

4.3.3 Existing Drainage Conditions

In general, the project area is approximately 80% undeveloped with the exception of small subdivisions such as Central Park, Chiles Industrial Park, Blindman Industrial Park and Spruce Lane Acres. The project area is mainly being serviced through surface drainage systems. Existing tributaries of the Blindman River and Red Deer River are utilized along with a series of drainage culverts, culverts/bridges structures and connecting ditches. The project area has a formal stormwater management facility, a dry pond, and an outlet storm sewer located on the east side of Highway 2A in the Chiles Industrial Subdivision.

As previously mentioned, the project area is divided into two major basins:

- Red Deer River Basin; and
- Blindman River Basin.

These basins are described further in the following sections.

4.3.3.1 Red Deer River Basin

The basin has a total drainage area of approximately 1635 ha with natural slopes ranging 1% to 6%. The basin includes:

- Two major natural features, the Hazlett Lake and a lake on the IPSCO property located in NW and SW of 3-39-27 W4 and in the SW of 4-39-27 W4;
- Approximately 1,028 ha of undeveloped area and approximately 607 ha of developed area (mainly residential and industrial);
- An overland drainage route from Hazlett Lake to the Red Deer River. Flows from the Lake drain through a ditch which runs along the south boundary of the Central Park subdivision, and then cross Range Road 273 via an 600 mm diameter culvert, and towards to the unnamed east lake through a natural channel;
- Two 900mm diameter culverts located under the Canadian Pacific Railway. Water from the lake on the IPSCO property is currently pumped through these culverts as the pipe invert elevations are 1 m above the bottom of the existing ditch; and
- A stormwater management facility (dry pond) that provides water quality and quantity control to the Chiles Industrial Park Subdivision and eventually discharges to the Red Deer River through an existing storm sewer pipe.

The following sections provide additional background information of the existing drainage conditions of Hazlett Lake, the unnamed east lake, and Chiles Industrial Park's stormwater management facility.

4.3.3.2 Hazlett Lake

Hazlett Lake has been identified by Alberta Environment and the City of Red Deer as a natural feature with high environmental significance. The Lake is habitat to a number of sensitive wildlife species and supports a number of wetlands and plant communities. For this reason, preservation of the Hazlett Lake is a priority and it has been assigned as natural “green spaces” in the proposed land use for future development.



Photo 1: Hazlett Lake

Photo 1 shows an overall view of Hazlett Lake taken during a site visit on May 2015 and **Figure 4-9** provides an illustration of the key components of the Hazlett Lake system.



- Legend:**
- Existing Drainage Route
 - Existing Stormwater Trunk
 - Existing Stormwater Pond
 - Proposed Transportation
 - Existing Transportation
 - Contour 1 m
 - Contour 5 m
 - Hazlett Lake Gauge Station
 - StudyArea



Hazlett Lake Gauge Station and Queens Business Park Overflow Pipe

Pipe Outlet EL. 877.10m
 Queens Business Park Overflow (1350mmØ)
 Pipe Invert EL. 877.17m

Hazlett Lake
 NWL = 877.30m
 HWL = 878.20m

EL. 878.4m
 (High Point to be regraded to 878.10 m)

Existing 900m Diameter Culvert
 Inv. 877.98 m
 (All Terra Engineering 2005 See Appendix E)

Natural Drainage Route (Hazlett Lake Overflow)

Note:
 Natural Drainage Route elevation is higher than the HWL of the lake. Discharge from the lake would only occur during catastrophic events (1-300 year event for example) as noted in the 2005 AI-Terra Engineering Report.

FIGURE No. 4-9
 NORTH OF HIGHWAY 11A SERVICING STUDY

STORMWATER
 HAZLETT LAKE INLET & OUTLET
 CONFIGURATIONS

| | |
|----------------|-------------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:10,000 |
| APPROVED | |
| DATE | JUNE 2016 |
| REV | |
| DESCRIPTION | ISSUED FOR FINAL REPORT |

A number of reports have been completed in the past that describe the overall drainage characteristics of the Lake, and also provide recommendations for conservation of the Hazlett Lake. A summary of the most relevant information is described below:

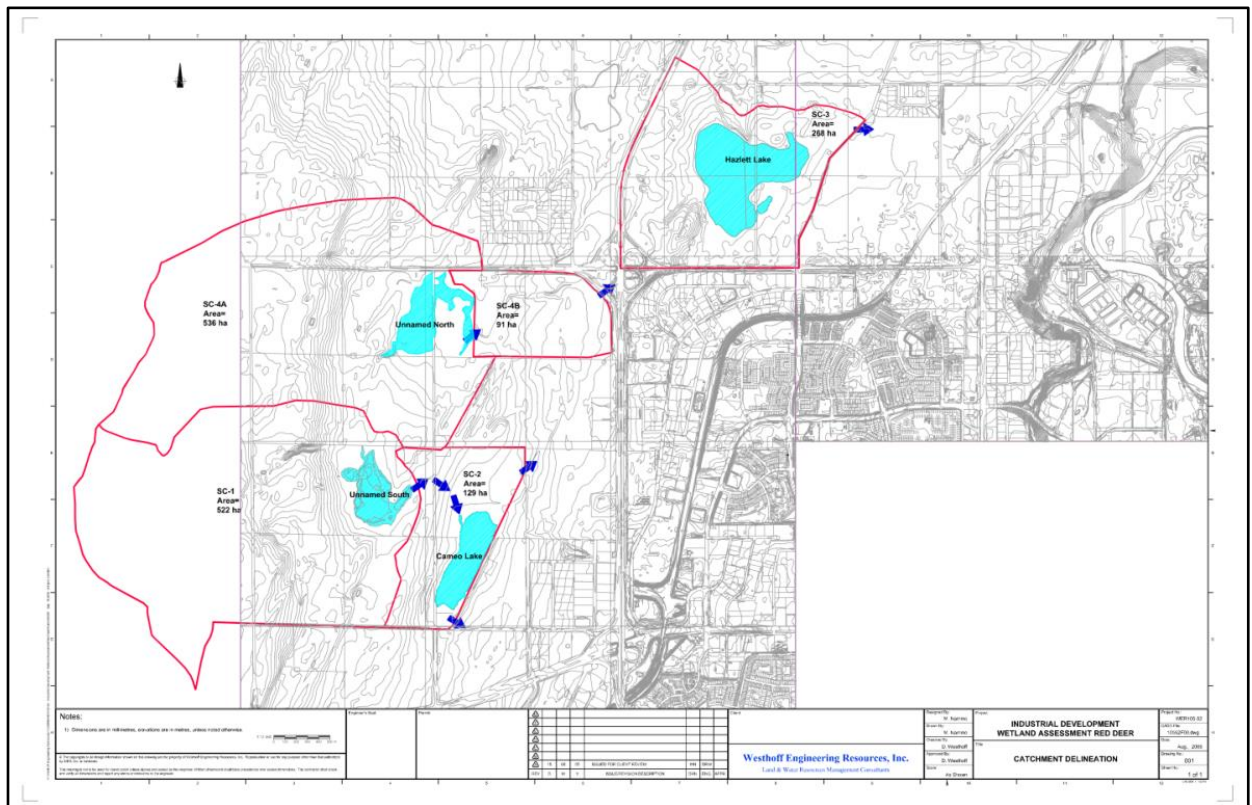
- **Master Drainage Plan for Queens Business Park” – Westhoff Engineering Resources, Inc., May 2007”.**

According to the report, the Hazlett Lake is considered an “overflow” facility since it receives runoff for the Queens Business Park in extremely severe storm events. The majority of the time, the runoff from the development area is controlled on-site through stormwater management facilities and flows are conveyed by a storm trunk that directly discharges into the Edgar storm sewer system.

Hazlett Lake also receives runoff from the Highway 11A and Highway 2A interchange; however, according to the report this configuration will remain a status quo in the future.

Figure 4-10 shows the upstream drainage areas of Hazlett Lake that were identified in the Westhoff report.

**Figure 4-10
Catchment Delineation Provided in Westhoff Report**



- ***“Queen Industrial Park & Future Industrial Lands Sanitary Sewer and Storm Sewer Trunks Projects” Pre-Design Report, AI-Terra Engineering Ltd., May 2007”***

The drainage analysis included the tributary areas of the water bodies of Cameo Lake, Hazlett Lake and various unnamed wetlands. According to the report, “the principal idea for the proposed stormwater drainage plan is to utilize all the available detention within these existing water bodies, maintain pre-development overland flow rates, and either provide additional detention onsite or pass the drainage onto the Red Deer River via existing overland drainage routes and/or proposed trunk mains.”

As part of the drainage analysis, a XPSWMM model was developed to include the natural waterbodies and the proposed Queen Business Industrial Park Area. According to the AI-Terra report, an extensive amount of time was spent in modelling the Hazlett Lake system in order to simulate the lake water levels in particular storm events; however, it was not possible to produce a detailed model that was able to simulate the field (or recorded) water levels in the Lake.

Upgrades to the existing Hazlett Lake drainage route was also recommended in the report. According to the report’s reference, “Hazlett Lake should never overflow through this drainage channel again except for catastrophic events such as a 1 in 300 year event for example; the drainage upgrades should be completed regardless.”

- ***“Stormwater Management Analysis Results”, Westhoff Engineering Resources Inc., September 2005”***

This report provides preliminary modelling results for four main wetlands including Hazlett Lake. The analysis was based on an impervious value of 75%, 1:100 year 24 hour Chicago Storm, and contours provided by the City of Red Deer.

According to the report, the Normal Water Level (NWL) of the Hazlett Lake was estimated to be 877.30 m which is consistent with the NWL estimated based on air photos (extend of water edge).

Two scenarios were run for Hazlett Lake with different contributing areas and release rates. The model results show that the maximum High Water Level (HWL) elevation for a zero release rate (worst case scenario) was estimated to be in the range of 877.70 m and 877.82 m (post-development conditions).

For pre-development conditions, dry and wet years of 1979 and 1999 respectively were used to estimate the water levels in the wetlands. As shown in the report, the Hazlett Lake resulted in HWLs in the range of 877.52 m and 878.20 m during the wet year. These results are relatively higher than the post-development conditions.

The report suggested that a continuous simulation model should be used to confirm the storage requirements since they are being underestimating by using single event analysis (for release rates lower than 3 l/s/ha). According to the report, a continuous simulation uses recorded climate data over a continuous period instead of a single synthetic data (IDF curves).

Westhoff model results are shown in [Appendix D](#).

- **“Hazlett Lake Monitoring Plan”, Westhoff Engineering Resources Inc., January 2015”.**
As previously mentioned, the City of Red Deer has identified the Hazlett Lake as a wetland of regional environmental significance. In order to preserve the habitat of endangered species and plants communities, a monitoring program of the pond ecological integrity and health was planned by the City.

According to the report, “Monitoring of Hazlett Lake is an important step in managing for the Lake’s long-term sustainability. The City initiated the Hazlett Lake Monitoring Program to track observed changes within Hazlett Lake and to identify any negative impacts associated with encroaching urban development.”

Several identified parameters to be monitored in the program includes wildlife, water quality, trophic state index, sediment quality, Lake water levels and wet meadow Index of biological integrity. In terms of water quality, the program looks for impacts to the lake’s water quality due to additional surrounding developments and direct discharge of surface runoff to the Lake. It also targets the increase of pollutants in the Lake and source of pollution. Lake water levels are monitored at the staff gauge installed at the concrete outfall located south of the Lake.

A photo of the Hazlett Lake outfall and gauge, taken on May 2015, is shown in Photo 2.

Photo 2: Hazlett Lake Gauge Station



In general, based on the background information of the Hazlett Lake and the existing topography of the project area, the Lake has a contributing area of approximately 273 ha (mainly undeveloped).

The normal water level (NWL) and top of lake elevations were estimated to be 877.3 m and 878.2 m respectively, based on available DEM data. Note that these elevations are consistent with the data provided in the “Stormwater management analysis results” report completed by Westhoff Engineering Resources Inc. and the “2005 Industrial Lands Sanitary and Storm Trunk Project” completed by AI-Terra Engineering Ltd.

As noted above, flows from the Highway 11A storm sewer “overflow” to the Lake only during severe storm events. Since these flows are relatively small and do not have an impact to the Lake water levels, and proposed downstream storm system, any upstream flows will not be incorporated in the PCSWMM model. The Majority of the flows from Queen Business and Edgar Industrial Parks are currently being intercepted by a 1050 mm diameter storm sewer and routed directly to the Red Deer River as noted in the “Master Drainage Plan for Queens Business Park” completed by Westhoff Engineering Resources, Inc.

Currently, Hazlett Lake does not have a proper outlet structure. Discharge from the Lake occurs through a natural drainage ditch located along the NE corner of the Lake. Based on the existing topography, the elevation of the NE ditch is higher than the Lake’s HWL elevation of 878.2 m, indicating that the lake would not overflow in the 1:100 year storm event. This information is consistent with the 2005 AI-Terra Engineering Report which noted that Hazlett Lake should only overflow into the drainage channel to the NE in the case of a storm event that exceeds the 1:100 year storm.

4.3.3.3 Lake on the IPSCO Property

The lake on the IPSCO property is located approximately in the center of the Red Deer River Basin. The contributing area was estimated to be 417 ha and consists of a mixture of industrial, country residential and undeveloped areas.

The following are the Lake characteristics based on the available DEM data:

- Approximately Lake footprint Area: 11.3 ha.
- Estimated NWL Elevation: 876.6 m.
- Estimated Top of Berm Elevation: 877.0 m.

As previously noted the lake on the IPSCO property connects to Hazlett Lake through a series of drainage culverts and ditch systems long the south side of the Central Park Subdivision, as shown in Photo 3. The lake on the IPSCO property inlet consists of a 600 mm diameter culvert located under Range Road 273.

Photo 3: Connecting Ditch between Hazlett Lake and the lake on the IPSCO Property



Based on the Queens Industrial Park & Future Industrial Lands Sanitary Sewer and Storm Sewer Trunks Project (Al-Terra Engineering Ltd. – 2007) report, the outlet of the Lake consists of two 900 mm culverts with inverts set 1 m higher than the bottom of the ditch. Flows from the lake on the IPSCO property are pumped through these culverts located under the Canadian Pacific Railway and the downstream two 1,200 mm culverts crossing Highway 2A. From Highway 2A, water drains through an industrial area to a natural stream, and eventually to the Red Deer River. Highway 2A culvert crossings and downstream ditch configuration are shown in Photo 4. Al-Terra Engineering drawing titled “Existing Overland Drainage Route for Hazlett Lake with Proposed Easements” is shown in [Appendix E](#).

Photo 4: Highway 2A Culvert Crossings and Downstream Ditch



4.3.3.4 Chiles Industrial Park Subdivision

The Chile Industrial Park Subdivision is located in the southeast area of the Red Deer River Basin. The existing storm drainage system of the subdivision consists of a series of drainage culverts and ditches which direct flows towards an existing stormwater management facility (dry pond).

According to ISL as-built drawings, the pond has an approximately footprint area of 0.47 ha and an average maximum pond depth of approximately 3 m (average depth from pond bottom to maximum water level). The estimated maximum storage capacity provided by the pond is approximately 14,100 m³.

Flows from the dry pond are controlled by a 350 mm diameter HDPE storm pipe before connecting to an existing 600 mm storm pipe, and eventually draining towards the Red Deer River.

ISL as-built drawings can be found in [Appendix F](#).

4.3.4 Blindman River Basin

The basin has a total drainage area of approximately 1169 ha with natural slopes ranging from 1.5% to 3.5%. The basin includes the following:

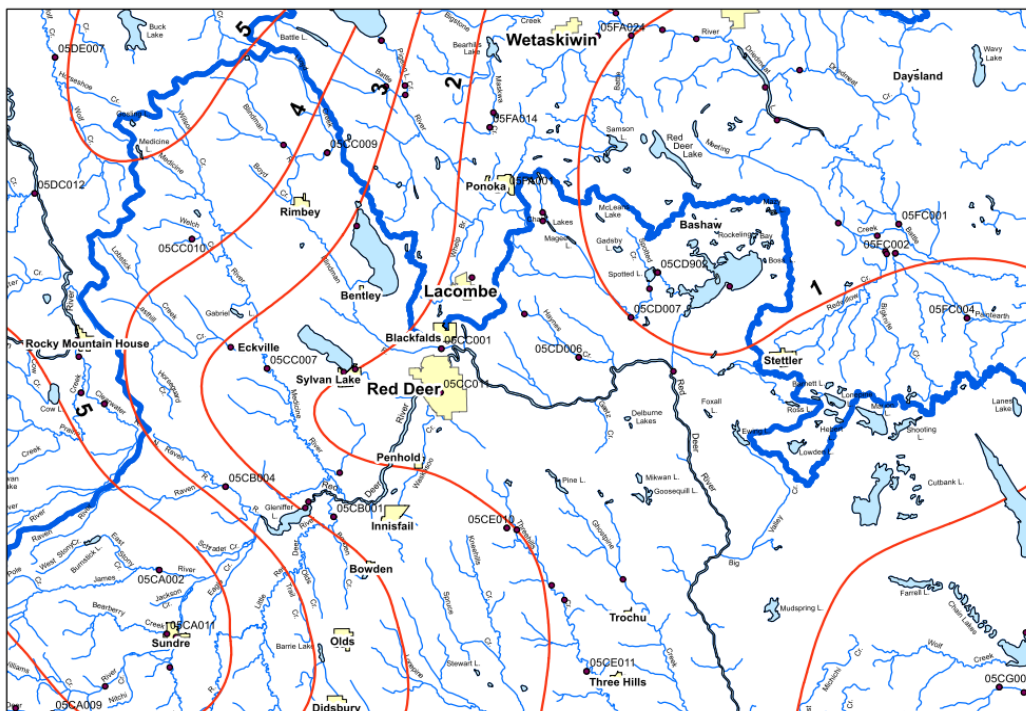
- Approximately 618 ha of undeveloped area and approximately 551 ha of developed area (mainly residential and industrial).
- Several natural drainage route tributaries to the Blindman River.
- A large natural wetland, approximately 1.04 ha, located in the southwest area of the basin.

Currently, the basin does not have storm sewer systems or stormwater management facilities for water quality and quantity control. Currently runoff from the industrial and country residential areas are being discharged directly to the existing natural streams through a series of culverts/bridges and ditch systems.

4.3.5 Pre-Development Release Rate

The construction of houses, commercial buildings, paved roads and parking lots increases the imperviousness of a watershed and reduces the infiltration of rainwater, increasing the volume and rate of runoff. In order to minimize the impact to the environment, stormwater management facilities are used to control the rate of flow to the rates expected prior to development of the land (pre-development flow rates). Alberta Environment and Parks (AEP) have developed a 1:100 year pre-development runoff rate for the Red Deer Region based on nearby hydrometric station instantaneous flow records. Based on the AEP preliminary chart, shown in **Figure 4-11**, the maximum pre-development rate for the project area is approximately 2.0 l/s/ha.

Figure 4-11
AEP Preliminary 1:100 Pre-Development Release Rate Chart



Associated Engineering conducted a preliminary review of the pre-development rate base on the Water Survey of Canada (WSC) gauges. A Regional Analysis was completed using gauge data for a number of rivers and creeks within the vicinity of the Red Deer area, including Threehills Creek, Renwick Creek, Haynes Creek, and Parlby Creek. The preliminary analysis resulted in a maximum outflow rate of 2.8 l/s/ha, as shown in **Figure 4-12**.

Figure 4-12
Regional Flood Frequency Analysis – WSC Gauges

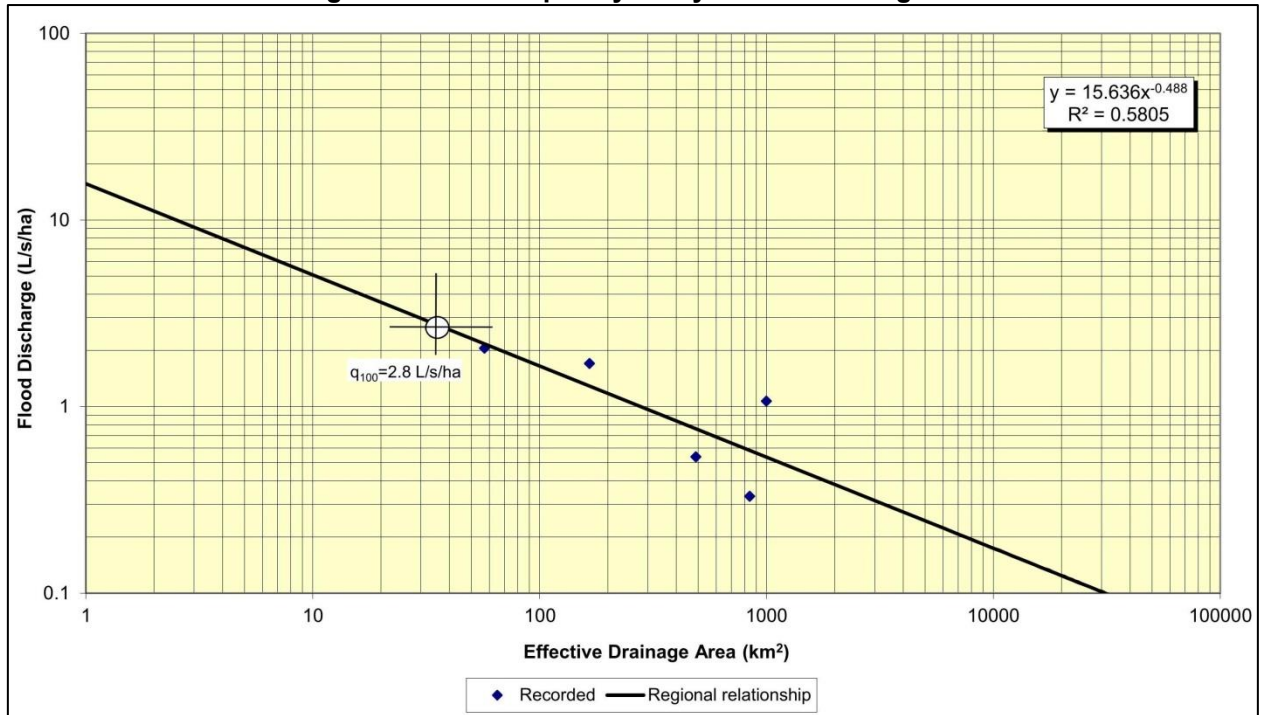


Table 4-10 summarizes the gauge data and flows for different return periods.

Table 4-10
Gauge Data and Flows

| No. | Name | DA (km ²) | Return Period (Years) | | | | | Design | L/s/ha |
|---------|-------------------------------|-----------------------|-----------------------|-------|-------|-------|--------|--------|--------|
| | | | 2 | 10 | 25 | 50 | 100 | 100 | |
| | | | 1 | 2 | 3 | 4 | 5 | 5 | |
| 05CD006 | Haynes Creek Near Haynes | 166 | 1.98 | 7.35 | 12.88 | 19.18 | 28.22 | 28.22 | 1.70 |
| 05CD007 | Parlby Creek at Alix | 488 | 6.81 | 14.85 | 19.26 | 22.69 | 26.23 | 26.23 | 0.54 |
| 05CD902 | Parlby Creek Near Mirror | 843 | 6.86 | 13.93 | 18.72 | 22.96 | 27.83 | 27.83 | 0.33 |
| 05CE007 | Threehills Creek Near Carbon | 999 | 13.71 | 41.29 | 62.35 | 82.35 | 106.87 | 106.87 | 1.07 |
| 05CE011 | Renwick Creek Near Threehills | 57.2 | 3.03 | 7.02 | 8.96 | 10.37 | 11.75 | 11.75 | 2.05 |

Taking the above noted information into account, a pre-development release rate of 2.0 L/s/ha has been assumed for the North of 11A Study Area.

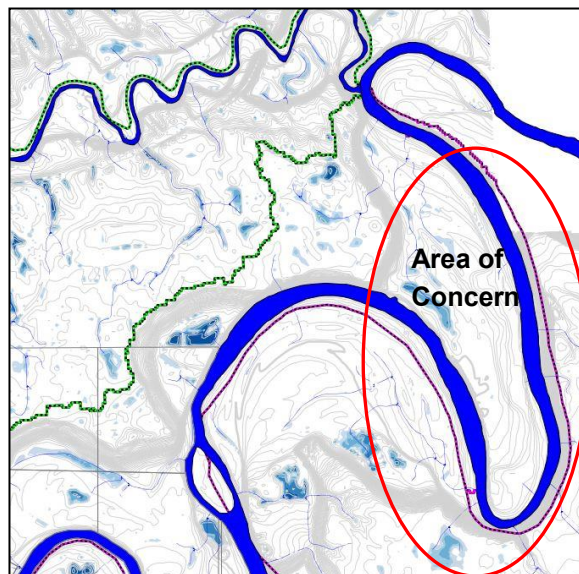
4.3.6 Conceptual Flood Fringe for Area of Concern

The City of Red Deer has identified an area of concern within the Red Deer River basin, as shown in **Figure 4-13**. In previous reports, a land use of “green spaces” was assigned to this area but reasoning behind this assumption was unclear. In order to confirm the feasibility of future development in the area of concern, an estimate of the conceptual flood fringe zone within the area was completed.

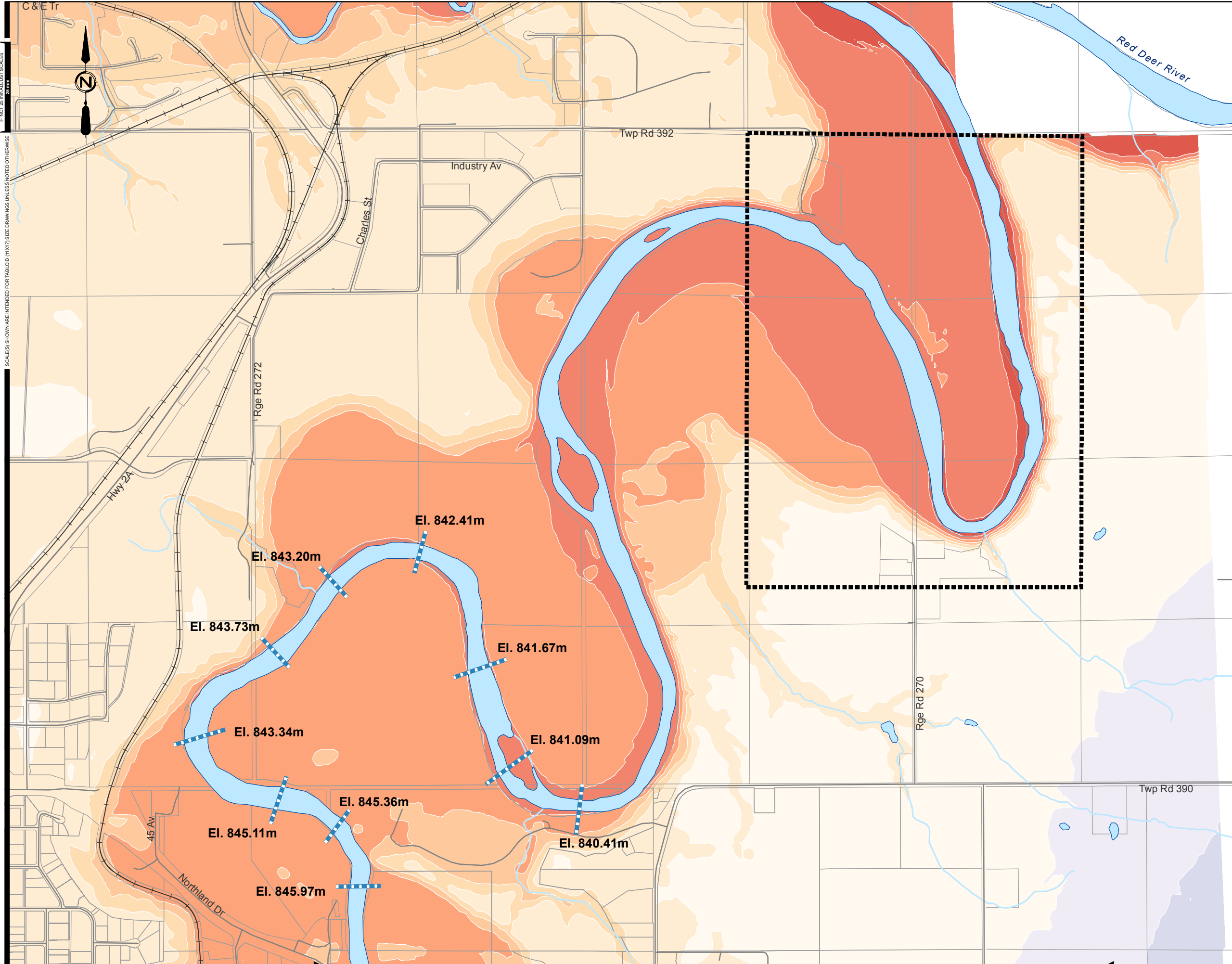
The conceptual flood fringe elevations were calculated based on the following assumptions:

- The 1:100 year flood elevation for the Red Deer River was taken from the AEP’s Hazard Map.
- An average slope of 0.14% for the Red Deer River was calculated based on the existing flood elevations.



Figure 4-13
Area of Concern



The conceptual extents of the flood fringe based on the available LIDAR data and calculated flood elevations are shown in **Figure 4-14**. Note that the illustrated flood fringe area is conceptual only. A more detailed analysis of the Red Deer River channel parameters and rainfall events should be completed in subsequent planning stages for the area.



Legend:

-  Area of Concern
-  Flood Fringe Elevation (Alberta Environment Flood Hazard Map)

Elevation










-  <830m
-  830m - 840m
-  840m - 850m
-  850m - 860m
-  860m - 870m
-  870m - 880m
-  880m - 890m
-  890m - 900m
-  900m - 910m

FIGURE No. 4-14
 NORTH OF HIGHWAY 11A SERVICING STUDY
 STORMWATER
 CONCEPTUAL FLOOD FRINGE ELEVATIONS

| | |
|-----------------------|-------------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:18,000 |
| APPROVED | |
| DATE | JUNE 2016 |
| REV | |
| DESCRIPTION | ISSUED FOR FINAL REPORT |

4.3.7 Ultimate Servicing Concept

To aid with the future development within the project area, this storm servicing plan will address, in concept, the future storm water management requirements. This section will also provide an overall drainage concept plan to assist with the planning of future development.

4.3.8 Stormwater Management Requirements

AEP's stormwater management guidelines require control of water quality in urban stormwater. The minimum requirements are to remove at least 85% of the suspended sediments larger than 75 micron (0.75 mm) is size.

According to AEP's, wet ponds and stormwater wetlands typically remove 80-90% of the suspended solids and 40-60% of the suspended and dissolved nutrients in urban stormwater. Therefore, best management practice implies that wet facilities be used. Existing wetlands and waterbodies should be preserved. If this is not possible, AEP will require replacement or compensation.

As indicated in Section 4.3.5, a maximum outflow rate of 2 l/s/ha is proposed to size ponds for the City of Red Deer based AEP's chart. The ponds will be designed to store runoff for the 1:100 year – 24 hours storm event.

It is important to note that the storage volumes that will be recommended in the following pond sizing in future are conceptual only. The size of each pond should be confirmed during the design stage when details of the pond design and the development concept are finalized.

4.3.9 Proposed Concept

Figure 4-15 provides an overall view of the stormwater management concept for the future development area. The proposed concept plan was defined based on the following:

- Stormwater management guidelines described above to prevent flooding and erosion of downstream system, and to protect the quality of water in the receiving streams;
- Existing topography. Follow the existing drainage systems; and
- Preservation of existing wetlands and streams.

A PCSWMM model was developed to evaluate the existing drainage conditions within the City of Red Deer boundaries based on as-built drawings and previous engineering reports. The Rational Method was used to conceptually size all the proposed stormwater management facilities and storm trunks within the project boundary. In order to service the future development area, a series of stormwater management (SWM) facilities are required within the project boundary to provide water quantity control, and to prevent any increase of erosion and downstream flooding to existing receiving streams.

FUTURE STORMWATER MANAGEMENT FACILITIES CHARACTERISTICS

| Pond ID | Contributing Area (ha) | Required Storage (m ³) | Pond Footprint Area (ha) | Average Storage per hectare (m ³ /ha) |
|---------|------------------------|------------------------------------|--------------------------|--|
| P1 | 107.91 | 63620 | 3.10 | 589.6 |
| P2 | 17.73 | 10210 | 1.30 | 578.9 |
| P3 | 60.02 | 50650 | 3.00 | 843.0 |
| P4 | 68.40 | 47550 | 3.62 | 695.2 |
| P5 | 44.44 | 40320 | 2.48 | 907.3 |
| P6 | 33.84 | 29140 | 1.83 | 861.1 |
| P7 | 26.92 | 18480 | 1.54 | 686.5 |
| P8 | 19.30 | 13250 | 1.15 | 686.5 |
| P9 | 19.38 | 13300 | 1.57 | 686.4 |
| P10 | 34.18 | 23460 | 1.51 | 686.4 |
| P11 | 35.10 | 20220 | 1.35 | 576.1 |
| P12 | 12.10 | 8310 | 0.77 | 686.8 |
| P13 | 108.10 | 50680 | 3.03 | 470.7 |
| P14 | 50.70 | 25230 | 2.85 | 497.6 |
| P15 | 43.90 | 19790 | 2.27 | 450.8 |
| P16 | 17.45 | 15630 | 1.37 | 907.2 |
| P17 | 111.60 | 64290 | 3.80 | 576.1 |
| P18 | 27.20 | 15670 | 1.31 | 576.1 |
| P19 | 31.80 | 18320 | 1.21 | 576.1 |
| P20 | 80.80 | 46550 | 2.35 | 576.1 |
| P21 | 47.80 | 32610 | 2.04 | 686.4 |
| P22 | 14.57 | 10000 | 1.21 | 686.3 |
| P23 | 40.80 | 22720 | 1.47 | 556.9 |
| P24 | 38.70 | 21000 | 1.37 | 542.6 |
| P25 | 51.48 | 35340 | 2.18 | 686.5 |
| P26 | 45.32 | 31110 | 1.97 | 686.5 |
| P27 | 65.80 | 39320 | 2.40 | 597.6 |
| P28 | 40.38 | 23290 | 1.50 | 576.0 |
| P29 | 78.60 | 38920 | 2.38 | 495.2 |
| P30 | 59.30 | 37140 | 2.31 | 626.3 |
| P31 | 49.50 | 30630 | 1.95 | 622.8 |
| P32 | 23.54 | 19280 | 1.29 | 819.0 |
| P33 | 43.20 | 24890 | 1.62 | 576.2 |
| P34 | 45.20 | 31030 | 2.47 | 686.5 |
| P35 | 21.00 | 8980 | 0.68 | 427.6 |
| P36 | 47.40 | 27880 | 1.79 | 588.2 |
| P37 | 26.10 | 12680 | 1.11 | 485.8 |
| P38 | 42.80 | 11670 | 1.41 | 272.7 |
| P39 | 39.50 | 22750 | 1.86 | 575.9 |
| P40 | 51.10 | 14270 | 1.67 | 279.3 |
| P41 | 12.40 | 4360 | 0.45 | 351.6 |
| P42 | 18.80 | 10560 | 0.77 | 561.7 |
| P43 | 21.30 | 5210 | 0.67 | 244.6 |
| P44 | 30.40 | 7440 | 0.92 | 244.7 |
| P45 | 20.40 | 4990 | 0.65 | 244.6 |
| P46 | 53.10 | 13000 | 1.54 | 244.8 |
| P47 | 67.50 | 46340 | 2.89 | 686.5 |
| P48 | 28.80 | 7050 | 0.56 | 244.8 |

* Estimated. Emissions based on DSM scenarios.
 ** Storage calculated based on the Modified Rational Method and Future Land Use.
 *** Peak Flow outfall are based on a release rate of 2 l/s/ha



Note:
 The locations and sizes of stormwater management facilities have been conceptually developed based on catchment areas. Please note that developers will be required to provide stormwater management facilities to meet pre-development release rates.

