.282
Lacombe_1:100_24hr_2	10:30	3.348	Lacombe_1:100_24hr_2	17:45	1.274
Lacombe_1:100_24hr_2	10:35	3.278	Lacombe_1:100_24hr_2	17:50	1.266
Lacombe_1:100_24hr_2	10:40	3.211	Lacombe_1:100_24hr_2	17:55	1.258
Lacombe_1:100_24hr_2	10:45	3.147	Lacombe_1:100_24hr_2	18:00	1.25
Lacombe_1:100_24hr_2	10:50	3.085	Lacombe_1:100_24hr_2	18:05	1.242
Lacombe_1:100_24hr_2	10:55	3.027	Lacombe_1:100_24hr_2	18:10	1.234
Lacombe_1:100_24hr_2	11:00	2.971	Lacombe_1:100_24hr_2	18:15	1.226
Lacombe_1:100_24hr_2	11:05	2.917	Lacombe_1:100_24hr_2	18:20	1.219
Lacombe_1:100_24hr_2	11:10	2.865	Lacombe_1:100_24hr_2	18:25	1.212

```
Lacombe_1:100_24hr_2            18:30      1.204
Lacombe_1:100_24hr_2            18:35      1.197
Lacombe_1:100_24hr_2            18:40      1.19
Lacombe_1:100_24hr_2            18:45      1.183
Lacombe_1:100_24hr_2            18:50      1.176
Lacombe_1:100_24hr_2            18:55      1.169
Lacombe_1:100_24hr_2            19:00      1.163
Lacombe_1:100_24hr_2            19:05      1.156
Lacombe_1:100_24hr_2            19:10      1.149
Lacombe_1:100_24hr_2            19:15      1.143
Lacombe_1:100_24hr_2            19:20      1.136
Lacombe_1:100_24hr_2            19:25      1.13
Lacombe_1:100_24hr_2            19:30      1.124
Lacombe_1:100_24hr_2            19:35      1.118
Lacombe_1:100_24hr_2            19:40      1.112
Lacombe_1:100_24hr_2            19:45      1.106
Lacombe_1:100_24hr_2            19:50      1.1
Lacombe_1:100_24hr_2            19:55      1.094
Lacombe_1:100_24hr_2            20:00      1.088
Lacombe_1:100_24hr_2            20:05      1.082
Lacombe_1:100_24hr_2            20:10      1.077
Lacombe_1:100_24hr_2            20:15      1.071
Lacombe_1:100_24hr_2            20:20      1.066
Lacombe_1:100_24hr_2            20:25      1.06
Lacombe_1:100_24hr_2            20:30      1.055
Lacombe_1:100_24hr_2            20:35      1.049
Lacombe_1:100_24hr_2            20:40      1.044
Lacombe_1:100_24hr_2            20:45      1.039
Lacombe_1:100_24hr_2            20:50      1.034
Lacombe_1:100_24hr_2            20:55      1.029
Lacombe_1:100_24hr_2            21:00      1.024
Lacombe_1:100_24hr_2            21:05      1.019
Lacombe_1:100_24hr_2            21:10      1.014
Lacombe_1:100_24hr_2            21:15      1.009
Lacombe_1:100_24hr_2            21:20      1.004
Lacombe_1:100_24hr_2            21:25      0.999
Lacombe_1:100_24hr_2            21:30      0.994
Lacombe_1:100_24hr_2            21:35      0.99
Lacombe_1:100_24hr_2            21:40      0.985
Lacombe_1:100_24hr_2            21:45      0.98
Lacombe_1:100_24hr_2            21:50      0.976
Lacombe_1:100_24hr_2            21:55      0.971
Lacombe_1:100_24hr_2            22:00      0.967
Lacombe_1:100_24hr_2            22:05      0.963
Lacombe_1:100_24hr_2            22:10      0.958
Lacombe_1:100_24hr_2            22:15      0.954
Lacombe_1:100_24hr_2            22:20      0.95
Lacombe_1:100_24hr_2            22:25      0.945
Lacombe_1:100_24hr_2            22:30      0.941
Lacombe_1:100_24hr_2            22:35      0.937
Lacombe_1:100_24hr_2            22:40      0.933
Lacombe_1:100_24hr_2            22:45      0.929
Lacombe_1:100_24hr_2            22:50      0.925
Lacombe_1:100_24hr_2            22:55      0.921
Lacombe_1:100_24hr_2            23:00      0.917
Lacombe_1:100_24hr_2            23:05      0.913
Lacombe_1:100_24hr_2            23:10      0.909
Lacombe_1:100_24hr_2            23:15      0.905
Lacombe_1:100_24hr_2            23:20      0.902
Lacombe_1:100_24hr_2            23:25      0.898
Lacombe_1:100_24hr_2            23:30      0.894
Lacombe_1:100_24hr_2            23:35      0.891
Lacombe_1:100_24hr_2            23:40      0.887
Lacombe_1:100_24hr_2            23:45      0.883
Lacombe_1:100_24hr_2            23:50      0.88
Lacombe_1:100_24hr_2            23:55      0.876
Lacombe_1:100_24hr_2            24:00      0

[PATTERNS]
;;Name           Type       Multipliers
;;-------------- ---------- -----------
;Summer months is 40 m³/day from degraffs and
winter months is 4 m³/day.
Summer-winter    MONTHLY    0.28  0.28  0.28  0.28
1.0   1.0
Summer-winter                1.0   1.0   1.0   0.28
0.28  0.28


[REPORT]
INPUT      YES
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL
```

B.2 OUTPUT DATA

Lincoln Ranch (Single Event).out

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)
--------------------------------------------------------------

WARNING 08: elevation drop exceeds length for Conduit C1
WARNING 10: crest elevation is below downstream invert for regulator Link ICD_2

*************
Element Count
*************
Number of rain gages ...... 1
Number of subcatchments ... 11
Number of nodes ........... 17
Number of links ........... 15
Number of pollutants ...... 5
Number of land uses ....... 2


*****************
Pollutant Summary
*****************
                            Ppt.      GW         Kdecay
Name                 Units  Concen.   Concen.    1/days    CoPollutant
-------------------------------------------------------------------------
TSS0_10               MG/L      0.00      0.00      0.00
TSS10_20              MG/L      0.00      0.00      0.00
TSS150_500            MG/L      0.00      0.00      0.00
TSS20_50              MG/L      0.00      0.00      0.00
TSS50_150             MG/L      0.00      0.00      0.00


***************
Landuse Summary
***************
                      Sweeping   Maximum      Last
Name                  Interval   Removal     Swept
-----------------------------------------------------
Landscaped                0.00      0.00      0.00
Pavement                  0.00      0.00      0.00


****************
Raingage Summary
****************
                                                    Data       Recording
Name                 Data Source                    Type       Interval
-----------------------------------------------------------------------
Lacombe_1:100_24hr_2 Lacombe_1:100_24hr_2           INTENSITY    5 min.