- Legend:
- Preliminary Outfall
 - Possible Future Pond Location (Ponds to be designed to meet pre-development rates)
 - Ultimate Manhole
 - Ultimate Ditch
 - Ultimate Stormwater Trunk
 - Ultimate SWMF
 - Pond Outlet
 - Pond Catchment Area
 - Existing Drainage Route
 - Existing Stormwater Trunk
 - Existing Stormwater Pond
 - Proposed Transportation
 - Existing Transportation
 - Blindman River Catchment
 - Red Deer River Catchment
 - Study Area

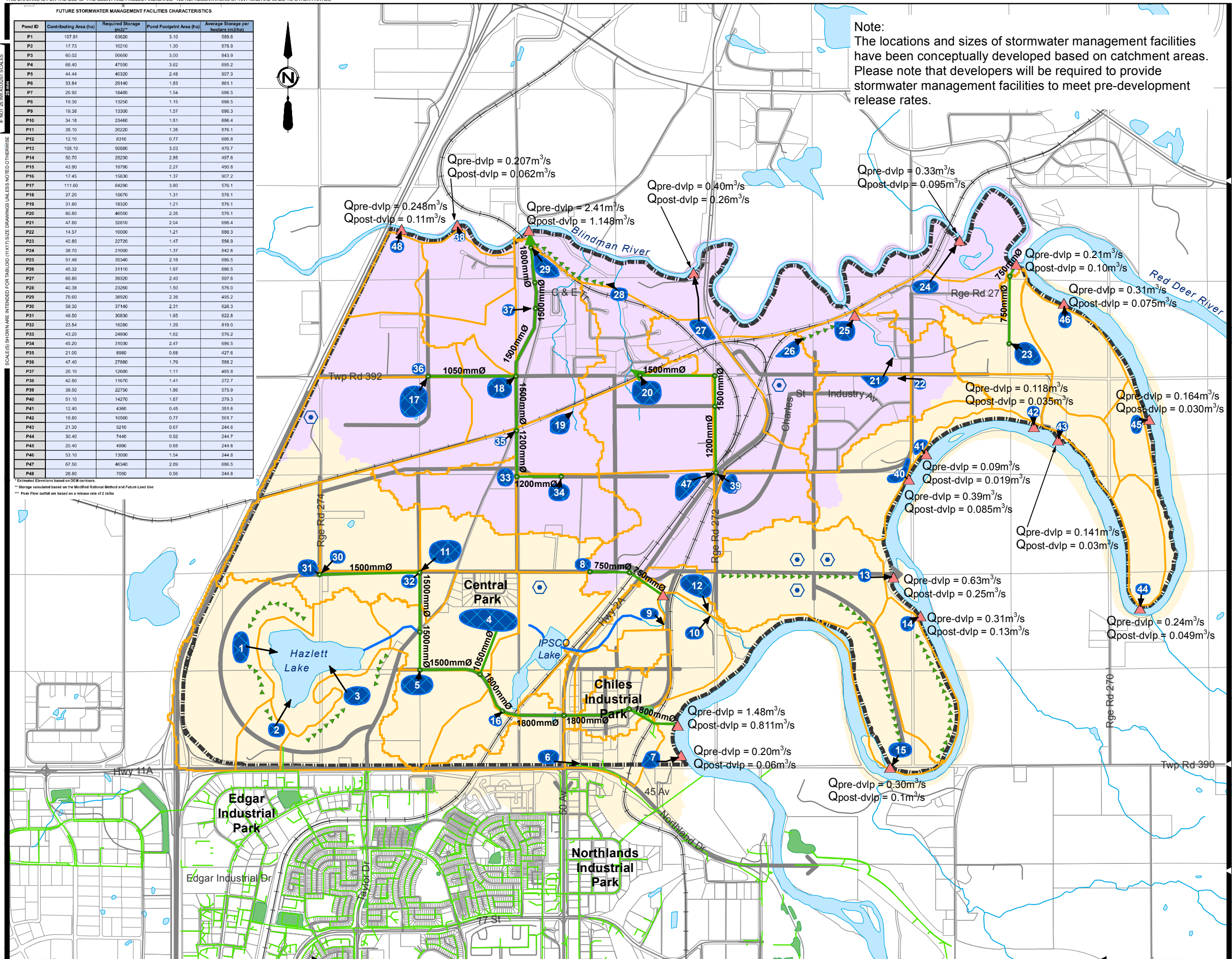


FIGURE No. 4-15
 NORTH OF HIGHWAY 11A SERVICING STUDY

STORMWATER
 ULTIMATE STORMWATER CONCEPT

| | |
|----------------|-------------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED | |
| DATE | JUNE 2016 |
| REV | |
| DESCRIPTION | ISSUED FOR FINAL REPORT |

The future stormwater management facilities were conceptually sized by using the modified rational method. The active storage requirements were determined by using the Intensity-duration-frequency (IDF) rainfall data from the Red Deer Industrial Airport (period 1964-2006) for the 1:100 year storm event and a release rate of 2.0 l/s/ha.

The preliminary size of the ponds were then calculated by an AE "Wet Pond Design" excel spreadsheet which take in consideration the different ponds depths, minimum freeboard and side slope requirements from the City of Red Deer design standards. Depth-area curves were developed for each pond, and imported into the PCSWMM model to confirm pond capacity and to determine the pre/post development hydrographs.

Table 4-11 (pages 4-45 to 4-47) summarizes the characteristics for the stormwater management facilities. **Appendix G** provides detailed calculations of the ponds sizes, storage volumes, and outfall rates. These are all subject to review in the design stage based on the design standards that apply at the time and based on the details of the catchment areas.

As shown in **Figure 4-15**, forty eight (48) stormwater management facilities are proposed within the project area in order to provide water quality and quantity control before discharging to existing waterbodies. In addition to the ponds, storm trunks with diameters ranging from 750 mm to 1800 mm are proposed. The main objective of the proposed storm trunks is to reduce the length of overland flow and intercept runoff from the future SWMFs. The proposed storm trunks and stormwater management ponds will be discharging (at pre-development release rate) to the existing tributaries in order to promote preservation of the existing drainage system.

The stormwater management facilities were included in the PCSWMM model to confirm that the post-development rates do not exceed the pre-development rates. Hydrographs for each proposed pond outfall were developed and included in **Appendix G**.

Based on the project area boundary, there will not be any impacts to downstream stormwater infrastructure since the project area is, and will continue draining directly to the Red Deer River and the Blindman River with a maximum discharge rate of 2.0 L/s/ha (pre-development release rate).

Due to the significant environmental characteristics of the Hazlett Lake, runoff from the future development surrounding the Lake will be intercepted through a series of ditches which will direct the flows to the proposed stormwater management facilities (Pond 1, 2 and 3), located around the perimeter of the Lake. Runoff will not be discharged directly into the Lake. It will be treated in order to maintain the natural ecosystem of the Lake, and controlled to the pre-development rate before being released into the Lake.

Based on the topography of the area and according to the model results, no flow will be released from the Hazlett Lake during the 1:100 year storm. This result is consistent with AI-Terra Engineering report which noted that the Hazlett Lake should never overflow through the drainage channel except for catastrophic events (1:300 year event for example). Minor regarding of the ditch will be required to provide positive drainage from the Lake to the proposed storm trunk (ditch will serve as emergency overflow). In general, the operation of Hazlett Lake will remain as it currently exists because the topography if the area does not allow for the installation of a control structure at the lake outlet.

Downstream of the lake on the IPSCO property, the existing system seems to be performing adequately for the 1:100 year storm. Grading of the existing ditch, downstream of the existing 2 × 900 mm diameter culverts under Highway 2A is required to provide additional capacity and minimize ponding levels along the ditch.

The existing dry pond located in the Chiles Industrial Subdivision has the capacity to provide the 1:100 year storage capacity for the contributing area. Minor grading of the existing ditches is recommended to provide positive drainage to the dry pond.

The proposed stormwater management concept plan sets out the primary parameters that will guide future development. It is not meant to be prescriptive, and it is subject to further review in subsequent stages of the development process.

The capacity of the existing local and highway drainage culverts and ditches should be reviewed during the design stage to ensure that adequate capacity is available for the proposed developments.

It is recommended that existing wetlands and streams be preserved to provide additional storage within the development area, and to reduce the construction of additional stormwater management facilities.

City of Red Deer

**Table 4-11
Characteristics of Future Stormwater Management Facilities**

| Pond ID | Contributing Area (ha) | Required Storage (m ³)** | Peak Outfall (m ³ /s)*** | Pond Footprint Area (ha) | Pond Bottom EL. (m) | NWL EL. (m)* | HWL EL. (m)* | Top of Berm EL. (m)* | Pond Active Depth (m) | Orifice Size (mm) |
|---------|------------------------|--------------------------------------|-------------------------------------|--------------------------|---------------------|--------------|--------------|----------------------|-----------------------|-------------------|
| P1 | 107.91 | 63,620 | 0.216 | 3.10 | 876.0 | 878.0 | 880.5 | 881.0 | 2.5 | 263 |
| P2 | 17.73 | 10,210 | 0.035 | 1.30 | 875.3 | 877.3 | 878.3 | 878.8 | 1.0 | 131 |
| P3 | 60.02 | 50,650 | 0.120 | 3.00 | 875.5 | 877.5 | 879.5 | 876.0 | 2.0 | 210 |
| P4 | 68.40 | 47,550 | 0.136 | 3.62 | 872.0 | 874.0 | 875.5 | 876.0 | 1.5 | 236 |
| P5 | 44.44 | 40,320 | 0.089 | 2.48 | 874.4 | 876.4 | 878.4 | 879.0 | 2.0 | 175 |
| P6 | 33.84 | 29,140 | 0.068 | 1.83 | 870.8 | 872.8 | 874.8 | 875.3 | 2.0 | 152 |
| P7 | 26.92 | 18,480 | 0.054 | 1.54 | 840.9 | 842.9 | 844.4 | 845.0 | 1.5 | 146 |
| P8 | 19.30 | 13,250 | 0.039 | 1.15 | 875.0 | 877.0 | 878.5 | 879.1 | 1.5 | 123 |
| P9 | 19.38 | 13,300 | 0.039 | 1.57 | 871.8 | 873.8 | 874.8 | 875.3 | 1.0 | 137 |
| P10 | 34.18 | 23,460 | 0.068 | 1.51 | 870.6 | 872.6 | 874.6 | 875.1 | 2.0 | 154 |
| P11 | 35.10 | 20,220 | 0.070 | 1.35 | 875.0 | 877.0 | 879.0 | 879.6 | 2.0 | 156 |
| P12 | 12.10 | 8,310 | 0.024 | 0.77 | 871.9 | 873.9 | 875.4 | 876.0 | 1.5 | 98 |
| P13 | 108.10 | 50,880 | 0.216 | 3.03 | 838.5 | 840.5 | 842.5 | 843.0 | 2.0 | 275 |
| P14 | 50.70 | 25,230 | 0.101 | 2.85 | 833.0 | 835.0 | 836.0 | 836.5 | 1.0 | 227 |
| P15 | 43.90 | 19,790 | 0.088 | 2.27 | 838.0 | 840.0 | 841.0 | 841.6 | 1.0 | 210 |
| P16 | 17.45 | 15,830 | 0.035 | 1.37 | 873.0 | 875.0 | 877.0 | 877.6 | 2.0 | 125 |
| P17 | 111.60 | 64,290 | 0.223 | 3.80 | 873.0 | 875.0 | 877.0 | 877.6 | 2.0 | 280 |

City of Red Deer

| Pond ID | Contributing Area (ha) | Required Storage (m ³)** | Peak Outfall (m ³ /s)*** | Pond Footprint Area (ha) | Pond Bottom EL. (m) | NWL EL. (m)* | HWL EL. (m)* | Top of Berm EL. (m)* | Pond Active Depth (m) | Orifice Size (mm) |
|---------|------------------------|--------------------------------------|-------------------------------------|--------------------------|---------------------|--------------|--------------|----------------------|-----------------------|-------------------|
| P18 | 27.20 | 15,670 | 0.054 | 1.31 | 870.0 | 872.0 | 873.5 | 874.0 | 1.5 | 147 |
| P19 | 31.80 | 18,320 | 0.064 | 1.21 | 871.5 | 873.5 | 875.5 | 876.0 | 2.0 | 148 |
| P20 | 80.80 | 46,550 | 0.162 | 2.35 | 865.0 | 867.0 | 869.5 | 870.0 | 2.5 | 224 |
| P21 | 47.80 | 32,810 | 0.096 | 2.04 | 866.5 | 868.5 | 870.5 | 871.0 | 2.0 | 182 |
| P22 | 14.57 | 10,000 | 0.029 | 1.21 | 867.5 | 869.5 | 870.5 | 871.0 | 1.0 | 120 |
| P23 | 40.80 | 22,720 | 0.082 | 1.47 | 863.5 | 865.5 | 867.5 | 868.0 | 2.0 | 167 |
| P24 | 38.70 | 21,000 | 0.077 | 1.37 | 860.5 | 862.5 | 864.5 | 865.0 | 2.0 | 163 |
| P25 | 51.48 | 35,340 | 0.103 | 2.18 | 860.5 | 862.5 | 864.5 | 865.0 | 2.0 | 188 |
| P26 | 45.32 | 31,110 | 0.091 | 1.97 | 863.5 | 865.5 | 867.5 | 868.1 | 2.0 | 177 |
| P27 | 65.80 | 39,320 | 0.132 | 2.40 | 854.5 | 856.5 | 858.5 | 859.0 | 2.0 | 214 |
| P28 | 40.38 | 23,260 | 0.081 | 1.50 | 849.5 | 851.5 | 853.5 | 854.0 | 2.0 | 166 |
| P29 | 78.60 | 38,920 | 0.157 | 2.38 | 844.5 | 846.5 | 848.5 | 849.0 | 2.0 | 234 |
| P30 | 59.30 | 37,140 | 0.119 | 2.31 | 876.0 | 878.0 | 880.0 | 880.6 | 2.0 | 203 |
| P31 | 49.50 | 30,830 | 0.099 | 1.95 | 876.0 | 878.0 | 880.0 | 880.6 | 2.0 | 185 |
| P32 | 23.54 | 19,280 | 0.047 | 1.29 | 875.0 | 877.0 | 879.0 | 879.6 | 2.0 | 127 |
| P33 | 43.20 | 24,890 | 0.086 | 1.62 | 871.5 | 873.5 | 875.5 | 876.1 | 2.0 | 173 |
| P34 | 45.20 | 31,030 | 0.090 | 2.47 | 871.9 | 873.9 | 875.4 | 876.0 | 1.5 | 191 |
| P35 | 21.00 | 8,980 | 0.042 | 0.68 | 871.4 | 873.4 | 875.4 | 876.0 | 2.0 | 120 |

City of Red Deer

| Pond ID | Contributing Area (ha) | Required Storage (m ³)** | Peak Outfall (m ³ /s)*** | Pond Footprint Area (ha) | Pond Bottom EL. (m) | NWL EL. (m)* | HWL EL. (m)* | Top of Berm EL. (m)* | Pond Active Depth (m) | Orifice Size (mm) |
|------------|------------------------|--------------------------------------|-------------------------------------|--------------------------|---------------------|--------------|--------------|----------------------|-----------------------|-------------------|
| P36 | 47.40 | 27,880 | 0.095 | 1.79 | 873.0 | 875.0 | 877.0 | 877.6 | 2.0 | 181 |
| P37 | 26.10 | 12,680 | 0.052 | 1.11 | 857.9 | 859.9 | 861.4 | 862.0 | 1.5 | 145 |
| P38 | 42.80 | 11,670 | 0.086 | 1.41 | 843.0 | 845.0 | 846.0 | 846.6 | 1.0 | 208 |
| P39 | 39.50 | 22,750 | 0.079 | 1.86 | 869.5 | 871.5 | 873.0 | 873.6 | 1.5 | 179 |
| P40 | 51.10 | 14,270 | 0.102 | 1.67 | 842.0 | 844.0 | 845.0 | 845.5 | 1.0 | 228 |
| P41 | 12.40 | 4,360 | 0.025 | 0.45 | 844.5 | 846.5 | 848.0 | 848.6 | 1.5 | 98 |
| P42 | 18.80 | 10,560 | 0.038 | 0.77 | 863.4 | 865.4 | 867.4 | 868.0 | 2.0 | 113 |
| P43 | 21.30 | 5,210 | 0.043 | 0.67 | 832.5 | 834.5 | 835.5 | 836.0 | 1.0 | 145 |
| P44 | 30.40 | 7,440 | 0.061 | 0.92 | 829.5 | 831.5 | 832.5 | 833.0 | 1.0 | 174 |
| P45 | 20.40 | 4,990 | 0.041 | 0.65 | 829.0 | 831.0 | 832.0 | 832.5 | 1.0 | 141 |
| P46 | 53.10 | 13,000 | 0.106 | 1.54 | 825.5 | 827.5 | 828.5 | 829.0 | 1.0 | 232 |
| P47 | 67.50 | 46,340 | 0.135 | 2.89 | 869.0 | 871.0 | 873.5 | 874.0 | 2.5 | 230 |
| P48 | 28.80 | 7,050 | 0.058 | 0.56 | 844.0 | 846.0 | 848.0 | 848.6 | 2.0 | 140 |

* Estimated Elevations based on DEM contours.

** Storage calculated based on the Modified Rational Method and land use.

*** Required storage volume and peak outfall flow rate are based on a release rate of 2 L/s/ha.

4.3.10 Cost Estimate

Cost estimates have been developed for each of the proposed stormwater management facilities and storm trunks shown in **Figure 4-15**. **Table 4-12** provides a summary of the servicing costs for stormwater management infrastructure.

Table 4-12
Preliminary Cost Estimate – Stormwater Management

| Description | Quantity | Total Cost |
|---|----------|-----------------------|
| Stormwater Management Facilities | 48 | \$ 77,625,600 |
| Stormwater Trunks | 10,175 m | \$ 29,467,100 |
| Total Cost | | \$ 107,092,700 |
| Cost Per Developable Hectare (1,721 ha) | | \$ 62,227 |

Detailed cost estimates for the stormwater management facilities for each phase of development are provided in **Appendix H** and are based on unit costs. The costs include an allowance of 30% for contingency and engineering. The costs presented are in 2016 dollars and do not include GST.

4.4 TRANSPORTATION

4.4.1 Road Network

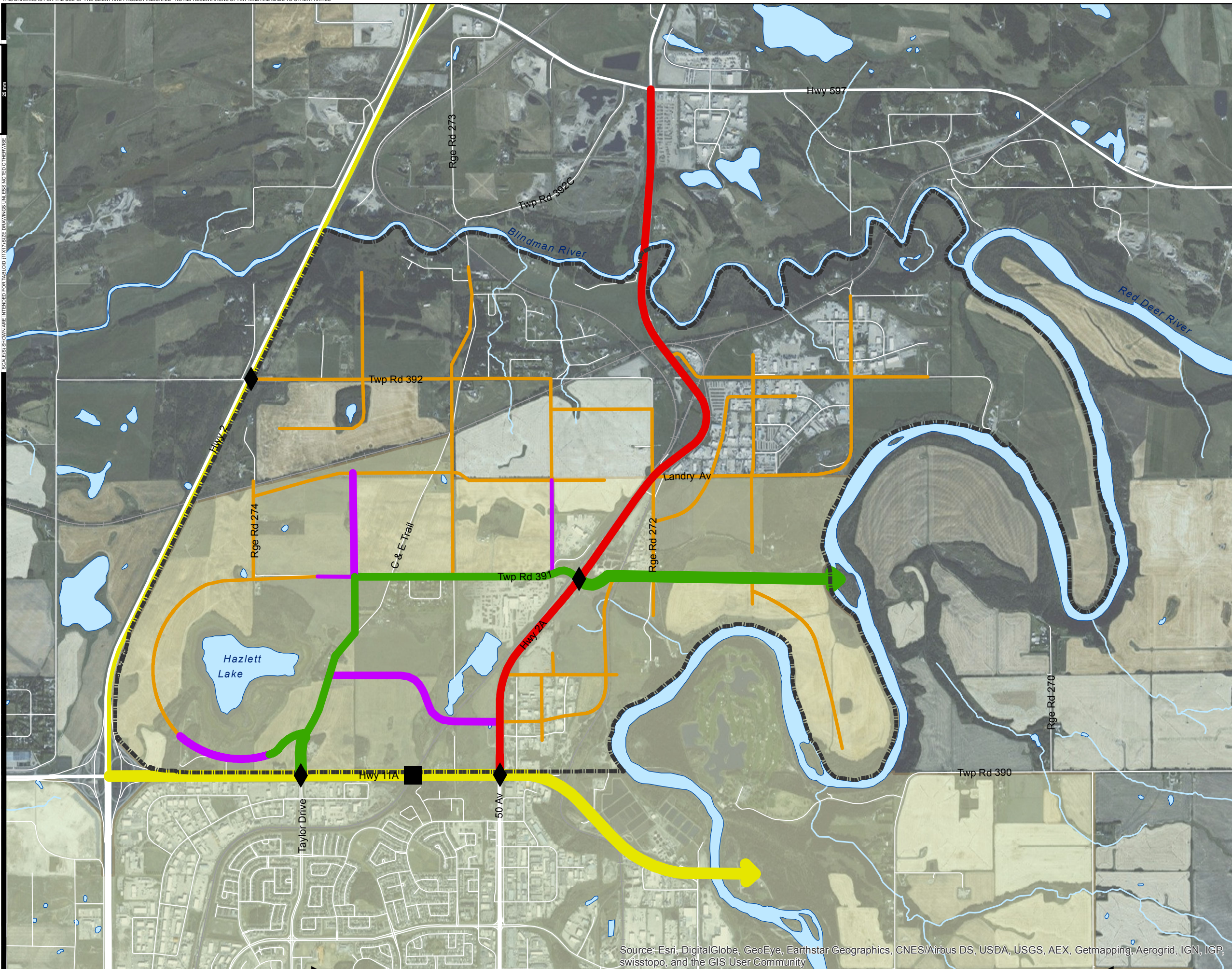
Using the road network identified in the transportation study completed previously by Watt Consulting Group (Watt) as a base, Associated Engineering developed a conceptual road network for the North of Highway 11A study area; this road network is presented in **Figure 4-16**. The proposed network consists of arterial and collector roads, as well as future interchanges on Highway 2, Highway 11A, and Highway 2A that will be required to service the lands within the North of Highway 11A study area, and takes into consideration both intersection and roadway capacity requirements, as well as environmental constraints such as water bodies and existing slopes.

In developing the ultimate road network, Associated Engineering first reviewed and confirmed the findings of the previous study and then, as required, modified the network recommended by Watt to reflect the additional information gathered and/or constraints identified as part of this study. In this way Associated Engineering was able to utilize the work that has been completed and approved by the City previously, while also ensuring that the identified road network reflects the most current information available. The following changes were made from the previous study:

- The east/west collector roadway north of Highway 11A, connecting Gaetz Avenue and the future extension of Taylor Drive should be realigned to the south in the detailed design stage in order to avoid impacting a water body.
- Realignment of the road north of Township Road 391, near Range Road 274, which will eliminate the need for an additional railway crossing.
- The alignment of the east/west collector road between Township Road 392 and Township Road 391 has been realigned to avoid a water body.

When reviewing options for the realignment of the east/west collector roadway, Associated Engineering examined options to realign the roadway around the water body to the north and to the south. Ultimately, the south option was chosen as it would have a lesser impact on existing developments, would provide greater separation along the roadway between the intersection with Highway 2A and the railway line running parallel to the highway. Additionally the resulting spacing from the Highway 2A/Highway 11A interchange will be approximately 500m, which should be sufficient to avoid operational issues.

IF NOT 20 mm AS SHOWN SCALES
 SCALES(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTICED OTHERWISE



- Legend:**
- Interchange
 - Overpass
 - Expressway
 - Highway
 - Divided Arterial
 - Arterial
 - Collector
 - Study Area
 - City of Red Deer



FIGURE No. 4-16
 NORTH OF HIGHWAY 11A SERVICING STUDY
 TRANSPORTATION
 PROPOSED NETWORK

| | |
|-----------------------|-------------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED | |
| DATE | JUNE 2016 |
| REV | |
| DESCRIPTION | ISSUED FOR FINAL REPORT |

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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 DATE: 6/13/2016, Kent Richardson

4.4.2 Lands Currently Outside the City Limits

For the lands within the study area located to the north of the existing city limits, the identified road network has been shown for illustrative purposes only. This road network in some cases utilizes roadways which have already been developed; however, for the purposes of this study, Associated Engineering has assumed that all roadways will have to be fully reconstructed to meet the city standards and therefore **Figure 4-16** does not differentiate between existing and proposed roadways.

Based on the land uses and trip generation assumptions made in previous studies, the development of these lands cannot be supported by the identified road network within the existing city limits or along the arterial roads - Taylor Drive and Gaetz Avenue - outside of the study limits without significant upgrades. This includes intersection improvements, a new intersection, and the construction of additional roadway lanes which would require additional right-of-way.

However, a road network was still identified for these lands as it is possible that development within the current city boundaries may not be feasible in all areas, or may not occur at the densities assumed. In this case it might be possible to utilize the excess capacity to support development within these lands. Additionally, if future development west of the study area on the other side of Highway 2, included a significant employment centre, the travel patterns within the study area could change as drivers utilize the new interchange north of Highway 11A. This will take taking pressure off the intersections along Taylor Drive and Gaetz Avenue and allowing for additional development within the previously unsupported lands.

As development plans are finalized, it will be necessary to compare the plans to what had been assumed previously to determine if there may be opportunities to extend development beyond the existing city limits.

4.4.3 Interchanges

The road network identifies interchanges at four locations:

- Highway 11A and Gaetz Avenue
- Highway 11A and Taylor Drive
- Highway 2A and Township Road 391
- Highway 2/Township Road 391

After reviewing the projected traffic volumes, Associated Engineering selected three interchange types that would be capable of accommodating the future traffic demands. The following interchange types were selected:

- Single point urban interchange
- Tight urban diamond interchange
- Parclo interchange

A summary of the advantages and disadvantages associated with each interchange type can be found in the following sections. For the purposes of this study it has been assumed that the Highway 2/ Township Road 391 interchange will be planned and designed by Alberta Transportation, and therefore has not been included in the alternatives evaluation later in the section.

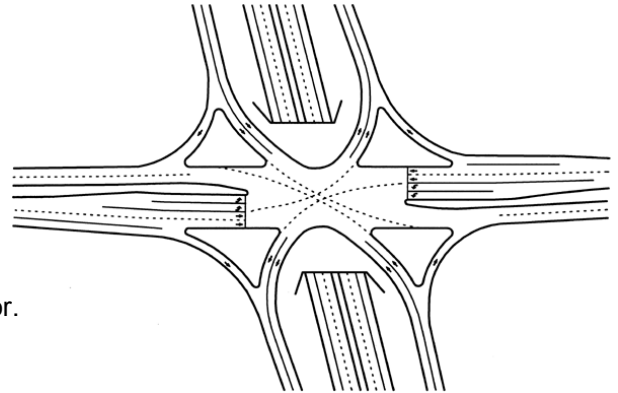
4.4.3.1 Single Point Interchange

Advantages

- Three phase signal.

Disadvantages

- One very large intersection.
- Difficult to mark, can lead to driver confusion and error.
- Not recommended for intersections with a skew.
- Pedestrians and cyclists may require a separate phase.



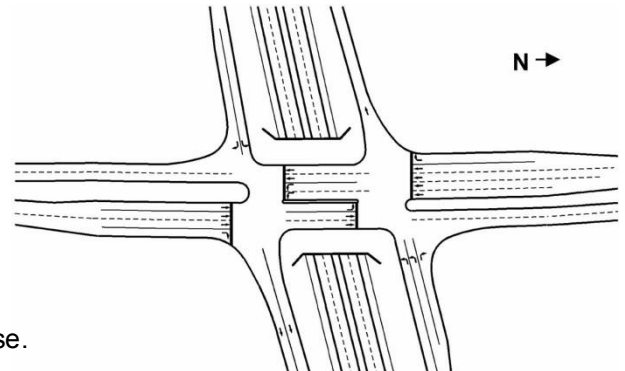
4.4.3.2 Tight Urban Diamond

Advantages

- Four phase overlap signal.
- Two small intersections.
- Can be staged as two intersections first.

Disadvantages

- Pedestrians and cyclists may require a separate phase.



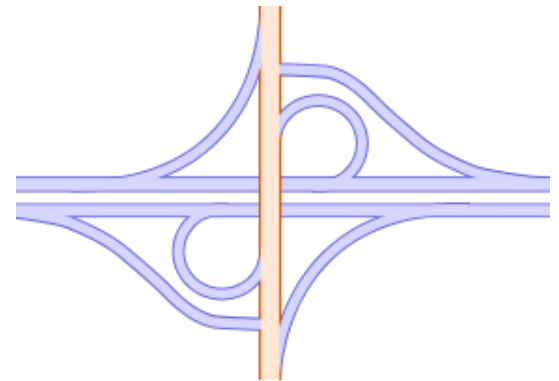
4.4.3.3 Parclo (A4)

Advantages

- Three phase signals.
- Two separate intersections.
- No pedestrian/bike phase required.

Disadvantages

- Significant right-of-way.



4.4.4 Alternatives Evaluation

The alternatives presented in the previous section were evaluated in accordance with a set of evaluation criteria developed by the project team. The evaluation criteria included traffic operations, staging opportunities, social impacts, right-of-way required, and construction cost. Note that safety was not considered as stand-alone criteria because all potential solutions should conform to recommended best practices and design guidelines; therefore, all alternatives should rank similar with respect to safety which would essentially make a potential safety category ineffective.

A description of each criterion and the method for weighing the alternatives based on the criteria are presented in **Table 4-13**. Each alternative was given a score from 1 to 3 for each criterion based on the degree of impact. A score of 3 indicated minor impact or few constraints for that particular criteria (preferred); a score of 2 indicated moderate impact or moderate amount of constraints; and a score of 1 indicated major impact or many constraints (not preferred).

**Table 4-13
Evaluation Criteria**

| Criteria | Description | Score |
|-----------------------|---|---|
| Traffic Operations | Functionality of the proposed interchange design under the peak hour traffic volumes associated with the full build out of the study lands. | 3 - Will function without significant delays 2 - Will operate with minor delays 1 - Will not be able to accommodate the projected traffic volumes |
| Staging Opportunities | Opportunities to construct the interchange over time, as traffic volumes warrant upgrades. | 3 - Can be fully staged 2 - Some staging is possible 1 - Interchange cannot be staged |
| Social Impacts | Impact to the surrounding road network and community during and after construction. Includes an evaluation of the impact of the interchange on vulnerable users (pedestrians and cyclists). | 3 - Minimal impact 2 - Some impact 1 - Significant impact |
| Right-of-Way Required | Relative footprint of the interchange design compared to other alternatives. | 3 - Minimal land required 2 - Some land required 1 - Significant land required |
| Construction Cost | Relative cost of the interchange design compared to other alternatives. | 3 - Lowest relative cost 2 - Moderate relative cost 1 - Highest relative cost |

The tables in the following sections summarize the results of the evaluation conducted on the interchange alternatives.

4.4.4.1 Highway 11A and Gaetz Avenue

Based on the evaluation completed on the three interchanges alternatives, Associated Engineering recommends that a tight urban interchange design be selected for the Highway 11A/Gaetz Avenue interchange.

Table 4-14
Highway 11 and Gaetz Avenue Evaluation

| Alternative | Traffic Operations | Staging Opportunities | Social Impacts | Right-of-way Required | Construction Cost |
|---------------------|--------------------|-----------------------|----------------|-----------------------|-------------------|
| Single Point | 3 | 2 | 1 | 3 | 2 |
| Tight Urban Diamond | 3 | 3 | 2 | 3 | 3 |
| Parclo (A4) | 3 | 1 | 2 | 1 | 3 |

4.4.4.2 Highway 11A and Taylor Drive

Based on the evaluation completed on the three interchanges alternatives, Associated Engineering recommends that a tight urban interchange design be selected for the Highway 11A/Taylor Drive interchange.

Table 4-15
Highway 11 and Taylor Drive Evaluation

| Alternative | Traffic Operations | Staging Opportunities | Social Impacts | Right-of-way Required | Construction Cost |
|---------------------|--------------------|-----------------------|----------------|-----------------------|-------------------|
| Single Point | 3 | 2 | 1 | 3 | 2 |
| Tight Urban Diamond | 3 | 3 | 2 | 3 | 3 |
| Parclo (A4) | 3 | 1 | 2 | 1 | 3 |

4.4.4.3 Highway 2A and Township Road 391

Based on the evaluation completed on the three interchanges alternatives, Associated Engineering recommends that a tight urban interchange design be selected for the Highway 2A/Township Road 391 interchange.

**Table 4-16
Highway 2A and Township Road 391 Evaluation**

| Alternative | Traffic Operations | Staging Opportunities | Social Impacts | Right-of-way Required | Construction Cost |
|---------------------|---|-----------------------|----------------|-----------------------|-------------------|
| Single Point | 3 | 2 | 1 | 3 | 2 |
| Tight Urban Diamond | 3 | 3 | 2 | 3 | 3 |
| Parclo (A4) | Not feasible due to existing developments | | | | |

4.4.5 Right-Of-Way

4.4.5.1 Roadways

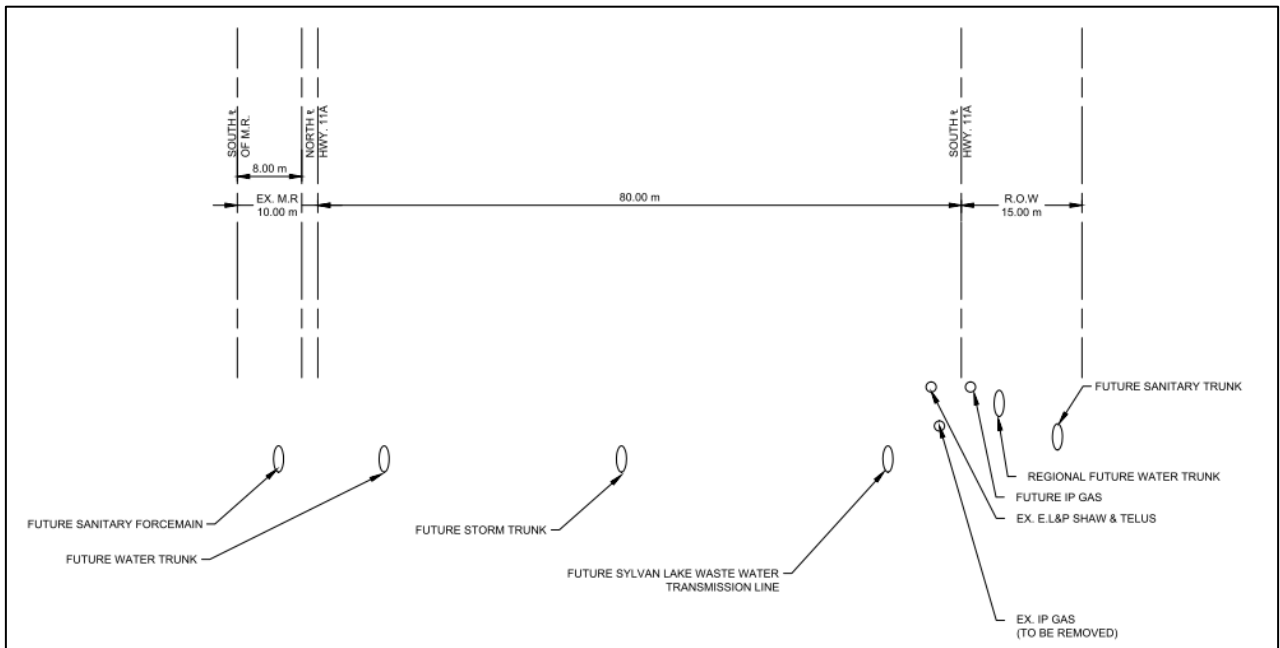
The right-of-way for each roadway with the study area should be based on the classification and standards identified in the design criteria; these standards were developed using the City of Red Deer Roadway Design Standards and the Transportation Association of Canada’s Geometric Design Guide for Canadian Roads. The right-of-ways for each road classification are as follows:

- Divided Arterial - 60 m
- Undivided Arterial - 48 m
- Divided Residential Collector – 30 to 32 m
- Industrial Collector (rural cross-section) - 30 m

Intersection treatments including left turn lanes and right turn channelization may result in the need for additional right-of-way or “corner cuts.” Intersection treatments and the associated right-of-way requirements will need to be confirmed through traffic impact assessments as development plans are finalized.

The following illustration shows the proposed right of way through the Highway 11A corridor, based on Option 2 (lift station and forcemain) for the sanitary sewer servicing.

Figure 4-16b
Right of Way for Highway 11A Corridor



4.4.5.2 Interchanges

The recommended interchange type, the tight urban diamond - has a relatively small foot print compared to many other interchange types. To ensure that sufficient right-of-way will be available when upgrading to an interchange is required, Associated Engineering has developed conceptual plans showing the required right-of-way for each interchange. These plans are based on the capacity requirements identified using the generated traffic volumes from the previously completed Watt study.

Associated Engineering recommends that City proceed with detailed planning of these interchanges to confirm the design requirements, including a weaving analysis, and required right-of-way.

Consultation with Alberta Transportation will also be required to ensure that the interchange plans at Highway 2/Highway 11A and Highway 11A/ Taylor Drive are compatible. Highway 2 has been designated as an expressway so it is likely that the interchange configuration for the interchange at Highway 11A will be a high capacity design which could impact entrance/exit ramps locations further to the east on Highway 11A at Taylor Drive. However as the interchanges are located 1.6 km apart, a distance used by many road authorities as the minimum interchange spacing, the typical recommended interchange spacing, it should be feasible to accommodate an interchange at Taylor Drive without a significant realignment of Taylor Drive.

An intersection providing access to the lands west of Taylor Drive has been proposed approximately 200 m north of the Highway 11A/Taylor Drive interchange. A factor in selecting the interchange design at Taylor Drive was the footprint, and trying to minimize that in order to reduce impact along the intersecting roadway. Although quite close, Associated Engineering believes that this intersection can be accommodated as it is anticipated that the majority of the turning movements from the intersecting roadway will be right turns, due to the proximity of Highway 11A to the south.

To ensure that this intersection operates at an acceptable level of service, and that queues do not impact the adjacent interchange, it will be necessary as development plans for the adjacent lands are developed that the intersection be moved as far north as is feasible. Additionally, upon completion of detailed planning of the interchanges the vertical alignment of Taylor Drive should be further reviewed to determine if the intersection can be safely accommodated.

For the purposes of this study Associated Engineering has assumed the following in determining the interchange right-of-ways:

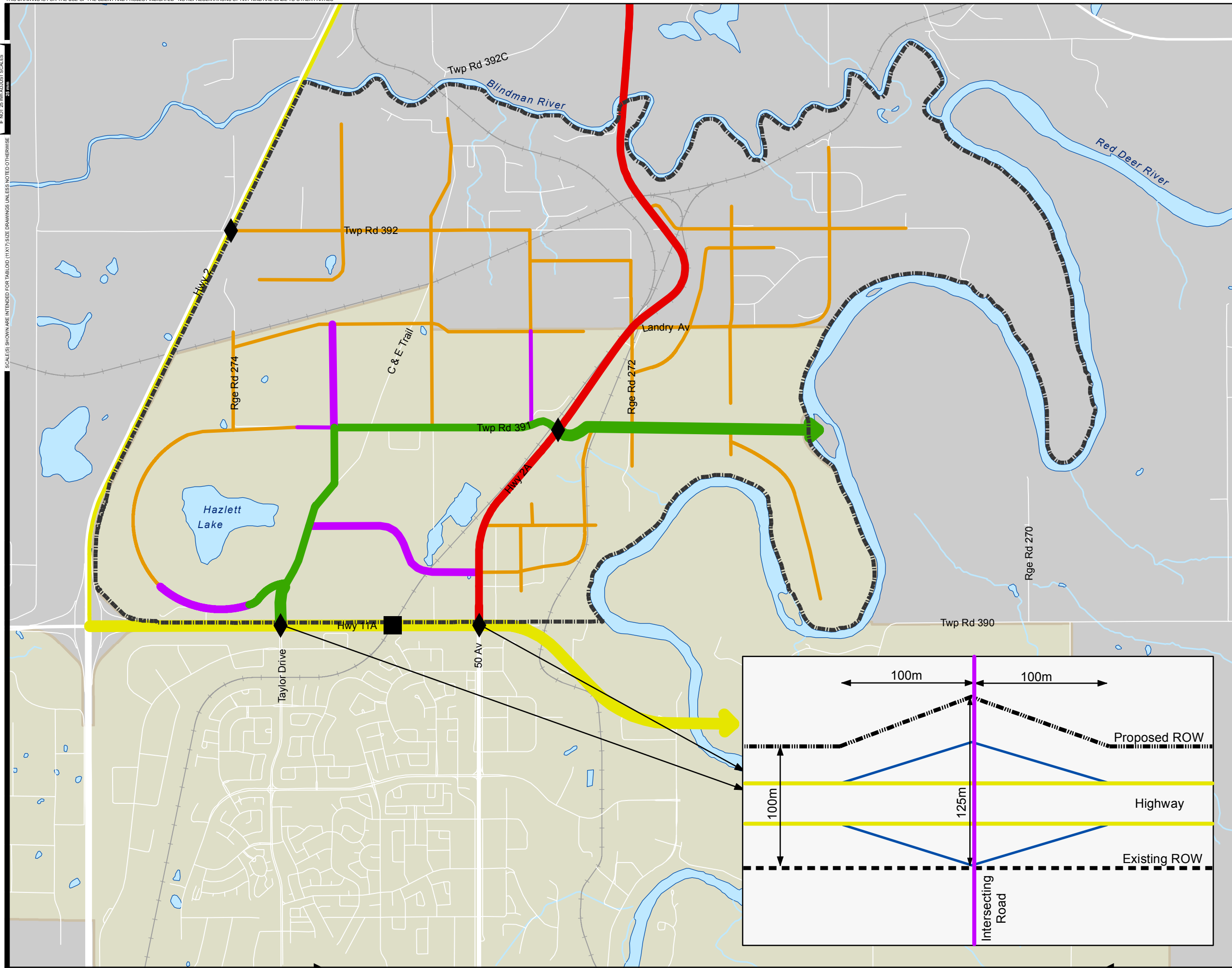
- At Taylor Drive and Gaetz Avenue, the Highway 11A will be developed as an underpass; similarly, Highway 2A will be developed as an underpass at Township Road 391.
- The intersections on the intersecting road will be spaced 50 m apart.
- Retaining walls will be used to limit the interchange foot print.

The conceptual plans showing the required right-of-way for each interchange can be found in [Figure 4-17](#).

IF NOT 20 mm AS NOTED OTHERWISE

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

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DATE: 6/13/2016, Kent Richardson



Legend:

- Interchange
- Overpass
- 100m ROW - Expressway
- 66m ROW - Highway
- 60m ROW - Divided Arterial
- 48m ROW - Arterial
- 24m ROW - Collector
- Study Area
- City of Red Deer

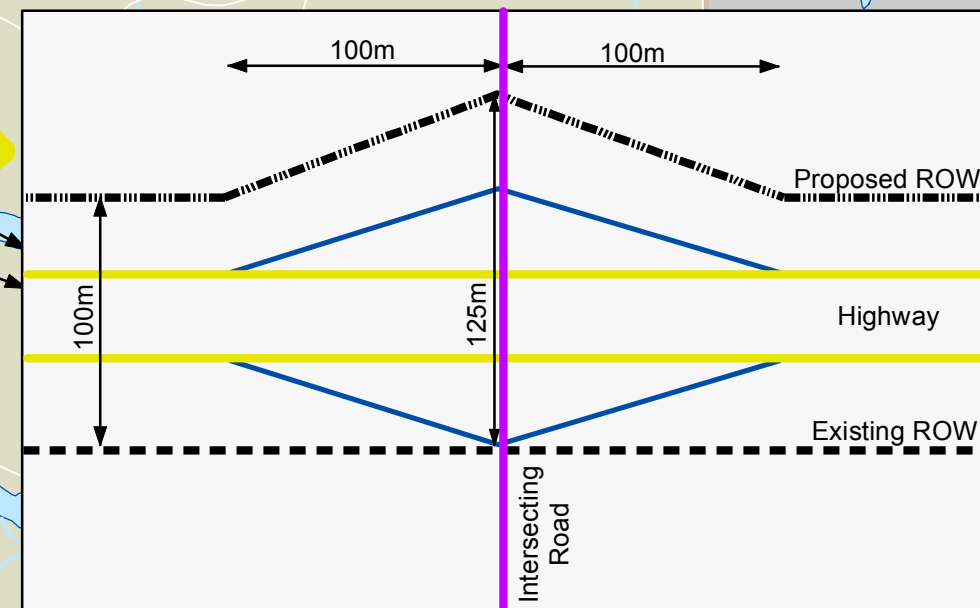


FIGURE No. 4-17
NORTH OF HIGHWAY 11A SERVICING STUDY

TRANSPORTATION
CONCEPTUAL ROAD RIGHT OF WAY

| | |
|----------------|-------------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED | |
| DATE | JUNE 2016 |
| REV | |
| DESCRIPTION | ISSUED FOR FINAL REPORT |

4.4.6 Cost Estimate

Cost estimates have been developed for each of the roadway types, based on total length, as shown in [Figure 4-16](#). A summary of the costs estimates are shown in [Table 4-17](#). The cost estimates identified below do not include the cost of the right-of-way associated with each road type and interchange.

Table 4-17
Preliminary Cost Estimate - Transportation

| Description | Quantity | Total Cost |
|----------------------------------|---|-----------------------|
| Highway 11A | 3.5 km | \$15,750,000 |
| Highway 2A | 2.9 km | \$8,700,000 |
| Divided Arterial | 5.0 km | \$12,500,000 |
| Arterial | 5.3 km | \$6,625,000 |
| Collector | 30.8 km | \$38,500,000 |
| Highway 11A and Taylor Drive | | \$65,000,000 |
| Highway 11A and Gaetz Avenue | | \$65,000,000 |
| Highway 2A and Township Road 391 | | \$75,000,000 |
| | Total Cost | \$ 287,075,000 |
| | Cost Per Developable Hectare (1,721 ha) | \$ 166,710 |

Detailed cost estimates for the transportation infrastructure for each phase of development are provided in [Appendix J](#) and are based on unit costs. The costs include an allowance of 30% for contingency and engineering. The costs presented are in 2016 dollars and do not include GST.

4.5 ULTIMATE SERVICING CONCEPT

The ultimate servicing concept is comprised of the four utilities studied: water, wastewater, storm drainage, and transportation. Implementation of the four utilities has been considered in the development of the proposed phasing plan, as shown on **Figure 4-18**.

Table 4-18 presents a summary of the ultimate servicing costs for the proposed servicing systems for water, sanitary sewer, stormwater management, and transportation.

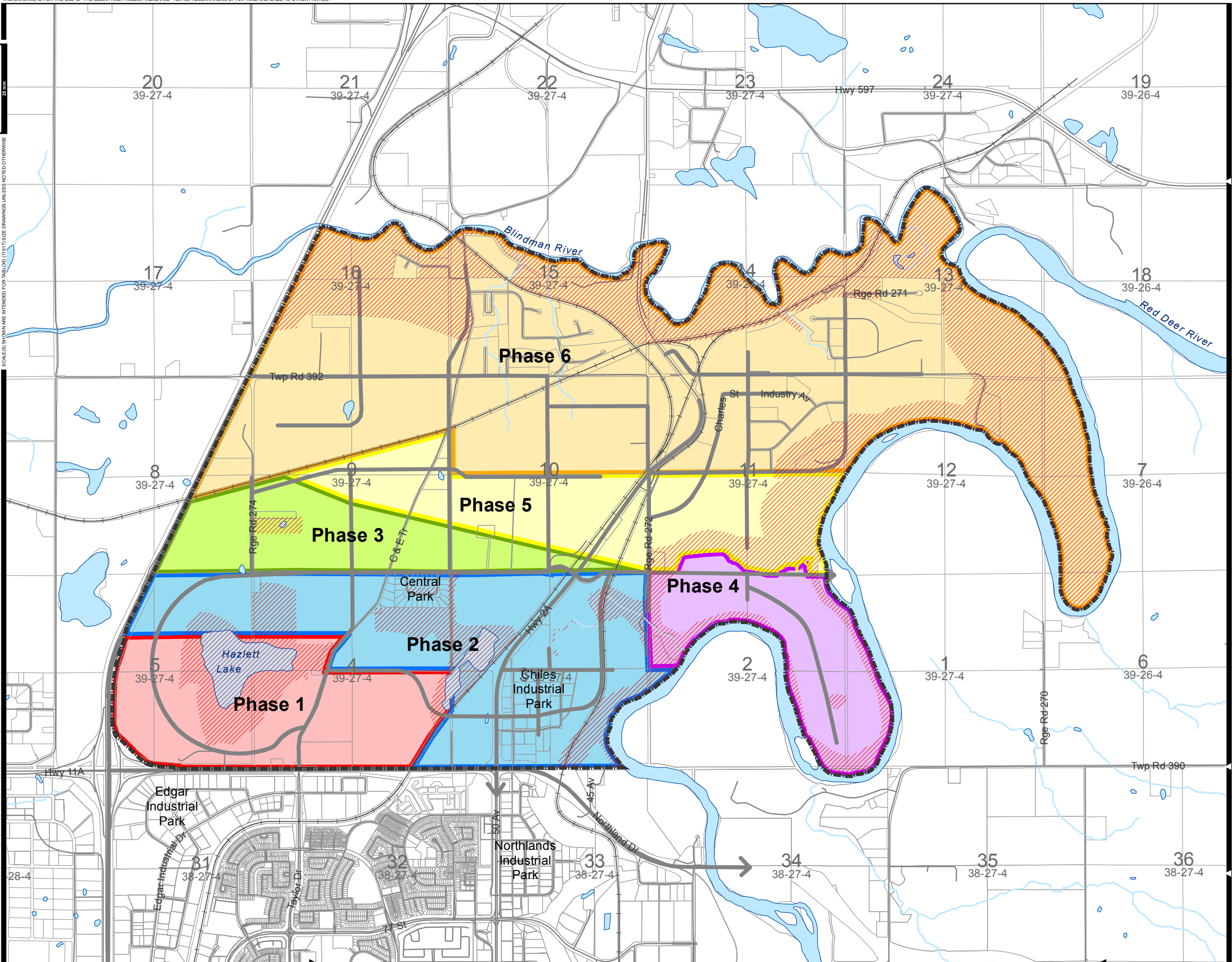
Table 4-18
Preliminary Cost Estimate - Summary

| Description | Total Cost |
|---|-----------------------|
| Water Distribution (Option | \$ 96,151,900 |
| Sanitary Sewer | \$ 124,604,900 |
| Stormwater Management | \$ 107,092,700 |
| Transportation | \$ 287,075,000 |
| Total Cost | \$ 614,924,500 |
| Cost Per Developable Hectare (1,721 ha) | \$ 357,307 |

Based on the phasing plan presented in **Figure 4-18**, **Table 4-19** presents the cost breakdown for servicing infrastructure for each phase of development.

SCALE(S) SHOWN ARE INTENDED FOR TABLORD (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

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DATE: 6/13/2016, Kent Richardson



- Legend:**
- Phase 1: 187ha, 78ha
 - Phase 2: 325ha, 95ha
 - Phase 3: 168ha, 6ha
 - Phase 4: 122ha, 52ha
 - Phase 5: 209ha, 60ha
 - Phase 6: 711ha, 463ha
 - ▨ Non-Developable
 - Proposed Transportation
 - Existing Transportation
 - Study Area

Developable Area
Non-Developable Area



FIGURE No. 4-18
NORTH OF HIGHWAY 11A SERVICING STUDY
PHASING PLAN

| | |
|------------------------|-------------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED DATE | JUNE 2016 |
| REV DESCRIPTION | ISSUED FOR FINAL REPORT |

4 - Ultimate Servicing

Table 4-19
Development Phasing Costs

| Servicing Component | Phase 1 | Phase 2 | Phase 3 | Phase 4 | Phase 5 | Phase 6 | Totals |
|---|---------------------|----------------------|---------------------|---------------------|----------------------|----------------------|----------------------|
| Water Distribution (Option 2) | | | | | | | |
| Watermains | \$8,093,800 | \$17,522,700 | \$2,494,700 | \$5,063,500 | \$11,063,000 | \$28,254,200 | \$72,491,900 |
| PRV Stations | - | - | - | \$200,000 | \$200,000 | \$400,000 | \$800,000 |
| Reservoir and Pumphouse | \$22,860,000 | - | - | - | - | - | |
| Subtotal - Water | \$30,953,800 | \$17,522,700 | \$2,494,700 | \$5,263,500 | \$11,263,000 | \$28,654,200 | \$96,151,900 |
| Sanitary Sewer (Option 2) | | | | | | | |
| Gravity Mains | \$24,545,300 | \$11,423,100 | \$1,873,300 | \$1,648,400 | \$12,872,600 | \$9,790,300 | \$62,153,000 |
| Forcemains | \$4,973,800 | - | - | \$5,475,600 | - | \$3,165,500 | \$13,614,900 |
| Lift Stations | \$13,780,000 | - | - | \$18,421,000 | - | \$16,636,000 | \$48,837,000 |
| Subtotal - Wastewater | \$43,299,100 | \$11,423,100 | \$1,873,300 | \$25,545,000 | \$12,872,600 | \$29,591,800 | \$124,604,900 |
| Stormwater Management | | | | | | | |
| Stormwater Management Facilities | \$8,434,623 | \$14,614,000 | \$7,577,630 | \$5,502,803 | \$9,426,932 | \$32,069,612 | \$77,625,600 |
| Stormwater Trunks | \$6,491,160 | \$5,930,730 | \$1,707,888 | \$4,468,776 | \$7,232,433 | \$3,636,113 | \$29,467,100 |
| Subtotal - Stormwater | \$14,925,784 | \$20,544,730 | \$9,285,518 | \$9,971,579 | \$16,659,365 | \$35,705,725 | \$107,092,701 |
| Transportation | | | | | | | |
| Roads | \$6,591,250 | \$31,342,500 | \$6,126,250 | \$6,371,250 | \$9,991,250 | \$21,652,500 | \$82,075,000 |
| Intersections | - | \$130,000,000 | - | - | \$75,000,000 | - | \$205,000,000 |
| Subtotal - Transportation | \$6,591,250 | \$161,342,500 | \$6,126,250 | \$6,371,250 | \$84,991,250 | \$21,652,500 | \$287,075,000 |
| Totals | \$95,769,934 | \$210,833,030 | \$19,779,768 | \$47,151,329 | \$125,786,215 | \$115,604,225 | \$614,924,500 |
| Developable Area (ha) | 187 | 325 | 168 | 122 | 208 | 711 | 1721 |
| Cost per Developable Hectare (\$/ha) | \$512,139 | \$648,717 | \$117,737 | \$386,486 | \$604,741 | \$162,594 | \$357,307 |

5 Interim Servicing

Interim servicing has been developed to provide the servicing requirements for development in the north of Highway 11A study area while making use of existing infrastructure and minimizing major infrastructure investments. The specific areas that have been evaluated for interim servicing include: Hazlett Lake Residential Development; Central Park Subdivision & EVRAZ Development; and Chiles Industrial Park. The following sections provide a summary of the water, sanitary, stormwater, and transportation systems as they relate to interim servicing for the North of Highway 11A service area.

5.1 WATER DISTRIBUTION SYSTEM

5.1.1 Hazlett Lake Area – Interim Water Servicing

To provide interim water servicing to the Hazlett Lake area, connections to the City's existing water distribution system can be considered from the Water Treatment Plant Pressure Zone (directly south of Hazlett Lake) or from the Queens Business Park Pressure Zone (south-west of Hazlett Lake). Previous work has been completed by the City to evaluate an interim connection for the Hazlett Lake Area and it has been determined that a connection to the Queens Business Park Pressure Zone provides the best alternative to provide the required pressure and reservoir storage for the Hazlett Lake Area. Most of the water infrastructure needed to establish the interim connection to the Hazlett Lake Area from the Queens Business Park can be re-purposed in the future as part of a reservoir filling pipe that will be needed for the Queens Business Park Reservoir in the long-term.

Two growth scenarios were assessed in terms of providing interim service from the Queens Reservoir:

- **Scenario A:** residential development in the Hazlett Lake area occurs at a rate of 68 ha/year; and
- **Scenario B:** residential development in the Hazlett Lake area occurs at a rate of 34 ha/year.

For both scenarios A and B, the following criteria was assumed:

- Approximately 2.5 quarter Sections (or 160 ha) of industrial land is currently developed within the Queens Reservoir service area; and
- Approximately 18.2 ha of industrial land within the Queens area will develop per year.

The March 24, 2014 Queens Business Park Reservoir and Pumping Station Capacity Memo from Stantec to the City of Red Deer (2013 Water Distribution Study) was used as a basis for this assessment. The memo outlines the existing capacity in terms of storage, pumping and supply as determined in the 2013 Water Study. Associated Engineering undertook a separate analysis based on the capacities identified in the study. **Table 5-1** presents Associated Engineering's analysis based on the maximum capacity identified in the memo, and applying the design criteria outlined in Section 2.

**Table 5-1
Water Interim Servicing Capacity Assessment Summary**

| Summary | Growth Scenario A | | Growth Scenario B | |
|------------------|-------------------------------|-----|-------------------------------|-----|
| | 68 ha/year Residential Growth | | 34 ha/year Residential Growth | |
| | years | ha | years | ha |
| Storage Capacity | 4.0 | 272 | 6.9 | 235 |
| Pumping Capacity | 3.8 | 250 | 6.8 | 231 |
| Filling Capacity | 3.8 | 258 | 6.6 | 224 |

As shown in the above table, a minimum developable area of 258 ha can be serviced based on Option A (68 ha/year) over a period of approximately 3.8 years, while approximately 224 ha can be serviced based on Option B (34 ha/year) over a period of approximately 6.6 years.

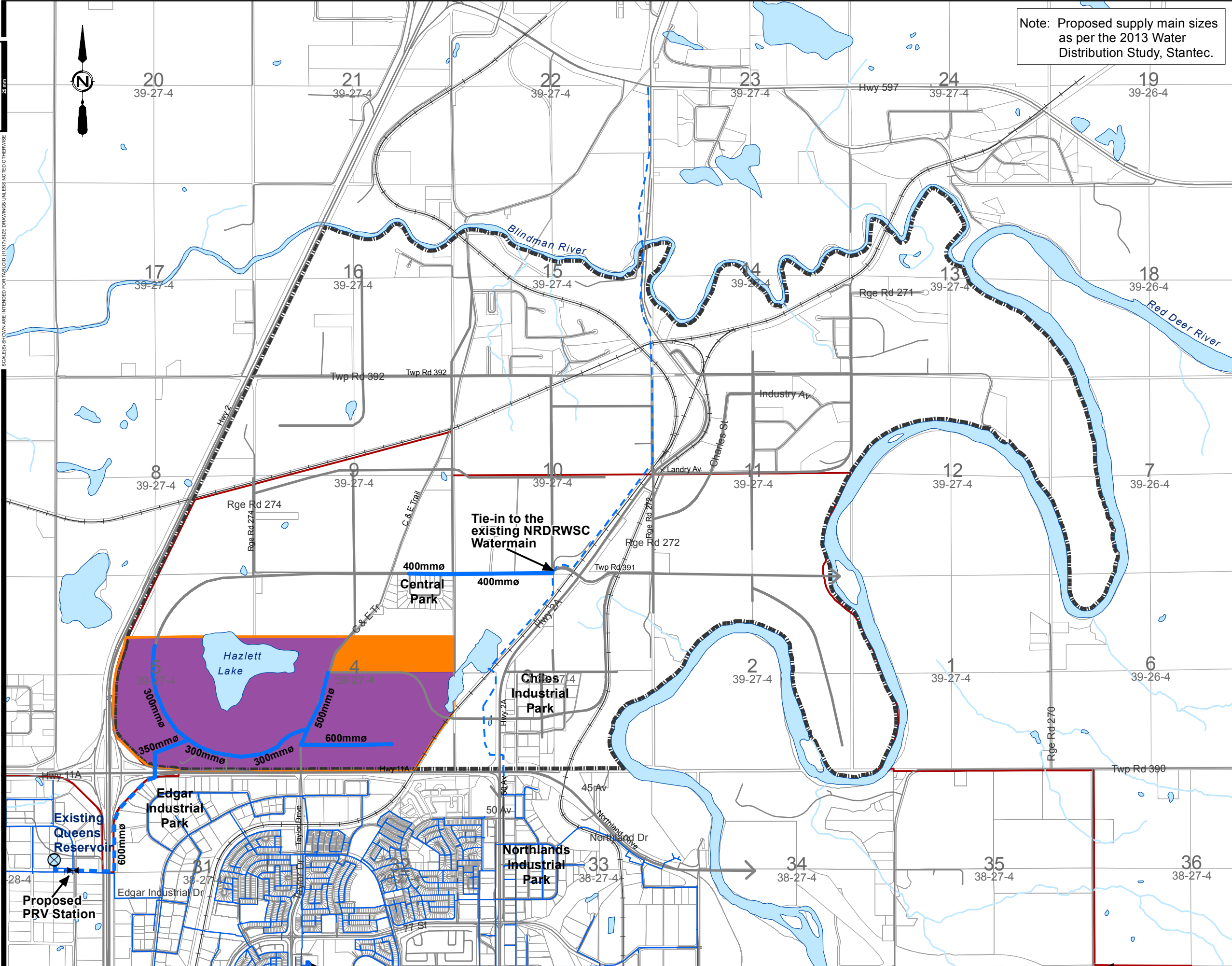
As the Queens Reservoir is the only water facility that can supply the Queens Business Park, the priority for the Queens Reservoir will be to provide water service to the Queens Business Park, and will provide only surplus capacity to the North of 11A area. Any development to the North of Highway 11A must establish its long-term water supply before the capacity at the Queens Reservoir is reached. For growth scenarios A and B, the capacity of the Queens Reservoir is reached in 3.8 years and 6.6 years respectively.

The interim servicing concept for water distribution around Hazlett Lake is presented on **Figure 5-1**. The service areas associated with scenarios A and B for the Hazlett Lake area are identified on the Figure. As shown on the Figure, temporary service will be provided from remaining capacity available at the Queens reservoir. A PRV will be required in order to reduce the pressure from the existing HGL of 950 m, to an HGL of 930 m. It is proposed that a portion of the future supply main to the Queens Reservoir be constructed as a temporary supply to the study area. Temporary interconnections to the development area will be required in order to provide water until such time as the North Reservoir is constructed and is connected to the initial stages of development. The interim concept presented is based on installing the ultimate pipe sizes identified on **Figure 4.2** (Option 2).

It will be necessary to construct the future North Reservoir and 900 mm diameter supply main prior to exhausting all remaining capacity at the Queens Reservoir and Pumphouse. At that time (3.8 years for Growth Scenario A, 6.6 years for Growth Scenario B), it will be necessary to abandon the temporary tie-ins along the Queens supply line, and construct the remainder of the line to allow for direct supply to the Queens Business Park.



Note: Proposed supply main sizes as per the 2013 Water Distribution Study, Stantec.



- Legend:**
- ⊗ Existing Reservoir
 - Proposed Supply Main
 - Proposed Distribution Main
 - - - Existing Supply Main
 - Existing Water Line
- Interim Service Areas**
- Option A
 - Option B
- Proposed Transportation
 - Study Area
 - City of Red Deer



FIGURE No. 5-1
 NORTH OF HIGHWAY 11A SERVICING STUDY
 WATER - INTERIM SERVICING PLAN

| | |
|------------------------|-------------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED DATE | JUNE 2016 |
| REV DESCRIPTION | ISSUED FOR FINAL REPORT |

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 DATE: 6/14/2016, Kent Richardson

SCALES(S) SHOWN ARE INTENDED FOR TABLORD (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE
 IF NOT 20 mm AS SHOWN SCALES

5.1.2 Chiles Industrial Park – Interim Water Servicing

A review of interim water service to the Chiles Industrial Park has been undertaken. It is assumed that water supply would be established through an extension of the water distribution system from the existing Water Treatment Plant Pressure Zone. The hydraulic review of interim servicing from the Water Treatment Plant Pressure Zone showed that it will not be possible to supply full commercial / industrial fire flows (300 L/s) and maintain the minimum required HGL of 912 m at the NRDRWSC meter vault near to the intersection of Highway 11A and Highway 2A.

Model results for the Chiles Industrial Park indicate that the maximum available fire flow rate would be 95 L/s for interim servicing.

5.1.3 Central Park and EVRAZ – Interim Water Servicing

As discussed earlier, the City is considering the purchase of a portion of the NRDRWSC main up to the City limits. This will provide an opportunity to supply existing developments within the current City limits on an interim basis. This is in response to the anticipated need for water in the Central Park subdivision, which is currently supplied by a private system. No information is currently available on the system. This will also allow the City to make use of current excess capacity within the NRDRWSC pipe in order to defer the costs of new water mains.

The City also wishes to assess the capacity of the NRDRWSC to supply the EVRAZ development on an interim basis until such time as the future North Reservoir is constructed. It has been assumed that the proposed ultimate pipe sizes will be constructed, as presented on **Figure 5-1**. This will require that pipes 400 mm in diameter be installed from a connection at the NRDRWSC main, to a connection at Central Park. The mains within Central Park and the EVRAZ site will need to be sized to accommodate fire flows appropriate for each land use.

The design demand for Central Park has been based on 25 residences and 70 people in total, as identified by the City. Demand for the EVRAZ site has been based on the method outlined in the design criteria and assumes full development of the north portion of NW Quarter Section 3-39-27-4.

During the peak hour scenario, pressures ranging from 49 psi to 51 psi are expected within the EVRAZ and Central Park areas (based on an HGL of 914.3 m). Approximately 95 L/s will be available during the maximum day demand for fire flow purposes at either location, assuming that Pumps 101 through 103 are operating at the WTP and pump 101 is operating at Glendale, resulting in an HGL of 912 m at the meter vault. All results are based on the City of Red Deer's 2013 existing system model.

5.1.1 Cost Estimate

A cost estimate for the interim servicing shown in **Figure 5-1** is shown in **Table 5-2**.

Table 5-2
Preliminary Cost Estimate – Water Distribution System

| Description | Quantity | Total Cost |
|---|----------|----------------------|
| Watermains (from Queens Business Park to service areas around Hazlett Lake) | 6.0 km | \$ 10,572,900 |
| PRV Station (Queens Business Park) | 1 | \$ 200,000 |
| Watermains (NRDRWSC to Central Park) | 1.2 km | \$ 1,782,300 |
| Total Cost | | \$ 12,555,200 |

5.2 SANITARY SEWER SYSTEM

The interim servicing review for the sanitary sewer system was completed to determine the serviceable areas based on using available capacity in existing wastewater trunks for the Hazlett Lake development and the Chiles Industrial Park.

5.2.1 Hazlett Lake

The Queens Business park is currently serviced by two trunk systems namely systems 1 and 2, for the northern and southern portions respectively, as shown in **Figure 5-2**.

- System 1 extends to the east, and then south, crosses Edgar Industrial Drive, Jaspar Crescent, and ultimately is discharged to the Waste Water Treatment Plant (WWTP).
- System 2 extends across Highway 2, Edgar Industrial Drive, Johnston drive and ultimately discharges to the WWTP. System 2 has adequate capacity to service the 170 ha that is proposed to drain to it.

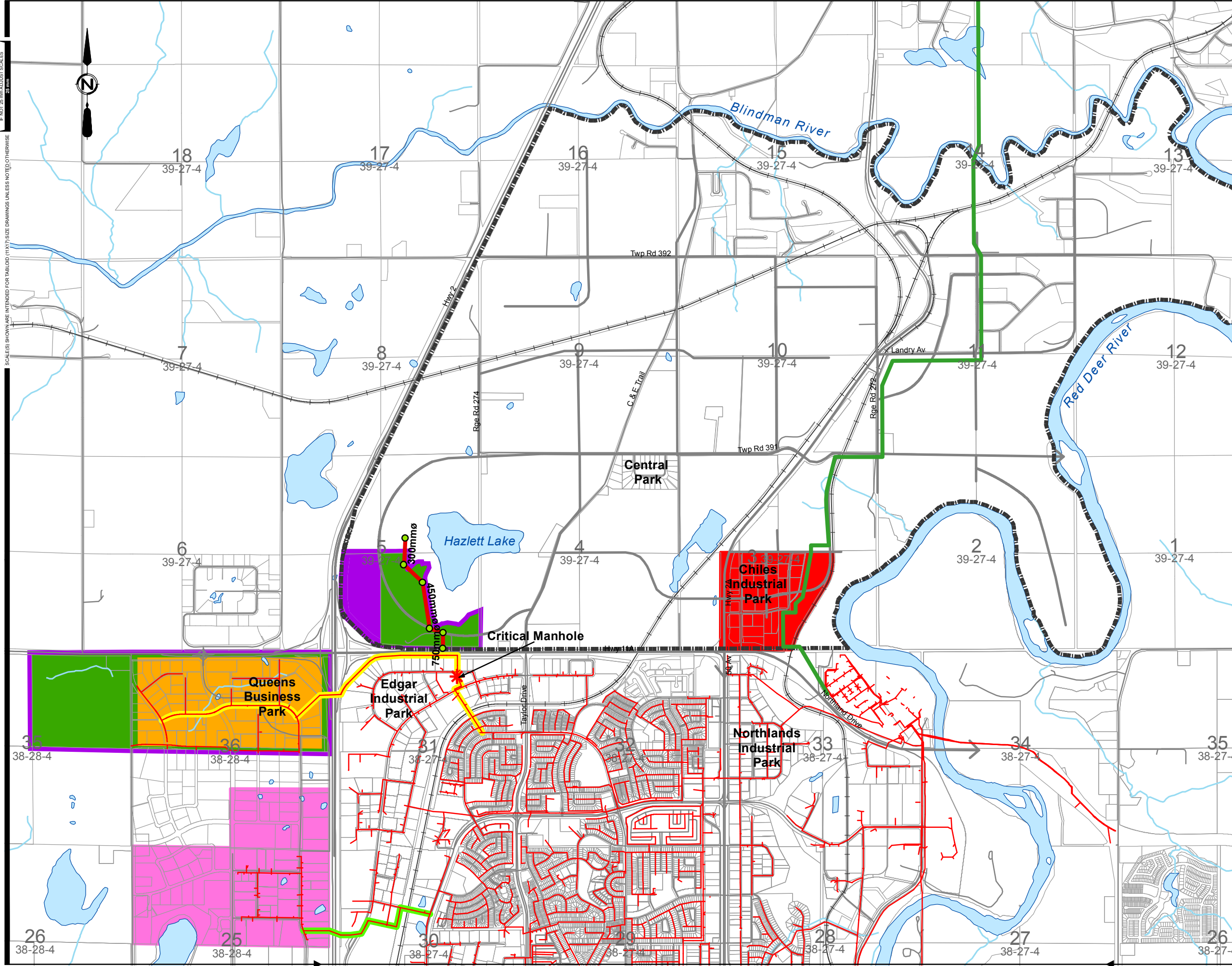
Any excess capacity that is available in System 1 could, be used by the Queen's Business Park and the areas north of Highway 11.

The critical point in System 1 is located approximately 40 m south of Edgar Industrial Crescent, at a sag manhole, which has a potential to surcharge to ground when the future development exceeds the system capacity. The existing sanitary system, the location of the critical manhole, and the extent of development that can be safely conveyed by the existing system are shown on **Figure 5-2**. The areas upstream of Jaspar Crescent are industrial areas, which do not typically have basements. Hence controlling the HGL to below 2.5 below the existing ground does not apply to this area, as there is no risk of basement flooding.

The area downstream of Jaspar Avenue is characterized by residential neighbourhoods with basements. However the existing sanitary sewer in this area is approximately 7-8 m deep, and does not pose a risk of basement flooding to the residential neighbourhoods. Sewage would likely spill into the industrial area at the location identified in **Figure 5-2**, when the existing system capacity is exceeded, before flooding basements in the residential neighbourhood.

To identify the existing system capacity, two development scenarios were identified as a part of the interim servicing where the areas to the west of Highway 2 were developed in conjunction with the areas north of Highway 11A, in a sequential fashion,. These scenarios have been discussed below:

Existing Scenario: The two quarter sections in the north portion of the Queens Business Park were considered to be a part of the existing development scenario. As shown in **Figure 5-2** this development comprises approximately 127 ha. **Figure 5-3** shows a profile of the existing system, which has capacity to accommodate the flows from this development while surcharging to the crown of the pipe.



Legend:

- Existing Scenario (127 ha)
- Scenario 1A (224 ha)
- Scenario 1B (246 ha)
- System 2 (170 ha)
- Chiles Industrial Park (65 ha)
- System 1
- System 2
- Proposed Manhole (Depth < 5.5m)
- Proposed Sanitary Trunk
- Proposed Pipe Alignment for the NRDRWWC
- * Critical Manhole
- Existing Sanitary Trunk
- Ultimate Transportation
- Existing Transportation
- Study Area



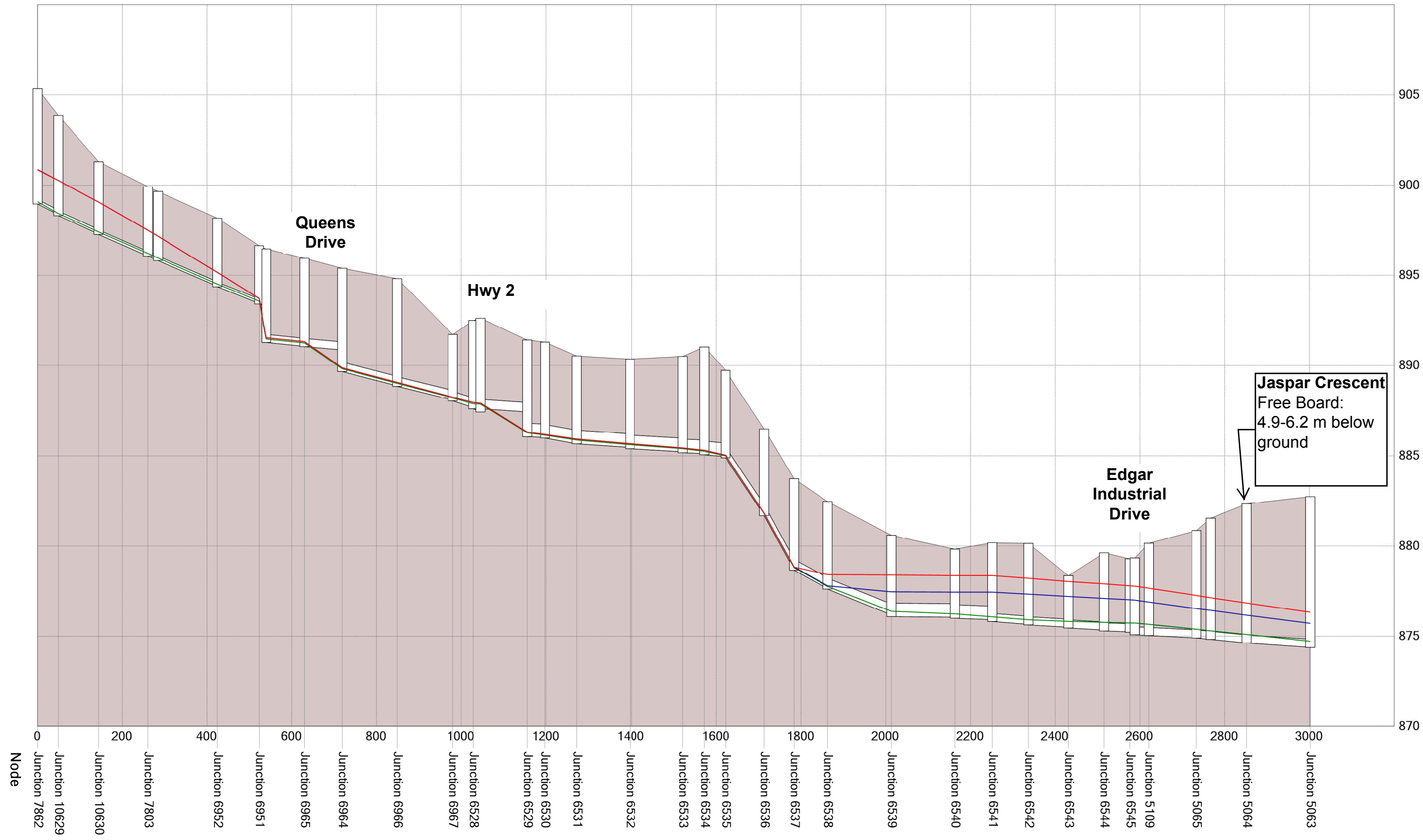
FIGURE No. 5-2

NORTH OF HIGHWAY 11A SERVICING STUDY

WASTEWATER - INTERIM SERVICING PLAN

| | |
|----------------|-------------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED | |
| DATE | JUNE 2016 |
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Existing Scenario 1A Scenario 1B Peak values



Jaspar Crescent
Free Board:
4.9-6.2 m below
ground

City of Red Deer
North of Hwy 11A Servicing Study
Figure 5-3: Interim Servicing HGL Profile

Scenario 1A: This scenario involves development of another quarter section (61 ha) to the west of the existing development in the Queens Business Park, and 36 ha to the southwest of Hazlett Lake to the north of Highway 11A as shown in **Figure 5-2**, thus including 224 ha of development.