*******************
Subcatchment Summary
*******************
Name                        Area     Width   %Imperv    %Slope Rain Gage            Outlet
-------------------------------------------------------------------------------------------------
10                          5.83    265.00     23.00    2.0000 Lacombe_1:100_24hr_2 POND_1
11                         22.94    655.43     20.00    2.0000 Lacombe_1:100_24hr_2 POND_2
12                         15.78    450.86     28.00    2.0000 Lacombe_1:100_24hr_2 POND_3
13                         15.39    439.71     17.00    2.0000 Lacombe_1:100_24hr_2 POND_4
14                          4.50    225.00     18.00    2.0000 Lacombe_1:100_24hr_2 POND_5
15                          1.97    985.00     15.00    2.0000 Lacombe_1:100_24hr_2 12
16                          2.65    220.83      5.00    2.0000 Lacombe_1:100_24hr_2 10
17                          4.30    358.33      5.00    2.0000 Lacombe_1:100_24hr_2 14
18                          0.78     97.50      5.00    2.0000 Lacombe_1:100_24hr_2 13
19                          0.88   1760.00     85.00    1.5000 Lacombe_1:100_24hr_2 POND_3
S1                          0.00      3.17    100.00   10.0000 Lacombe_1:100_24hr_2 RAIN-GAUGE