Figure 5-3 shows the HGL for this scenario, which indicates that though the existing system is surcharged, there is a freeboard of 1.15 m to the ground.

Scenario 1B: This scenario involves the development of an additional 22 ha to the north of Highway 11A in addition to the area identified for development under scenario 1A. **Figure 5-3** shows the HGL corresponding to the development identified under this scenario, where 0.3 m of freeboard is available before the system spills to ground. Due to lack of adequate freeboard, development of additional areas in excess of those identified under Option 1A is not recommended.

System 1 has adequate capacity for the development of 61 ha to the west of Highway 2 and 36 ha to the north of Highway 11A, in addition to the 127 ha of existing development in the Queens Business Park, which adds up to 224 ha.

Within the Queens Business Park, the City can develop the 170 ha that drains to System 2, as this system has adequate capacity to service this area.

Temporary interconnections from the 36 ha to the North of Highway 11A and 188 ha to the west of Highway 2 to System 1 will be required to service the area. Once a new sanitary system is installed to service the area north of Highway 11A, the temporary interconnections to System 1 can be removed.

Model results indicate that the System 1 Trunk can accommodate approximately two years of industrial growth to the west of Highway 2 at a growth rate of 18.2 ha per year and approximately 10 months of residential growth to the north of Highway 11A at a growth rate of 68 ha per year. The City of Red Deer conducted flow monitoring during 2015. A comparison between the flow monitoring data and the model flows indicate that the flow monitoring data may be lower than the model's representation of dry weather flows. The flow monitoring data from the City of Red Deer suggests that minor rainfall events are accurately represented in the model.

The maximum allowable flow rates from the industrial area to the west of Highway 2 and the residential area to the north of Highway 11A is 21 L/s.

5.2.2 Chiles Industrial Park

The capacity of the 750mm trunk along 50th Avenue was identified to be approximately 350 L/s. The 750 mm trunk currently services 10 ha in the existing condition. The Chiles Industrial Area comprises of approximately 65 ha and would generate approximately 38 L/s. The 750 mm trunk has sufficient capacity to accommodate the entire Chiles Industrial Park for interim servicing.

5.2.3 Cost Estimate

The cost estimate for interim servicing for the sanitary sewer system as shown in **Figure 5-2** is presented in **Table 5-3**.

Table 5-3
Preliminary Cost Estimate – Sanitary Sewer

| Description | Quantity | Total Cost |
|-------------------|----------|---------------------|
| Gravity Mains | 1.1 km | \$ 2,133,300 |
| Total Cost | | \$ 2,133,300 |

5.4 STORMWATER DRAINAGE SYSTEM

5.4.1 Hazlett Lake

Based on the topography of the area and the environmental significance of Hazlett Lake, no connection to the existing storm system is recommended for interim purposes. To ensure that the eco-system and water-balance is maintained for the Hazlett Lake area, it is recommended that development areas surrounding the lake continue to discharge to the lake at pre-development release rates. Stormwater must be collected and treated in stormwater management ponds prior to discharge into Hazlett Lake for the interim development scenario.

There is no requirement for storm trunks for areas surrounding Hazlett Lake that are within the stormwater pond catchments areas for Ponds 1, 2, and 3 shown on **Figure 4-15**. Stormwater ponds will be required for the interim development scenario to control flow into Hazlett Lake to predevelopment rates.

5.4.2 Chiles Industrial Park

The Chiles Industrial Park Subdivision is located in the southeast area of the Red Deer River Basin. The existing storm drainage system of the subdivision consists of a series of drainage culverts and ditches which direct flows towards an existing stormwater management facility (dry pond).

According to ISL as-built drawings, the pond has an approximately footprint area of 0.47 ha and an average pond of depth of approximately 3 m (average depth from pond bottom to maximum water level). The estimated maximum storage capacity provided by the pond is approximately 14,100 m³.

Flows from the dry pond are controlled by a 350 mm diameter HDPE storm pipe before connecting to an existing 600 mm diameter storm, and eventually draining towards the Red Deer River

5.4.3 Cost Estimate

Costs for interim servicing for stormwater management in the area around Hazlett Lake are shown on **Table 5-4**.

Table 5-4
Preliminary Cost Estimate – Stormwater Drainage System

| Description | Quantity | Total Cost |
|---|-------------------|---------------------|
| Stormwater Management Facilities (ponds 1, 2, & 3) | 3 | \$ 6,975,150 |
| | Total Cost | \$ 6,975,150 |

5.5 TRANSPORTATION NETWORK

It is understood that a new access from Highway 11A servicing the Hazlett Lake area has been approved by the City and Alberta Transportation. This access will ultimately be removed when access from the internal road network is provided, as the access spacing will not be consistent with the future interchanges proposed for the Highway 11A area.

To determine the limitations of the existing roads and intersections, Associated Engineering completed a capacity analysis to determine when upgrades would be required. For this exercise the Associated Engineering project team used the same Synchro inputs (peak hour factor, saturated flow rate, etc.) as outlined in the City of Red Deer's Traffic/Transportation Impact Assessment Guidelines. As required, traffic signal timings were optimized to delay the need for additional infrastructure upgrades for as long as possible, new phases, such as dedicated left turn phases, were not added though.

This analysis is summarized in the following sections; detailed printouts of the Synchro analysis have been included in [Appendix I](#).

5.5.1 Capacity Analysis

The Synchro/SimTraffic 9 traffic analysis program is based on the Institute of Transportation Engineers Highway Capacity Manual 2010 and was used to analyze the capacity of the study intersections and determine the need for additional intersection and capacity improvements. This program applies the methodology established by the Highway Capacity Manual to output a level of service for a study intersection, given the lane designations, vehicular volumes, signal timing and heavy vehicle percentages. Intersection operations are typically rated by two measures: level of service and volume-to-capacity ratios.

Level of service is based on the estimated average delay per vehicle for all traffic passing through an intersection. A high level of service is a result of a very low average delay; the highest level of service is identified as level of service A. A low level of service is a result of a large average delay; typically, the lowest level of service is identified as level of service F. The level of service categories varies depending on whether an intersection is signalized or stop or yield-controlled. The Highway Capacity Manual justifies this difference by noting that drivers stopped at a signal light will have more tolerance for delays because they will perceive that eventually they will get their turn. The table below identifies the level of service criteria for intersections.

**Table 5-5
Level of Service for Intersections**

| Level of Service | Average Signalized Control Delay per Vehicle (s) | Average Stop Control Delay per Vehicle (s) |
|------------------|--|--|
| A | less than 10 | less than 10 |
| B | 10 – 20 | 10 – 15 |
| C | 20 – 35 | 15 – 25 |
| D | 35 – 55 | 25 – 35 |
| E | 55 – 80 | 35 – 50 |
| F | greater than 80 | greater than 50 |

The volume-to-capacity ratio of an intersection describes the extent to which the traffic volumes can be accommodated by the theoretical capacity of the intersection. A volume-to-capacity ratio below 0.9 indicates that there is generally sufficient capacity to accommodate the traffic on the approach or at the intersection. A value between 0.9 and 1.0 suggests unstable operations and congestion may occur as volumes are nearing the theoretical capacity of the roadway. A calculated value over 1.0 indicates that volumes are theoretically exceeding capacity.

For the purpose of this study a minimum level of service D was required for the intersection and for each approach. Volume-to-capacity ratios were not to exceed 0.85.

5.5.1.1 Development Assumptions

As it is unknown at this time where development within the study area will occur first, the rate at which development will occur, or what types of land uses will be developed first, Associated Engineering made a number of assumptions regarding development patterns surrounding each intersection. These assumptions are as follows:

- All development has assumed to be single family residential, using the trip generation information available from the City of Red Deer Traffic/Transportation Impact Assessment Guidelines. As development occurs it will be necessary to compare the trip generation associated with the land uses being developed to the assumed rates used in this analysis.
- At the intersection of Highway 11A and Taylor Drive it was assumed that the future inbound and outbound trips would have the same distribution as exists today, based on the 2015 traffic count data available from Alberta Transportation.

- At the intersection of Highway 2A and Highway 11A it was assumed that the future inbound and outbound trips would have the same distribution as exists today, based on the 2015 traffic count data available from Alberta Transportation.
- At the intersection of Highway 2A and Township Road 390 it was assumed that the future inbound and outbound trips would have the same distribution as exists today, based on the 2015 traffic count data available from Alberta Transportation. It was further assumed that 75% of the development would occur on the west side of Highway 2A and 25% would occur on the east side of Highway 2A.

5.5.1.2 Analysis of Existing Traffic Volumes

An analysis of the existing (2015) traffic volumes was completed to determine if there are any existing deficiencies at the Highway 11A/Taylor Drive, Highway 2A/Highway 11A, or Highway 2A/Township Road 390 intersections. The analysis found that the intersections at Highway 11A/Taylor Drive and Highway 2A/Highway 11A have sufficient capacity today; however, at the intersection on Highway 2A and Township Road 390, delays on the intersecting roadway are below acceptable levels. If traffic signals were installed at this location the additional capacity would be sufficient to accommodate the existing traffic volumes.

Details of the analysis can be found in Appendix K, a summary of the analysis is presented in **Table 5-3** below.

**Table 5-6
Capacity Analysis of Existing Traffic Volumes**

| Analysis Period | Control | Maximum Approach Delay (s) | Minimum Approach LOS | Max v/c | Intersection Delay (s) | Intersection LOS |
|-------------------------------------|---------|----------------------------|----------------------|---------|------------------------|------------------|
| Highway 11A/Taylor Drive | | | | | | |
| AM Peak hour | Signal | 17.1 | B | 0.71 | 11.4 | B |
| PM Peak hour | Signal | 29.7 | C | 0.71 | 17.1 | B |
| Highway 2A/Highway 11A | | | | | | |
| AM Peak hour | Signal | 19.1 | B | 0.52 | 15.4 | B |
| PM Peak hour | Signal | 23.3 | C | 0.50 | 15.8 | B |
| Highway 2A/Township Road 390 | | | | | | |
| AM Peak hour | Stop | 72.3 | F | 0.54 | 1.0 | A |
| PM Peak hour | Stop | 68.9 | F | 0.47 | 2.2 | A |

5.5.1.3 Limitation of Existing Infrastructure

Using the development assumptions outlined above, Associated Engineering completed a capacity analysis to determine the limitations of the existing infrastructure. For this analysis it was assumed that traffic signals

were present at the Highway 2A/Township Road 390 intersection, as detailed above, and that left turn phases could be added to each intersection as required. The capacity analysis determined the following:

- At Highway 11A/Taylor Drive 550 residential units (or equivalent) can be developed prior to the intersection requiring any infrastructure upgrades. To accommodate these traffic volumes a protected-permitted left turn phase was required for the northbound to westbound left turn movement.
- The intersection of Highway 2A/11A can handle approximately 70% growth on all leg prior to infrastructure upgrades. This is the equivalent of 1,483 residential units. No additional turn signal phases were required.
- With the installation of traffic signals, the intersection of Highway 2A/Township Road 390 will be able to accommodate 700 residential development units. No signals phases were required at this intersection.

Details of the analysis can be found in Appendix I, a summary of the analysis is presented in **Table 5-4** below.

**Table 5-7
Limitation of Existing Infrastructure**

| Analysis Period | Control | Maximum Approach Delay (s) | Minimum Approach LOS | Max v/c | Intersection Delay (s) | Intersection LOS |
|-------------------------------------|---------|----------------------------|----------------------|---------|------------------------|------------------|
| Highway 11A/Taylor Drive | | | | | | |
| AM Peak hour | Signal | 42.4 | D | 0.82 | 22.6 | C |
| PM Peak hour | Signal | 32.9 | C | 0.84 | 21.4 | C |
| Highway 2A/Highway 11A | | | | | | |
| AM Peak hour | Signal | 31.7 | C | 0.84 | 25.1 | C |
| PM Peak hour | Signal | 32.6 | C | 0.84 | 24.0 | C |
| Highway 2A/Township Road 390 | | | | | | |
| AM Peak hour | Stop | 45.1 | D | 0.83 | 17.0 | B |
| PM Peak hour | Stop | 32.6 | C | 0.84 | 24.0 | C |

5.5.1.4 Interim Intersection Upgrades

Associated Engineering reviewed each intersection to determine interim upgrades for each intersection which could be constructed without resulting in significant future throwaway costs associated with the construction on an interchange. A capacity analysis was then completed to determine how many additional residential development units (or equivalent) these upgrades would be capable of accommodating.

At the intersection of Highway 11A and Taylor Drive it was assumed that the north leg of the intersection could be widened to include a left turn lane, a through lane, and a shared through-right turn lane for the southbound direction. With these upgrades the intersection will be capable of accommodating an addition 200 residential units (or equivalent), bringing the total to 750. It should be noted that at this point the critical movements are the northbound to west left turn during the AM peak hour and the eastbound to southbound right turn during the PM peak hour, movements that are not associated with development within the study area.

At the intersection of Highway 2A/Highway 11A no interim was determined as the critical movements identified in the previous section - the northbound to westbound left turn and the southbound through movement - cannot be addressed without construction of significant additional infrastructure.

The interim improvements identified at the Highway 2A/Township Road 390 intersection included the development of left turn lanes on Township Road 390 and additional through lanes on Highway 2A. With these upgrades the intersection will be capable of accommodating an additional 700 residential units (or equivalent), bringing the total for the intersection to 1,400.

5.5.2 Cost Estimate

Cost estimates have been developed for interim intersection upgrades identified in the previous section; a summary of the costs estimates are shown in **Table 5-8**.

**Table 5-8
Interim Cost Estimate - Transportation**

| Description | Upgrade | Total Cost |
|----------------------------------|--|---------------------|
| Highway 11A and Taylor Drive | - Widening the north leg | \$250,000 |
| Highway 11A and Gaetz Avenue | - No improvements identified | \$0 |
| Highway 2A and Township Road 391 | - Install traffic signals - Add left turn lanes on Twp Rd 391 - Additional through lanes on Hwy 2A | \$1,750,000 |
| Total Cost | | \$ 2,000,000 |

6 Conclusions

Based on the analysis completed and the servicing concepts that were developed for the North of Highway 11A area, the following sections outline the conclusions for the water distribution system, sanitary sewer system, stormwater management system, and transportation system.

6.1 WATER DISTRIBUTION SYSTEM

6.1.1 North Reservoir

- A review of the location for the proposed North Reservoir showed that locating the reservoir near to the intersection of Highway 11A and Highway 2A provided the most economical solution when compared to locating the reservoir further west and north in the study area.
- A storage volume of approximately 21,000 m³ is required for the proposed North Reservoir to support the study area, based on the design criteria applied.
- The sizing of the future supply mains from the Water Treatment Plant to the North of 11A service area was not assessed as these mains will also supply additional future areas.

6.1.2 Water Servicing Concepts

- Two configurations for the water distribution system in the study area were evaluated in detail and are summarized as follows:
 - **Servicing Concept Option 1:** Pressure zone separation between existing and proposed areas. The key considerations for this concept are as follows:
 - Provides a simple operational concept for the proposed service area.
 - Will provide more consistent pressures.
 - Reservoir storage will be easily accessed by the study area, but will not support additional lands outside of the study area.
 - The capital cost for Option 1 was estimated to be \$92,619,400.
 - **Servicing Concept Option 2:** Extension of the Water Treatment Plant Pressure Zone to the east of Highway 2A.
 - The area east of Highway 2A can be serviced using available pressure from the WTP pressure zone (HGL 919 m).
 - Saves energy by using available pressure for distribution and will result in lower pumping costs over time.
 - The capital cost for Option 2 was estimated to be \$96,151,900.
- Refinements to the pressure zone boundaries have provided opportunities to reduce pipe requirements and to minimize areas with high pressures

- It has been assumed that the large hill located in the northwest portion of the study area will be re-graded to an elevation of 890 m, a cut of up to 10 m in some locations. If this is not possible, other servicing options to increase pressure in this location will need to be considered for servicing.

6.1.3 NRDRWC 750 mm Trunk

- The NRDRWSC cannot be incorporated into the distribution system located west of Highway 2A in either option, without pumping of the regional flows through the proposed reservoir and pump station.
- The NRDRWSC can be incorporated in to the distribution system located east of Highway 2A, in Servicing Concept Option 2.
- Incorporating the NRDRWSC into the easterly distribution system in Option 2 may allow the City to defer costs of new watermains. Future increased supply to the NRDRWSC will be required and can be accommodated through oversizing of distribution mains or installing a future twin 750 mm diameter main.

6.1.4 Interim Water Servicing

- Based on the Queens Reservoir Capacity Analysis for interim servicing, an area of approximately 258 ha can be serviced in Option A, while approximately 224 ha can be serviced in Option B.
- The Phase 1 area can be serviced from the existing Queens Reservoir in the interim scenario, based on the assessment criteria applied.
- A PRV will be required in order to reduce the current pressure at the Queens Reservoir to a maximum of 930 m HGL in the interim development scenario.

6.2 SANITARY SEWER SYSTEM

6.2.1 Servicing Concepts

- Four pump stations, 9.6 km of force main and 20.9 km of gravity sewer will be required to service the study area at an approximate cost of \$124.6 Million (cost based on Option 2).
- Within the Highway 11A corridor, deep gravity trunks (Option 1) were evaluated in comparison to a lift station and forcemain system (Option 2). The capital cost for deep gravity trunks (Option 1) was found to be approximately \$1.8M higher than the costs for a lift station and forcemain system (Option 2).
- The conceptual design of wastewater servicing considered future flows from outside of the North of Highway 11A service area in addition to wastewater from within the service area. There was a total off-site flow allowance of 3,830 L/s which accounted for 6,320 ha of future development to the west and south of the North of Highway 11A Service area.
- There were six sewer catchments (A,B,C,D,E, and F) that were developed as part of the servicing concept. The sewer catchment areas are shown on **Figures 4-4 and 4-5**.

- The servicing concept shows a lift station at the intersection of Range Road 272 and Landry Ave. which can be removed over the long-term development of the North of Highway 11A service area by conveying the lift station inflows by gravity to the proposed lift station at Township Road 392 and Range Road 272.

6.2.2 Regional Wastewater

- The North Red Deer Regional Wastewater Commission (NRDRWWC) is undertaking design of a regional wastewater pipeline that will extend from the City of Lacombe to the City of Red Deer Wastewater Treatment Plant.
- There may be opportunity to share use of wastewater trunk infrastructure as the NRDRWWC system approaches the City of Red Deer Wastewater Treatment Plant. A wastewater manhole to the north east of the Chiles Industrial Park may provide an opportunity for a tie-in point and sharing of infrastructure.
- Odour management should be a consideration for the City of Red Deer for a tie-in point from the NRDRWWC. It is expected that the NRDRWWC system will be a closed system with an extended sewage retention time that could result in odour at an open-air gravity tie-in.

6.2.3 Interim Sanitary Sewer Servicing

- Available capacity in an existing sewer trunk in the Edgar Industrial Development can provide some capacity for development before major trunks are installed. The existing Edgar system has capacity for 97 ha of development in addition to the existing 127 ha of development in the Queens Business Park. 61 ha of the 97 ha lie in the Queens Business Park Area, while 36 ha lies within the study area.
- All of the flow from the Chiles Industrial Park can be serviced by using the existing 750mm trunk located to the south of the Chiles Industrial Park.

6.3 STORMWATER MANAGEMENT SYSTEM

6.3.1 Existing Drainage Conditions

- The existing project area is servicing through a surface drainage system (i.e. culverts and ditches). A stormwater management facility (dry pond) which provides water quality and quantity control is located in the Chiles Industrial Park Subdivision.
- The project area is divided into two major drainage basins: Red Deer River Basin and Blindman River Basin. Based on the available DEM data, both basins seem to have a good natural drainage system which will likely facilitate the intersection of surface runoff through storm sewer systems and surface drainage towards the proposed stormwater management facilities and eventually to the Red Deer River and Blindman River.

6.3.2 Hazlett Lake

- Hazlett Lake has been identified as a natural feature with high environmental significance. Preservation of the Hazlett Lake has become a priority in future development of the area.
- High flows from the Highway 11A storm sewer “overflow” to the Lake only during severe storm events. These flows are not included in the PCSWMM model since they do not have an impact to the Hazlett Lake water levels, and proposed downstream storm system. The Majority of the flows from Queen Business and Edgar Industrial Parks are currently being intercepted by a 1050 mm diameter storm sewer and routed directly to the Red Deer River.

6.3.3 Servicing Concept

- Stormwater management will be required in all new developments to control peak runoff rates and to provide water quality control.
- A pre-development release rate of 2 L/s/ha was used for the conceptual design of the stormwater management facilities based on the AEP chart.
- Best management practice implies that wet pond facilities be used as they provide higher water quality control.
- Existing wetlands should be preserved.
- Proposed stormwater management ponds will be discharging to the existing drainage paths and tributaries in order to promote preservation of the existing drainage system.
- Recommended storage volumes used for the ponds sizing are conceptual only. The size of each pond should be confirmed during the design stage when details of the pond catchment and the development concept are finalized.
- Proposed storm sewers are based on the existing topography. Future planning will be required to confirm sizes and pipe lengths.
- No stormwater trunks are required to establish interim servicing for the Hazlett Lake residential development.

6.4 TRANSPORTATION

6.4.1 Watt Transportation Study

- The proposed road network developed as part of the Watt study will be sufficient to support development within the existing city boundaries. As required, Associated Engineering modified the network recommended by Watt to reflect the additional information gathered and/or constraints identified as part of this study.

6.4.2 Servicing Concept

- For the lands within the study area, located to the north of the existing city limits, the identified road network has been shown for illustrative purposes only. As development plans are finalized, it will be necessary to compare the plans to what had been assumed previously to determine if there may be opportunities to extend development beyond the existing city limits.
- The results of the capacity analysis on the existing network shows that the Highway 11A/Taylor Drive intersection can accommodate the development of 550 residential development units before intersection operations reach unacceptable levels; Highway 2A/Township Road 391 can accommodate 700, assuming that traffic signals are installed. At Highway 11A/Gaetz Avenue an additional 1,483 residential units can be accommodated prior to the intersection requiring upgrading.
- The road network identifies interchanges at four locations.
- For this study future traffic volumes were analyzed at three locations to determine the type of interchange that will be required.
 - Highway 11A and Gaetz Avenue
 - Highway 11A and Taylor Drive
 - Highway 2A and Township Road 391
- Three interchange types were selected that would be capable of accommodating the future traffic demands. Tight urban interchange designs are the preferred alternatives for all three locations.
- It is recommended that the City proceed with detailed planning of these interchanges to confirm the design requirements, including a weaving analysis, and required right-of-way.

7 Recommendations

The following sections outline the key recommendations from the water distribution system, sanitary sewer system, and transportation systems.

7.1 WATER DISTRIBUTION SYSTEM

- Proceed with Option 2 for water servicing, as presented in **Figure 4-2** which extends the Water Treatment Plant Pressure Zone to the east of Highway 2A.
- Locate the future North Reservoir near to the intersection of Highway 11A and Highway 2A.
- Locate storage for the entire study area (21,000 m³) at the North Reservoir.
- Proceed with interim servicing from the Queens Business Park to service the proposed residential development around Hazlett Lake.
- For interim water service provided from the NRDRWSC for the existing Central Park area, it is recommended that watermains be sized adequately for long term development.
- Construct the water supply trunk(s) to the North Reservoir, the North Reservoir, and water distribution mains for servicing before the capacity of the Queens Business Park Reservoir is reached for the interim servicing condition.

7.2 SANITARY SEWER SYSTEM

- Use available capacity in the City's Edgar trunks to provide interim servicing for the proposed residential development around Hazlett Lake. The capacity in the trunk can provide up to 96 ha of development shared between the Queens Business Park and the Hazlett Lake development.
- Undertake preliminary and detailed design for a new sanitary trunk along Highway 11A, draining to the WWTP. This trunk will be needed to service a large portion of Phase 1.
- The recommended servicing option for the Highway 11A corridor is Option 2 which includes the installation of a wastewater lift station and forcemain system. The capital cost for Option 2 was found to be approximately \$1.8m lower than the capital cost required for Option 1 (deep gravity trunks).

7.3 STORMWATER MANAGEMENT SYSTEM

- Adopt the stormwater management plan shown in **Figure 4-15** as the basis for future developments, subject to review during the development planning and subdivision design process.
- Three new storm trunks are proposed to be installed along the divided arterial and collector roads in order to convey stormwater to the proposed stormwater management facilities within the North of Highway 11A area.
- Provide stormwater management facilities in all future development areas to control flows and runoff water quality.

- Complete a detailed flood fringe analysis for low-lying areas along the Red Deer River.
- Preserve existing wetlands, waterbodies, and overland drainage courses.
- Address water quality improvements in all drainage design.
- Detailed field data such as LIDAR or survey should be used during the future design of the stormwater management facilities to confirm pond characteristics and elevations of outlets pipes.

7.4 TRANSPORTATION

- Develop a road network of arterial and collector roads as shown in Figure 4-12. As development plans are finalized, development densities and traffic volumes should be reviewed to determine if additional development in the lands currently outside of the city boundaries can be supported by the road network.
- A tight urban diamond interchange design has been recommended for the interchanges that will ultimately be required at Highway 11A/Gaetz Avenue, Highway 11A/Taylor Drive, Highway 2A/Township Road 391. Associated Engineering recommends that City proceed with detailed planning of these interchanges to confirm the design requirements, including a weaving analysis, and required right-of-way.
- Road right-of-ways should be protected in accordance with current city standards.
- The existing road network has excess capacity to accommodate growth in the study lands without requiring upgrades. At Highway 11A/Taylor Drive it was determined that an additional 550 single family homes can be supported; at Highway 2A/Township Road 391 an additional 700 homes can be supported. The Highway 2A/Highway 11A intersection will be able to accommodate 1,483 additional residential units.

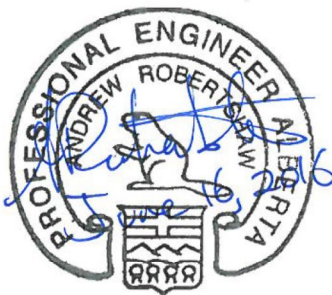
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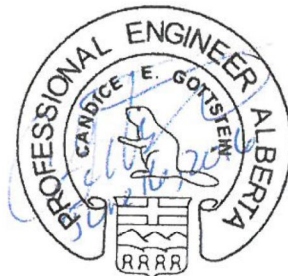
This report was prepared for the City of Red Deer to provide a servicing study for lands north of Highway 11A.

The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering Alberta Ltd.



Andrew Robertshaw, P.Eng.
Project Manager



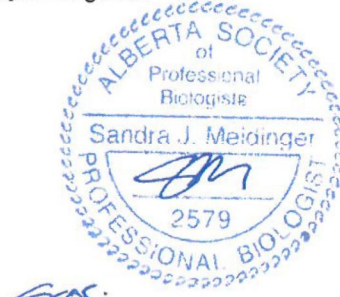
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| |
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| ASSOCIATED ENGINEERING QUALITY MANAGEMENT SIGN-OFF |
| Signature: _____ |
| Date: <u>June 16, 2016</u> |

APEGA Permit to Practice P 3979





Appendix A – Environmental Tables



**Table A-1
Environmentally Sensitive Fish and Wildlife Documented Within the Study Area**

| Common Name | Scientific Name | Data Source | General Status of Alberta Wild species 2010 | Wildlife Regulation Schedule 6 | COSEWIC Status | Species At Risk Act Schedule | Species At Risk Act Status |
|--------------------------|----------------------------------|--------------------|--|---------------------------------------|-----------------------|-------------------------------------|-----------------------------------|
| <i>FISH</i> | | | | | | | |
| Brown trout | <i>Salmo trutta</i> | FWMIS | EX/AL | | | | |
| Lake sturgeon | <i>Acipenser fulvescens</i> | FWMIS | UN | TH | EN | | |
| Sauger | <i>Sander canadensis</i> | FWMIS | SEN | | | | |
| Spoonhead sculpin | <i>Cottus ricei</i> | FWMIS | MBAR | | NAR | | |
| <i>AMPHIBIANS</i> | | | | | | | |
| Canadian toad | <i>Anaxyrus hemiophrys</i> | ACIMS | MBAR | | | | |
| <i>INSECTS</i> | | | | | | | |
| River Jewelwing | <i>Calopteryx aequabilis</i> | ACIMS | SEN | | | | |
| <i>MAMMALS</i> | | | | | | | |
| Long-tailed weasel | <i>Mustela frenata</i> | HLBA | MBAR | | | | |
| <i>BIRDS</i> | | | | | | | |
| American bittern | <i>Botaurus lentiginosus</i> | HLBA | SEN | | | | |
| American kestrel | <i>Falco sparverius</i> | HLBA | SEN | | | | |
| American white pelican | <i>Pelecanus erythrorhynchos</i> | HLBA / FWMIS | SEN | | NAR | | |
| Baird's sparrow | <i>Ammodramus bairdii</i> | HLBA | SEN | | | | |
| Bald eagle | <i>Haliaeetus leucocephalus</i> | HLBA | SEN | | | | |
| Baltimore oriole | <i>Icterus galbula</i> | HLBA | SEN | | | | |
| Barn swallow | <i>Hirundo rustica</i> | HLBA | SEN | | | | |
| Barred owl | <i>Strix varia</i> | HLBA | SEN | | | | |
| Bay-breasted warbler | <i>Dendroica castanea</i> | HLBA | SEN | | | | |
| Black tern | <i>Chlidonias niger</i> | HLBA | SEN | | | | |

| Common Name | Scientific Name | Data Source | General Status of Alberta Wild species 2010 | Wildlife Regulation Schedule 6 | COSEWIC Status | Species At Risk Act Schedule | Species At Risk Act Status |
|------------------------------|------------------------------|--------------|---|--------------------------------|----------------|------------------------------|----------------------------|
| Black-backed woodpecker | <i>Picoides arcticus</i> | HLBA | SEN | | | | |
| Black-crowned night-heron | <i>Nycticorax nycticorax</i> | HLBA | SEN | | | | |
| Black-necked stilt | <i>Himantopus mexicanus</i> | HLBA | SEN | | | | |
| Black-throated green warbler | <i>Dendroica virens</i> | HLBA | SEN | | | | |
| Bobolink | <i>Dolichonyx oryzivorus</i> | HLBA | SEN | | | | |
| Broad-winged hawk | <i>Buteo platypterus</i> | HLBA | SEN | | | | |
| Brown creeper | <i>Certhia americana</i> | HLBA | SEN | | | | |
| Canada warbler | <i>Wilsonia canadensis</i> | HLBA | SEN | | | | |
| Common nighthawk | <i>Chordeiles minor</i> | HLBA | SEN | | | | |
| Common Yellowthroat | <i>Geothlypis trichas</i> | HLBA | SEN | | | | |
| Eastern phoebe | <i>Sayornis phoebe</i> | HLBA | SEN | | | | |
| Ferruginous hawk | <i>Buteo regalis</i> | HLBA | AR | EN | TH | S1 | TH |
| Golden eagle | <i>Aquila chrysaetos</i> | HLBA | SEN | | | | |
| Grasshopper sparrow | <i>Ammodramus savannarum</i> | HLBA | SEN | | | | |
| Great blue heron | <i>Ardea herodias</i> | HLBA / FWMIS | SEN | | | | |
| Great grey owl | <i>Strix nebulosa</i> | HLBA | SEN | | | | |
| Green-winged teal | <i>Anas crecca</i> | HLBA | SEN | | | | |
| Horned grebe | <i>Podiceps auritus</i> | HLBA | SEN | | | | |
| Least flycatcher | <i>Empidonax minimus</i> | HLBA | SEN | | | | |
| Lesser scaup | <i>Aythya affinis</i> | HLBA | SEN | | | | |
| Long-billed curlew | <i>Numenius americanus</i> | HLBA | SEN | | SC | S1 | SC |
| Northern goshawk | <i>Accipiter gentilis</i> | HLBA | SEN | | | | |
| Northern harrier | <i>Circus cyaneus</i> | HLBA | SEN | | | | |
| Northern pintail | <i>Anas acuta</i> | HLBA | SEN | | | | |
| Olive-sided flycatcher | <i>Contopus cooperi</i> | HLBA | MBAR | | TH | S1 | TH |
| Osprey | <i>Pandion haliaetus</i> | HLBA / | SEN | | | | |

| Common Name | Scientific Name | Data Source | General Status of Alberta Wild species 2010 | Wildlife Regulation Schedule 6 | COSEWIC Status | Species At Risk Act Schedule | Species At Risk Act Status |
|---------------------|----------------------------------|--------------|---|--------------------------------|----------------|------------------------------|----------------------------|
| | | FWMIS | | | | | |
| Peregrine falcon | <i>Falco peregrinus</i> | HLBA / FWMIS | AR | EN | SC | S1 | SC |
| Pied-billed grebe | <i>Podilymbus podiceps</i> | HLBA | SEN | | | | |
| Pileated woodpecker | <i>Dryocopus pileatus</i> | HLBA | SEN | | | | |
| | | | | | | | |
| prairie falcon | <i>Falco mexicanus</i> | HLBA | SEN | | | | |
| | | HLBA / FWMIS | | | | | |
| Purple martin | <i>Progne subis</i> | HLBA / FWMIS | SEN | | | | |
| Rusty blackbird | <i>Euphagus carolinus</i> | HLBA | SEN | | SC | S1 | SC |
| Sandhill crane | <i>Grus canadensis</i> | HLBA | SEN | | | | |
| Sharp-tailed grouse | <i>Tympanuchus phasianellus</i> | HLBA | SEN | | | | |
| Short-eared owl | <i>Asio flammeus</i> | HLBA | MBAR | | SC | S1 | SC |
| Sora | <i>Porzana carolina</i> | HLBA | SEN | | | | |
| Sprague's pipit | <i>Anthus spragueii</i> | HLBA | SEN | | TH | S1 | TH |
| | | HLBA / FWMIS | | | | | |
| Swainson's hawk | <i>Buteo swainsoni</i> | HLBA / FWMIS | SEN | | | | |
| Trumpeter swan | <i>Cygnus buccinator</i> | HLBA | AR | | NAR | | |
| Western grebe | <i>Aechmophorus occidentalis</i> | HLBA | SEN | | | | |
| Western tanager | <i>Piranga ludoviciana</i> | HLBA | SEN | | | | |
| Western wood-pewee | <i>Contopus sordidulus</i> | HLBA | SEN | | | | |
| White-winged scoter | <i>Melanitta fusca</i> | HLBA | SEN | | | | |

Abbreviations:

| Common Name | Scientific Name | Data Source | General Status of Alberta Wild species 2010 | Wildlife Regulation Schedule 6 | COSEWIC Status | Species At Risk Act Schedule | Species At Risk Act Status |
|-------------|-----------------|-------------|---|--------------------------------|----------------|------------------------------|----------------------------|
|-------------|-----------------|-------------|---|--------------------------------|----------------|------------------------------|----------------------------|

Data Source

ACIMS = Alberta Conservation Information Management System
 FWMIS = Fish and Wildlife Information Management System
 HLBA = Hazlett Lake 2014 Baseline Assessment

General Status of Alberta Wild Species 2010

AR = At Risk
 MBAR = May Be At Risk
 SEN = Sensitive
 EX/AL = Exotic / Alien

Wildlife Regulations Schedule 6

EN = Endangered
 TH = Threatened

COSEWIC Status

EN = Endangered
 TH = Threatened
 SC = Special Concern

Species At Risk Act Schedule

S1 = Schedule 1

Species At Risk Act Status

EN = Endangered
 TH = Threatened
 SC = Special Concern

Table A-2
Environmental Regulations Which May Apply To The Expansion Of Service Areas

| Act Title and Description | General Practices for Complying with the Act |
|--|--|
| <p><i>Navigation Protection Act</i> Activities with the potential to impact water-based navigation are regulated under this Act.</p> | <p>Proposed work on a navigable watercourse may require either a Transport Canada (TC) Application or self-directed navigation protection measures.</p> <p>A TC Approval is required for work outside the minor works order¹ on Scheduled water bodies².</p> <p>Navigation protection measures are required for all navigable water bodies (including navigation by a canoe or kayak), in order to comply with the Act.</p> |
| <p><i>Fisheries Act</i> Activities with potential to cause harm to fish or fish habitat are regulated under this Act.</p> | <p>Any construction near water may require approval through Fisheries and Oceans Canada (DFO). Depending on the scope of impact and quality of fish habitat, the project may require a fish habitat assessment and/or fish habitat compensation.</p> <p>Specifics: Projects near water require either a “self-assessment”, a “DFO Project Review”, or an “Authorization”.</p> <p>Note: All projects must implement the Measures to Avoid Causing Harm to Fish and Fish Habitat³.</p> |
| <p><i>Fisheries (Alberta) Act</i> Alberta fisheries are regulated under this Act.</p> | <p>If handling or investigating fish during any stage of a project, then a qualified environmental professional should obtain and adhere to the conditions of a fish research licence (FRL) acquired through the Government of Alberta.</p> <p>Specifics: If the work site is isolated from running water for construction, a fish salvage (with FRL) must be conducted to remove any fish from the isolated area.</p> |
| <p><i>Water Act</i> (Alberta) Work in or near a waterbody is regulated under this Act.</p> | <p>Work that falls under the Codes of Practice requires notification to the Government of Alberta (Alberta Environment and Parks. (AEP) or Alberta Energy Regulator (AER)). Work not covered by a Code of Practice may require <i>Water Act</i> Approval.</p> |

¹ Government of Canada Canada. 2014. Minor Works Order. Transport Canada. <https://www.tc.gc.ca/eng/programs-633.html> (accessed 5 May 2015).

² Government of Canada. 2015. Scheduled Waters. Transport Canada. <http://laws-lois.justice.gc.ca/eng/acts/n-22/FullText.html#h-27> (accessed 5 May 2015).