************
Node Summary
************
                                    Invert      Max.    Ponded    External
Name                 Type            Elev.     Depth      Area    Inflow
-----------------------------------------------------------------------------
J1                   JUNCTION          908.00      2.10       0.0
J2                   JUNCTION          907.00      2.60       0.0
J4                   JUNCTION          908.00      2.60       0.0
OF_West              OUTFALL           905.00      0.00       0.0
OF6                  OUTFALL           902.00      0.00       0.0
OF-IRR-10            OUTFALL           902.00      0.00       0.0
OF-IRR-11            OUTFALL           902.00      0.00       0.0
```

OF-IRR-12	OUTFALL	902.00	0.00	0.0	
OF-IRR-13	OUTFALL	902.00	0.00	0.0	
OF-RG	OUTFALL	1055.00	0.50	0.0	
IRRIGATION	STORAGE	905.00	5.00	0.0	
POND_1	STORAGE	906.00	4.10	0.0	
POND_2	STORAGE	905.00	4.60	0.0	
POND_3	STORAGE	902.00	4.60	0.0	
POND_4	STORAGE	906.00	4.60	0.0	
POND_5	STORAGE	914.30	3.70	0.0	Yes
RAIN-GAUGE	STORAGE	0.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	RAIN-GAUGE	OF-RG	CONDUIT	50.0-2109.9500		0.0100
Pond_1-2	J1	POND_2	CONDUIT	200.0	0.5000	0.0110
Pond_2-3	J2	POND_3	CONDUIT	200.0	1.5002	0.0110
Pond_4-2	J4	POND_2	CONDUIT	400.0	0.2500	0.0110
PUMP1	POND_3	POND_5	TYPE2 PUMP			
PUMP2	POND_5	IRRIGATION	TYPE2 PUMP			
ICD_1	POND_1	J1	ORIFICE			
ICD_2	POND_2	J2	ORIFICE			
ICD_4	POND_4	J4	ORIFICE			
OL-IRR-10	IRRIGATION	OF-IRR-10	OUTLET			
OL-IRR-11	IRRIGATION	OF-IRR-11	OUTLET			
OL-IRR-12	IRRIGATION	OF-IRR-12	OUTLET			
OL-IRR-13	IRRIGATION	OF-IRR-13	OUTLET			
OL-IRR-EFFICIENCY	IRRIGATION	OF6	OUTLET			
OL-POND3-OF	POND_3	OF_West	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	CIRCULAR	0.50	0.20	0.12	0.50	1	22.55
Pond_1-2	CIRCULAR	0.30	0.07	0.07	0.30	1	0.08
Pond_2-3	CIRCULAR	0.30	0.07	0.07	0.30	1	0.14
Pond_4-2	CIRCULAR	0.30	0.07	0.07	0.30	1	0.06

****
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 ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... YES
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... YES
Infiltration Method ..... HORTON
Flow Routing Method ..... DYNWAVE
Starting Date JUN-01-2016 00:00:00
Ending Date JUN-03-2016 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:01:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step ..... 3.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Initial Snow Cover	0.000	0.000
Total Precipitation	7.610	101.438
Evaporation Loss	0.222	2.964
Infiltration Loss	3.206	42.740

Surface Runoff	4.196	55.929
Snow Removed	0.000	0.000
Final Snow Cover	0.000	0.000
Final Storage	0.000	0.000
Continuity Error (%)	-0.193	

Runoff Quality Continuity	TSS0_10 kg	TSS10_20 kg	TSS150_500 kg	TSS20_50 kg	TSS50_150 kg
Initial Buildup	0.000	0.000	0.000	0.000	0.000
Surface Buildup	101.479	39.696	141.220	57.347	101.484
Wet Deposition	0.000	0.000	0.000	0.000	0.000
Sweeping Removal	0.000	0.000	0.000	0.000	0.000
Infiltration Loss	0.004	0.001	0.007	0.001	0.004
BMP Removal	0.272	0.043	0.522	0.105	0.296
Surface Runoff	0.201	0.032	0.386	0.078	0.219
Remaining Buildup	101.001	39.620	140.303	57.163	100.965
Continuity Error (%)	0.000	0.000	0.001	0.000	0.000

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	4.196	41.959
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.025	0.250
External Outflow	1.264	12.638
Flooding Loss	0.000	0.000
Evaporation Loss	0.029	0.291
Exfiltration Loss	0.000	0.000
Initial Stored Volume	3.539	35.389
Final Stored Volume	6.459	64.587
Continuity Error (%)	0.107	

Quality Routing Continuity	TSS0_10 kg	TSS10_20 kg	TSS150_500 kg	TSS20_50 kg	TSS50_150 kg
Dry Weather Inflow	0.000	0.000	0.000	0.000	0.000
Wet Weather Inflow	0.201	0.032	0.386	0.078	0.219
Groundwater Inflow	0.000	0.000	0.000	0.000	0.000
RDII Inflow	0.000	0.000	0.000	0.000	0.000
External Inflow	0.000	0.000	0.000	0.000	0.000
External Outflow	0.007	0.000	0.000	0.000	0.000
Flooding Loss	0.000	0.000	0.000	0.000	0.000
Exfiltration Loss	0.000	0.000	0.000	0.000	0.000
Mass Reacted	0.169	0.028	0.338	0.068	0.191
Initial Stored Mass	0.000	0.000	0.000	0.000	0.000
Final Stored Mass	0.025	0.004	0.048	0.010	0.028
Continuity Error (%)	0.093	0.053	-0.001	0.000	-0.001

Highest Continuity Errors

Node J4 (9.60%)

Time-Step Critical Elements

None

Highest Flow Instability Indexes

All links are stable.

Routing Time Step Summary

Minimum Time Step	:	2.50 sec
Average Time Step	:	3.00 sec
Maximum Time Step	:	3.00 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 CMS	Runoff Coeff
10	101.44	22.83	3.04	41.15	80.27	4.68	0.89	0.646
11	101.44	0.00	3.00	43.16	55.45	12.72	2.75	0.547
12	101.44	7.09	3.32	38.86	66.57	10.50	2.45	0.613
13	101.44	2.58	2.91	44.96	56.30	8.66	1.64	0.541
14	101.44	47.99	2.90	44.31	102.40	4.61	0.62	0.685
15	101.44	0.00	2.34	42.97	56.80	1.12	0.61	0.560
16	101.44	0.00	2.12	49.29	50.22	1.33	0.28	0.495
17	101.44	0.00	2.12	49.29	50.22	2.16	0.45	0.495
18	101.44	0.00	2.04	48.80	50.86	0.40	0.10	0.501
19	101.44	0.00	5.36	7.54	88.74	0.78	0.46	0.875
S1	101.44	0.00	4.40	0.00	97.05	0.00	0.00	0.957

****
Subcatchment Washoff Summary
****

Subcatchment	TSS0_10 kg	TSS10_20 kg	TSS150_500 kg	TSS20_50 kg	TSS50_150 kg
10	0.024	0.004	0.046	0.009	0.026
11	0.056	0.009	0.109	0.022	0.061
12	0.052	0.008	0.099	0.020	0.056
13	0.038	0.006	0.073	0.015	0.041
14	0.025	0.004	0.048	0.010	0.028
15	0.005	0.001	0.010	0.002	0.006
16	0.005	0.001	0.010	0.002	0.006
17	0.009	0.001	0.017	0.003	0.010
18	0.002	0.000	0.003	0.001	0.002
19	0.006	0.001	0.011	0.002	0.006
S1	0.000	0.000	0.000	0.000	0.000
System	0.223	0.035	0.427	0.086	0.242

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.70	1.27	909.27	0 11:09	0.39
J2	JUNCTION	0.05	0.06	907.06	1 00:51	0.02
J4	JUNCTION	0.53	0.73	908.73	1 00:50	0.22
OF_West	OUTFALL	0.00	0.00	905.00	0 00:00	0.00
OF6	OUTFALL	0.00	0.00	902.00	0 00:00	0.00
OF-IRR-10	OUTFALL	0.00	0.00	902.00	0 00:00	0.00
OF-IRR-11	OUTFALL	0.00	0.00	902.00	0 00:00	0.00
OF-IRR-12	OUTFALL	0.00	0.00	902.00	0 00:00	0.00
OF-IRR-13	OUTFALL	0.00	0.00	902.00	0 00:00	0.00
OF-RG	OUTFALL	0.00	0.00	1055.00	0 00:00	0.00
IRRIGATION	STORAGE	0.00	0.00	905.00	0 00:00	0.00
POND_1	STORAGE	2.74	3.43	909.43	0 10:43	1.04
POND_2	STORAGE	3.37	3.73	908.73	1 00:50	1.14
POND_3	STORAGE	3.33	3.96	905.96	0 10:46	1.21
POND_4	STORAGE	3.13	3.39	909.39	1 00:12	1.03
POND_5	STORAGE	1.12	1.28	915.58	2 00:00	0.39
RAIN-GAUGE	STORAGE	0.06	0.07	0.07	1 00:04	0.02

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent	
J1	JUNCTION	0.000	0.087	0 07:25	0	3.54	0.378	
J2	JUNCTION	0.000	0.013	1 00:50	0	1.87	0.083	
J4	JUNCTION	0.000	0.006	0 09:03	0	0.239	10.618	
OF_West	OUTFALL	0.000	0.184	0 10:46	0	12.6	0.000	
OF6	OUTFALL	0.000	0.000	0 00:00	0	0	0.000	ltr
OF-IRR-10	OUTFALL	0.000	0.000	0 00:00	0	0	0.000	ltr
OF-IRR-11	OUTFALL	0.000	0.000	0 00:00	0	0	0.000	ltr

OF-IRR-12	OUTFALL	0.000	0.000	0	00:00	0	0	0.000 ltr
OF-IRR-13	OUTFALL	0.000	0.000	0	00:00	0	0	0.000 ltr
OF-RG	OUTFALL	0.000	0.000	0	00:00	0	0	0.000 ltr
IRRIGATION	STORAGE	0.000	0.000	0	00:00	0	0	0.000 ltr
POND_1	STORAGE	0.885	0.885	0	07:15	4.68	6.07	0.002
POND_2	STORAGE	2.749	2.780	0	07:15	12.7	27.7	0.314
POND_3	STORAGE	2.914	2.917	0	07:15	11.3	27.2	0.006
POND_4	STORAGE	1.639	1.639	0	07:15	8.66	14.8	0.006
POND_5	STORAGE	0.619	0.619	0	07:35	4.86	7.49	0.007
RAIN-GAUGE	STORAGE	0.001	0.001	0	07:15	0.00097	0.00097	24.751

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
IRRIGATION	STORAGE	48.00	0.000	5.000
POND_1	STORAGE	40.71	1.127	0.673
POND_2	STORAGE	40.64	1.428	0.873
POND_3	STORAGE	45.95	0.965	0.635
POND_4	STORAGE	42.16	1.359	1.211
POND_5	STORAGE	48.00	1.275	2.425

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
IRRIGATION	0.000	0	0	0	0.000	0	0 00:00	0.000
POND_1	2.756	42	0	0	4.398	67	0 10:43	0.087
POND_2	23.132	64	0	0	26.401	73	1 00:50	0.015
POND_3	16.476	60	0	0	21.506	79	0 10:46	0.184
POND_4	13.059	51	0	0	14.696	58	1 00:12	0.002
POND_5	6.486	23	1	0	7.432	27	2 00:00	0.000
RAIN-GAUGE	0.001	6	0	6	0.001	7	1 00:04	0.000

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr	Total TSS0_10 kg	Total TSS10_20 kg	Total TSS150_500 kg	Total TSS20_50 kg	Total TSS50_150 kg
OF_West	95.28	0.077	0.184	12.637	0.007	0.000	0.000	0.000	0.000
OF6	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OF-IRR-10	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OF-IRR-11	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OF-IRR-12	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OF-IRR-13	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OF-RG	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
System	13.61	0.077	0.184	12.637	0.007	0.000	0.000	0.000	0.000

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	0.000	0	00:00	0.00	0.00	0.05
Pond_1-2	CONDUIT	0.083	0	07:25	1.22	1.03	1.00
Pond_2-3	CONDUIT	0.013	1	00:51	0.30	0.10	0.60
Pond_4-2	CONDUIT	0.004	0	09:03	0.08	0.07	1.00
PUMP1	PUMP	0.000	0	00:00		0.00	
PUMP2	PUMP	0.000	0	00:00		0.00	
ICD_1	ORIFICE	0.087	0	07:25			1.00
ICD_2	ORIFICE	0.013	1	00:50			1.00
ICD_4	ORIFICE	0.002	0	08:57			1.00
OL-IRR-10	DUMMY	0.000	0	00:00			
OL-IRR-11	DUMMY	0.000	0	00:00			
OL-IRR-12	DUMMY	0.000	0	00:00			
OL-IRR-13	DUMMY	0.000	0	00:00			
OL-IRR-EFFICIENCY	DUMMY	0.000	0	00:00			
OL-POND3-OF	DUMMY	0.184	0	10:46			

****
Flow Classification Summary
****

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
C1	1.00	0.15	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pond_1-2	1.00	0.05	0.00	0.00	0.88	0.02	0.00	0.06	0.03	0.00
Pond_2-3	1.00	0.00	0.05	0.00	0.95	0.00	0.00	0.00	0.95	0.00
Pond_4-2	1.00	0.05	0.00	0.00	0.95	0.00	0.00	0.00	0.13	0.00

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Upstream	Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
Pond_1-2	40.55	40.55	40.64	2.03	1.97
Pond_2-3	0.01	0.01	45.53	0.01	0.01
Pond_4-2	37.76	37.76	40.64	0.01	0.01

****
Pumping Summary
****

Pump	Percent Utilized	Number of Start-Ups	Min Flow CMS	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr	Power Usage Kw-hr	% Time Off Pump Curve Low	High
PUMP1	0.00	0	0.00	0.00	0.00	0.000	0.00	0.0	0.0
PUMP2	0.00	0	0.00	0.00	0.00	0.000	0.00	0.0	0.0

****
Link Pollutant Load Summary
****

Link	TSS0_10 kg	TSS10_20 kg	TSS150_500 kg	TSS20_50 kg	TSS50_150 kg
C1	0.000	0.000	0.000	0.000	0.000
Pond_1-2	0.005	0.000	0.000	0.000	0.000
Pond_2-3	0.001	0.000	0.000	0.000	0.000
Pond_4-2	0.000	0.000	0.000	0.000	0.000
PUMP1	0.000	0.000	0.000	0.000	0.000
PUMP2	0.000	0.000	0.000	0.000	0.000
ICD_1	0.005	0.000	0.000	0.000	0.000
ICD_2	0.001	0.000	0.000	0.000	0.000
ICD_4	0.000	0.000	0.000	0.000	0.000

OL-IRR-10	0.000	0.000	0.000	0.000	0.000
OL-IRR-11	0.000	0.000	0.000	0.000	0.000
OL-IRR-12	0.000	0.000	0.000	0.000	0.000
OL-IRR-13	0.000	0.000	0.000	0.000	0.000
OL-IRR-EFFICIENCY	0.000	0.000	0.000	0.000	0.000
OL-POND3-OF	0.007	0.000	0.000	0.000	0.000

Analysis begun on: Tue Sep 27 15:25:28 2016
Analysis ended on: Tue Sep 27 15:25:29 2016
Total elapsed time: 00:00:01

B.3 INPUT DATA

Lincoln Ranch (Continuous Event).dat