³ Government of Canada. 2013. Measures to Avoid Causing Harm to Fish and Fish Habitat. Fisheries and Oceans Canada. <http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html> (accessed 26 Mar. 2014).

| Act Title and Description | General Practices for Complying with the Act |
|--|---|
| <p>Specific requirements are regulated by the Codes of Practice, which also assigns a quality classification to watercourses with associated restricted activity periods (RAPs) for waterbodies (i.e. periods when instream work should be avoided).</p> | <p>Specifics: Submit a notification or Approval as required.</p> <p>Note: In some cases it is necessary to obtain and implement the written specifications and recommendations of a qualified aquatic environment specialist (QAES).</p> |
| <p>Public Lands Act (Alberta) All Crown land, including the bed and shore of all waterbodies, is regulated under this Act.</p> | <p>Works on crown land require access rights to obtain a new disposition or amend an existing disposition for any permanent structure on public land. A temporary field authorization (TFA) is required for temporary use of public land, such as equipment storage, laydown areas, or de-watering.</p> |
| <p>Historical Resources Act (Alberta) Archaeological and paleontological resources are regulated under this Act.</p> | <p>Consultation with Alberta Culture and Tourism is required prior to the onset of development activities for all projects within a designated historical resource listing and for all major pipeline projects regardless of listing.</p> <p>Project details are provided to Alberta Culture and Tourism in a Historical Resources Application submitted through an online clearance application. Depending on the outcome of the Alberta Culture and Tourism review, additional Historical Resources Impact Assessments may be required.</p> |
| <p>Environmental Protection and Enhancement Act (Alberta) Any development with potential for environmental contamination is regulated under this Act.</p> | <p>Consider any potential sources for environmental contamination on a development project, and whether any such sources/activities fall within EPEA-designated activities or the miscellaneous regulations associated with the EPEA.</p> <p>Specifics: Actions to comply with the EPEA range from a notification of proposed work relating to an existing EPEA approval, to amendment of an existing approval, to submission of a new EPEA approval application.</p> <p>Note: At minimum, a notification is required for outfalls and for any changes to water treatment or waste water systems.</p> |
| <p>Species At Risk Act (SARA) Activities with potential to impact a species at risk /</p> | <p>Consider whether any SARA-scheduled species are known to occur in the project area.</p> |

| Act Title and Description | General Practices for Complying with the Act |
|--|---|
| species of concern and/or its habitat are regulated under this Act. | If a species at risk will be handled during the project (i.e. during fish salvage), a permit is required under SARA. |
| <p><i>Migratory Birds Convention Act</i> This act protects migratory birds, their eggs, and their active nests.</p> | <p>Any vegetation clearing scheduled to occur within the migratory bird nesting window for a particular area has the potential to impact migratory birds (a project's nesting window is determined by the Bird Conservation Region⁴ within which the project occurs).</p> <p>General practice for compliance with this Act is to have a qualified environmental professional complete surveys for nests. Surveys must be species-appropriate and vegetation-appropriate. Following the survey, the environmental professional should provide recommendations for operating around migratory birds, and establish appropriate buffers (zones where no construction activities, equipment, or personnel are permitted) around nests.</p> <p>Note: Vegetation clearing scheduled outside the migratory bird nesting window is strongly preferred by Environment Canada over clearing within the nesting window.</p> <p>Clearing scheduled for winter should consider migratory species nests, and surveys for nests through species-appropriate means may be necessary to demonstrate due diligence under the Alberta <i>Wildlife Act</i>.</p> |
| <p><i>Wildlife Act</i> (Alberta) Wilful molestation, disruption, or destruction of wildlife, or a house, nest, or den of wildlife, are all prohibited by this Act. This Act makes special provisions for the protection of raptors and their nests/habitat.</p> | <p>Any direct encounters with wildlife, their nests, or dens should be reported to the local area biologist. Some projects will need to demonstrate due diligence activities for compliance with this Act. For example, a desktop assessment (and/or field surveys for houses, nests, or dens of wildlife) may be completed by a qualified environmental professional to identify wildlife species that are present/ may be present in and around any proposed work sites. Environmental professionals may also suggest mitigating actions that the project can implement to avoid impacting wildlife.</p> |
| <p><i>Weed Control Act</i> (Alberta) This act regulates the specific weed species that are listed in its Schedule 1 (prohibited noxious weeds) and 2</p> | <p>Project activities must destroy weed species listed in Schedule 1 of the Act and control/prevent the spread of weed species listed in Schedule 2⁵.</p> <p>A weed management plan may be developed to outline weed control</p> |

⁴ Government of Canada. 2014. General Nesting Periods of Migratory Birds in Canada. Environment Canada. <https://www.ec.gc.ca/paom-itmb/default.asp?lang=En&n=4F39A78F-1> (accessed 5 May 2015).

⁵ Government of Alberta. 2010. Weed Control Regulation, Schedule 1 and 2. http://www.qp.alberta.ca/documents/Regs/2010_019.pdf (accessed 5 May 2015).

| Act Title and Description | General Practices for Complying with the Act |
|---|--|
| (noxious weeds). | <p>measures to comply with the Act.</p> <p>Specifics: Do not transport equipment with potential to be carrying weed plant material without first thoroughly cleaning the equipment. Destroy all prohibited noxious weeds on lands occupied by the project proponent. Control all noxious weeds on lands occupied by the project proponent.</p> <p>Note: Proponents may maintain a copy of the Alberta Invasive Plant Identification Guide on work sites to identify suspect plants.⁶</p> |
| <p>Agricultural Pests Act (Alberta) Species with the potential to interfere with agricultural productivity are regulated under this Act.</p> | <p>A desktop assessment of potential pest species and pathogens may be conducted. Appropriate measures to mitigate their spread should be employed.</p> <p>Note: Clubroot (<i>Plasmodiophora brassicae</i>) has been identified in some parts of Alberta.⁷ Project area soils should be tested to determine whether clubroot is present. If present, equipment and tools must be disinfected before leaving work sites and soil spoil may only be disposed of in a manner designated and/or approved by local jurisdictions.</p> |

⁶ Government of Alberta. 2012. Alberta Invasive Plant Identification Guide: Prohibited Noxious and Noxious. Alberta Agriculture and Rural Development. http://www.edmonton.ca/for_residents/PDF/Weed_Identification_Book.pdf (accessed 26 Mar. 2014).

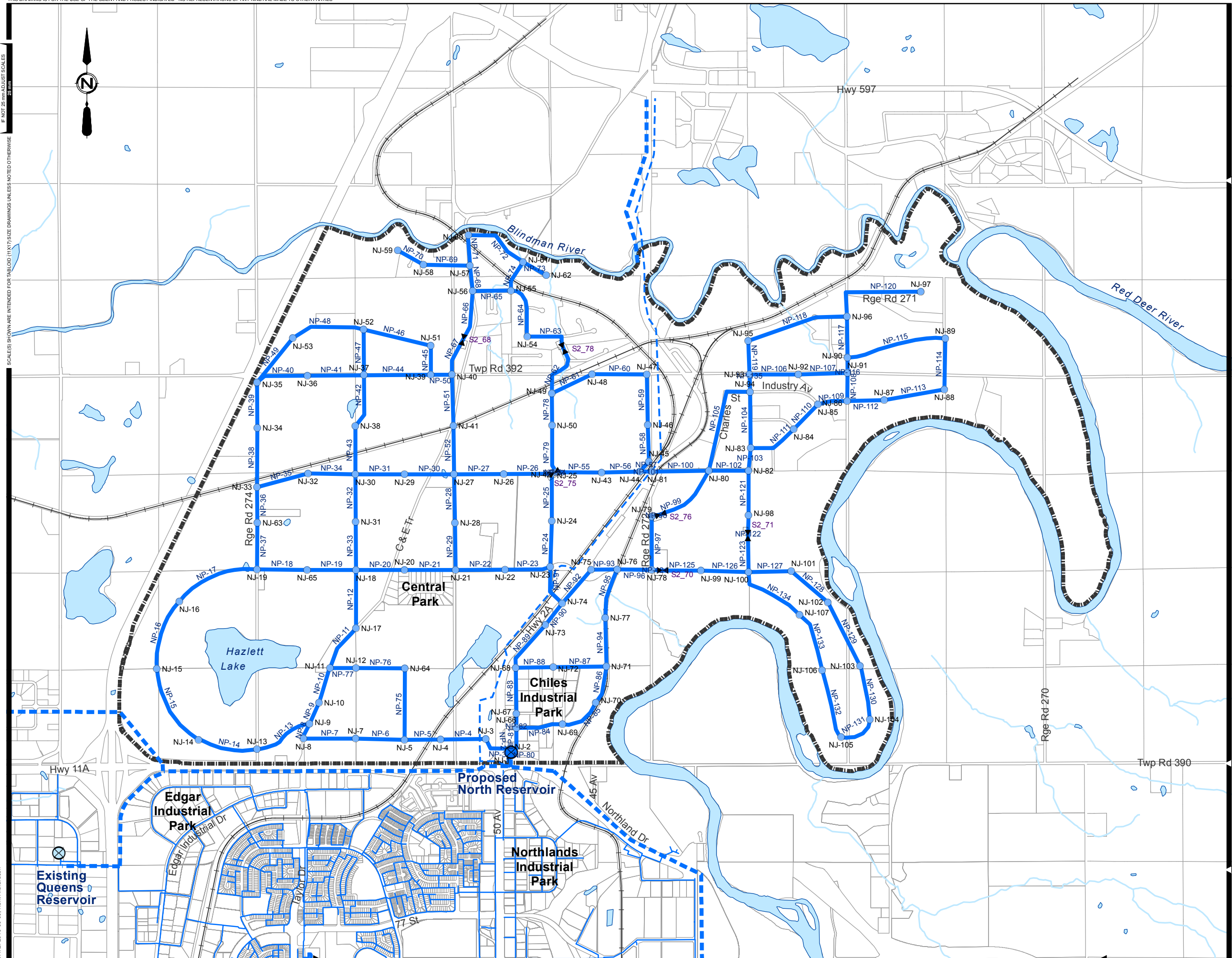
⁷ Government of Alberta. 2011. Clubroot Infested Areas in Alberta 2009. Alberta Agriculture and Rural Development. [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/prm12945](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/prm12945) (accessed 26 Mar. 2014).

REPORT

Appendix B - Cost Estimates - Water

SCALE(S) SHOWN ARE INTENDED FOR TABLORD (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

\\s-efm-fs-01\projects\20153382\02_N_of_Hwy_11A_ServWorking_Dwg\010_GIS\ArcMapIB-1.mxd
DATE: 2016-06-09 Kent Richardson



- Legend:
- Node
 - ▶ PRV
 - ⊗ Existing Reservoir
 - ⊗ Proposed Reservoir
 - Existing Supply Main
 - Proposed Supply Main
 - Existing Distribution Main
 - Study Area

DRAFT



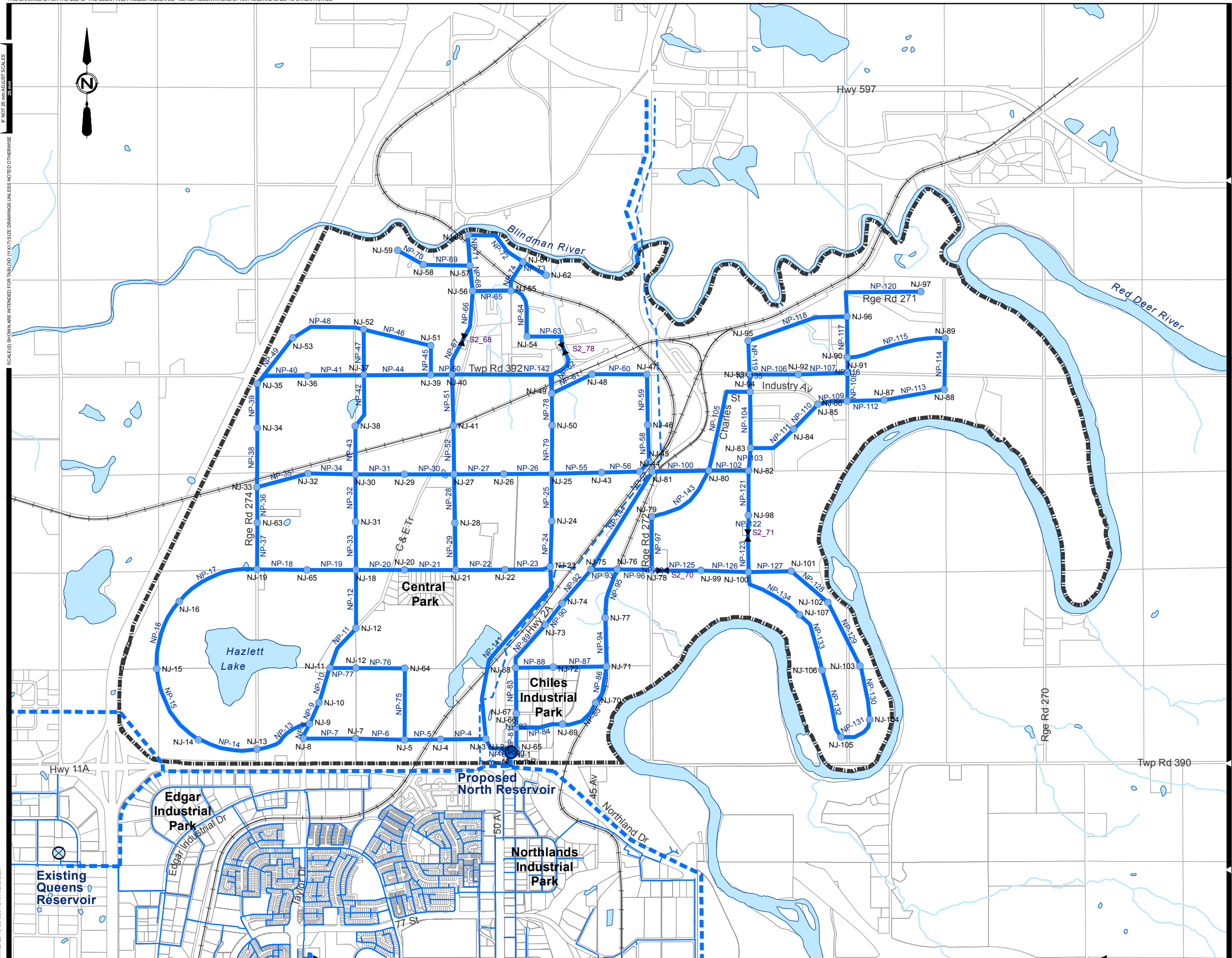
FIGURE No. B-1
NORTH OF HIGHWAY 11A SERVICING STUDY

WATER
REFERENCE OPTION 1

| | |
|----------------|-------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED | |
| DATE | 2016JUN09 |
| REV | |
| DESCRIPTION | ISSUED FOR REPORT |

SCALE(S) SHOWN ARE INTENDED FOR TABLORD (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

\\s-efm-fs-01\projects\2015338200_N_of_Hwy_11A_ServWorking_Dwg\010_GIS\Map\B-2.mxd
DATE: 2016-06-09, Kent Richardson



- Legend:
- Node
 - ▣ PRV
 - ⊗ Existing Reservoir
 - ⊗ Proposed Reservoir
 - - - Existing Supply Main
 - - - Proposed Supply Main
 - Existing Distribution Main
 - ▭ Study Area

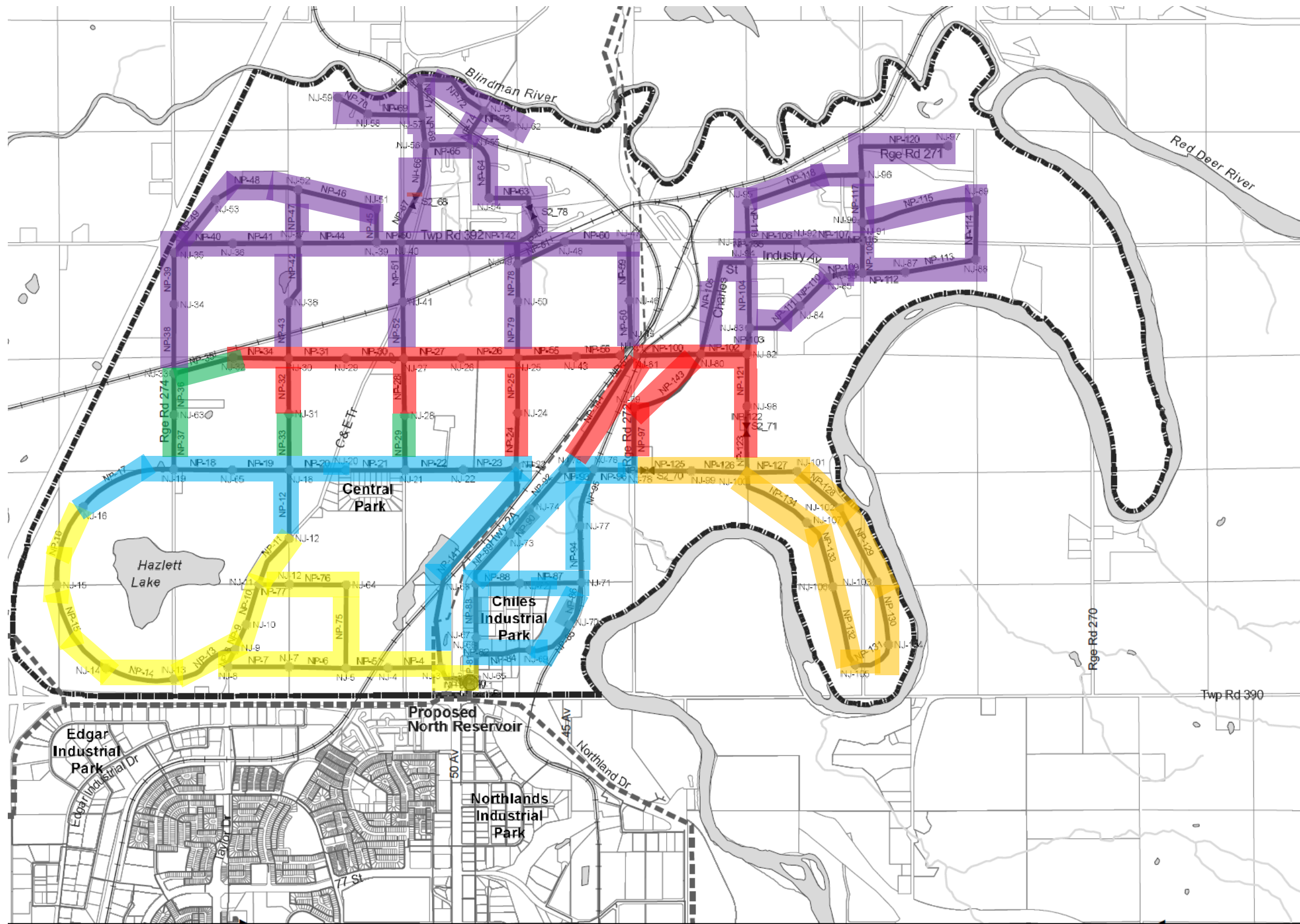
DRAFT



FIGURE No. B-2
NORTH OF HIGHWAY 11A SERVICING STUDY

WATER
REFERENCE OPTION 2

| | |
|----------------|-------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED | |
| DATE | 2016JUN09 |
| REV | |
| DESCRIPTION | ISSUED FOR REPORT |



- Phase 1
- Phase 2
- Phase 3
- Phase 4
- Phase 5
- Phase 6



FIGURE No. B-3
 NORTH OF HIGHWAY 11A SERVICING STUDY

WATER
 REFERENCE OPTION 2

| | |
|----------------|-------------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED | |
| DATE | JUNE 2016 |
| REV | |
| DESCRIPTION | ISSUED FOR FINAL REPORT |

APPENDIX B - Table B-1
City of Red Deer North of Highway 11A Servicing Study
Water Distribution System Unit Costs

Watermains

Undeveloped Lands

| Item | 200mm | 250mm | 300mm | 350mm | 400mm | 450mm | 500mm | 600mm | 750mm | 900mm | 1050mm |
|---|---------------|---------------|---------------|---------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Topsoil Stripping and Stockpile (assume depth of 0.4m) | \$ 20 | \$ 20 | \$ 20 | \$ 20 | \$ 22 | \$ 22 | \$ 22 | \$ 22 | \$ 25 | \$ 25 | \$ 250 |
| Trenching and backfilling | \$ 290 | \$ 290 | \$ 290 | \$ 290 | \$ 340 | \$ 340 | \$ 340 | \$ 340 | \$ 390 | \$ 390 | \$ 390 |
| Pipe Zone Material | \$ 30 | \$ 30 | \$ 30 | \$ 30 | \$ 55 | \$ 55 | \$ 55 | \$ 55 | \$ 80 | \$ 80 | \$ 80 |
| Supply and Install DR18 Pipe | \$ 90 | \$ 120 | \$ 170 | \$ 230 | \$ 300 | \$ 385 | \$ 475 | \$ 660 | \$ 870 | \$ 1,150 | \$ 1,520 |
| Place Topsoil, compact and seed | \$ 40 | \$ 40 | \$ 40 | \$ 40 | \$ 45 | \$ 45 | \$ 45 | \$ 45 | \$ 50 | \$ 50 | \$ 50 |
| Fire Hydrant (1 every 90 m) | \$ 110 | \$ 110 | \$ 110 | \$ 110 | \$ 110 | \$ 110 | \$ 110 | \$ 110 | \$ 100 | \$ 100 | \$ 100 |
| Gate valve (1 per 100m 300mm down, 1 per 200m 400mm and up) | \$ 35 | \$ 55 | \$ 75 | \$ 100 | \$ 65 | \$ 85 | \$ 110 | \$ 140 | \$ 175 | \$ 215 | \$ 260 |
| Fittings (Tees, Bends, Reducers, Plugs) | \$ 12 | \$ 14 | \$ 16 | \$ 18 | \$ 22 | \$ 26 | \$ 30 | \$ 34 | \$ 42 | \$ 50 | \$ 58 |
| Miscellaneous (Mob/De-Mob, Survey, Signage) (10%) | \$ 63 | \$ 68 | \$ 75 | \$ 84 | \$ 96 | \$ 107 | \$ 119 | \$ 141 | \$ 173 | \$ 206 | \$ 271 |
| Project Total (rounded) | \$ 690 | \$ 750 | \$ 830 | \$ 920 | \$ 1,050 | \$ 1,170 | \$ 1,310 | \$ 1,550 | \$ 1,910 | \$ 2,270 | \$ 2,980 |

Developed Lands - Rural

| Item | 200mm | 250mm | 300mm | 350mm | 400mm | 450mm | 500mm | 600mm | 750mm | 900mm | 1050mm |
|---|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Asphalt Pavement Removal | \$ 50 | \$ 50 | \$ 50 | \$ 50 | \$ 75 | \$ 75 | \$ 75 | \$ 75 | \$ 100 | \$ 100 | \$ 100 |
| Granular Base Removal and Disposal | \$ 35 | \$ 35 | \$ 35 | \$ 35 | \$ 50 | \$ 50 | \$ 50 | \$ 50 | \$ 65 | \$ 65 | \$ 65 |
| Trenching and Backfilling | \$ 400 | \$ 400 | \$ 400 | \$ 400 | \$ 450 | \$ 450 | \$ 450 | \$ 450 | \$ 500 | \$ 500 | \$ 500 |
| Pipe Zone Material | \$ 30 | \$ 30 | \$ 30 | \$ 30 | \$ 55 | \$ 55 | \$ 55 | \$ 55 | \$ 80 | \$ 80 | \$ 80 |
| Supply and Install DR 18 Pipe | \$ 90 | \$ 120 | \$ 170 | \$ 230 | \$ 300 | \$ 385 | \$ 475 | \$ 660 | \$ 870 | \$ 1,150 | \$ 1,520 |
| Existing Pavement Repair | \$ 220 | \$ 220 | \$ 220 | \$ 220 | \$ 330 | \$ 330 | \$ 330 | \$ 330 | \$ 500 | \$ 500 | \$ 500 |
| Fire Hydrant (1 every 90 m) | \$ 110 | \$ 110 | \$ 110 | \$ 110 | \$ 110 | \$ 110 | \$ 110 | \$ 110 | \$ 110 | \$ 100 | \$ 100 |
| Gate valve (1 per 100m 300mm down, 1 per 200m 400mm and up) | \$ 35 | \$ 55 | \$ 75 | \$ 100 | \$ 65 | \$ 85 | \$ 110 | \$ 140 | \$ 175 | \$ 215 | \$ 260 |
| Fittings (Tees, Bends, Reducers, Plugs) | \$ 12 | \$ 14 | \$ 16 | \$ 18 | \$ 22 | \$ 26 | \$ 30 | \$ 34 | \$ 42 | \$ 50 | \$ 58 |
| Connect Services | \$ 220 | \$ 220 | \$ 220 | \$ 220 | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - |
| Manhole/Valve/Catch Basin Adjustments | \$ 10 | \$ 10 | \$ 10 | \$ 10 | \$ 10 | \$ 10 | \$ 10 | \$ 10 | \$ 10 | \$ 10 | \$ 10 |
| Miscellaneous (Mob/De-Mob, Survey, Signage) (10%) | \$ 121 | \$ 126 | \$ 134 | \$ 142 | \$ 147 | \$ 158 | \$ 170 | \$ 191 | \$ 245 | \$ 277 | \$ 319 |
| Project Total (rounded) | \$ 1,330 | \$ 1,390 | \$ 1,470 | \$ 1,560 | \$ 1,610 | \$ 1,730 | \$ 1,860 | \$ 2,110 | \$ 2,700 | \$ 3,050 | \$ 3,510 |

APPENDIX B - Table B-2
City of Red Deer North of Highway 11A Servicing Study
Option 1 Cost Breakdown

PHASE 1

North Reservoir and Pumphouse (Phase 2)

| Volume (m ³) | Unit Cost (\$/m) | Total Cost (includes contingency and engineering (30%)) |
|--------------------------|------------------|--|
| 18,738 | \$ 1,220 | \$ 22,860,000 |

Watermains - Within City Boundary (Phase 1)

| ID | Label | Start Node | Stop Node | Diameter (mm) | Type | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|-----------------------------------|-------|------------|-----------|---------------|-------------|------------|------------------|---------------------|-----------------------------------|---------------------|
| 28539 | NP-5 | NJ-4 | NJ-5 | 600 | Undeveloped | 301 | \$ 1,550 | \$ 466,000 | \$ 139,800 | \$ 605,800 |
| 28502 | NP-6 | NJ-7 | NJ-5 | 450 | Undeveloped | 406 | \$ 1,170 | \$ 475,000 | \$ 142,500 | \$ 617,500 |
| 28489 | NP-7 | NJ-8 | NJ-7 | 450 | Undeveloped | 435 | \$ 1,170 | \$ 509,000 | \$ 152,700 | \$ 661,700 |
| 28487 | NP-8 | NJ-9 | NJ-8 | 450 | Undeveloped | 134 | \$ 1,170 | \$ 157,000 | \$ 47,100 | \$ 204,100 |
| 28494 | NP-9 | NJ-9 | NJ-10 | 450 | Undeveloped | 196 | \$ 1,170 | \$ 230,000 | \$ 69,000 | \$ 299,000 |
| 28495 | NP-10 | NJ-10 | NJ-11 | 450 | Undeveloped | 301 | \$ 1,170 | \$ 353,000 | \$ 105,900 | \$ 458,900 |
| 28515 | NP-11 | NJ-11 | NJ-17 | 450 | Undeveloped | 403 | \$ 1,170 | \$ 471,000 | \$ 141,300 | \$ 612,300 |
| 28540 | NP-13 | NJ-9 | NJ-13 | 400 | Undeveloped | 499 | \$ 1,050 | \$ 524,000 | \$ 157,200 | \$ 681,200 |
| 28531 | NP-14 | NJ-13 | NJ-14 | 300 | Undeveloped | 503 | \$ 830 | \$ 418,000 | \$ 125,400 | \$ 543,400 |
| 28534 | NP-15 | NJ-14 | NJ-15 | 300 | Undeveloped | 713 | \$ 830 | \$ 592,000 | \$ 177,600 | \$ 769,600 |
| 28537 | NP-16 | NJ-15 | NJ-16 | 300 | Undeveloped | 607 | \$ 830 | \$ 504,000 | \$ 151,200 | \$ 655,200 |
| 28680 | NP-75 | NJ-5 | NJ-64 | 350 | Undeveloped | 595 | \$ 920 | \$ 547,000 | \$ 164,100 | \$ 711,100 |
| 24012 | NP-76 | NJ-12 | NJ-64 | 350 | Undeveloped | 406 | \$ 920 | \$ 374,000 | \$ 112,200 | \$ 486,200 |
| 28484 | NP-77 | NJ-11 | NJ-12 | 350 | Undeveloped | 216 | \$ 920 | \$ 199,000 | \$ 59,700 | \$ 258,700 |
| Total Watermains - Phase 1 | | | | | | | | \$ 5,819,000 | \$ 1,745,700 | \$ 7,564,700 |

Total Phase 1 \$ 30,424,700

PHASE 2

Watermains - Within City Boundary (Phase 2)

| ID | Label | Start Node | Stop Node | Diameter (mm) | Type | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|-----------------------------------|-------|------------|-----------|---------------|-------------|------------|------------------|----------------------|-----------------------------------|----------------------|
| 28688 | NP-2 | NJ-1 | NJ-2 | 1,050 | Undeveloped | 30 | \$ 2,980 | \$ 90,000 | \$ 27,000 | \$ 117,000 |
| 24228 | NP-3 | NJ-3 | NJ-2 | 600 | Undeveloped | 248 | \$ 1,550 | \$ 384,000 | \$ 115,200 | \$ 499,200 |
| 24195 | NP-4 | NJ-4 | NJ-3 | 600 | Undeveloped | 374 | \$ 1,550 | \$ 579,000 | \$ 173,700 | \$ 752,700 |
| 23984 | NP-12 | NJ-18 | NJ-17 | 450 | Undeveloped | 484 | \$ 1,170 | \$ 566,000 | \$ 169,800 | \$ 735,800 |
| 28538 | NP-17 | NJ-16 | NJ-19 | 300 | Undeveloped | 728 | \$ 830 | \$ 604,000 | \$ 181,200 | \$ 785,200 |
| 23956 | NP-18 | NJ-19 | NJ-65 | 400 | Undeveloped | 415 | \$ 1,050 | \$ 436,000 | \$ 130,800 | \$ 566,800 |
| 24270 | NP-19 | NJ-65 | NJ-18 | 400 | Undeveloped | 407 | \$ 1,050 | \$ 427,000 | \$ 128,100 | \$ 555,100 |
| 24038 | NP-20 | NJ-18 | NJ-20 | 400 | Undeveloped | 403 | \$ 1,050 | \$ 423,000 | \$ 126,900 | \$ 549,900 |
| 24342 | NP-21 | NJ-20 | NJ-21 | 400 | Undeveloped | 425 | \$ 1,050 | \$ 446,000 | \$ 133,800 | \$ 579,800 |
| 28679 | NP-22 | NJ-21 | NJ-22 | 450 | Undeveloped | 410 | \$ 1,170 | \$ 480,000 | \$ 144,000 | \$ 624,000 |
| 28513 | NP-23 | NJ-22 | NJ-23 | 450 | Undeveloped | 380 | \$ 1,170 | \$ 445,000 | \$ 133,500 | \$ 578,500 |
| 28637 | NP-80 | NJ-2 | NJ-65 | 900 | Undeveloped | 55 | \$ 2,270 | \$ 126,000 | \$ 37,800 | \$ 163,800 |
| 28636 | NP-81 | NJ-65 | NJ-66 | 900 | Developed | 173 | \$ 3,050 | \$ 529,000 | \$ 158,700 | \$ 687,700 |
| 28402 | NP-82 | NJ-66 | NJ-67 | 750 | Developed | 117 | \$ 2,700 | \$ 317,000 | \$ 95,100 | \$ 412,100 |
| 24085 | NP-83 | NJ-67 | NJ-68 | 750 | Developed | 382 | \$ 2,700 | \$ 1,030,000 | \$ 309,000 | \$ 1,339,000 |
| 28564 | NP-84 | NJ-69 | NJ-66 | 400 | Developed | 387 | \$ 1,610 | \$ 623,000 | \$ 186,900 | \$ 809,900 |
| 28563 | NP-85 | NJ-70 | NJ-69 | 400 | Undeveloped | 358 | \$ 1,050 | \$ 376,000 | \$ 112,800 | \$ 488,800 |
| 24345 | NP-86 | NJ-70 | NJ-71 | 400 | Undeveloped | 319 | \$ 1,050 | \$ 335,000 | \$ 100,500 | \$ 435,500 |
| 24100 | NP-87 | NJ-72 | NJ-71 | 300 | Undeveloped | 441 | \$ 830 | \$ 366,000 | \$ 109,800 | \$ 475,800 |
| 24033 | NP-88 | NJ-68 | NJ-72 | 300 | Undeveloped | 313 | \$ 830 | \$ 260,000 | \$ 78,000 | \$ 338,000 |
| 24316 | NP-89 | NJ-73 | NJ-68 | 750 | Undeveloped | 451 | \$ 1,910 | \$ 862,000 | \$ 258,600 | \$ 1,120,600 |
| 28584 | NP-90 | NJ-73 | NJ-74 | 750 | Undeveloped | 227 | \$ 1,910 | \$ 434,000 | \$ 130,200 | \$ 564,200 |
| 28682 | NP-91 | NJ-74 | NJ-23 | 600 | Undeveloped | 346 | \$ 1,550 | \$ 536,000 | \$ 160,800 | \$ 696,800 |
| 24205 | NP-92 | NJ-75 | NJ-74 | 600 | Undeveloped | 368 | \$ 1,550 | \$ 571,000 | \$ 171,300 | \$ 742,300 |
| 28616 | NP-93 | NJ-75 | NJ-76 | 600 | Undeveloped | 216 | \$ 1,550 | \$ 335,000 | \$ 100,500 | \$ 435,500 |
| 24015 | NP-94 | NJ-71 | NJ-77 | 350 | Undeveloped | 404 | \$ 920 | \$ 372,000 | \$ 111,600 | \$ 483,600 |
| 28413 | NP-95 | NJ-77 | NJ-76 | 350 | Undeveloped | 421 | \$ 920 | \$ 387,000 | \$ 116,100 | \$ 503,100 |
| 28399 | NP-96 | NJ-78 | NJ-76 | 600 | Undeveloped | 289 | \$ 1,550 | \$ 448,000 | \$ 134,400 | \$ 582,400 |
| Total Watermains - Phase 2 | | | | | | | | \$ 12,787,000 | \$ 3,836,100 | \$ 16,623,100 |

Total Phase 2 \$ 16,623,100

APPENDIX B - Table B-2
City of Red Deer North of Highway 11A Servicing Study
Option 1 Cost Breakdown

PHASE 3

Watermains - Within City Boundary (Phase 3)

| ID | Label | Start Node | Stop Node | Diameter (mm) | Type | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|-----------------------------------|-------|------------|-----------|---------------|-------------|------------|------------------|---------------------|-----------------------------------|---------------------|
| 24178 | NP-29 | NJ-28 | NJ-21 | 350 | Undeveloped | 391 | \$ 920 | \$ 360,000 | \$ 108,000 | \$ 468,000 |
| 24122 | NP-33 | NJ-31 | NJ-18 | 400 | Undeveloped | 402 | \$ 1,050 | \$ 423,000 | \$ 126,900 | \$ 549,900 |
| 28067 | NP-35 | NJ-33 | NJ-32 | 300 | Undeveloped | 438 | \$ 830 | \$ 364,000 | \$ 109,200 | \$ 473,200 |
| 28065 | NP-36 | NJ-33 | NJ-63 | 350 | Undeveloped | 294 | \$ 920 | \$ 270,000 | \$ 81,000 | \$ 351,000 |
| 24165 | NP-37 | NJ-63 | NJ-19 | 350 | Undeveloped | 390 | \$ 920 | \$ 359,000 | \$ 107,700 | \$ 466,700 |
| Total Watermains - Phase 3 | | | | | | | | \$ 1,776,000 | \$ 532,800 | \$ 2,308,800 |

Total Phase 3 \$ **2,308,800**

PHASE 4

PRV Stations - Within City Boundary (Phase 4)

| Quantity | Unit Cost (\$/each) | Total Cost (includes contingency and engineering (30%)) |
|----------|---------------------|---|
| 1 | \$ 200,000 | \$ 200,000 |

Watermains - Within City Boundary (Phase 4)

| ID | Label | Start Node | Stop Node | Diameter (mm) | Type | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|-----------------------------------|--------|------------|-----------|---------------|-------------|------------|------------------|---------------------|-----------------------------------|---------------------|
| 28610 | NP-124 | PRV-N3 | NJ-78 | 300 | Undeveloped | 91 | \$ 830 | \$ 75,000 | \$ 22,500 | \$ 97,500 |
| 28609 | NP-125 | NJ-99 | PRV-N3 | 300 | Undeveloped | 317 | \$ 830 | \$ 263,000 | \$ 78,900 | \$ 341,900 |
| 28396 | NP-126 | NJ-100 | NJ-99 | 300 | Undeveloped | 397 | \$ 830 | \$ 329,000 | \$ 98,700 | \$ 427,700 |
| 28597 | NP-127 | NJ-101 | NJ-100 | 300 | Undeveloped | 355 | \$ 830 | \$ 295,000 | \$ 88,500 | \$ 383,500 |
| 28596 | NP-128 | NJ-102 | NJ-101 | 300 | Undeveloped | 400 | \$ 830 | \$ 332,000 | \$ 99,600 | \$ 431,600 |
| 28594 | NP-129 | NJ-103 | NJ-102 | 300 | Undeveloped | 592 | \$ 830 | \$ 492,000 | \$ 147,600 | \$ 639,600 |
| 28592 | NP-130 | NJ-104 | NJ-103 | 300 | Undeveloped | 537 | \$ 830 | \$ 446,000 | \$ 133,800 | \$ 579,800 |
| 28590 | NP-131 | NJ-105 | NJ-104 | 300 | Undeveloped | 292 | \$ 830 | \$ 242,000 | \$ 72,600 | \$ 314,600 |
| 28546 | NP-132 | NJ-106 | NJ-105 | 300 | Undeveloped | 608 | \$ 830 | \$ 505,000 | \$ 151,500 | \$ 656,500 |
| 28545 | NP-133 | NJ-107 | NJ-106 | 300 | Undeveloped | 510 | \$ 830 | \$ 423,000 | \$ 126,900 | \$ 549,900 |
| 28673 | NP-134 | NJ-100 | NJ-107 | 300 | Undeveloped | 594 | \$ 830 | \$ 493,000 | \$ 147,900 | \$ 640,900 |
| Total Watermains - Phase 4 | | | | | | | | \$ 3,895,000 | \$ 1,168,500 | \$ 5,063,500 |