```
[TITLE]

[OPTIONS]
;;Options            Value
;;------------------ ------------
FLOW_UNITS           CMS
INFILTRATION         HORTON
FLOW_ROUTING         DYNWAVE
START_DATE           01/01/1964
START_TIME           00:00:00
REPORT_START_DATE    01/01/1964
REPORT_START_TIME    00:00:00
END_DATE             12/31/2007
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:20:00
WET_STEP             00:05:00
DRY_STEP             00:05:00
ROUTING_STEP         200
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[EVAPORATION]
;;Type          Parameters
;;------------- ----------
MONTHLY      -0.06  0      0.66   2.35   3.72   4.40   4.76   3.79   2.12   0.87   0.07   -0.10
DRY_ONLY     NO
[TEMPERATURE]
FILE         "\\CD1044-F06\work_Group\1128\resource\design\Stormwater Management\Modeling\TSchafer\Climate
Data\Red Deer\Final_Min_Max_Temperature_Data_SWMM5_Format_Red_Deer.txt"
WINDSPEED    MONTHLY    10.4 10.3 11.3 13.3 13.8 12.2 10.4 9.8 11.1 11.7 10.4 10.4
SNOWMELT                0 0.5 0.6 905 52 0
ADC          IMPERVIOUS 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
ADC          PERVIOUS   0.10 0.35 0.53 0.66 0.75 0.82 0.87 0.92 0.95 0.98

[RAINGAGES]
;;               Rain      Time   Snow   Data
;;Name           Type      Intrvl Catch  Source
;;-------------- --------- ------ ------ ----------
Precip           INTENSITY 1:00   1.0    FILE       "V:\1128\resource\design\Stormwater Management\Precip
Data\Red Deer\Final_Hour_Precip_Data_Red_Deer_SWMM5_Format.prn" Sylvan_Lake MM

[SUBCATCHMENTS]
;;                                                  Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
10               Precip           POND_1           5.83     23       265      2        0        Snowpack1
11               Precip           POND_2           22.94    20       655.429  2        0        Snowpack1
12               Precip           POND_3           15.78    28       450.857  2        0        Snowpack1
13               Precip           POND_4           15.39    17       439.714  2        0        Snowpack1
14               Precip           POND_5           4.5      18       225      2        0        Snowpack1
15               Precip           12               1.97     15       985      2        0        Snowpack1
16               Precip           10               2.65     5        220.833  2        0        Snowpack1
17               Precip           14               4.3      5        358.333  2        0        Snowpack1
18               Precip           13               0.78     5        97.5     2        0        Snowpack1
19               Precip           12               0.88     85       1760     1.5      0        Snowpack1
S1               Precip           RAIN-GAUGE       0.001    100      3.165    10       0        Snowpack1

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
10               0.015      0.25       1.6        3.2        0          OUTLET
11               0.015      0.25       1.6        3.2        0          OUTLET
12               0.015      0.25       1.6        3.2        0          OUTLET
13               0.015      0.25       1.6        3.2        0          OUTLET
14               0.015      0.25       1.6        3.2        0          OUTLET
```

```
15              0.015      0.25       1.6        3.2        0          OUTLET
16              0.015      0.25       1.6        3.2        0          OUTLET
17              0.015      0.25       1.6        3.2        0          OUTLET
18              0.015      0.25       1.6        3.2        0          OUTLET
19              0.015      0.25       1.6        3.2        0          OUTLET
S1              0.015      0.25       0          3.2        100        OUTLET

[INFILTRATION]
;;Subcatchment   MaxRate    MinRate    Decay      DryTime    MaxInfil
;;-------------- ---------- ---------- ---------- ---------- ----------
10              75         2.5        4.14       7          0
11              75         2.5        4.14       7          0
12              75         2.5        4.14       7          0
13              75         2.5        4.14       7          0
14              75         2.5        4.14       7          0
15              75         2.5        4.14       7          0
16              75         2.5        4.14       7          0
17              75         2.5        4.14       7          0
18              75         2.5        4.14       7          0
19              75         2.5        4.14       7          0
S1              75         2.5        4.14       7          0

[SNOWPACKS]
Snowpack1       PLOWABLE   0.05       5          0.0        0.10       0.00       0.00       0.0
Snowpack1       IMPERVIOUS 0.05       5          0.0        0.10       0.00       0.00       15
Snowpack1       PERVIOUS   0.05       5          0.0        0.10       0.00       0.00       100
Snowpack1       REMOVAL    10         0.0        0.0        1          0.0        0.0

[JUNCTIONS]
;;              Invert     Max.       Init.      Surcharge  Ponded
;;Name          Elev.      Depth      Depth      Depth      Area
;;-------------- ---------- ---------- ---------- ---------- ----------
J1              908        2.1        0          0          0
J2              907        2.6        0          0          0
J4              908        2.6        0          0          0

[OUTFALLS]
;;              Invert     Outfall      Stage/Table      Tide
;;Name          Elev.      Type         Time Series      Gate Route To
;;-------------- ---------- ------------ ---------------- ---- ----------------
OF_West         905        FREE                          NO
OF6             902        FREE                          NO
OF-IRR-10       902        FREE                          NO   10
OF-IRR-11       902        FREE                          NO   11
OF-IRR-12       902        FREE                          NO   12
OF-IRR-13       902        FREE                          NO   13
OF-RG           1055       FREE                          NO

[STORAGE]
;;              Invert   Max.     Init.    Storage    Curve                    Ponded   Evap.
;;Name          Elev.    Depth    Depth    Curve      Params                   Area     Frac.
Infiltration parameters
;;-------------- -------- -------- -------- ---------- -------- -------- -------- -------- -------- -----------
------------
IRRIGATION      905      5        0        FUNCTIONAL 260500   0        0        0        0
POND_1          906      4.1      2        TABULAR    POND1                      0        1
POND_2          905      4.6      2        TABULAR    POND2                      0        1
POND_3          902      4.6      3        TABULAR    POND3                      0        1
POND_4          906      4.6      2        TABULAR    POND4                      0        1
POND_5          914.3    3.7      0.5      TABULAR    POND5                      0        1
RAIN-GAUGE      0        1        0        FUNCTIONAL 10       0        0        0        0        0
0.125    0

[CONDUITS]
;;              Inlet            Outlet                      Manning    Inlet      Outlet     Init.      Max.
;;Name          Node             Node             Length     N          Offset     Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- -----
-----
C1              RAIN-GAUGE       OF-RG            50         0.01       0.025      0          0          0
Pond_1-2        J1               POND_2           200        0.011      0          2          0          0
Pond_2-1        J2               POND_3           200        0.011      0          2          0          0
Pond_4-2        J4               POND_2           400        0.011      0          2          0          0

[PUMPS]
;;              Inlet            Outlet           Pump             Init.  Startup  Shutoff
;;Name          Node             Node             Curve            Status Depth    Depth
;;-------------- ---------------- ---------------- ---------------- ------ -------- --------
PUMP1           POND_3           POND_5           Storm_Pump       OFF    2.05     2
PUMP2           POND_5           IRRIGATION       Irrigation       OFF    0.55     0.5

[ORIFICES]
;;              Inlet            Outlet           Orifice      Crest      Disch.     Flap Open/Close
;;Name          Node             Node             Type         Height     Coeff.     Gate Time
;;-------------- ---------------- ---------------- ------------ ---------- ---------- ---- ----------
ICD_1           POND_1           J1               SIDE         2          0.6        NO   0
ICD_2           POND_2           J2               SIDE         2          0.6        NO   0
ICD_4           POND_4           J4               SIDE         2          0.6        NO   0
```