Total Phase 4 \$ **5,263,500**

PHASE 5

PRV Stations - Within City Boundary (Phase 5)

| Quantity | Unit Cost (\$/each) | Total Cost (includes contingency and engineering (30%)) |
|----------|---------------------|---|
| 3 | \$ 200,000 | \$ 600,000 |

Watermains - Within City Boundary (Phase 5)

| ID | Label | Start Node | Stop Node | Diameter (mm) | Type | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|-----------------------------------|--------|------------|-----------|---------------|-------------|------------|------------------|---------------------|-----------------------------------|---------------------|
| 28678 | NP-24 | NJ-23 | NJ-24 | 400 | Undeveloped | 382 | \$ 1,050 | \$ 401,000 | \$ 120,300 | \$ 521,300 |
| 24049 | NP-25 | NJ-25 | NJ-24 | 400 | Undeveloped | 395 | \$ 1,050 | \$ 414,000 | \$ 124,200 | \$ 538,200 |
| 24035 | NP-26 | NJ-26 | NJ-25 | 300 | Undeveloped | 400 | \$ 830 | \$ 332,000 | \$ 99,600 | \$ 431,600 |
| 24065 | NP-27 | NJ-27 | NJ-26 | 300 | Undeveloped | 415 | \$ 830 | \$ 344,000 | \$ 103,200 | \$ 447,200 |
| 23970 | NP-28 | NJ-27 | NJ-28 | 350 | Undeveloped | 403 | \$ 920 | \$ 371,000 | \$ 111,300 | \$ 482,300 |
| 24337 | NP-30 | NJ-29 | NJ-27 | 300 | Undeveloped | 411 | \$ 830 | \$ 341,000 | \$ 102,300 | \$ 443,300 |
| 24131 | NP-31 | NJ-30 | NJ-29 | 300 | Undeveloped | 409 | \$ 830 | \$ 340,000 | \$ 102,000 | \$ 442,000 |
| 24112 | NP-32 | NJ-30 | NJ-31 | 400 | Undeveloped | 394 | \$ 1,050 | \$ 414,000 | \$ 124,200 | \$ 538,200 |
| 24271 | NP-34 | NJ-32 | NJ-30 | 300 | Undeveloped | 393 | \$ 830 | \$ 326,000 | \$ 97,800 | \$ 423,800 |
| 28653 | NP-53 | PRV-N5 | NJ-25 | 350 | Undeveloped | 23 | \$ 920 | \$ 21,000 | \$ 6,300 | \$ 27,300 |
| 28652 | NP-54 | NJ-42 | PRV-N5 | 350 | Undeveloped | 17 | \$ 920 | \$ 16,000 | \$ 4,800 | \$ 20,800 |
| 28650 | NP-55 | NJ-42 | NJ-43 | 300 | Undeveloped | 377 | \$ 830 | \$ 313,000 | \$ 93,900 | \$ 406,900 |
| 28655 | NP-56 | NJ-43 | NJ-44 | 300 | Undeveloped | 318 | \$ 830 | \$ 264,000 | \$ 79,200 | \$ 343,200 |
| 28547 | NP-97 | NJ-79 | NJ-78 | 500 | Undeveloped | 440 | \$ 1,310 | \$ 577,000 | \$ 173,100 | \$ 750,100 |
| 28659 | NP-98 | PRV-N6 | NJ-79 | 500 | Undeveloped | 79 | \$ 1,310 | \$ 104,000 | \$ 31,200 | \$ 135,200 |
| 28658 | NP-99 | NJ-80 | PRV-N6 | 500 | Undeveloped | 563 | \$ 1,310 | \$ 738,000 | \$ 221,400 | \$ 959,400 |
| 28666 | NP-100 | NJ-81 | NJ-80 | 400 | Developed | 468 | \$ 1,610 | \$ 754,000 | \$ 226,200 | \$ 980,200 |
| 28631 | NP-101 | NJ-44 | NJ-81 | 400 | Undeveloped | 105 | \$ 1,050 | \$ 110,000 | \$ 33,000 | \$ 143,000 |
| 24170 | NP-102 | NJ-80 | NJ-82 | 400 | Developed | 330 | \$ 1,610 | \$ 531,000 | \$ 159,300 | \$ 690,300 |
| 24340 | NP-121 | NJ-98 | NJ-82 | 350 | Undeveloped | 370 | \$ 920 | \$ 341,000 | \$ 102,300 | \$ 443,300 |
| 28612 | NP-122 | NJ-98 | PRV-N4 | 350 | Undeveloped | 169 | \$ 920 | \$ 155,000 | \$ 46,500 | \$ 201,500 |
| 28613 | NP-123 | PRV-N4 | NJ-100 | 350 | Undeveloped | 303 | \$ 920 | \$ 279,000 | \$ 83,700 | \$ 362,700 |
| Total Watermains - Phase 5 | | | | | | | | \$ 7,486,000 | \$ 2,245,800 | \$ 9,731,800 |

Total Phase 5 \$ **10,331,800**

APPENDIX B - Table B-2
City of Red Deer North of Highway 11A Servicing Study
Option 1 Cost Breakdown

PHASE 6

PRV Stations - North of City Boundary (Phase 6)

| Quantity | Unit Cost (\$/each) | Total Cost (includes contingency and engineering (30%)) |
|----------|---------------------|---|
| 2 | \$ 200,000 | \$ 400,000 |

Watermains - North of City Boundary (Phase 6)

| ID | Label | Start Node | Stop Node | Diameter (mm) | Type | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|-----------------------------------|--------|------------|-----------|---------------|-------------|------------|------------------|----------------------|-----------------------------------|----------------------|
| 26750 | NP-38 | NJ-34 | NJ-33 | 300 | Undeveloped | 492 | \$ 830 | \$ 408,000 | \$ 122,400 | \$ 530,400 |
| 28555 | NP-39 | NJ-35 | NJ-34 | 300 | Undeveloped | 380 | \$ 830 | \$ 316,000 | \$ 94,800 | \$ 410,800 |
| 28557 | NP-40 | NJ-36 | NJ-35 | 300 | Undeveloped | 438 | \$ 830 | \$ 364,000 | \$ 109,200 | \$ 473,200 |
| 27195 | NP-41 | NJ-36 | NJ-37 | 300 | Undeveloped | 399 | \$ 830 | \$ 331,000 | \$ 99,300 | \$ 430,300 |
| 27908 | NP-42 | NJ-37 | NJ-38 | 350 | Undeveloped | 422 | \$ 920 | \$ 388,000 | \$ 116,400 | \$ 504,400 |
| 28068 | NP-43 | NJ-38 | NJ-30 | 350 | Undeveloped | 401 | \$ 920 | \$ 369,000 | \$ 110,700 | \$ 479,700 |
| 25848 | NP-44 | NJ-37 | NJ-39 | 300 | Undeveloped | 627 | \$ 830 | \$ 521,000 | \$ 156,300 | \$ 677,300 |
| 27858 | NP-45 | NJ-51 | NJ-39 | 250 | Undeveloped | 243 | \$ 750 | \$ 182,000 | \$ 54,600 | \$ 236,600 |
| 26021 | NP-46 | NJ-52 | NJ-51 | 250 | Undeveloped | 651 | \$ 750 | \$ 488,000 | \$ 146,400 | \$ 634,400 |
| 26076 | NP-47 | NJ-52 | NJ-37 | 300 | Undeveloped | 398 | \$ 830 | \$ 330,000 | \$ 99,000 | \$ 429,000 |
| 27805 | NP-48 | NJ-53 | NJ-52 | 300 | Undeveloped | 543 | \$ 830 | \$ 451,000 | \$ 135,300 | \$ 586,300 |
| 28661 | NP-49 | NJ-53 | NJ-35 | 300 | Undeveloped | 472 | \$ 830 | \$ 392,000 | \$ 117,600 | \$ 509,600 |
| 27106 | NP-50 | NJ-39 | NJ-40 | 300 | Undeveloped | 257 | \$ 830 | \$ 214,000 | \$ 64,200 | \$ 278,200 |
| 27115 | NP-51 | NJ-40 | NJ-41 | 300 | Undeveloped | 432 | \$ 830 | \$ 358,000 | \$ 107,400 | \$ 465,400 |
| 28070 | NP-52 | NJ-41 | NJ-27 | 300 | Undeveloped | 403 | \$ 830 | \$ 335,000 | \$ 100,500 | \$ 435,500 |
| 28235 | NP-57 | NJ-44 | NJ-45 | 300 | Undeveloped | 113 | \$ 830 | \$ 93,000 | \$ 27,900 | \$ 120,900 |
| 27334 | NP-58 | NJ-46 | NJ-45 | 300 | Undeveloped | 304 | \$ 830 | \$ 252,000 | \$ 75,600 | \$ 327,600 |
| 27895 | NP-59 | NJ-47 | NJ-46 | 300 | Undeveloped | 420 | \$ 830 | \$ 348,000 | \$ 104,400 | \$ 452,400 |
| 27036 | NP-60 | NJ-48 | NJ-47 | 250 | Undeveloped | 455 | \$ 750 | \$ 341,000 | \$ 102,300 | \$ 443,300 |
| 28654 | NP-61 | NJ-49 | NJ-48 | 250 | Undeveloped | 372 | \$ 750 | \$ 279,000 | \$ 83,700 | \$ 362,700 |
| 28670 | NP-62 | NJ-49 | PRV-N2 | 250 | Undeveloped | 452 | \$ 750 | \$ 339,000 | \$ 101,700 | \$ 440,700 |
| 28671 | NP-63 | PRV-N2 | NJ-54 | 250 | Undeveloped | 389 | \$ 750 | \$ 292,000 | \$ 87,600 | \$ 379,600 |
| 28576 | NP-64 | NJ-54 | NJ-55 | 250 | Undeveloped | 464 | \$ 750 | \$ 348,000 | \$ 104,400 | \$ 452,400 |
| 28472 | NP-65 | NJ-55 | NJ-56 | 250 | Undeveloped | 318 | \$ 750 | \$ 238,000 | \$ 71,400 | \$ 309,400 |
| 28681 | NP-66 | PRV-N1 | NJ-56 | 250 | Undeveloped | 445 | \$ 750 | \$ 334,000 | \$ 100,200 | \$ 434,200 |
| 28603 | NP-67 | NJ-40 | PRV-N1 | 250 | Undeveloped | 272 | \$ 750 | \$ 204,000 | \$ 61,200 | \$ 265,200 |
| 28478 | NP-68 | NJ-56 | NJ-57 | 250 | Undeveloped | 213 | \$ 750 | \$ 159,000 | \$ 47,700 | \$ 206,700 |
| 28558 | NP-69 | NJ-57 | NJ-58 | 250 | Undeveloped | 384 | \$ 750 | \$ 288,000 | \$ 86,400 | \$ 374,400 |
| 28468 | NP-70 | NJ-58 | NJ-59 | 250 | Undeveloped | 244 | \$ 750 | \$ 183,000 | \$ 54,900 | \$ 237,900 |
| 28572 | NP-71 | NJ-57 | NJ-60 | 200 | Undeveloped | 261 | \$ 690 | \$ 180,000 | \$ 54,000 | \$ 234,000 |
| 28573 | NP-72 | NJ-60 | NJ-61 | 200 | Undeveloped | 549 | \$ 690 | \$ 379,000 | \$ 113,700 | \$ 492,700 |
| 28529 | NP-73 | NJ-61 | NJ-62 | 200 | Undeveloped | 221 | \$ 690 | \$ 153,000 | \$ 45,900 | \$ 198,900 |
| 28461 | NP-74 | NJ-55 | NJ-61 | 200 | Undeveloped | 269 | \$ 690 | \$ 185,000 | \$ 55,500 | \$ 240,500 |
| 28518 | NP-78 | NJ-49 | NJ-50 | 300 | Undeveloped | 267 | \$ 830 | \$ 222,000 | \$ 66,600 | \$ 288,600 |
| 28648 | NP-79 | NJ-50 | NJ-42 | 300 | Undeveloped | 400 | \$ 830 | \$ 332,000 | \$ 99,600 | \$ 431,600 |
| 28522 | NP-103 | NJ-83 | NJ-82 | 400 | Developed | 189 | \$ 1,610 | \$ 305,000 | \$ 91,500 | \$ 396,500 |
| 28677 | NP-104 | NJ-83 | NJ-94 | 300 | Developed | 468 | \$ 1,470 | \$ 689,000 | \$ 206,700 | \$ 895,700 |
| 28601 | NP-105 | NJ-80 | NJ-94 | 400 | Developed | 870 | \$ 1,610 | \$ 1,400,000 | \$ 420,000 | \$ 1,820,000 |
| 25985 | NP-106 | NJ-92 | NJ-93 | 300 | Developed | 405 | \$ 1,470 | \$ 596,000 | \$ 178,800 | \$ 774,800 |
| 27021 | NP-107 | NJ-91 | NJ-92 | 300 | Developed | 411 | \$ 1,470 | \$ 603,000 | \$ 180,900 | \$ 783,900 |
| 28429 | NP-108 | NJ-86 | NJ-91 | 300 | Developed | 234 | \$ 1,470 | \$ 343,000 | \$ 102,900 | \$ 445,900 |
| 28430 | NP-109 | NJ-85 | NJ-86 | 350 | Developed | 248 | \$ 1,560 | \$ 387,000 | \$ 116,100 | \$ 503,100 |
| 28426 | NP-110 | NJ-84 | NJ-85 | 350 | Developed | 289 | \$ 1,560 | \$ 450,000 | \$ 135,000 | \$ 585,000 |
| 28523 | NP-111 | NJ-83 | NJ-84 | 350 | Developed | 419 | \$ 1,560 | \$ 654,000 | \$ 196,200 | \$ 850,200 |
| 28453 | NP-112 | NJ-87 | NJ-86 | 350 | Undeveloped | 306 | \$ 920 | \$ 282,000 | \$ 84,600 | \$ 366,600 |
| 28452 | NP-113 | NJ-88 | NJ-87 | 350 | Undeveloped | 508 | \$ 920 | \$ 467,000 | \$ 140,100 | \$ 607,100 |
| 28675 | NP-114 | NJ-89 | NJ-88 | 350 | Undeveloped | 424 | \$ 920 | \$ 390,000 | \$ 117,000 | \$ 507,000 |
| 28527 | NP-115 | NJ-90 | NJ-89 | 300 | Developed | 835 | \$ 1,470 | \$ 1,228,000 | \$ 368,400 | \$ 1,596,400 |
| 28443 | NP-116 | NJ-91 | NJ-90 | 300 | Developed | 128 | \$ 1,470 | \$ 188,000 | \$ 56,400 | \$ 244,400 |
| 28548 | NP-117 | NJ-96 | NJ-90 | 300 | Developed | 343 | \$ 1,470 | \$ 504,000 | \$ 151,200 | \$ 655,200 |
| 28674 | NP-118 | NJ-96 | NJ-95 | 350 | Undeveloped | 855 | \$ 920 | \$ 786,000 | \$ 235,800 | \$ 1,021,800 |
| 28439 | NP-119 | NJ-95 | NJ-93 | 350 | Undeveloped | 280 | \$ 920 | \$ 258,000 | \$ 77,400 | \$ 335,400 |
| 28676 | NP-120 | NJ-96 | NJ-97 | 250 | Undeveloped | 826 | \$ 750 | \$ 620,000 | \$ 186,000 | \$ 806,000 |
| 28600 | NP-135 | NJ-94 | NJ-93 | 400 | Developed | 143 | \$ 1,610 | \$ 229,000 | \$ 68,700 | \$ 297,700 |
| Total Watermains - Phase 6 | | | | | | | | \$ 20,975,000 | \$ 6,292,500 | \$ 27,267,500 |

Total Phase 6 \$ 27,667,500

Total Water Cost \$ 92,619,400

APPENDIX B - Table B-3
City of Red Deer North of Highway 11A Servicing Study
Option 2 Cost Breakdown

PHASE 1

North Reservoir and Pumphouse (Phase 2)

| Volume (m ³) | Unit Cost (\$/m) | Total Cost (includes contingency and engineering (30%)) |
|--------------------------|------------------|--|
| 18,738 | \$ 1,220 | \$ 22,860,000 |

Watermains - Within City Boundary (Phase 1)

| ID | Label | Start Node | Stop Node | Diameter (mm) | Type | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|----------------------------|-------|------------|-----------|---------------|-------------|------------|------------------|---------------------|-----------------------------------|---------------------|
| 28539 | NP-5 | NJ-4 | NJ-5 | 600 | Undeveloped | 301 | \$ 1,550 | \$ 466,000 | \$ 139,800 | \$ 605,800 |
| 28502 | NP-6 | NJ-7 | NJ-5 | 600 | Undeveloped | 406 | \$ 1,550 | \$ 629,000 | \$ 188,700 | \$ 817,700 |
| 28489 | NP-7 | NJ-8 | NJ-7 | 600 | Undeveloped | 435 | \$ 1,550 | \$ 674,000 | \$ 202,200 | \$ 876,200 |
| 28487 | NP-8 | NJ-9 | NJ-8 | 600 | Undeveloped | 134 | \$ 1,550 | \$ 208,000 | \$ 62,400 | \$ 270,400 |
| 28494 | NP-9 | NJ-9 | NJ-10 | 500 | Undeveloped | 196 | \$ 1,310 | \$ 257,000 | \$ 77,100 | \$ 334,100 |
| 28495 | NP-10 | NJ-10 | NJ-11 | 500 | Undeveloped | 301 | \$ 1,310 | \$ 395,000 | \$ 118,500 | \$ 513,500 |
| 28515 | NP-11 | NJ-11 | NJ-12 | 500 | Undeveloped | 403 | \$ 1,310 | \$ 528,000 | \$ 158,400 | \$ 686,400 |
| 28540 | NP-13 | NJ-9 | NJ-13 | 300 | Undeveloped | 499 | \$ 830 | \$ 414,000 | \$ 124,200 | \$ 538,200 |
| 28531 | NP-14 | NJ-13 | NJ-14 | 300 | Undeveloped | 503 | \$ 830 | \$ 418,000 | \$ 125,400 | \$ 543,400 |
| 28534 | NP-15 | NJ-14 | NJ-15 | 300 | Undeveloped | 713 | \$ 830 | \$ 592,000 | \$ 177,600 | \$ 769,600 |
| 28537 | NP-16 | NJ-15 | NJ-16 | 300 | Undeveloped | 607 | \$ 830 | \$ 504,000 | \$ 151,200 | \$ 655,200 |
| 28680 | NP-75 | NJ-5 | NJ-64 | 400 | Undeveloped | 595 | \$ 1,050 | \$ 625,000 | \$ 187,500 | \$ 812,500 |
| 24012 | NP-76 | NJ-12 | NJ-64 | 300 | Undeveloped | 406 | \$ 830 | \$ 337,000 | \$ 101,100 | \$ 438,100 |
| 28484 | NP-77 | NJ-11 | NJ-12 | 300 | Undeveloped | 216 | \$ 830 | \$ 179,000 | \$ 53,700 | \$ 232,700 |
| Total Watermains - Phase 1 | | | | | | | | \$ 6,226,000 | \$ 1,867,800 | \$ 8,093,800 |

Total Phase 1 \$ **30,953,800**

PHASE 2

Watermains - Within City Boundary (Phase 2)

| ID | Label | Start Node | Stop Node | Diameter (mm) | Type | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|----------------------------|--------|------------|-----------|---------------|-------------|------------|------------------|----------------------|-----------------------------------|----------------------|
| 28697 | NP-2 | NJ-1 | NJ-2 | 750 | Undeveloped | 30 | \$ 1,910 | \$ 57,000 | \$ 17,100 | \$ 74,100 |
| 24228 | NP-3 | NJ-3 | NJ-2 | 750 | Undeveloped | 248 | \$ 1,910 | \$ 473,000 | \$ 141,900 | \$ 614,900 |
| 24195 | NP-4 | NJ-4 | NJ-3 | 600 | Undeveloped | 374 | \$ 1,550 | \$ 579,000 | \$ 173,700 | \$ 752,700 |
| 23984 | NP-12 | NJ-18 | NJ-12 | 500 | Undeveloped | 484 | \$ 1,310 | \$ 634,000 | \$ 190,200 | \$ 824,200 |
| 28538 | NP-17 | NJ-16 | NJ-19 | 300 | Undeveloped | 728 | \$ 830 | \$ 604,000 | \$ 181,200 | \$ 785,200 |
| 23956 | NP-18 | NJ-19 | NJ-65 | 500 | Undeveloped | 415 | \$ 1,310 | \$ 544,000 | \$ 163,200 | \$ 707,200 |
| 24270 | NP-19 | NJ-65 | NJ-18 | 500 | Undeveloped | 407 | \$ 1,310 | \$ 533,000 | \$ 159,900 | \$ 692,900 |
| 24038 | NP-20 | NJ-18 | NJ-20 | 300 | Undeveloped | 403 | \$ 830 | \$ 335,000 | \$ 100,500 | \$ 435,500 |
| 24342 | NP-21 | NJ-20 | NJ-21 | 400 | Undeveloped | 425 | \$ 1,050 | \$ 446,000 | \$ 133,800 | \$ 579,800 |
| 28679 | NP-22 | NJ-21 | NJ-22 | 400 | Undeveloped | 410 | \$ 1,050 | \$ 430,000 | \$ 129,000 | \$ 559,000 |
| 28513 | NP-23 | NJ-22 | NJ-23 | 400 | Undeveloped | 380 | \$ 1,050 | \$ 399,000 | \$ 119,700 | \$ 518,700 |
| 28636 | NP-81 | NJ-65 | NJ-66 | 600 | Developed | 173 | \$ 2,110 | \$ 366,000 | \$ 109,800 | \$ 475,800 |
| 28402 | NP-82 | NJ-66 | NJ-67 | 450 | Developed | 117 | \$ 1,730 | \$ 203,000 | \$ 60,900 | \$ 263,900 |
| 24085 | NP-83 | NJ-67 | NJ-68 | 450 | Developed | 382 | \$ 1,730 | \$ 660,000 | \$ 198,000 | \$ 858,000 |
| 28564 | NP-84 | NJ-69 | NJ-66 | 450 | Developed | 387 | \$ 1,730 | \$ 670,000 | \$ 201,000 | \$ 871,000 |
| 28563 | NP-85 | NJ-70 | NJ-69 | 450 | Undeveloped | 358 | \$ 1,170 | \$ 419,000 | \$ 125,700 | \$ 544,700 |
| 24345 | NP-86 | NJ-70 | NJ-71 | 450 | Undeveloped | 319 | \$ 1,170 | \$ 373,000 | \$ 111,900 | \$ 484,900 |
| 24100 | NP-87 | NJ-72 | NJ-71 | 300 | Undeveloped | 441 | \$ 830 | \$ 366,000 | \$ 109,800 | \$ 475,800 |
| 24033 | NP-88 | NJ-68 | NJ-72 | 300 | Undeveloped | 313 | \$ 830 | \$ 260,000 | \$ 78,000 | \$ 338,000 |
| 24316 | NP-89 | NJ-73 | NJ-68 | 450 | Undeveloped | 451 | \$ 1,170 | \$ 528,000 | \$ 158,400 | \$ 686,400 |
| 28584 | NP-90 | NJ-73 | NJ-74 | 450 | Undeveloped | 227 | \$ 1,170 | \$ 266,000 | \$ 79,800 | \$ 345,800 |
| 24205 | NP-92 | NJ-75 | NJ-74 | 450 | Undeveloped | 368 | \$ 1,170 | \$ 431,000 | \$ 129,300 | \$ 560,300 |
| 28616 | NP-93 | NJ-75 | NJ-76 | 400 | Undeveloped | 216 | \$ 1,050 | \$ 227,000 | \$ 68,100 | \$ 295,100 |
| 24015 | NP-94 | NJ-71 | NJ-77 | 500 | Undeveloped | 404 | \$ 1,310 | \$ 529,000 | \$ 158,700 | \$ 687,700 |
| 28413 | NP-95 | NJ-77 | NJ-76 | 500 | Undeveloped | 421 | \$ 1,310 | \$ 551,000 | \$ 165,300 | \$ 716,300 |
| 28399 | NP-96 | NJ-78 | NJ-76 | 500 | Undeveloped | 289 | \$ 1,310 | \$ 379,000 | \$ 113,700 | \$ 492,700 |
| 28689 | NP-141 | NJ-3 | NJ-23 | 500 | Undeveloped | 1627 | \$ 1,310 | \$ 2,131,000 | \$ 639,300 | \$ 2,770,300 |
| 28727 | NP-147 | NJ-2 | PRV-N5 | 600 | Undeveloped | 10 | \$ 1,550 | \$ 16,000 | \$ 4,800 | \$ 20,800 |
| 28728 | Np-148 | PRV-N5 | NJ-65 | 600 | Undeveloped | 45 | \$ 1,550 | \$ 70,000 | \$ 21,000 | \$ 91,000 |
| Total Watermains - Phase 2 | | | | | | | | \$ 13,479,000 | \$ 4,043,700 | \$ 17,522,700 |

Total Phase 2 \$ **17,522,700**

APPENDIX B - Table B-3
City of Red Deer North of Highway 11A Servicing Study
Option 2 Cost Breakdown

PHASE 3

Watermains - Within City Boundary (Phase 3)

| ID | Label | Start Node | Stop Node | Diameter (mm) | Type | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|----------------------------|-------|------------|-----------|---------------|-------------|------------|------------------|----------------|-----------------------------------|--------------|
| 24178 | NP-29 | NJ-28 | NJ-21 | 300 | Undeveloped | 391 | \$ 830 | \$ 325,000 | \$ 97,500 | \$ 422,500 |
| 24122 | NP-33 | NJ-31 | NJ-18 | 300 | Undeveloped | 402 | \$ 830 | \$ 334,000 | \$ 100,200 | \$ 434,200 |
| 28067 | NP-35 | NJ-33 | NJ-32 | 300 | Undeveloped | 438 | \$ 830 | \$ 364,000 | \$ 109,200 | \$ 473,200 |
| 28065 | NP-36 | NJ-33 | NJ-63 | 500 | Undeveloped | 294 | \$ 1,310 | \$ 385,000 | \$ 115,500 | \$ 500,500 |
| 24165 | NP-37 | NJ-63 | NJ-19 | 500 | Undeveloped | 390 | \$ 1,310 | \$ 511,000 | \$ 153,300 | \$ 664,300 |
| Total Watermains - Phase 3 | | | | | | | | \$ 1,919,000 | \$ 575,700 | \$ 2,494,700 |

Total Phase 3 \$2,494,700

PHASE 4

PRV Stations - Within City Boundary (Phase 4)

| Quantity | Unit Cost (\$/each) | Total Cost (includes contingency and engineering (30%)) |
|----------|---------------------|---|
| 1 | \$ 200,000 | \$ 200,000 |

Watermains - Within City Boundary (Phase 4)

| ID | Label | Start Node | Stop Node | Diameter (mm) | Type | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|----------------------------|--------|------------|-----------|---------------|-------------|------------|------------------|----------------|-----------------------------------|--------------|
| 28610 | NP-124 | PRV-N3 | NJ-78 | 300 | Undeveloped | 91 | \$ 830 | \$ 75,000 | \$ 22,500 | \$ 97,500 |
| 28609 | NP-125 | NJ-99 | PRV-N3 | 300 | Undeveloped | 317 | \$ 830 | \$ 263,000 | \$ 78,900 | \$ 341,900 |
| 28396 | NP-126 | NJ-100 | NJ-99 | 300 | Undeveloped | 397 | \$ 830 | \$ 329,000 | \$ 98,700 | \$ 427,700 |
| 28597 | NP-127 | NJ-101 | NJ-100 | 300 | Undeveloped | 355 | \$ 830 | \$ 295,000 | \$ 88,500 | \$ 383,500 |
| 28596 | NP-128 | NJ-102 | NJ-101 | 300 | Undeveloped | 400 | \$ 830 | \$ 332,000 | \$ 99,600 | \$ 431,600 |
| 28594 | NP-129 | NJ-103 | NJ-102 | 300 | Undeveloped | 592 | \$ 830 | \$ 492,000 | \$ 147,600 | \$ 639,600 |
| 28592 | NP-130 | NJ-104 | NJ-103 | 300 | Undeveloped | 537 | \$ 830 | \$ 446,000 | \$ 133,800 | \$ 579,800 |
| 28590 | NP-131 | NJ-105 | NJ-104 | 300 | Undeveloped | 292 | \$ 830 | \$ 242,000 | \$ 72,600 | \$ 314,600 |
| 28546 | NP-132 | NJ-106 | NJ-105 | 300 | Undeveloped | 608 | \$ 830 | \$ 505,000 | \$ 151,500 | \$ 656,500 |
| 28545 | NP-133 | NJ-107 | NJ-106 | 300 | Undeveloped | 510 | \$ 830 | \$ 423,000 | \$ 126,900 | \$ 549,900 |
| 28673 | NP-134 | NJ-100 | NJ-107 | 300 | Undeveloped | 594 | \$ 830 | \$ 493,000 | \$ 147,900 | \$ 640,900 |
| Total Watermains - Phase 4 | | | | | | | | \$ 3,895,000 | \$ 1,168,500 | \$ 5,063,500 |

Total Phase 4 \$ 5,263,500

PHASE 5

PRV Stations - Within City Boundary (Phase 5)

| Quantity | Unit Cost (\$/each) | Total Cost (includes contingency and engineering (30%)) |
|----------|---------------------|---|
| 1 | \$ 200,000 | \$ 200,000 |

Watermains - Within City Boundary (Phase 5)

| ID | Label | Start Node | Stop Node | Diameter (mm) | Type | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|----------------------------|--------|------------|-----------|---------------|-------------|------------|------------------|----------------|-----------------------------------|---------------|
| 28678 | NP-24 | NJ-23 | NJ-24 | 400 | Undeveloped | 382 | \$ 1,050 | \$ 401,000 | \$ 120,300 | \$ 521,300 |
| 24049 | NP-25 | NJ-25 | NJ-24 | 400 | Undeveloped | 395 | \$ 1,050 | \$ 414,000 | \$ 124,200 | \$ 538,200 |
| 24035 | NP-26 | NJ-26 | NJ-25 | 300 | Undeveloped | 400 | \$ 830 | \$ 332,000 | \$ 99,600 | \$ 431,600 |
| 24065 | NP-27 | NJ-27 | NJ-26 | 300 | Undeveloped | 415 | \$ 830 | \$ 344,000 | \$ 103,200 | \$ 447,200 |
| 23970 | NP-28 | NJ-27 | NJ-28 | 300 | Undeveloped | 403 | \$ 830 | \$ 335,000 | \$ 100,500 | \$ 435,500 |
| 24337 | NP-30 | NJ-29 | NJ-27 | 300 | Undeveloped | 411 | \$ 830 | \$ 341,000 | \$ 102,300 | \$ 443,300 |
| 24131 | NP-31 | NJ-30 | NJ-29 | 300 | Undeveloped | 409 | \$ 830 | \$ 340,000 | \$ 102,000 | \$ 442,000 |
| 24112 | NP-32 | NJ-30 | NJ-31 | 300 | Undeveloped | 394 | \$ 830 | \$ 327,000 | \$ 98,100 | \$ 425,100 |
| 24271 | NP-34 | NJ-32 | NJ-30 | 300 | Undeveloped | 393 | \$ 830 | \$ 326,000 | \$ 97,800 | \$ 423,800 |
| 24092 | NP-55 | NJ-25 | NJ-43 | 300 | Undeveloped | 414 | \$ 830 | \$ 343,000 | \$ 102,900 | \$ 445,900 |
| 28655 | NP-56 | NJ-43 | NJ-44 | 300 | Undeveloped | 318 | \$ 830 | \$ 264,000 | \$ 79,200 | \$ 343,200 |
| 28547 | NP-97 | NJ-79 | NJ-78 | 500 | Undeveloped | 440 | \$ 1,310 | \$ 577,000 | \$ 173,100 | \$ 750,100 |
| 28666 | NP-100 | NJ-81 | NJ-80 | 450 | Developed | 468 | \$ 1,730 | \$ 810,000 | \$ 243,000 | \$ 1,053,000 |
| 24170 | NP-102 | NJ-80 | NJ-82 | 500 | Developed | 330 | \$ 1,860 | \$ 614,000 | \$ 184,200 | \$ 798,200 |
| 24340 | NP-121 | NJ-98 | NJ-82 | 350 | Undeveloped | 370 | \$ 920 | \$ 341,000 | \$ 102,300 | \$ 443,300 |
| 28612 | NP-122 | NJ-98 | PRV-N4 | 350 | Undeveloped | 169 | \$ 920 | \$ 155,000 | \$ 46,500 | \$ 201,500 |
| 28613 | NP-123 | PRV-N4 | NJ-100 | 350 | Undeveloped | 303 | \$ 920 | \$ 279,000 | \$ 83,700 | \$ 362,700 |
| 28698 | NP-143 | NJ-79 | NJ-80 | 500 | Undeveloped | 644 | \$ 1,306 | \$ 841,000 | \$ 252,300 | \$ 1,093,300 |
| 28691 | NP-144 | NJ-93 | NJ-100 | 450 | Undeveloped | 962 | \$ 1,170 | \$ 1,126,000 | \$ 337,800 | \$ 1,463,800 |
| Total Watermains - Phase 5 | | | | | | | | \$ 8,510,000 | \$ 2,553,000 | \$ 11,063,000 |

Total Phase 5 \$ 11,263,000

APPENDIX B - Table B-3
City of Red Deer North of Highway 11A Servicing Study
Option 2 Cost Breakdown

PHASE 6

PRV Stations - North of City Boundary (Phase 6)

| Quantity | Unit Cost (\$/each) | Total Cost (includes contingency and engineering (30%)) |
|----------|---------------------|---|
| 2 | \$ 200,000 | \$ 400,000 |

Watermains - North of City Boundary (Phase 6)

| ID | Label | Start Node | Stop Node | Diameter (mm) | Type | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|--|--------|-------------|-----------|---------------|-------------|------------|------------------|----------------------|-----------------------------------|----------------------|
| 26750 | NP-38 | NJ-34 | NJ-33 | 450 | Undeveloped | 492 | \$ 1,170 | \$ 576,000 | \$ 172,800 | \$ 748,800 |
| 28555 | NP-39 | NJ-35 | NJ-34 | 400 | Undeveloped | 370 | \$ 1,050 | \$ 388,000 | \$ 116,400 | \$ 504,400 |
| 28557 | NP-40 | NJ-36 | NJ-35 | 300 | Undeveloped | 444 | \$ 830 | \$ 368,000 | \$ 110,400 | \$ 478,400 |
| 27195 | NP-41 | NJ-36 | NJ-37 | 300 | Undeveloped | 399 | \$ 830 | \$ 331,000 | \$ 99,300 | \$ 430,300 |
| 27908 | NP-42 | NJ-37 | NJ-38 | 300 | Undeveloped | 422 | \$ 830 | \$ 350,000 | \$ 105,000 | \$ 455,000 |
| 28068 | NP-43 | NJ-38 | NJ-30 | 300 | Undeveloped | 401 | \$ 830 | \$ 333,000 | \$ 99,900 | \$ 432,900 |
| 25848 | NP-44 | NJ-37 | NJ-39 | 300 | Undeveloped | 627 | \$ 830 | \$ 521,000 | \$ 156,300 | \$ 677,300 |
| 27858 | NP-45 | NJ-51 | NJ-39 | 250 | Undeveloped | 243 | \$ 750 | \$ 182,000 | \$ 54,600 | \$ 236,600 |
| 26021 | NP-46 | NJ-52 | NJ-51 | 250 | Undeveloped | 651 | \$ 750 | \$ 488,000 | \$ 146,400 | \$ 634,400 |
| 26076 | NP-47 | NJ-52 | NJ-37 | 300 | Undeveloped | 398 | \$ 830 | \$ 330,000 | \$ 99,000 | \$ 429,000 |
| 27805 | NP-48 | NJ-53 | NJ-52 | 300 | Undeveloped | 543 | \$ 830 | \$ 451,000 | \$ 135,300 | \$ 586,300 |
| 28661 | NP-49 | NJ-53 | NJ-35 | 300 | Undeveloped | 479 | \$ 830 | \$ 397,000 | \$ 119,100 | \$ 516,100 |
| 27106 | NP-50 | NJ-39 | NJ-40 | 300 | Undeveloped | 257 | \$ 830 | \$ 214,000 | \$ 64,200 | \$ 278,200 |
| 27115 | NP-51 | NJ-40 | NJ-41 | 300 | Undeveloped | 432 | \$ 830 | \$ 358,000 | \$ 107,400 | \$ 465,400 |
| 28070 | NP-52 | NJ-41 | NJ-27 | 300 | Undeveloped | 403 | \$ 830 | \$ 335,000 | \$ 100,500 | \$ 435,500 |
| 28235 | NP-57 | NJ-44 | NJ-45 | 300 | Undeveloped | 113 | \$ 830 | \$ 93,000 | \$ 27,900 | \$ 120,900 |
| 27334 | NP-58 | NJ-46 | NJ-45 | 300 | Undeveloped | 304 | \$ 830 | \$ 252,000 | \$ 75,600 | \$ 327,600 |
| 27895 | NP-59 | NJ-47 | NJ-46 | 300 | Undeveloped | 420 | \$ 830 | \$ 348,000 | \$ 104,400 | \$ 452,400 |
| 27036 | NP-60 | NJ-48 | NJ-47 | 300 | Undeveloped | 455 | \$ 830 | \$ 378,000 | \$ 113,400 | \$ 491,400 |
| 28654 | NP-61 | NJ-49 | NJ-48 | 300 | Undeveloped | 372 | \$ 830 | \$ 309,000 | \$ 92,700 | \$ 401,700 |
| 28670 | NP-62 | NJ-49 | PRV-N2 | 250 | Undeveloped | 452 | \$ 750 | \$ 339,000 | \$ 101,700 | \$ 440,700 |
| 28671 | NP-63 | PRV-N2 | NJ-54 | 250 | Undeveloped | 389 | \$ 750 | \$ 292,000 | \$ 87,600 | \$ 379,600 |
| 28576 | NP-64 | NJ-54 | NJ-55 | 250 | Undeveloped | 464 | \$ 750 | \$ 348,000 | \$ 104,400 | \$ 452,400 |
| 28472 | NP-65 | NJ-55 | NJ-56 | 250 | Undeveloped | 318 | \$ 750 | \$ 238,000 | \$ 71,400 | \$ 309,400 |
| 28681 | NP-66 | PRV-N1 | NJ-56 | 250 | Undeveloped | 445 | \$ 750 | \$ 334,000 | \$ 100,200 | \$ 434,200 |
| 28603 | NP-67 | NJ-40 | PRV-N1 | 250 | Undeveloped | 272 | \$ 750 | \$ 204,000 | \$ 61,200 | \$ 265,200 |
| 28478 | NP-68 | NJ-56 | NJ-57 | 250 | Undeveloped | 213 | \$ 750 | \$ 159,000 | \$ 47,700 | \$ 206,700 |
| 28558 | NP-69 | NJ-57 | NJ-58 | 250 | Undeveloped | 384 | \$ 750 | \$ 288,000 | \$ 86,400 | \$ 374,400 |
| 28468 | NP-70 | NJ-58 | NJ-59 | 250 | Undeveloped | 244 | \$ 750 | \$ 183,000 | \$ 54,900 | \$ 237,900 |
| 28572 | NP-71 | NJ-57 | NJ-60 | 200 | Undeveloped | 261 | \$ 690 | \$ 180,000 | \$ 54,000 | \$ 234,000 |
| 28573 | NP-72 | NJ-60 | NJ-61 | 200 | Undeveloped | 549 | \$ 690 | \$ 379,000 | \$ 113,700 | \$ 492,700 |
| 28529 | NP-73 | NJ-61 | NJ-62 | 200 | Undeveloped | 221 | \$ 690 | \$ 153,000 | \$ 45,900 | \$ 198,900 |
| 28461 | NP-74 | NJ-55 | NJ-61 | 200 | Undeveloped | 269 | \$ 690 | \$ 185,000 | \$ 55,500 | \$ 240,500 |
| 28518 | NP-78 | NJ-49 | NJ-50 | 300 | Undeveloped | 267 | \$ 830 | \$ 222,000 | \$ 66,600 | \$ 288,600 |
| 28662 | NP-79 | NJ-25 | NJ-50 | 300 | Undeveloped | 401 | \$ 830 | \$ 333,000 | \$ 99,900 | \$ 432,900 |
| 28728 | NP-80 | NJ-2 | NJ-65 | 600 | Undeveloped | 55 | \$ 1,550 | \$ 85,000 | \$ 25,500 | \$ 110,500 |
| 28522 | NP-103 | NJ-83 | NJ-82 | 450 | Developed | 189 | \$ 1,730 | \$ 327,000 | \$ 98,100 | \$ 425,100 |
| 28677 | NP-104 | NJ-83 | NJ-94 | 300 | Developed | 468 | \$ 1,470 | \$ 689,000 | \$ 206,700 | \$ 895,700 |
| 28601 | NP-105 | NJ-80 | NJ-94 | 400 | Developed | 870 | \$ 1,610 | \$ 1,400,000 | \$ 420,000 | \$ 1,820,000 |
| 25985 | NP-106 | NJ-92 | NJ-93 | 300 | Developed | 405 | \$ 1,470 | \$ 596,000 | \$ 178,800 | \$ 774,800 |
| 27021 | NP-107 | NJ-91 | NJ-92 | 300 | Developed | 411 | \$ 1,470 | \$ 603,000 | \$ 180,900 | \$ 783,900 |
| 28429 | NP-108 | NJ-86 | NJ-91 | 300 | Developed | 234 | \$ 1,470 | \$ 343,000 | \$ 102,900 | \$ 445,900 |
| 28430 | NP-109 | NJ-85 | NJ-86 | 300 | Developed | 248 | \$ 1,470 | \$ 365,000 | \$ 109,500 | \$ 474,500 |
| 28426 | NP-110 | NJ-84 | NJ-85 | 300 | Developed | 289 | \$ 1,470 | \$ 424,000 | \$ 127,200 | \$ 551,200 |
| 28523 | NP-111 | NJ-83 | NJ-84 | 300 | Developed | 419 | \$ 1,470 | \$ 616,000 | \$ 184,800 | \$ 800,800 |
| 28453 | NP-112 | NJ-87 | NJ-86 | 300 | Undeveloped | 306 | \$ 830 | \$ 254,000 | \$ 76,200 | \$ 330,200 |
| 28452 | NP-113 | NJ-88 | NJ-87 | 300 | Undeveloped | 508 | \$ 830 | \$ 422,000 | \$ 126,600 | \$ 548,600 |
| 28675 | NP-114 | NJ-89 | NJ-88 | 300 | Undeveloped | 424 | \$ 830 | \$ 352,000 | \$ 105,600 | \$ 457,600 |
| 28527 | NP-115 | NJ-90 | NJ-89 | 300 | Developed | 835 | \$ 1,470 | \$ 1,228,000 | \$ 368,400 | \$ 1,596,400 |
| 28443 | NP-116 | NJ-91 | NJ-90 | 300 | Developed | 128 | \$ 1,470 | \$ 188,000 | \$ 56,400 | \$ 244,400 |
| 28548 | NP-117 | NJ-96 | NJ-90 | 300 | Developed | 343 | \$ 1,470 | \$ 504,000 | \$ 151,200 | \$ 655,200 |
| 28674 | NP-118 | NJ-96 | NJ-95 | 300 | Undeveloped | 855 | \$ 830 | \$ 709,000 | \$ 212,700 | \$ 921,700 |
| 28439 | NP-119 | NJ-95 | NJ-93 | 300 | Undeveloped | 280 | \$ 830 | \$ 233,000 | \$ 69,900 | \$ 302,900 |
| 28676 | NP-120 | NJ-96 | NJ-97 | 250 | Undeveloped | 826 | \$ 750 | \$ 620,000 | \$ 186,000 | \$ 806,000 |
| 28600 | NP-135 | NJ-94 | NJ-93 | 400 | Developed | 143 | \$ 1,050 | \$ 150,000 | \$ 45,000 | \$ 195,000 |
| 28688 | NP-140 | fill_northR | NJ-65 | 750 | Undeveloped | 62 | \$ 1,910 | \$ 118,000 | \$ 35,400 | \$ 153,400 |
| 28690 | NP-142 | NJ-40 | NJ-49 | 250 | Undeveloped | 892 | \$ 750 | \$ 669,000 | \$ 200,700 | \$ 869,700 |
| Total Watermains North of Boundary - Phase 6 | | | | | | | | \$ 21,734,000 | \$ 6,520,200 | \$ 28,254,200 |

Total Phase 6 \$ **28,654,200**

Total Water Cost \$ **96,151,900**

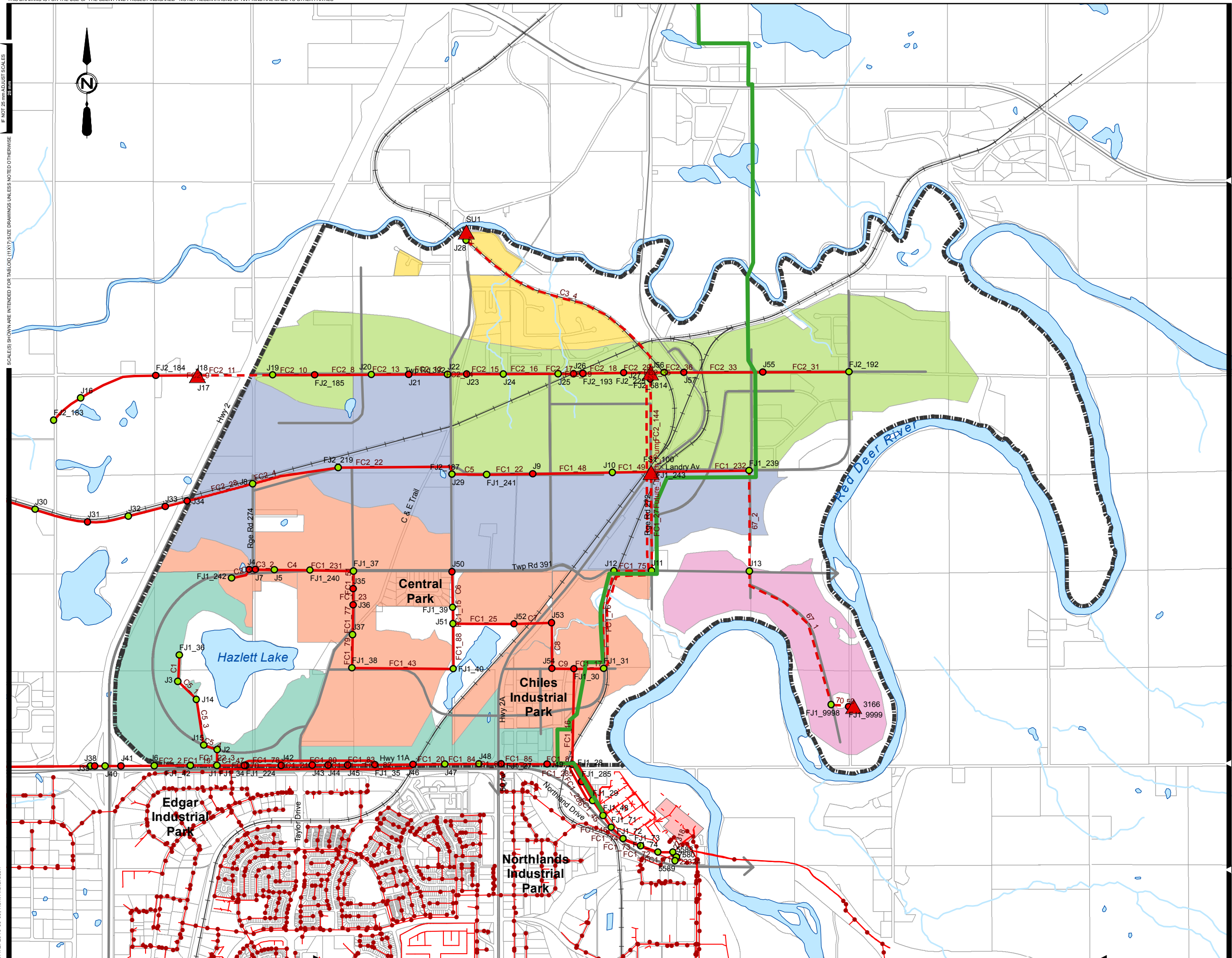
REPORT

Appendix C - Cost Estimates - Sanitary

IF NOT AS SHOWN SCALES

SCALE(S) SHOWN ARE INTENDED FOR TABLORD (1:1X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

\\s-efm-fe-01\projects\20153382\02_N_of_Hwy_11A_ServWorking_Dwg\010_GIS\Map\C-1.mxd
DATE: 2016-06-09, Kent Richardson



- Legend:**
- Manhole (Depth >= 5.5m)
 - Manhole (Depth < 5.5m)
 - ▲ Proposed Sanitary Lift Station
 - Proposed Sanitary Force Main
 - Proposed Sanitary Trunk
 - Existing Sanitary Manhole
 - Existing Sanitary Line
 - ▭ Wastewater Treatment Plant
 - Proposed Pipe Alignment for the NRDRWWC

- Catchment Areas**
- ▭ A
 - ▭ B
 - ▭ C
 - ▭ D
 - ▭ E
 - ▭ F
 - Study Area



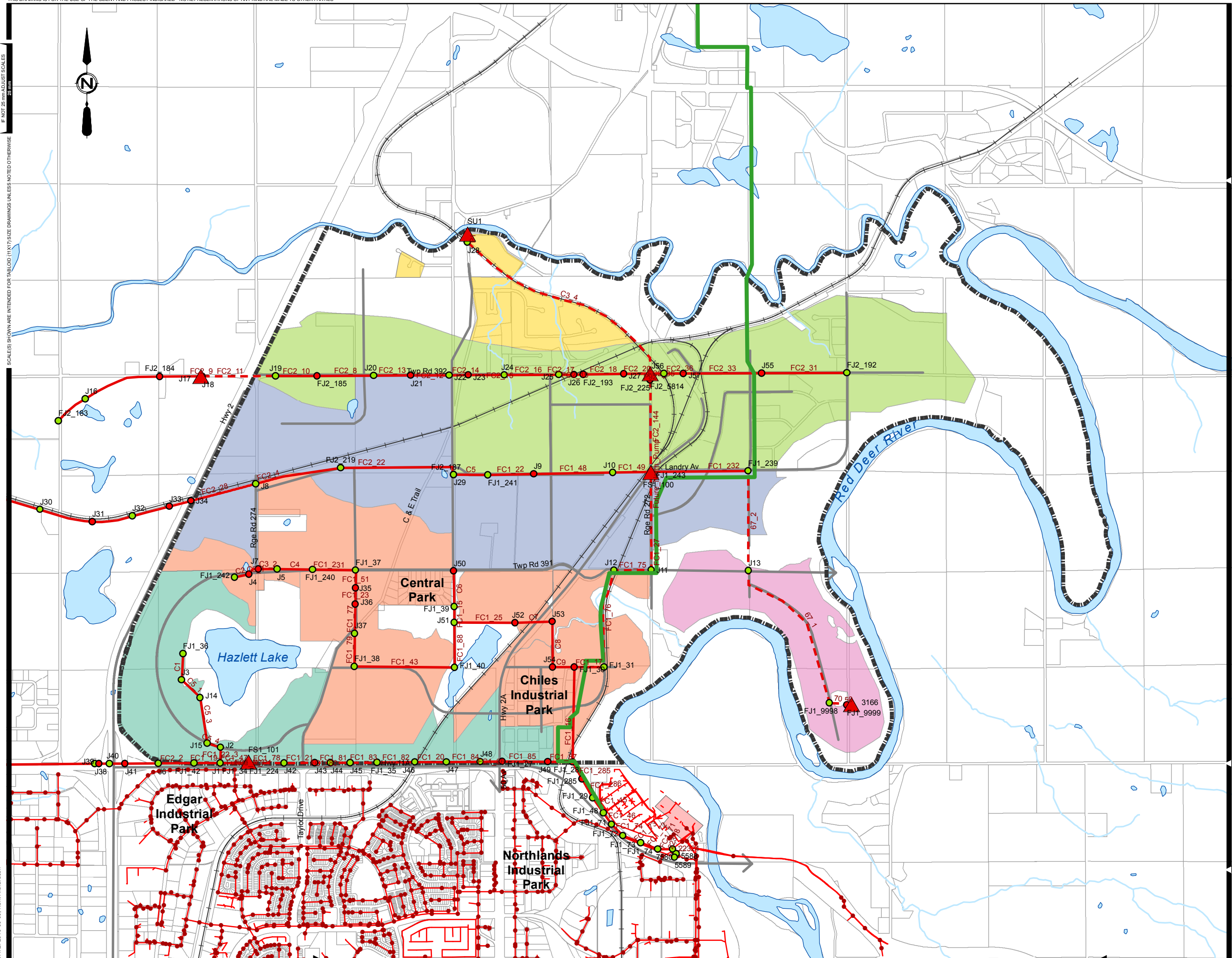
FIGURE No. C-1
NORTH OF HIGHWAY 11A SERVICING STUDY

WASTEWATER
REFERENCE OPTION 1

| | |
|-----------------------|-------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED | |
| DATE | 2016JUN09 |
| REV | |
| DESCRIPTION | ISSUED FOR REPORT |

SCALE(S) SHOWN ARE INTENDED FOR TABLORD (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

I:\a-edm-fe-01\projects\20153382\02_N_of_Hwy_11A_SewerWorking_Dwg\010_GIS\Map\C-2.mxd
DATE: 2016-06-09, Kent Richardson



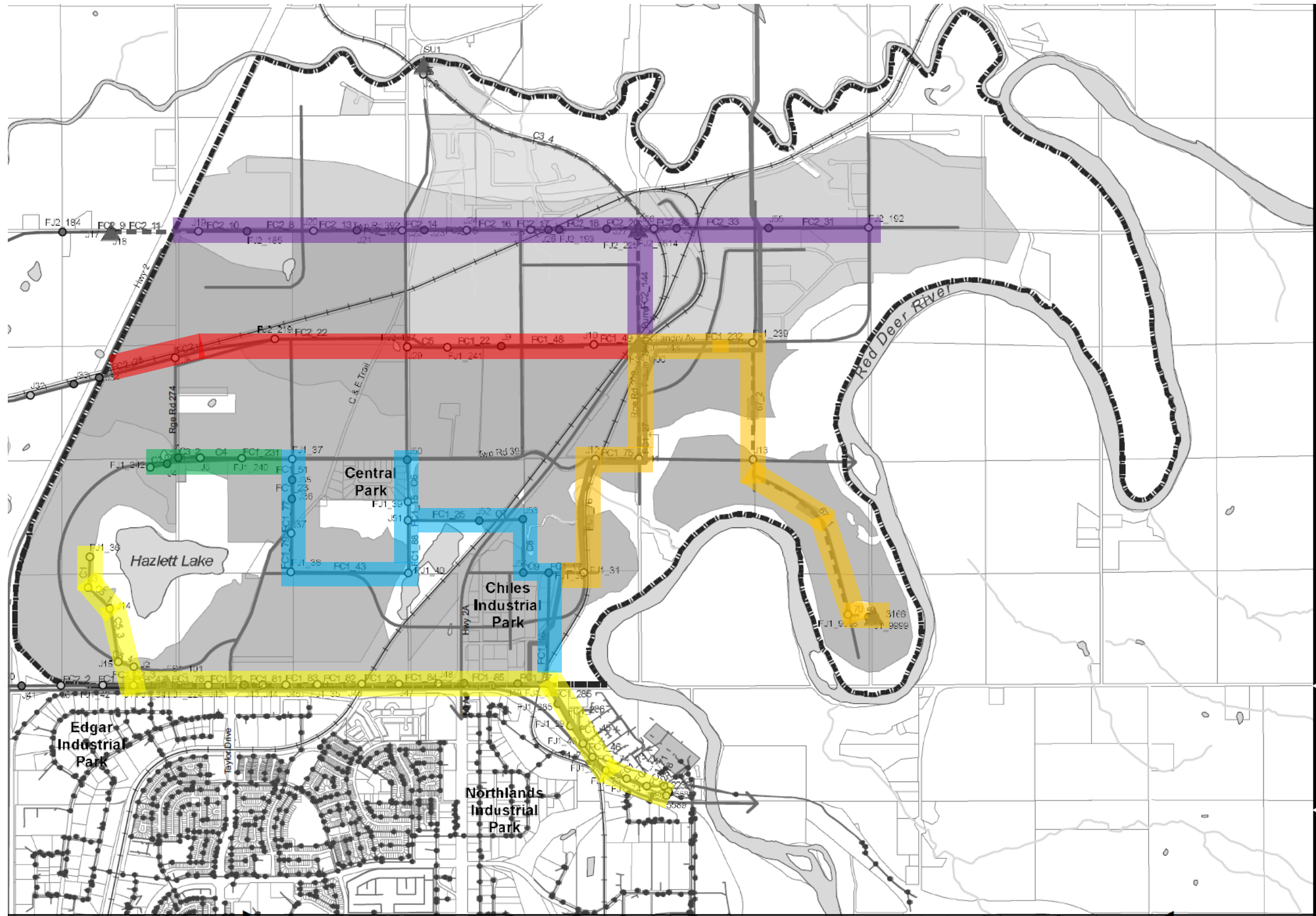
- Legend:**
- Manhole (Depth ≥ 5.5m)
 - Manhole (Depth < 5.5m)
 - ▲ Proposed Sanitary Lift Station
 - Proposed Sanitary Force Main
 - Proposed Sanitary Trunk
 - Existing Sanitary Manhole
 - Existing Sanitary Line
 - Wastewater Treatment Plant
 - Proposed Pipe Alignment for the NRDRWWC

- Catchment**
- A
 - B
 - C
 - D
 - E
 - F
 - Study



FIGURE No. C-2
NORTH OF HIGHWAY 11A SERVICING STUDY
WASTEWATER
REFERENCE OPTION 2

| | |
|-----------------------|-------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED | |
| DATE | 2016JUN09 |
| REV | |
| DESCRIPTION | ISSUED FOR REPORT |



- Phase 1
- Phase 2
- Phase 3
- Phase 4
- Phase 5
- Phase 6



FIGURE No C-3
 NORTH OF HIGHWAY 11A SERVICING STUDY

WASTEWATER
 REFERENCE OPTION 2

Phasing Plan

| | |
|----------------|-------------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED | |
| DATE | JUNE 2016 |
| REV | |
| DESCRIPTION | ISSUED FOR FINAL REPORT |

APPENDIX C - Table C-1
City of Red Deer North of Highway 11A Servicing Study
Option 1 Cost Breakdown: Gravity trunks within the Highway 11A corridor

Gravity Mains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|-------------------------------|----------|------------|-----------|------------|---------|---------------|------------------|----------------|-----------------------------------|---------------|
| 1 | C1 | FJ1 36 | J3 | 213.1 | 1 | 300 | \$ 1,400 | \$ 298,000 | \$ 89,400 | \$ 387,400 |
| 2 | C5 1 | J3 | J14 | 211.9 | 1 | 375 | \$ 1,400 | \$ 297,000 | \$ 89,100 | \$ 386,100 |
| 3 | C5 3 | J14 | J15 | 383.0 | 1 | 450 | \$ 1,500 | \$ 574,000 | \$ 172,200 | \$ 746,200 |
| 4 | C5 4 | J15 | J2 | 116.5 | 1 | 600 | \$ 1,800 | \$ 210,000 | \$ 63,000 | \$ 273,000 |
| 5 | FC1 22 3 | J2 | J1 | 131.3 | 1 | 750 | \$ 2,000 | \$ 263,000 | \$ 78,900 | \$ 341,900 |
| 6 | FC1 87 | J49 | FJ1 28 | 206.5 | 1 | 750 | \$ 2,000 | \$ 413,000 | \$ 123,900 | \$ 536,900 |
| 7 | 22318 | 5589 | 5588 | 32.2 | 1 | 1050 | \$ 2,500 | \$ 80,000 | \$ 24,000 | \$ 104,000 |
| 8 | 22324 | 5588 | 7580 | 47.7 | 1 | 1200 | \$ 2,600 | \$ 124,000 | \$ 37,200 | \$ 161,200 |
| 9 | FC1 19 | FJ1 42 | J1 | 219.4 | 1 | 1200 | \$ 2,600 | \$ 570,000 | \$ 171,000 | \$ 741,000 |
| 10 | FC2 2 | J6 | FJ1 42 | 296.6 | 1 | 1200 | \$ 2,600 | \$ 771,000 | \$ 231,300 | \$ 1,002,300 |
| 11 | FC1 70 | FJ1 34 | FJ1 224 | 14.0 | 2 | 1350 | \$ 2,700 | \$ 76,000 | \$ 22,800 | \$ 98,800 |
| 12 | FC1 47 | J1 | FJ1 34 | 227.1 | 2 | 1350 | \$ 2,700 | \$ 1,226,000 | \$ 367,800 | \$ 1,593,800 |
| 13 | FC1 78 | FJ1 224 | J42 | 290.4 | 2 | 1350 | \$ 2,700 | \$ 1,568,000 | \$ 470,400 | \$ 2,038,400 |
| 14 | FC1 21 | J42 | J43 | 254.0 | 2 | 1500 | \$ 6,500 | \$ 3,302,000 | \$ 990,600 | \$ 4,292,600 |
| 15 | FC1 80 | J43 | J44 | 131.9 | 2 | 1500 | \$ 6,500 | \$ 1,715,000 | \$ 514,500 | \$ 2,229,500 |
| 16 | FC1 81 | J44 | J45 | 161.0 | 2 | 1500 | \$ 6,500 | \$ 2,093,000 | \$ 627,900 | \$ 2,720,900 |
| 17 | FC1 83 | J45 | FJ1 35 | 225.0 | 2 | 1500 | \$ 6,500 | \$ 2,925,000 | \$ 877,500 | \$ 3,802,500 |
| 18 | FC1 82 | FJ1 35 | J46 | 314.5 | 2 | 1500 | \$ 6,500 | \$ 4,089,000 | \$ 1,226,700 | \$ 5,315,700 |
| 19 | FC1 286 | FJ1 285 | FJ1 29 | 181.8 | 2 | 1500 | \$ 2,900 | \$ 1,054,000 | \$ 316,200 | \$ 1,370,200 |
| 20 | FC1 20 | J46 | J47 | 260.7 | 1 | 1500 | \$ 2,900 | \$ 756,000 | \$ 226,800 | \$ 982,800 |
| 21 | FC1 84 | J47 | J48 | 283.6 | 1 | 1500 | \$ 2,900 | \$ 823,000 | \$ 246,900 | \$ 1,069,900 |
| 22 | FC1 86 | J48 | FJ1 27 | 182.3 | 1 | 1500 | \$ 2,900 | \$ 529,000 | \$ 158,700 | \$ 687,700 |
| 23 | FC1 85 | FJ1 27 | J49 | 378.5 | 1 | 1500 | \$ 2,900 | \$ 1,098,000 | \$ 329,400 | \$ 1,427,400 |
| 24 | FC1 45 | FJ1 29 | FJ1 48 | 150.3 | 1 | 2250x2400 | \$ 5,400 | \$ 812,000 | \$ 243,600 | \$ 1,055,600 |
| 25 | FC1 46 | FJ1 48 | FJ1 71 | 120.1 | 1 | 2250x2400 | \$ 5,400 | \$ 649,000 | \$ 194,700 | \$ 843,700 |
| 26 | FC1 71 | FJ1 74 | 7580 | 125.1 | 1 | 2250x2400 | \$ 5,400 | \$ 675,000 | \$ 202,500 | \$ 877,500 |
| 27 | FC1 72 | FJ1 73 | FJ1 74 | 152.7 | 1 | 2250x2400 | \$ 5,400 | \$ 825,000 | \$ 247,500 | \$ 1,072,500 |
| 28 | FC1 73 | FJ1 72 | FJ1 73 | 155.8 | 1 | 2250x2400 | \$ 5,400 | \$ 841,000 | \$ 252,300 | \$ 1,093,300 |
| 29 | FC1 74 | FJ1 71 | FJ1 72 | 134.0 | 1 | 2250x2400 | \$ 5,400 | \$ 724,000 | \$ 217,200 | \$ 941,200 |
| 30 | FC1 285 | FJ1 28 | FJ1 285 | 161.0 | 3 | 2750 | \$ 11,000 | \$ 5,312,000 | \$ 1,593,600 | \$ 6,905,600 |
| Total Gravity Mains - Phase 1 | | | | | | | | \$ 34,692,000 | \$ 10,407,600 | \$ 45,099,600 |

Total Phase 1 \$ **45,099,600**

PHASE 2

Gravity Mains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|-------------------------------|--------|------------|-----------|------------|---------|---------------|------------------|----------------|-----------------------------------|---------------|
| 1 | C6 | J50 | FJ1 39 | 295.1 | 1 | 300 | \$ 1,400 | \$ 413,000 | \$ 123,900 | \$ 536,900 |
| 2 | FC1 15 | FJ1 39 | J51 | 132.3 | 1 | 300 | \$ 1,400 | \$ 185,000 | \$ 55,500 | \$ 240,500 |
| 3 | FC1 51 | FJ1 37 | J35 | 146.2 | 1 | 450 | \$ 1,500 | \$ 219,000 | \$ 65,700 | \$ 284,700 |
| 4 | FC1 23 | J35 | J36 | 134.6 | 1 | 450 | \$ 1,500 | \$ 202,000 | \$ 60,600 | \$ 262,600 |
| 5 | FC1 77 | J36 | J37 | 243.6 | 1 | 450 | \$ 1,500 | \$ 365,000 | \$ 109,500 | \$ 474,500 |
| 6 | FC1 43 | FJ1 38 | FJ1 40 | 834.5 | 1 | 525 | \$ 1,600 | \$ 1,335,000 | \$ 400,500 | \$ 1,735,500 |
| 7 | FC1 79 | J37 | FJ1 38 | 275.5 | 1 | 525 | \$ 1,600 | \$ 441,000 | \$ 132,300 | \$ 573,300 |
| 8 | FC1 25 | J51 | J52 | 503.5 | 1 | 600 | \$ 1,800 | \$ 906,000 | \$ 271,800 | \$ 1,177,800 |
| 9 | FC1 88 | FJ1 40 | J51 | 374.8 | 1 | 600 | \$ 1,800 | \$ 675,000 | \$ 202,500 | \$ 877,500 |
| 10 | C7 | J52 | J53 | 311.0 | 1 | 600 | \$ 1,800 | \$ 560,000 | \$ 168,000 | \$ 728,000 |
| 11 | C8 | J53 | J54 | 377.1 | 1 | 675 | \$ 1,900 | \$ 716,000 | \$ 214,800 | \$ 930,800 |
| 12 | FC1 16 | FJ1 30 | FJ1 28 | 788.1 | 1 | 900 | \$ 2,200 | \$ 1,734,000 | \$ 520,200 | \$ 2,254,200 |
| 13 | C9 | J54 | FJ1 30 | 179.5 | 1 | 900 | \$ 2,200 | \$ 395,000 | \$ 118,500 | \$ 513,500 |
| 14 | FC1 17 | FJ1 31 | FJ1 30 | 246.4 | 1 | 1200 | \$ 2,600 | \$ 641,000 | \$ 192,300 | \$ 833,300 |
| Total Gravity Mains - Phase 2 | | | | | | | | \$ 8,787,000 | \$ 2,636,100 | \$ 11,423,100 |

Total Phase 2 \$ **11,423,100**

APPENDIX C - Table C-1
City of Red Deer North of Highway 11A Servicing Study
Option 1 Cost Breakdown: Gravity trunks within the Highway 11A corridor

PHASE 3

Gravity Mains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|--------------------------------------|---------|------------|-----------|------------|---------|---------------|------------------|---------------------|-----------------------------------|---------------------|
| 1 | C2 | FJ1_242 | J4 | 140.9 | 1 | 300 | \$ 1,400 | \$ 197,000 | \$ 59,100 | \$ 256,100 |
| 2 | C4 | J5 | FJ1_240 | 294.3 | 1 | 300 | \$ 1,400 | \$ 412,000 | \$ 123,600 | \$ 535,600 |
| 3 | C3_1 | J4 | J7 | 80.0 | 1 | 300 | \$ 1,400 | \$ 112,000 | \$ 33,600 | \$ 145,600 |
| 4 | C3_2 | J7 | J5 | 154.9 | 1 | 300 | \$ 1,400 | \$ 217,000 | \$ 65,100 | \$ 282,100 |
| 5 | FC1_231 | FJ1_240 | FJ1_37 | 359.3 | 1 | 375 | \$ 1,400 | \$ 503,000 | \$ 150,900 | \$ 653,900 |
| Total Gravity Mains - Phase 3 | | | | | | | | \$ 1,441,000 | \$ 432,300 | \$ 1,873,300 |

Total Phase 3 \$ **1,873,300**

PHASE 4

Gravity Mains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|--------------------------------------|---------|------------|-----------|------------|---------|---------------|------------------|---------------------|-----------------------------------|---------------------|
| 1 | FC1_232 | FJ1_239 | FS1_100 | 808.7 | 1 | 450 | \$ 1,500 | \$ 1,213,000 | \$ 363,900 | \$ 1,576,900 |
| 2 | 50 | FJ1_9999 | 3166 | 39.5 | 1 | 300 | \$ 1,400 | \$ 55,000 | \$ 16,500 | \$ 71,500 |
| Total Gravity Mains - Phase 4 | | | | | | | | \$ 1,268,000 | \$ 380,400 | \$ 1,648,400 |

Forcemains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|-----------------------------------|--------|------------|-----------|------------|---------|---------------|------------------|---------------------|-----------------------------------|---------------------|
| 1 | FC1_75 | J11 | J12 | 310.1 | 1 | 900 | \$ 1,500 | \$ 465,000 | \$ 139,500 | \$ 604,500 |
| 2 | FC1_76 | J12 | FJ1_31 | 821.7 | 1 | 900 | \$ 1,500 | \$ 1,233,000 | \$ 369,900 | \$ 1,602,900 |
| 3 | 67_2 | J13 | FJ1_239 | 828.4 | 1 | 300 | \$ 600 | \$ 497,000 | \$ 149,100 | \$ 646,100 |
| 4 | FC1_27 | FJ1_243 | J11 | 787.0 | 1 | 900 | \$ 1,500 | \$ 1,180,000 | \$ 354,000 | \$ 1,534,000 |
| 5 | 67_1 | FJ1_9998 | J13 | 1,395.8 | 1 | 300 | \$ 600 | \$ 837,000 | \$ 251,100 | \$ 1,088,100 |
| Total Forcemains - Phase 4 | | | | | | | | \$ 4,212,000 | \$ 1,263,600 | \$ 5,475,600 |

Lift Stations

| Item No. | Unit Cost | Lift Station Cost (includes engineering and contingency (30%)) |
|--------------------------------------|---------------|--|
| 1 | \$ 13,780,000 | \$ 13,780,000 |
| 2 | \$ 4,641,000 | \$ 4,641,000 |
| Total Lift Stations - Phase 4 | | \$ 18,421,000 |

Total Phase 4 \$ **25,545,000**

PHASE 5

Gravity Mains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|--------------------------------------|--------|------------|-----------|------------|---------|---------------|------------------|---------------------|-----------------------------------|----------------------|
| 1 | FC2_4 | J8 | FJ2_219 | 857.2 | 1 | 900 | \$ 2,200 | \$ 1,886,000 | \$ 565,800 | \$ 2,451,800 |
| 2 | FC2_21 | FJ2_219 | J29 | 845.0 | 1 | 900 | \$ 2,200 | \$ 1,859,000 | \$ 557,700 | \$ 2,416,700 |
| 3 | FC2_22 | J29 | FJ2_187 | 377.0 | 1 | 900 | \$ 2,200 | \$ 829,000 | \$ 248,700 | \$ 1,077,700 |
| 4 | FC2_28 | J34 | J8 | 558.1 | 1 | 900 | \$ 2,200 | \$ 1,228,000 | \$ 368,400 | \$ 1,596,400 |
| 5 | FC1_22 | FJ1_241 | J9 | 380.8 | 1 | 1050 | \$ 2,500 | \$ 952,000 | \$ 285,600 | \$ 1,237,600 |
| 6 | FC1_48 | J9 | J10 | 658.1 | 1 | 1050 | \$ 2,500 | \$ 1,645,000 | \$ 493,500 | \$ 2,138,500 |
| 7 | FC1_49 | J10 | FS1_100 | 316.8 | 1 | 1050 | \$ 2,500 | \$ 792,000 | \$ 237,600 | \$ 1,029,600 |
| 8 | C5 | FJ2_187 | FJ1_241 | 284.6 | 1 | 1050 | \$ 2,500 | \$ 711,000 | \$ 213,300 | \$ 924,300 |
| Total Gravity Mains - Phase 5 | | | | | | | | \$ 9,902,000 | \$ 2,970,600 | \$ 12,872,600 |

Total Phase 5 \$ **12,872,600**

APPENDIX C - Table C-1
City of Red Deer North of Highway 11A Servicing Study
Option 1 Cost Breakdown: Gravity trunks within the Highway 11A corridor

PHASE 6

Gravity Mains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|-------------------------------|--------|------------|-----------|------------|---------|---------------|------------------|----------------|-----------------------------------|--------------|
| 1 | FC2_10 | J19 | FJ2_185 | 344.4 | 1 | 300 | \$ 1,400 | \$ 482,000 | \$ 144,600 | \$ 626,600 |
| 2 | FC2_15 | J23 | J24 | 300.7 | 1 | 375 | \$ 1,400 | \$ 421,000 | \$ 126,300 | \$ 547,300 |
| 3 | FC2_8 | FJ2_185 | J20 | 470.2 | 1 | 450 | \$ 1,500 | \$ 705,000 | \$ 211,500 | \$ 916,500 |
| 4 | FC2_13 | J20 | J21 | 306.9 | 1 | 450 | \$ 1,500 | \$ 460,000 | \$ 138,000 | \$ 598,000 |
| 5 | FC2_14 | J22 | J23 | 159.0 | 1 | 450 | \$ 1,500 | \$ 238,000 | \$ 71,400 | \$ 309,400 |
| 6 | FC2_31 | FJ2_192 | J55 | 710.4 | 1 | 450 | \$ 1,500 | \$ 1,066,000 | \$ 319,800 | \$ 1,385,800 |
| 7 | FC2_12 | J21 | J22 | 320.1 | 1 | 525 | \$ 1,600 | \$ 512,000 | \$ 153,600 | \$ 665,600 |
| 8 | FC2_16 | J24 | J25 | 450.9 | 1 | 525 | \$ 1,600 | \$ 721,000 | \$ 216,300 | \$ 937,300 |
| 9 | FC2_35 | J56 | FJ2_5814 | 114.0 | 1 | 525 | \$ 1,600 | \$ 182,000 | \$ 54,600 | \$ 236,600 |
| 10 | FC2_33 | J55 | J57 | 648.8 | 1 | 525 | \$ 1,600 | \$ 1,038,000 | \$ 311,400 | \$ 1,349,400 |
| 11 | FC2_36 | J57 | J56 | 163.2 | 1 | 525 | \$ 1,600 | \$ 261,000 | \$ 78,300 | \$ 339,300 |
| 12 | FC2_17 | J25 | J26 | 128.8 | 1 | 600 | \$ 1,800 | \$ 232,000 | \$ 69,600 | \$ 301,600 |
| 13 | FC2_20 | J27 | FJ2_5814 | 219.3 | 1 | 600 | \$ 1,800 | \$ 395,000 | \$ 118,500 | \$ 513,500 |
| 14 | FC2_19 | J26 | FJ2_193 | 76.1 | 1 | 675 | \$ 1,900 | \$ 145,000 | \$ 43,500 | \$ 188,500 |
| 15 | FC2_18 | FJ2_193 | J27 | 336.4 | 1 | 750 | \$ 2,000 | \$ 673,000 | \$ 201,900 | \$ 874,900 |
| Total Gravity Mains - Phase 6 | | | | | | | | \$ 7,531,000 | \$ 2,259,300 | \$ 9,790,300 |