```
[OUTLETS]
;;               Inlet            Outlet           Outflow    Outlet           Qcoeff/                     Flap
;;Name           Node             Node             Height     Type             QTable           Qexpon     Gate
;;-------------- ---------------- ---------------- ---------- ---------------- ---------------- ---------- ----
OL-IRR-10        IRRIGATION       OF-IRR-10        0          FUNCTIONAL/DEPTH 0.001138         0          NO
OL-IRR-11        IRRIGATION       OF-IRR-11        0          FUNCTIONAL/DEPTH 0.004212         0          NO
OL-IRR-12        IRRIGATION       OF-IRR-12        0          FUNCTIONAL/DEPTH 0.003            0          NO
OL-IRR-13        IRRIGATION       OF-IRR-13        0          FUNCTIONAL/DEPTH 0.002429         0          NO
OL-IRR-EFFICIENCY IRRIGATION      OF6              0          FUNCTIONAL/DEPTH 0.00147          0          NO
OL-POND3-OF      POND_3           OF_West          3          TABULAR/DEPTH    OL-POND3-TOTAL              NO

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels
;;-------------- ------------ ---------------- ---------- ---------- ---------- ----------
C1               CIRCULAR     0.5              0          0          0          1
Pond_1-2         CIRCULAR     0.299            0          0          0          1
Pond_2-1         CIRCULAR     0.299            0          0          0          1
Pond_4-2         CIRCULAR     0.299            0          0          0          1
ICD_1            CIRCULAR     0.3              0          0          0
ICD_2            CIRCULAR     0.07             0          0          0
ICD_4            CIRCULAR     0.03             0          0          0

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------

[CONTROLS]
RULE 1
IF SIMULATION MONTH < 5
OR SIMULATION MONTH > 9
THEN PUMP PUMP2 STATUS = OFF
PRIORITY 1
RULE 2
IF NODE RAIN-GAUGE DEPTH > .006
THEN PUMP PUMP2 STATUS = OFF
PRIORITY 2
RULE 3
IF NODE IRRIGATION DEPTH > 0.0284
THEN PUMP PUMP2 STATUS = OFF
PRIORITY 3
RULE 4
IF SIMULATION MONTH < 5
OR SIMULATION MONTH > 9
THEN PUMP PUMP1 STATUS = OFF
PRIORITY 1
RULE 5
IF NODE RAIN-GAUGE DEPTH > .006
THEN PUMP PUMP1 STATUS = OFF
PRIORITY 2
RULE 6
IF NODE IRRIGATION DEPTH > 0.0284
THEN PUMP PUMP1 STATUS = OFF
PRIORITY 3
RULE 7
IF NODE POND_5 DEPTH < .5
THEN PUMP PUMP1 STATUS = OFF
PRIORITY 1

[POLLUTANTS]
;;               Mass   Rain       GW         I&I        Decay      Snow  Co-Pollut.       Co-Pollut. DWF
Init.
;;Name          Units  Concen.    Concen.    Concen.    Coeff.     Only  Name             Fraction   Concen.
Concen.
;;-------------- ------ ---------- ---------- ---------- ---------- ----- ---------------- ---------- ---------
- ----------
TSS0_10          MG/L   0          0          0          0          NO    *                0.0        0
0
TSS10_20         MG/L   0          0          0          0          NO    *                0.0        0
0
TSS150_500       MG/L   0          0          0          0          NO    *                0.0        0
0
TSS20_50         MG/L   0          0          0          0          NO    *                0.0        0
0
TSS50_150        MG/L   0          0          0          0          NO    *                0.0        0
0

[LANDUSES]
;;               Cleaning   Fraction   Last
;;Name           Interval   Available  Cleaned
;;-------------- ---------- ---------- ----------
Landscaped       0          0          0
Pavement         0          0          0

[COVERAGES]
;;Subcatchment   Land Use         Percent
;;-------------- ---------------- ----------
```

```
10               Landscaped       77
10               Pavement         23
11               Landscaped       80
11               Pavement         20
12               Landscaped       72
12               Pavement         28
13               Landscaped       83
13               Pavement         17
14               Landscaped       82
14               Pavement         18
15               Landscaped       85
15               Pavement         15
16               Landscaped       95
16               Pavement         5
17               Landscaped       95
17               Pavement         5
18               Landscaped       95
18               Pavement         5
19               Landscaped       15
19               Pavement         85

[LOADINGS]
;;Subcatchment   Pollutant        Loading
;;-------------- ---------------- ----------

[BUILDUP]
;;LandUse        Pollutant        Function   Coeff1     Coeff2     Coeff3     Normalizer
;;-------------- ---------------- ---------- ---------- ---------- ---------- ----------
Landscaped       TSS0_10          POW        460        1.265      0.95       AREA
Landscaped       TSS10_20         POW        180        0.495      0.95       AREA
Landscaped       TSS150_500       POW        640        1.76       0.95       AREA
Landscaped       TSS20_50         POW        260        0.715      0.95       AREA
Landscaped       TSS50_150        POW        460        1.265      0.95       AREA
Pavement         TSS0_10          POW        460        1.265      0.95       AREA
Pavement         TSS10_20         POW        180        0.495      0.95       AREA
Pavement         TSS150_500       POW        640        1.76       0.95       AREA
Pavement         TSS20_50         POW        260        0.715      0.95       AREA
Pavement         TSS50_150        POW        460        1.265      0.95       AREA

[WASHOFF]
;;                                                                 Cleaning   BMP
;;Land Use       Pollutant        Function   Coeff1     Coeff2     Effic.     Effic.
;;-------------- ---------------- ---------- ---------- ---------- ---------- ----------
Landscaped       TSS0_10          EXP        0.00043    1.2        0.0        55
Landscaped       TSS10_20         EXP        0.00017    1.2        0.0        55
Landscaped       TSS150_500       EXP        0.0006     1.2        0.0        55
Landscaped       TSS20_50         EXP        0.00029    1.2        0.0        55
Landscaped       TSS50_150        EXP        0.00047    1.2        0.0        55
Pavement         TSS0_10          EXP        0.00086    1.2        0          55
Pavement         TSS10_20         EXP        0.00034    1.2        0.0        55
Pavement         TSS150_500       EXP        0.0012     1.2        0.0        55
Pavement         TSS20_50         EXP        0.00058    1.2        0.0        55
Pavement         TSS50_150        EXP        0.00093    1.2        0.0        55

[TREATMENT]
;;Node           Pollutant        Function
;;-------------- ---------------- ----------
POND_1           TSS0_10          R=0.00000592*AREA/FLOW
POND_1           TSS10_20         R=0.0000473*AREA/FLOW
POND_1           TSS150_500       R=0.0124*AREA/FLOW
POND_1           TSS20_50         R=0.000283*AREA/FLOW
POND_1           TSS50_150        R=0.00195*AREA/FLOW
POND_2           TSS0_10          R=0.00000592*AREA/FLOW
POND_2           TSS10_20         R=0.0000473*AREA/FLOW
POND_2           TSS150_500       R=0.0124*AREA/FLOW
POND_2           TSS20_50         R=0.000283*AREA/FLOW
POND_2           TSS50_150        R=0.00195*AREA/FLOW
POND_3           TSS0_10          R=0.00000592*AREA/FLOW
POND_3           TSS10_20         R=0.0000473*AREA/FLOW
POND_3           TSS150_500       R=0.0124*AREA/FLOW
POND_3           TSS20_50         R=0.000283*AREA/FLOW
POND_3           TSS50_150        R=0.00195*AREA/FLOW
POND_4           TSS0_10          R=0.00000592*AREA/FLOW
POND_4           TSS10_20         R=0.0000473*AREA/FLOW
POND_4           TSS150_500       R=0.0124*AREA/FLOW
POND_4           TSS20_50         R=0.000283*AREA/FLOW
POND_4           TSS50_150        R=0.00195*AREA/FLOW

[INFLOWS]
;;                                                 Param    Units    Scale    Baseline Baseline
;;Node           Parameter        Time Series      Type     Factor   Factor   Value    Pattern
;;-------------- ---------------- ---------------- -------- -------- -------- -------- --------
POND_5           FLOW             ""               FLOW     1.0      1        0.001447 Summer-winter

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
```

```
Irrigation       Pump2      0          0
Irrigation                  0.49       0
Irrigation                  0.50       0.05879
Irrigation                  7.5        0.05879

Storm_Pump       Pump2      0          0
Storm_Pump                  1.99       0
Storm_Pump                  2.00       0.05879
Storm_Pump                  7.5        0.05879

OL-POND3-TOTAL   Rating     0.000      0.0000
OL-POND3-TOTAL              0.300      0.0775
OL-POND3-TOTAL              0.500      0.1199
OL-POND3-TOTAL              0.600      0.1362
OL-POND3-TOTAL              0.700      0.1508
OL-POND3-TOTAL              0.800      0.1640
OL-POND3-TOTAL              0.900      0.1763
OL-POND3-TOTAL              1.000      0.1878
OL-POND3-TOTAL              1.600      0.2457

POND1            Storage    0.0        225
POND1                       0.5        372
POND1                       1.0        596
POND1                       1.5        984
POND1                       2.0        1412
POND1                       2.5        1882
POND1                       3.0        2392
POND1                       3.5        2943
POND1                       4.1        3659

POND2            Storage    0.0        4442
POND2                       0.5        4912
POND2                       1.0        5416
POND2                       1.5        6262
POND2                       2.0        7152
POND2                       2.5        8081
POND2                       3.0        9049
POND2                       3.5        10058
POND2                       4.0        11106
POND2                       4.6        12417

POND3            Storage    0.0        2990
POND3                       0.5        3389
POND3                       1.0        3802
POND3                       1.5        4522
POND3                       2.0        5281
POND3                       2.5        6079
POND3                       3.0        6915
POND3                       3.5        7791
POND3                       4.0        8705
POND3                       4.6        9854

POND4            Storage    0.0        1583
POND4                       0.5        2244
POND4                       1.0        3019
POND4                       1.5        3877
POND4                       2.0        4787
POND4                       2.5        5747
POND4                       3.0        6743
POND4                       3.5        7781
POND4                       4.0        8858
POND4                       4.6        10208

POND5            Storage    0.0        4900
POND5                       0.5        5625
POND5                       2.7        8836
POND5                       2.8        8911
POND5                       3.0        9120

[PATTERNS]
;;Name           Type       Multipliers
;;-------------- ---------- -----------
;Summer months is 40 m³/day from degraffs and winter months is 4 m³/day.
Summer-winter    MONTHLY    0.28  0.28  0.28  0.28  1.0   1.0
Summer-winter                1.0   1.0   1.0   0.28  0.28  0.28


[REPORT]
INPUT      YES
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL
```

B.4 OUTPUT DATA

Lincoln Ranch (Continuous Event).out

```
  EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)
  ---------------------------------------------------------------

  WARNING 08: elevation drop exceeds length for Conduit C1
  WARNING 10: crest elevation is below downstream invert for regulator Link ICD_2

  *************
  Element Count
  *************
  Number of rain gages ...... 1
  Number of subcatchments ... 11
  Number of nodes ........... 17
  Number of links ........... 15
  Number of pollutants ...... 5
  Number of land uses ....... 2


  *****************
  Pollutant Summary
  *****************
                             Ppt.      GW         Kdecay
  Name                 Units  Concen.   Concen.    1/days    CoPollutant
  ---------------------------------------------------------------------
  TSS0_10               MG/L      0.00      0.00      0.00
  TSS10_20              MG/L      0.00      0.00      0.00
  TSS150_500            MG/L      0.00      0.00      0.00
  TSS20_50              MG/L      0.00      0.00      0.00
  TSS50_150             MG/L      0.00      0.00      0.00


  ***************
  Landuse Summary
  ***************
                        Sweeping   Maximum      Last
  Name                  Interval   Removal     Swept
  ---------------------------------------------------
  Landscaped                0.00      0.00      0.00
  Pavement                  0.00      0.00      0.00


  ****************
  Raingage Summary
  ****************
                                                    Data       Recording
  Name                 Data Source                  Type       Interval
  ----------------------------------------------------------------------
  Precip               V:\1128\resource\design\Stormwater Management\Precip Data\Red
Deer\Final_Hour_Precip_Data_Red_Deer_SWMM5_Format.prn


  ********************
  Subcatchment Summary
  ********************
  Name                         Area     Width   %Imperv    %Slope Rain Gage            Outlet
  ------------------------------------------------------------------------------------------------
  10                           5.83    265.00     23.00    2.0000 Precip              POND_1
  11                          22.94    655.43     20.00    2.0000 Precip              POND_2
  12                          15.78    450.86     28.00    2.0000 Precip              POND_3
  13                          15.39    439.71     17.00    2.0000 Precip              POND_4
  14                           4.50    225.00     18.00    2.0000 Precip              POND_5
  15                           1.97    985.00     15.00    2.0000 Precip              12
  16                           2.65    220.83      5.00    2.0000 Precip              10
  17                           4.30    358.33      5.00    2.0000 Precip              14
  18                           0.78     97.50      5.00    2.0000 Precip              13
  19                           0.88   1760.00     85.00    1.5000 Precip              12
  S1                           0.00      3.17    100.00   10.0000 Precip              RAIN-GAUGE


  ************
  Node Summary
  ************
                                      Invert      Max.    Ponded    External
  Name                 Type            Elev.     Depth      Area    Inflow
  ---------------------------------------------------------------------------
  J1                   JUNCTION           908.00      2.10       0.0
  J2                   JUNCTION           907.00      2.60       0.0
  J4                   JUNCTION           908.00      2.60       0.0
  OF_West              OUTFALL            905.00      0.00       0.0
  OF6                  OUTFALL            902.00      0.00       0.0
  OF-IRR-10            OUTFALL            902.00      0.00       0.0
  OF-IRR-11            OUTFALL            902.00      0.00       0.0
  OF-IRR-12            OUTFALL            902.00      0.00       0.0
```

OF-IRR-13	OUTFALL	902.00	0.00	0.0	
OF-RG	OUTFALL	1055.00	0.50	0.0	
IRRIGATION	STORAGE	905.00	5.00	0.0	
POND_1	STORAGE	906.00	4.10	0.0	
POND_2	STORAGE	905.00	4.60	0.0	
POND_3	STORAGE	902.00	4.60	0.0	
POND_4	STORAGE	906.00	4.60	0.0	
POND_5	STORAGE	914.30	3.70	0.0	Yes
RAIN-GAUGE	STORAGE	0.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	RAIN-GAUGE	OF-RG	CONDUIT	50.0-2109.9500		0.0100
Pond_1-2	J1	POND_2	CONDUIT	200.0	0.5000	0.0110
Pond_2-1	J2	POND_3	CONDUIT	200.0	1.5002	0.0110
Pond_4-2	J4	POND_2	CONDUIT	400.0	0.2500	0.0110
PUMP1	POND_3	POND_5	TYPE2 PUMP			
PUMP2	POND_5	IRRIGATION	TYPE2 PUMP			
ICD_1	POND_1	J1	ORIFICE			
ICD_2	POND_2	J2	ORIFICE			
ICD_4	POND_4	J4	ORIFICE			
OL-IRR-10	IRRIGATION	OF-IRR-10	OUTLET			
OL-IRR-11	IRRIGATION	OF-IRR-11	OUTLET			
OL-IRR-12	IRRIGATION	OF-IRR-12	OUTLET			
OL-IRR-13	IRRIGATION	OF-IRR-13	OUTLET			
OL-IRR-EFFICIENCY	IRRIGATION	OF6	OUTLET			
OL-POND3-OF	POND_3	OF_West	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	CIRCULAR	0.50	0.20	0.12	0.50	1	22.55
Pond_1-2	CIRCULAR	0.30	0.07	0.07	0.30	1	0.08
Pond_2-1	CIRCULAR	0.30	0.07	0.07	0.30	1	0.14
Pond_4-2	CIRCULAR	0.30	0.07	0.07	0.30	1	0.06

****
Rainfall File Summary
****

Station ID	First Date	Last Date	Recording Frequency	Periods w/Precip	Periods Missing	Periods Malfunc.
Sylvan_Lake	DEC-31-1963	OCT-31-2007	60 min	54022	0	0

****
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 ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... YES
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... YES
Infiltration Method ..... HORTON
Flow Routing Method ..... DYNWAVE
Starting Date JAN-01-1964 00:00:00
Ending Date DEC-31-2007 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:20:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step ..... 200.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Initial Snow Cover	0.000	0.000
Total Precipitation	1747.007	23286.900
Outfall Runon	154.466	2058.972
Evaporation Loss	172.746	2302.637
Infiltration Loss	1515.248	20197.646
Surface Runoff	214.156	2854.619
Snow Removed	0.000	0.000
Final Snow Cover	0.000	0.000
Final Storage	0.025	0.327
Continuity Error (%)	-0.037	

Runoff Quality Continuity	TSS0_10 kg	TSS10_20 kg	TSS150_500 kg	TSS20_50 kg	TSS50_150 kg
Initial Buildup	0.000	0.000	0.000	0.000	0.000
Surface Buildup	86719.683	21609.373	149075.614	39448.082	91300.880
Wet Deposition	1301.381	202.351	2517.229	497.462	1416.862
Sweeping Removal	0.000	0.000	0.000	0.000	0.000
Infiltration Loss	2760.154	430.355	5317.376	1057.118	2995.436
BMP Removal	29305.674	4550.354	56719.003	11194.789	31874.949
Surface Runoff	21021.449	3261.253	40724.708	8025.896	22876.590
Remaining Buildup	34509.200	13503.600	48012.800	19505.200	34509.200
Continuity Error (%)	0.482	0.303	0.540	0.407	0.498

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	213.803	2138.054
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	116.839	1168.405
External Outflow	253.340	2533.430
Flooding Loss	0.000	0.000
Evaporation Loss	77.594	775.944
Exfiltration Loss	0.020	0.200
Initial Stored Volume	3.539	35.389
Final Stored Volume	3.211	32.107
Continuity Error (%)	0.005	

Quality Routing Continuity	TSS0_10 kg	TSS10_20 kg	TSS150_500 kg	TSS20_50 kg	TSS50_150 kg
Dry Weather Inflow	0.000	0.000	0.000	0.000	0.000
Wet Weather Inflow	20966.798	3252.787	40618.762	8005.046	22817.145
Groundwater Inflow	0.000	0.000	0.000	0.000	0.000
RDII Inflow	0.000	0.000	0.000	0.000	0.000
External Inflow	0.000	0.000	0.000	0.000	0.000
External Outflow	1557.347	231.187	2860.518	565.303	1610.087
Flooding Loss	0.000	0.000	0.000	0.000	0.000
Exfiltration Loss	0.000	0.000	0.000	0.000	0.000
Mass Reacted	19447.287	3023.608	37764.142	7440.906	21210.374
Initial Stored Mass	0.000	0.000	0.000	0.000	0.000
Final Stored Mass	0.638	0.099	1.238	0.243	0.695
Continuity Error (%)	-0.183	-0.065	-0.018	-0.018	-0.018

Time-Step Critical Elements

Link Pond_2-1 (1.30%)

Highest Flow Instability Indexes

All links are stable.

Routing Time Step Summary

Minimum Time Step	:	5.53 sec
Average Time Step	:	197.96 sec
Maximum Time Step	:	200.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.00
Percent Not Converging	:	0.04

****
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 CMS	Runoff Coeff
10	23286.90	3265.36	2748.45	20140.13	3673.51	214.17	0.43	0.138
11	23286.90	2631.18	2345.66	20588.98	2990.89	686.11	1.06	0.115
12	23286.90	3677.01	3379.29	19170.41	4422.71	697.91	1.01	0.164
13	23286.90	2315.27	1917.93	21088.17	2603.26	400.64	0.71	0.102
14	23286.90	984.11	1660.42	19452.20	3167.61	142.54	0.41	0.131
15	23286.90	0.00	1335.07	19535.19	2436.01	47.99	0.13	0.105
16	23286.90	0.00	344.38	21919.12	1029.89	27.29	0.14	0.044
17	23286.90	0.00	344.38	21919.12	1029.89	44.29	0.22	0.044
18	23286.90	0.00	343.19	21894.83	1056.09	8.24	0.04	0.045
19	23286.90	0.00	8300.54	3441.32	11628.88	102.33	0.08	0.499
S1	23286.90	0.00	3355.26	0.00	20038.54	0.20	0.00	0.861

****
Subcatchment Washoff Summary
****

Subcatchment	TSS0_10 kg	TSS10_20 kg	TSS150_500 kg	TSS20_50 kg	TSS50_150 kg
10	2177.468	337.997	4217.059	831.603	2369.495
11	6222.308	964.360	12063.852	2374.265	6775.217
12	7635.098	1185.299	14782.113	2916.258	8300.555
13	3508.085	543.700	6801.761	1338.589	3821.576
14	1478.491	229.897	2859.924	565.181	1609.747
15	441.979	68.539	856.593	168.700	481.577
16	213.223	33.072	413.241	81.393	232.732
17	345.985	53.664	670.541	132.072	377.640
18	65.989	10.237	127.877	25.192	72.025
19	1888.745	296.253	3613.497	726.120	2038.939
S1	0.000	0.000	0.000	0.000	0.000
System	23977.370	3723.017	46406.457	9159.373	26079.503

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.00	1.13	909.13	2992 17:43	0.34
J2	JUNCTION	0.01	0.06	907.06	2993 06:00	0.02
J4	JUNCTION	0.01	0.50	908.50	2993 06:00	0.15
OF_West	OUTFALL	0.00	0.00	905.00	0 00:00	0.00
OF6	OUTFALL	0.00	0.00	902.00	0 00:00	0.00
OF-IRR-10	OUTFALL	0.00	0.00	902.00	0 00:00	0.00
OF-IRR-11	OUTFALL	0.00	0.00	902.00	0 00:00	0.00
OF-IRR-12	OUTFALL	0.00	0.00	902.00	0 00:00	0.00
OF-IRR-13	OUTFALL	0.00	0.00	902.00	0 00:00	0.00
OF-RG	OUTFALL	0.00	0.00	1055.00	0 00:00	0.00
IRRIGATION	STORAGE	0.00	0.03	905.03	123 15:16	0.01
POND_1	STORAGE	1.98	3.28	909.28	2992 17:29	1.00
POND_2	STORAGE	2.02	3.50	908.50	2993 06:00	1.07
POND_3	STORAGE	2.53	3.87	905.87	2992 17:24	1.18
POND_4	STORAGE	2.02	3.26	909.26	2374 00:58	0.99
POND_5	STORAGE	1.10	3.10	917.40	13271 04:29	0.94
RAIN-GAUGE	STORAGE	0.01	0.12	0.12	12980 00:05	0.04

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J1	JUNCTION	0.000	0.083	2992 14:16	0	172	-0.107
J2	JUNCTION	0.000	0.012	2993 06:00	0	890	-0.003
J4	JUNCTION	0.000	0.005	2992 16:15	0	253	0.008
OF_West	OUTFALL	0.000	0.173	2992 17:26	0	778	0.000

OF6	OUTFALL	0.000	0.001	121	00:13	0	211	0.000	
OF-IRR-10	OUTFALL	0.000	0.001	121	00:13	0	163	0.000	
OF-IRR-11	OUTFALL	0.000	0.004	121	00:13	0	604	0.000	
OF-IRR-12	OUTFALL	0.000	0.003	121	00:13	0	430	0.000	
OF-IRR-13	OUTFALL	0.000	0.002	121	00:13	0	348	0.000	
OF-RG	OUTFALL	0.000	0.000	0	00:00	0	0	0.000	ltr
IRRIGATION	STORAGE	0.000	0.059	121	00:06	0	1.76e+003	0.004	
POND_1	STORAGE	0.426	0.426	2992	14:45	214	216	0.133	
POND_2	STORAGE	1.060	1.139	2992	14:45	686	1.12e+003	0.000	
POND_3	STORAGE	1.006	1.014	2992	14:45	698	1.6e+003	-0.000	
POND_4	STORAGE	0.705	0.705	2992	14:45	401	406	0.001	
POND_5	STORAGE	0.414	0.414	2992	14:45	1.31e+003	1.95e+003	0.000	
RAIN-GAUGE	STORAGE	0.000	0.000	12130	12:00	0.2	0.2	-0.116	

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Meters	Min. Depth Below Rim Meters
IRRIGATION	STORAGE	385680.00	0.028	4.972
POND_1	STORAGE	179.78	0.979	0.821
POND_2	STORAGE	5951.50	1.197	1.104
POND_3	STORAGE	125927.16	0.874	0.726
POND_4	STORAGE	115421.23	1.230	1.340
POND_5	STORAGE	385680.00	3.095	0.605

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
IRRIGATION	0.339	0	0	0	7.411	1	123 15:16	0.012
POND_1	1.364	21	20	0	3.988	61	2992 17:29	0.083
POND_2	11.373	31	19	0	24.024	66	2993 06:00	0.015
POND_3	11.106	41	11	0	20.732	76	2992 17:24	0.173
POND_4	6.293	25	36	0	13.743	54	2374 00:58	0.002
POND_5	6.489	23	10	0	22.101	79	13271 04:29	0.059
RAIN-GAUGE	0.000	1	0	100	0.001	12	12980 00:05	0.000

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr	Total TSS0_10 kg	Total TSS10_20 kg	Total TSS150_500 kg	Total TSS20_50 kg	Total TSS50_150 kg
OF_West	32.05	0.002	0.173	778.092	78.515	1.238	0.000	0.000	0.000
OF6	10.28	0.001	0.001	210.656	177.477	27.596	343.290	67.842	193.226
OF-IRR-10	10.28	0.001	0.001	163.079	137.394	21.363	265.758	52.520	149.586
OF-IRR-11	10.28	0.004	0.004	603.595	508.527	79.071	983.632	194.388	553.653
OF-IRR-12	10.28	0.003	0.003	429.911	362.199	56.318	700.593	138.453	394.339
OF-IRR-13	10.28	0.002	0.002	348.084	293.260	45.599	567.246	112.101	319.284
OF-RG	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

```
  ---------------------------------------------------------------------------------------------------------------------
--------------------
  System               11.92     0.014     0.173    2533.418      1557.373       231.185      2860.520
565.304      1610.088


  ********************
  Link Flow Summary
  ********************

  ------------------------------------------------------------------------------
                               Maximum  Time of Max   Maximum    Max/    Max/
                                |Flow|   Occurrence   |Veloc|    Full    Full
  Link                 Type         CMS  days hr:min     m/sec    Flow   Depth
  ------------------------------------------------------------------------------
  C1                   CONDUIT    0.000     0  00:00      0.00    0.00    0.09
  Pond_1-2             CONDUIT    0.081  2992  14:15      1.19    1.01    1.00
  Pond_2-1             CONDUIT    0.012  2993  06:02      0.73    0.09    0.60
  Pond_4-2             CONDUIT    0.003  2992  16:15      0.22    0.06    1.00
  PUMP1                PUMP       0.059   121  00:06              1.00
  PUMP2                PUMP       0.059   121  00:06              1.00
  ICD_1                ORIFICE    0.083  2992  14:16                      1.00
  ICD_2                ORIFICE    0.012  2993  06:00                      1.00
  ICD_4                ORIFICE    0.002  2379  06:49                      1.00
  OL-IRR-10            DUMMY      0.001   121  00:13
  OL-IRR-11            DUMMY      0.004   121  00:13
  OL-IRR-12            DUMMY      0.003   121  00:13
  OL-IRR-13            DUMMY      0.002   121  00:13
  OL-IRR-EFFICIENCY    DUMMY      0.001   121  00:13
  OL-POND3-OF          DUMMY      0.173  2992  17:26


  ***************************
  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
  ------------------------------------------------------------------------------------
  C1                     1.00   0.91  0.09  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  Pond_1-2               1.00   0.30  0.22  0.00  0.46  0.00  0.00  0.02  0.94  0.00
  Pond_2-1               1.00   0.20  0.12  0.00  0.64  0.01  0.00  0.03  0.85  0.00
  Pond_4-2               1.00   0.32  0.04  0.00  0.64  0.00  0.00  0.00  0.95  0.00


  ************************
  Conduit Surcharge Summary
  ************************

  ---------------------------------------------------------------------------
                                                        Hours        Hours
                       --------- Hours Full --------   Above Full   Capacity
  Conduit               Both Ends  Upstream  Dnstream   Normal Flow   Limited
  ---------------------------------------------------------------------------
  Pond_1-2                 154.95    154.95   7654.65      0.09         0.01
  Pond_2-1                   0.01      0.01  257186.82      0.01         0.01
  Pond_4-2                 118.19    118.19   5950.59      0.01         0.01


  ***************
  Pumping Summary
  ***************

  ---------------------------------------------------------------------------------------------------------------------
                                            Min       Avg       Max     Total     Power    % Time Off
                       Percent   Number of   Flow      Flow      Flow    Volume     Usage    Pump Curve
  Pump                Utilized   Start-Ups    CMS       CMS       CMS  10^6 ltr     Kw-hr    Low   High
  ---------------------------------------------------------------------------------------------------------------------
  PUMP1                   0.78         433   0.00      0.06      0.06   636.981  19599.30    0.0    0.0
  PUMP2                   2.15       28564   0.00      0.06      0.06  1755.401  49634.60    0.0    0.0


  ***************************
  Link Pollutant Load Summary
  ***************************

  ------------------------------------------------------------------------------------------
                           TSS0_10      TSS10_20    TSS150_500      TSS20_50     TSS50_150
  Link                          kg            kg            kg            kg            kg
  ------------------------------------------------------------------------------------------
  C1                         0.000         0.000         0.000         0.000         0.000
  Pond_1-2                 151.058         4.662         0.000         0.000         0.000
  Pond_2-1                  10.556         0.126         0.000         0.000         0.000
  Pond_4-2                   1.902         0.017         0.000         0.000         0.000
  PUMP1                      0.053         0.000         0.000         0.000         0.000
```

PUMP2	1479.011	229.971	2860.815	565.362	1610.254
ICD_1	151.897	4.694	0.000	0.000	0.000
ICD_2	10.480	0.126	0.000	0.000	0.000
ICD_4	1.376	0.013	0.000	0.000	0.000
OL-IRR-10	137.394	21.363	265.758	52.520	149.586
OL-IRR-11	508.527	79.071	983.632	194.388	553.653
OL-IRR-12	362.199	56.318	700.593	138.453	394.339
OL-IRR-13	293.260	45.599	567.246	112.101	319.284
OL-IRR-EFFICIENCY	177.477	27.596	343.290	67.842	193.226
OL-POND3-OF	78.515	1.238	0.000	0.000	0.000

```
Analysis begun on:  Tue Sep 27 15:21:08 2016
Analysis ended on:  Tue Sep 27 15:24:35 2016
Total elapsed time: 00:03:27
```

Appendix C

SUPPORTING DOCUMENTS

September, 2016

ESRD Preliminary 1:100 Year, Pre-Development Stormwater Runoff Rate Iso-Chart
Units in l/s/ha