Forcemains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|-----------|---------|------------|-----------|------------|---------|---------------|------------------|----------------|-----------------------------------|--------------|
| 1 | FC2_11 | J18 | J19 | 612.1 | 1 | 450 | \$ 800 | \$ 490,000 | \$ 147,000 | \$ 637,000 |
| 2 | FC2_144 | FJ2_225 | FS1_100 | 766.9 | 1 | 750 | \$ 1,000 | \$ 767,000 | \$ 230,100 | \$ 997,100 |
| 3 | C3_4 | J28 | FJ2_5814 | 1,963.2 | 1 | 300 | \$ 600 | \$ 1,178,000 | \$ 353,400 | \$ 1,531,400 |
| Sub-Total | | | | | | | | \$ 2,435,000 | \$ 730,500 | \$ 3,165,500 |

Lift Stations

| Item No. | Unit Cost | Lift Station Cost (includes engineering and contingency (30%)) |
|-------------------------------|---------------|--|
| 1 | \$ 11,995,000 | \$ 11,995,000 |
| 2 | \$ 4,641,000 | \$ 4,641,000 |
| Total Lift Stations - Phase 6 | | \$ 16,636,000 |

Total Phase 6 \$ 29,591,800

| | | |
|----------------------------------|----|--------------------|
| Gravity Mains | \$ | 82,707,300 |
| Forcemains | \$ | 8,641,100 |
| Lift Stations | \$ | 35,057,000 |
| Total Sanitary Sewer Cost | \$ | 126,405,400 |

APPENDIX C - Table C-2
City of Red Deer North of Highway 11A Servicing Study
Option 2 Cost Breakdown: Lift Station and Forcemain within the Highway 11A corridor

PHASE 2

Gravity Mains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost | Contingency and Engineering (30%) | Total Cost |
|--------------------------------------|--------|------------|-----------|------------|---------|---------------|------------------|---------------------|-----------------------------------|----------------------|
| 1 | C6 | J50 | FJ1_39 | 295.1 | 1 | 300 | \$ 1,400 | \$ 413,000 | \$ 123,900 | \$ 536,900 |
| 2 | FC1_15 | FJ1_39 | J51 | 132.3 | 1 | 300 | \$ 1,400 | \$ 185,000 | \$ 55,500 | \$ 240,500 |
| 3 | FC1_51 | FJ1_37 | J35 | 146.2 | 1 | 450 | \$ 1,500 | \$ 219,000 | \$ 65,700 | \$ 284,700 |
| 4 | FC1_23 | J35 | J36 | 134.6 | 1 | 450 | \$ 1,500 | \$ 202,000 | \$ 60,600 | \$ 262,600 |
| 5 | FC1_77 | J36 | J37 | 243.6 | 1 | 450 | \$ 1,500 | \$ 365,000 | \$ 109,500 | \$ 474,500 |
| 6 | FC1_43 | FJ1_38 | FJ1_40 | 834.5 | 1 | 525 | \$ 1,600 | \$ 1,335,000 | \$ 400,500 | \$ 1,735,500 |
| 7 | FC1_79 | J37 | FJ1_38 | 275.5 | 1 | 525 | \$ 1,600 | \$ 441,000 | \$ 132,300 | \$ 573,300 |
| 8 | FC1_25 | J51 | J52 | 503.5 | 1 | 600 | \$ 1,800 | \$ 906,000 | \$ 271,800 | \$ 1,177,800 |
| 9 | FC1_88 | FJ1_40 | J51 | 374.8 | 1 | 600 | \$ 1,800 | \$ 675,000 | \$ 202,500 | \$ 877,500 |
| 10 | C7 | J52 | J53 | 311.0 | 1 | 600 | \$ 1,800 | \$ 560,000 | \$ 168,000 | \$ 728,000 |
| 11 | C8 | J53 | J54 | 377.1 | 1 | 675 | \$ 1,900 | \$ 716,000 | \$ 214,800 | \$ 930,800 |
| 12 | FC1_16 | FJ1_30 | FJ1_28 | 788.1 | 1 | 900 | \$ 2,200 | \$ 1,734,000 | \$ 520,200 | \$ 2,254,200 |
| 13 | C9 | J54 | FJ1_30 | 179.5 | 1 | 900 | \$ 2,200 | \$ 395,000 | \$ 118,500 | \$ 513,500 |
| 14 | FC1_17 | FJ1_31 | FJ1_30 | 246.4 | 1 | 1200 | \$ 2,600 | \$ 641,000 | \$ 192,300 | \$ 833,300 |
| Total Gravity Mains - Phase 2 | | | | | | | | \$ 8,787,000 | \$ 2,636,100 | \$ 11,423,100 |

Total Phase 2 \$ **11,423,100**

PHASE 3

Gravity Mains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost | Contingency and Engineering (30%) | Total Cost |
|--------------------------------------|---------|------------|-----------|------------|---------|---------------|------------------|---------------------|-----------------------------------|---------------------|
| 1 | C2 | FJ1_242 | J4 | 140.9 | 1 | 300 | \$ 1,400 | \$ 197,000 | \$ 59,100 | \$ 256,100 |
| 2 | C4 | J5 | FJ1_240 | 294.3 | 1 | 300 | \$ 1,400 | \$ 412,000 | \$ 123,600 | \$ 535,600 |
| 3 | C3_1 | J4 | J7 | 80.0 | 1 | 300 | \$ 1,400 | \$ 112,000 | \$ 33,600 | \$ 145,600 |
| 4 | C3_2 | J7 | J5 | 154.9 | 1 | 300 | \$ 1,400 | \$ 217,000 | \$ 65,100 | \$ 282,100 |
| 5 | FC1_231 | FJ1_240 | FJ1_37 | 359.3 | 1 | 375 | \$ 1,400 | \$ 503,000 | \$ 150,900 | \$ 653,900 |
| Total Gravity Mains - Phase 3 | | | | | | | | \$ 1,441,000 | \$ 432,300 | \$ 1,873,300 |

Total Phase 3 \$ **1,873,300**

PHASE 4

Gravity Mains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost | Contingency and Engineering (30%) | Total Cost |
|--------------------------------------|---------|------------|-----------|------------|---------|---------------|------------------|---------------------|-----------------------------------|---------------------|
| 1 | FC1_232 | FJ1_239 | FS1_100 | 808.7 | 1 | 450 | \$ 1,500 | \$ 1,213,000 | \$ 363,900 | \$ 1,576,900 |
| 2 | 50 | FJ1_9999 | 3166 | 39.5 | 1 | 300 | \$ 1,400 | \$ 55,000 | \$ 16,500 | \$ 71,500 |
| Total Gravity Mains - Phase 4 | | | | | | | | \$ 1,268,000 | \$ 380,400 | \$ 1,648,400 |

Forcemains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost | Contingency and Engineering (30%) | Total Cost |
|-----------------------------------|--------|------------|-----------|------------|---------|---------------|------------------|---------------------|-----------------------------------|---------------------|
| 1 | FC1_75 | J11 | J12 | 310.1 | 1 | 900 | \$ 1,500 | \$ 465,000 | \$ 139,500 | \$ 604,500 |
| 2 | FC1_76 | J12 | FJ1_31 | 821.7 | 1 | 900 | \$ 1,500 | \$ 1,233,000 | \$ 369,900 | \$ 1,602,900 |
| 3 | 67_2 | J13 | FJ1_239 | 828.4 | 1 | 300 | \$ 600 | \$ 497,000 | \$ 149,100 | \$ 646,100 |
| 4 | FC1_27 | FJ1_243 | J11 | 787.0 | 1 | 900 | \$ 1,500 | \$ 1,180,000 | \$ 354,000 | \$ 1,534,000 |
| 5 | 67_1 | FJ1_9998 | J13 | 1,395.8 | 1 | 300 | \$ 600 | \$ 837,000 | \$ 251,100 | \$ 1,088,100 |
| Total Forcemains - Phase 4 | | | | | | | | \$ 4,212,000 | \$ 1,263,600 | \$ 5,475,600 |

Lift Stations

| Item No. | Unit Cost | Lift Station Cost (includes engineering and contingency (30%)) |
|--------------------------------------|---------------|---|
| 1 | \$ 13,780,000 | \$ 13,780,000 |
| 2 | \$ 4,641,000 | \$ 4,641,000 |
| Total Lift Stations - Phase 4 | | \$ 18,421,000 |

Total Phase 4 \$ **25,545,000**

APPENDIX C - Table C-2
City of Red Deer North of Highway 11A Servicing Study
Option 2 Cost Breakdown: Lift Station and Forcemain within the Highway 11A corridor

PHASE 5

Gravity Mains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost | Contingency and Engineering (30%) | Total Cost |
|--------------------------------------|--------|------------|-----------|------------|---------|---------------|------------------|---------------------|-----------------------------------|----------------------|
| 1 | FC2_4 | J8 | FJ2_219 | 857.2 | 1 | 900 | \$ 2,200 | \$ 1,886,000 | \$ 565,800 | \$ 2,451,800 |
| 2 | FC2_21 | FJ2_219 | J29 | 845.0 | 1 | 900 | \$ 2,200 | \$ 1,859,000 | \$ 557,700 | \$ 2,416,700 |
| 3 | FC2_22 | J29 | FJ2_187 | 377.0 | 1 | 900 | \$ 2,200 | \$ 829,000 | \$ 248,700 | \$ 1,077,700 |
| 4 | FC2_28 | J34 | J8 | 558.1 | 1 | 900 | \$ 2,200 | \$ 1,228,000 | \$ 368,400 | \$ 1,596,400 |
| 5 | FC1_22 | FJ1_241 | J9 | 380.8 | 1 | 1050 | \$ 2,500 | \$ 952,000 | \$ 285,600 | \$ 1,237,600 |
| 6 | FC1_48 | J9 | J10 | 658.1 | 1 | 1050 | \$ 2,500 | \$ 1,645,000 | \$ 493,500 | \$ 2,138,500 |
| 7 | FC1_49 | J10 | FS1_100 | 316.8 | 1 | 1050 | \$ 2,500 | \$ 792,000 | \$ 237,600 | \$ 1,029,600 |
| 8 | C5 | FJ2_187 | FJ1_241 | 284.6 | 1 | 1050 | \$ 2,500 | \$ 711,000 | \$ 213,300 | \$ 924,300 |
| Total Gravity Mains - Phase 5 | | | | | | | | \$ 9,902,000 | \$ 2,970,600 | \$ 12,872,600 |

Total Phase 5 \$ **12,872,600**

PHASE 6

Gravity Mains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost | Contingency and Engineering (30%) | Total Cost |
|--------------------------------------|--------|------------|-----------|------------|---------|---------------|------------------|---------------------|-----------------------------------|---------------------|
| 1 | FC2_10 | J19 | FJ2_185 | 344.4 | 1 | 300 | \$ 1,400 | \$ 482,000 | \$ 144,600 | \$ 626,600 |
| 2 | FC2_15 | J23 | J24 | 300.7 | 1 | 375 | \$ 1,400 | \$ 421,000 | \$ 126,300 | \$ 547,300 |
| 3 | FC2_8 | FJ2_185 | J20 | 470.2 | 1 | 450 | \$ 1,500 | \$ 705,000 | \$ 211,500 | \$ 916,500 |
| 4 | FC2_13 | J20 | J21 | 306.9 | 1 | 450 | \$ 1,500 | \$ 460,000 | \$ 138,000 | \$ 598,000 |
| 5 | FC2_14 | J22 | J23 | 159.0 | 1 | 450 | \$ 1,500 | \$ 238,000 | \$ 71,400 | \$ 309,400 |
| 6 | FC2_31 | FJ2_192 | J55 | 710.4 | 1 | 450 | \$ 1,500 | \$ 1,066,000 | \$ 319,800 | \$ 1,385,800 |
| 7 | FC2_12 | J21 | J22 | 320.1 | 1 | 525 | \$ 1,600 | \$ 512,000 | \$ 153,600 | \$ 665,600 |
| 8 | FC2_16 | J24 | J25 | 450.9 | 1 | 525 | \$ 1,600 | \$ 721,000 | \$ 216,300 | \$ 937,300 |
| 9 | FC2_35 | J56 | FJ2_5814 | 114.0 | 1 | 525 | \$ 1,600 | \$ 182,000 | \$ 54,600 | \$ 236,600 |
| 10 | FC2_33 | J55 | J57 | 648.8 | 1 | 525 | \$ 1,600 | \$ 1,038,000 | \$ 311,400 | \$ 1,349,400 |
| 11 | FC2_36 | J57 | J56 | 163.2 | 1 | 525 | \$ 1,600 | \$ 261,000 | \$ 78,300 | \$ 339,300 |
| 12 | FC2_17 | J25 | J26 | 128.8 | 1 | 600 | \$ 1,800 | \$ 232,000 | \$ 69,600 | \$ 301,600 |
| 13 | FC2_20 | J27 | FJ2_5814 | 219.3 | 1 | 600 | \$ 1,800 | \$ 395,000 | \$ 118,500 | \$ 513,500 |
| 14 | FC2_19 | J26 | FJ2_193 | 76.1 | 1 | 675 | \$ 1,900 | \$ 145,000 | \$ 43,500 | \$ 188,500 |
| 15 | FC2_18 | FJ2_193 | J27 | 336.4 | 1 | 750 | \$ 2,000 | \$ 673,000 | \$ 201,900 | \$ 874,900 |
| Total Gravity Mains - Phase 6 | | | | | | | | \$ 7,531,000 | \$ 2,259,300 | \$ 9,790,300 |

Forcemains

| Item No. | Label | Start Node | Stop Node | Length (m) | Barrels | Diameter (mm) | Unit Cost (\$/m) | Pipe Cost | Contingency and Engineering (30%) | Total Cost |
|------------------|---------|------------|-----------|------------|---------|---------------|------------------|---------------------|-----------------------------------|---------------------|
| 1 | FC2_11 | J18 | J19 | 612.1 | 1 | 450 | \$ 800 | \$ 490,000 | \$ 147,000 | \$ 637,000 |
| 2 | FC2_144 | FJ2_225 | FS1_100 | 766.9 | 1 | 750 | \$ 1,000 | \$ 767,000 | \$ 230,100 | \$ 997,100 |
| 3 | C3_4 | J28 | FJ2_5814 | 1,963.2 | 1 | 300 | \$ 600 | \$ 1,178,000 | \$ 353,400 | \$ 1,531,400 |
| Sub-Total | | | | | | | | \$ 2,435,000 | \$ 730,500 | \$ 3,165,500 |

Lift Stations

| Item No. | Unit Cost | Lift Station Cost (includes engineering and contingency (30%)) |
|--------------------------------------|---------------|--|
| 1 | \$ 11,995,000 | \$ 11,995,000 |
| 2 | \$ 4,641,000 | \$ 4,641,000 |
| Total Lift Stations - Phase 6 | | \$ 16,636,000 |

Total Phase 6 \$ **29,591,800**

| | | |
|----------------------------------|-----------|--------------------|
| Gravity Mains | \$ | 62,153,000 |
| Forcemains | \$ | 13,614,900 |
| Lift Stations | \$ | 48,837,000 |
| Total Sanitary Sewer Cost | \$ | 124,604,900 |

Appendix D - Westhoff Model Results

16/09/2005

Table 2: Post development SWMHYMO modelling using a 1:100 year 24 hour Chicago Storm

Unnamed South

| Catchment ID | Catchment area (ha) | Release rate (L/s/ha) | Active Storage required | | Wetland surface area | | Elevation at NWL (m) | Depth of active stoarege (m) | Elevation at HWL (m) |
|--------------|---------------------|-----------------------|-------------------------|---------------------|----------------------|----------|----------------------|------------------------------|----------------------|
| | | | Per ha (m3) | Total catchment(m3) | NWL (ha) | HWL (ha) | | | |
| SC-1 | 522 | 0 | 938 | 489561 | 20.00 | 26.22 | 914.00 | 2.3 | 916.30 |
| SC-1 | 522 | 1 | 895 | 467205 | 20.00 | 26.00 | 914.00 | 2.22 | 916.22 |
| SC-1 | 522 | 2 | 853 | 445039 | 20.00 | 25.70 | 914.00 | 2.12 | 916.12 |
| SC-1 | 522 | 3 | 810 | 422880 | 20.00 | 25.42 | 914.00 | 2.01 | 916.01 |
| SC-1 | 522 | 4 | 768 | 400848 | 20.00 | 25.15 | 914.00 | 1.91 | 915.91 |
| SC-1 | 522 | 5 | 726 | 378765 | 20.00 | 24.86 | 914.00 | 1.8 | 915.80 |
| SC-1 | 522 | 10 | 419 | 218694 | 20.00 | 22.78 | 914.00 | 1.04 | 915.04 |

Cameo Lake

| Catchment ID | Catchment area (ha) | Release rate (L/s/ha) | Active Storage required | | Wetland surface area | | Elevation at NWL (m) | Depth of active storage (m) | Elevation at HWL (m) |
|--------------|---------------------|-----------------------|-------------------------|---------------------|----------------------|----------|----------------------|-----------------------------|----------------------|
| | | | Per ha (m3) | Total catchment(m3) | NWL (ha) | HWL (ha) | | | |
| SC-2 | 129 | 0 | 938 | 120983 | 21.16 | 22.33 | 903.50 | 0.56 | 904.06 |
| SC-2 | 129 | 1 | 895 | 115459 | 21.16 | 22.26 | 903.50 | 0.53 | 904.03 |
| SC-2 | 129 | 2 | 853 | 109981 | 21.16 | 22.21 | 903.50 | 0.51 | 904.01 |
| SC-2 | 129 | 3 | 810 | 104505 | 21.16 | 22.14 | 903.50 | 0.48 | 903.98 |
| SC-2 | 129 | 4 | 769 | 99229 | 21.16 | 22.10 | 903.50 | 0.46 | 903.96 |
| SC-2 | 129 | 5 | 726 | 93603 | 21.16 | 22.03 | 903.50 | 0.43 | 903.93 |
| SC-2 | 129 | 10 | 419 | 54045 | 21.16 | 21.61 | 903.50 | 0.25 | 903.75 |

Hazlett Lake

| Catchment ID | Catchment area (ha) | Release rate (L/s/ha) | Active Storage required | | Wetland surface area | | Elevation at NWL (m) | Depth of active storage (m) | Elevation at HWL (m) |
|--------------|---------------------|-----------------------|-------------------------|---------------------|----------------------|----------|----------------------|-----------------------------|----------------------|
| | | | Per ha (m3) | Total catchment(m3) | NWL (ha) | HWL (ha) | | | |
| SC-3 | 268 | 0 | 938 | 251345 | 55.40 | 57.03 | 877.30 | 0.40 | 877.70 |
| SC-3 | 268 | 1 | 895 | 239868 | 55.40 | 56.95 | 877.30 | 0.38 | 877.68 |
| SC-3 | 268 | 2 | 853 | 228488 | 55.40 | 56.87 | 877.30 | 0.36 | 877.66 |
| SC-3 | 268 | 3 | 810 | 217111 | 55.40 | 56.82 | 877.30 | 0.35 | 877.65 |
| SC-3 | 268 | 4 | 768 | 205800 | 55.40 | 56.74 | 877.30 | 0.33 | 877.63 |
| SC-3 | 268 | 5 | 726 | 194461 | 55.40 | 56.65 | 877.30 | 0.31 | 877.61 |
| SC-3 | 268 | 10 | 419 | 112279 | 55.40 | 56.11 | 877.30 | 0.18 | 877.48 |

Hazlett Lake

| Catchment ID | Catchment area (ha) | Release rate (L/s/ha) | Active Storage required | | Wetland surface area | | Elevation at NWL (m) | Depth of active storage (m) | Elevation at HWL (m) |
|--------------|---------------------|-----------------------|-------------------------|---------------------|----------------------|----------|----------------------|-----------------------------|----------------------|
| | | | Per ha (m3) | Total catchment(m3) | NWL (ha) | HWL (ha) | | | |
| SC-3 + SC-4B | 359 | 0 | 938 | 336690 | 55.40 | 57.54 | 877.30 | 0.52 | 877.82 |
| SC-3 + SC-4B | 359 | 1 | 895 | 321315 | 55.40 | 57.45 | 877.30 | 0.50 | 877.80 |
| SC-3 + SC-4B | 359 | 2 | 853 | 306071 | 55.40 | 57.32 | 877.30 | 0.47 | 877.77 |
| SC-3 + SC-4B | 359 | 3 | 810 | 290831 | 55.40 | 57.24 | 877.30 | 0.45 | 877.75 |
| SC-3 + SC-4B | 359 | 4 | 768 | 275679 | 55.40 | 57.2 | 877.30 | 0.44 | 877.74 |
| SC-3 + SC-4B | 359 | 5 | 726 | 260491 | 55.40 | 57.11 | 877.30 | 0.42 | 877.72 |
| SC-3 + SC-4B | 359 | 10 | 419 | 150404 | 55.40 | 56.41 | 877.30 | 0.25 | 877.55 |

Unnamed North

| Catchment ID | Catchment area (ha) | Release rate (L/s/ha) | Active Storage required | | Wetland surface area | | Elevation at NWL (m) | Depth of active storage (m) | Elevation at HWL (m) |
|--------------|---------------------|-----------------------|-------------------------|---------------------|----------------------|----------|----------------------|-----------------------------|----------------------|
| | | | Per ha (m3) | Total catchment(m3) | NWL (ha) | HWL (ha) | | | |
| SC-4A | 536 | 0 | 938 | 502691 | 22.00 | 31.00 | 906.00 | 1.84 | 907.84 |
| SC-4A | 536 | 1 | 895 | 479735 | 22.00 | 30.64 | 906.00 | 1.75 | 907.75 |
| SC-4A | 536 | 2 | 853 | 456975 | 22.00 | 30.25 | 906.00 | 1.66 | 907.66 |
| SC-4A | 536 | 3 | 810 | 434221 | 22.00 | 29.90 | 906.00 | 1.58 | 907.58 |
| SC-4A | 536 | 4 | 768 | 411599 | 22.00 | 29.55 | 906.00 | 1.50 | 907.50 |
| SC-4A | 536 | 5 | 726 | 388923 | 22.00 | 29.20 | 906.00 | 1.42 | 907.42 |
| SC-4A | 536 | 10 | 419 | 224559 | 22.00 | 27.00 | 906.00 | 0.91 | 906.91 |

16/09/2005

Table 3: Pre development wetland elevations for representative dry and wet years

DRY YEAR 1979

| Wetland ID | Contributing Catchments | Catchment area (ha) | Max volume Wetland (m3) | Annual spill Volume (m3) | Wetland surface area | | Elevation at NWL (m) | Depth of active stoarege (m) | Elevation at HWL (m) |
|---------------|-------------------------|---------------------|-------------------------|--------------------------|----------------------|----------|----------------------|------------------------------|----------------------|
| | | | | | NWL (ha) | HWL (ha) | | | |
| Unnamed South | SC-1 | 522 | 14627 | 0 | 20.00 | 20.19 | 914.00 | 0.072 | 914.072 |
| Cameo Lake | SC-2 | 129 | 108917 | 483316 | 21.60 | 22.41 | 903.50 | 0.500 | 904.00 |
| Hazlett Lake | SC-3 | 268 | 6373 | 0 | 55.40 | 55.77 | 877.30 | 0.011 | 877.31 |
| Hazlett Lake | SC-3+SC-4B | 359 | 477533 | 100933 | 55.40 | 81.10 | 877.30 | 0.700 | 878.00 |
| Unnamed North | SC-4A | 536 | 11791 | 0 | 22.00 | 22.11 | 906.00 | 0.053 | 906.05 |

In case of spill, max elevation = assumed spillover elevation

WET YEAR 1999

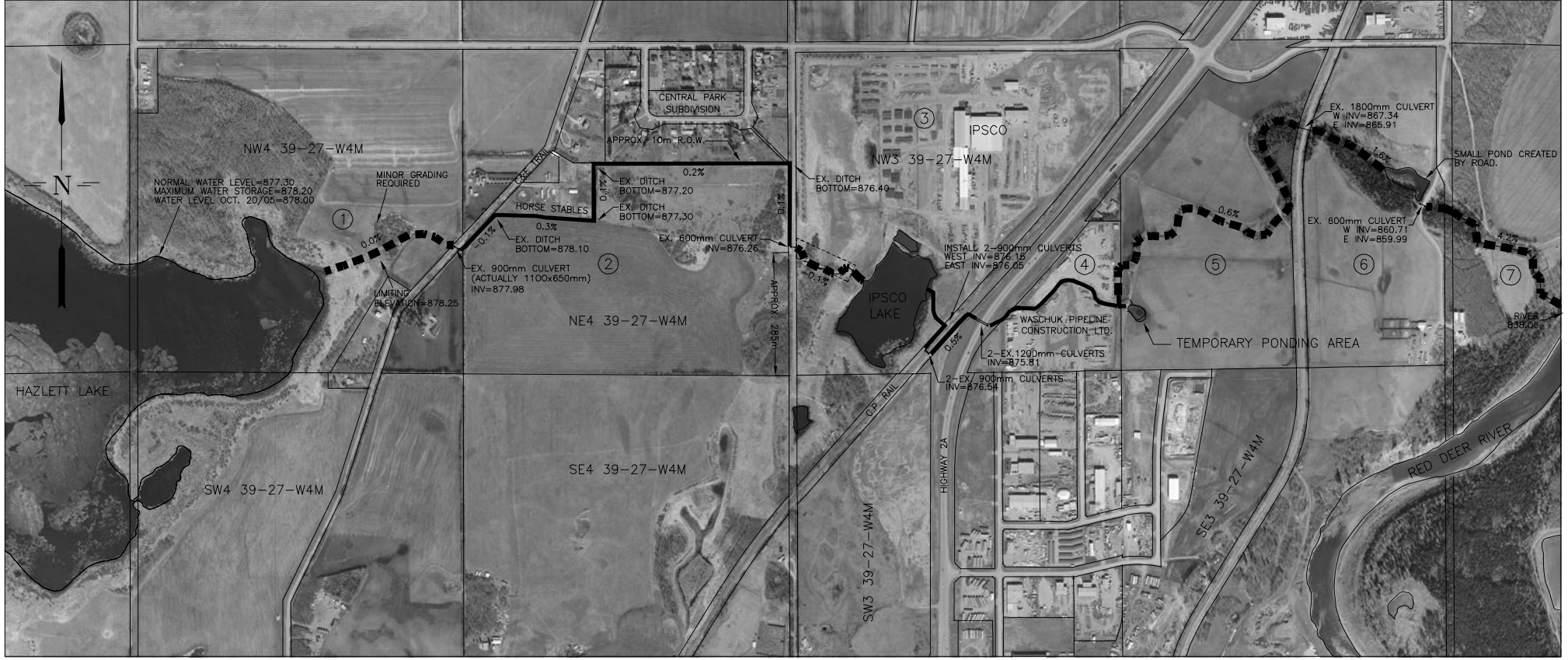
| Wetland ID | Contributing Catchments | Catchment area (ha) | Max volume Wetland (m3) | Annual spill Volume (m3) | Wetland surface area | | Elevation at NWL (m) | Depth of active stoarege (m) | Elevation at HWL (m) |
|---------------|-------------------------|---------------------|-------------------------|--------------------------|----------------------|----------|----------------------|------------------------------|----------------------|
| | | | | | NWL (ha) | HWL (ha) | | | |
| Unnamed South | SC-1 | 522 | 212994 | 487867 | 20.00 | 22.60 | 914.00 | 1.000 | 915.00 |
| Cameo Lake | SC-2 | 129 | 108917 | 537844 | 21.60 | 22.41 | 903.50 | 0.500 | 904.00 |
| Hazlett Lake | SC-3 | 268 | 132353 | 0 | 55.40 | 63.53 | 877.30 | 0.222 | 877.52 |
| Hazlett Lake | SC-3+SC-4B | 359 | 640181 | 454947 | 55.40 | 82.00 | 877.30 | 0.900 | 878.20 |
| Unnamed North | SC-4A | 536 | 90798 | 607698 | 22.00 | 23.40 | 906.00 | 0.400 | 906.40 |

In case of spill, max elevation = assumed spillover elevation

REPORT



Appendix E - "Existing Overland Drainage Route for Hazlett Lake with Proposed Easements" Drawings - Al Terra Engineering



| AREA | LEGAL | CURRENT REFERENCE TO DRAINAGE | NOTES | EASEMENT AREA REQUIRED (BASED ON 20m WIDTH) | EASEMENT COST (BASED ON \$20,000/ac) |
|------|------------------------------|--|---|---|--------------------------------------|
| ① | NW4 39-27-W4M | REGISTERED TO PLAN 2105BM-3 | REFERS TO EXISTING DRAINAGE PATTERN TO BE MAINTAINED | 1.710ac (0.692 ha) | \$34,200 |
| ② | NE4 39-27-W4M | REGISTERED TO PLAN 2105BM-3 | REFERS TO EXISTING DRAINAGE PATTERN TO BE MAINTAINED | 5.970ac (2.416 ha) | \$119,400 |
| ③ | NW3 39-27-W4M (NW OF HWY 2A) | REGISTERED TO DOCUMENT NUMBERED 94236769 SHOWS EASEMENT IN PLACE | WRITTEN EASEMENT IN PLACE TO MAINTAIN EXISTING DRAINAGE DITCH | 0.531ac (0.215 ha) | \$10,620 |
| ④ | NW3 39-27-W4M (SE OF HWY 2A) | REGISTERED TO DOCUMENT NUMBERED 982098000 SHOWS EXISTING DRAINAGE TO BE MAINTAINED | REFERS TO EXISTING DRAINAGE PATTERN TO BE MAINTAINED | 1.742ac (0.705 ha) | \$87,100 (\$50,000/ac) |
| ⑤ | NE3 39-27-W4M (W OF CN RAIL) | REGISTERED TO DOCUMENT NUMBERED 982097999 SHOWS EXISTING DRAINAGE TO BE MAINTAINED | REFERS TO EXISTING DRAINAGE PATTERN TO BE MAINTAINED | 4.040ac (1.635 ha) | \$80,800 |
| ⑥ | NE3 39-27-W4M (E OF CN RAIL) | REGISTERED TO DOCUMENT NUMBERED 982097999 SHOWS EXISTING DRAINAGE TO BE MAINTAINED | REFERS TO EXISTING DRAINAGE PATTERN TO BE MAINTAINED | 1.243ac (0.503 ha) | \$24,860 |
| ⑦ | NW2 39-27-W4M | NONE | APPEARS THAT REGISTERED PROPERTY LINE IS ALONG VISIBLE DRAINAGE ROUTE | 2.036ac (0.824 ha) | \$40,720 |
| | | | | TOTAL = 17.272ac (6.990 ha) | TOTAL = \$397,700 |

LEGEND:

- NATURAL DRAINAGE ROUTE [Dashed line symbol]
- GRADED DRAINAGE ROUTE [Thick solid line symbol]
- ULTIMATE DRAINAGE ROUTE [Thin solid line symbol]

| | | | | | |
|---|-----------------|--|--|---|--|
| AL-TERRA ENGINEERING LTD. EDMONTON | RED DEER | THE CITY OF RED DEER 2005 INDUSTRIAL LANDS SANITARY AND STORM TRUNK PROJECT EXISTING OVERLAND DRAINAGE ROUTE FOR HAZLETT LAKE WITH PROPOSED EASEMENTS | | DRAWN: TDG DESIGN: MAB APPROVED: MAB ACAD: E:\PROJ\260-2005 Industrial Lands\Overland Drainage\Hazlett Lake Drainage\Case.dwg SCALE: A1 SIZE 1:5000 1x17 SIZE 1:10000 | JOB No.: 260-G SHEET No.: 1/1 DATE ORIGINAL DRAWING: SEPT 2005 DATE PNL: DRAWING: D1 |
| | | | | | |

REPORT



Appendix F - Chiles Industrial Park Subdivision - ISL As-Built Drawings

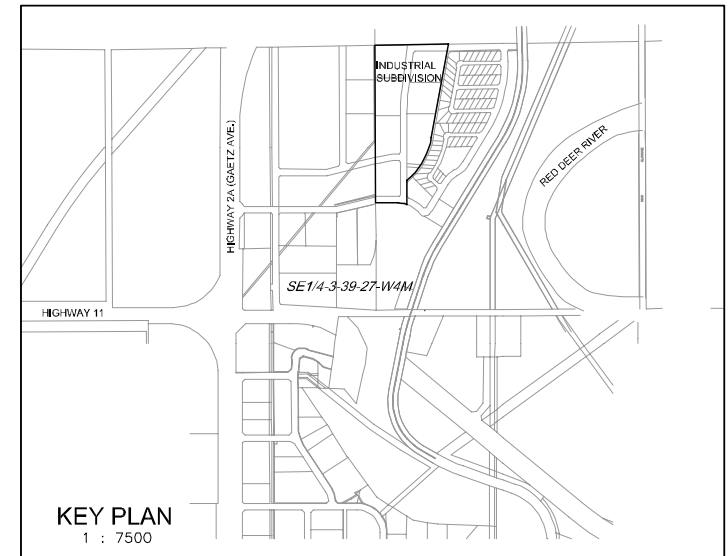
CHILES DEVELOPMENT CORPORATION LTD.

SUBMISSION DRAWINGS
FOR

S.E. 1/4 3-39-27-4 INDUSTRIAL SUBDIVISION

COUNTY OF RED DEER, ALBERTA

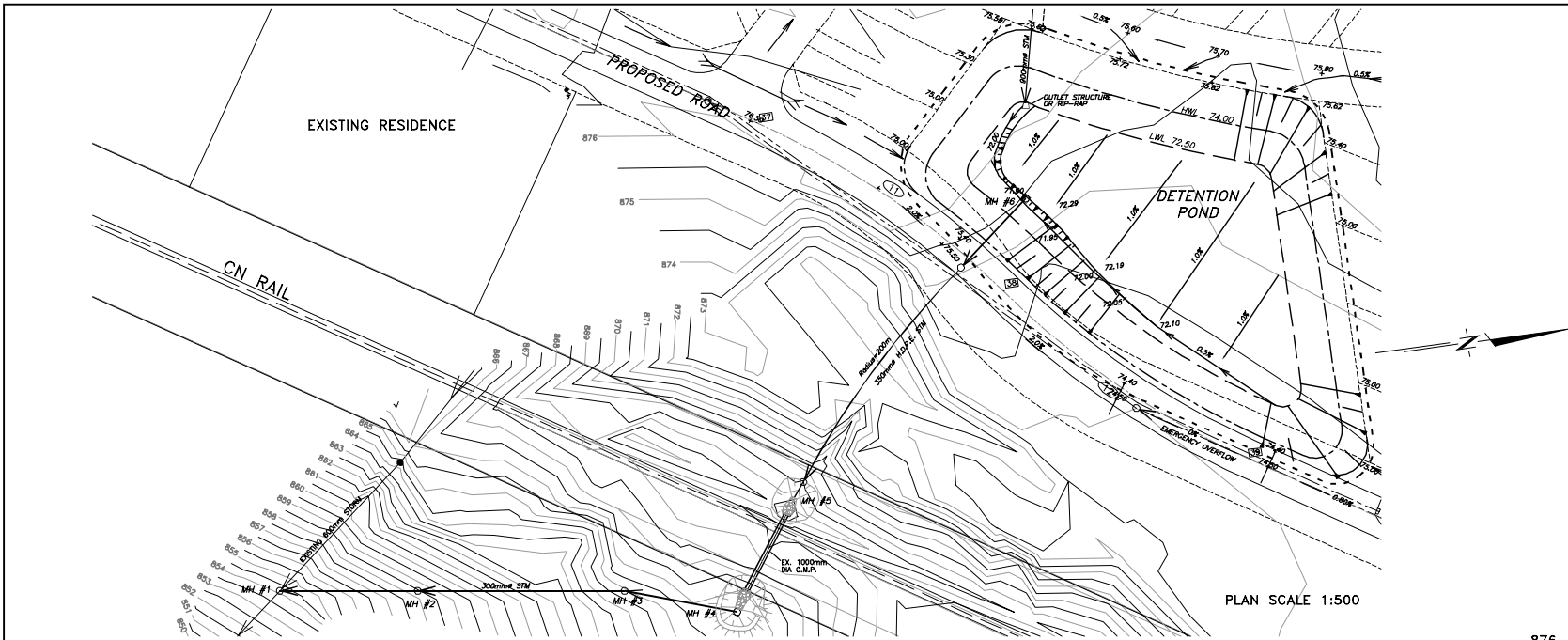
JULY, 2000



LIST OF DRAWINGS

| DRAWING No. | DESCRIPTION |
|-------------|--|
| 3684GR | OVERALL GRADING PLAN AND DRAINAGE PLAN |
| 3684ST02 | DRY DETENTION POND / STORM SEWER |
| 3685SD01 | STANDARD DETAILS |

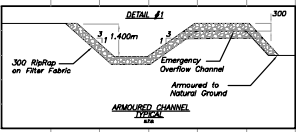
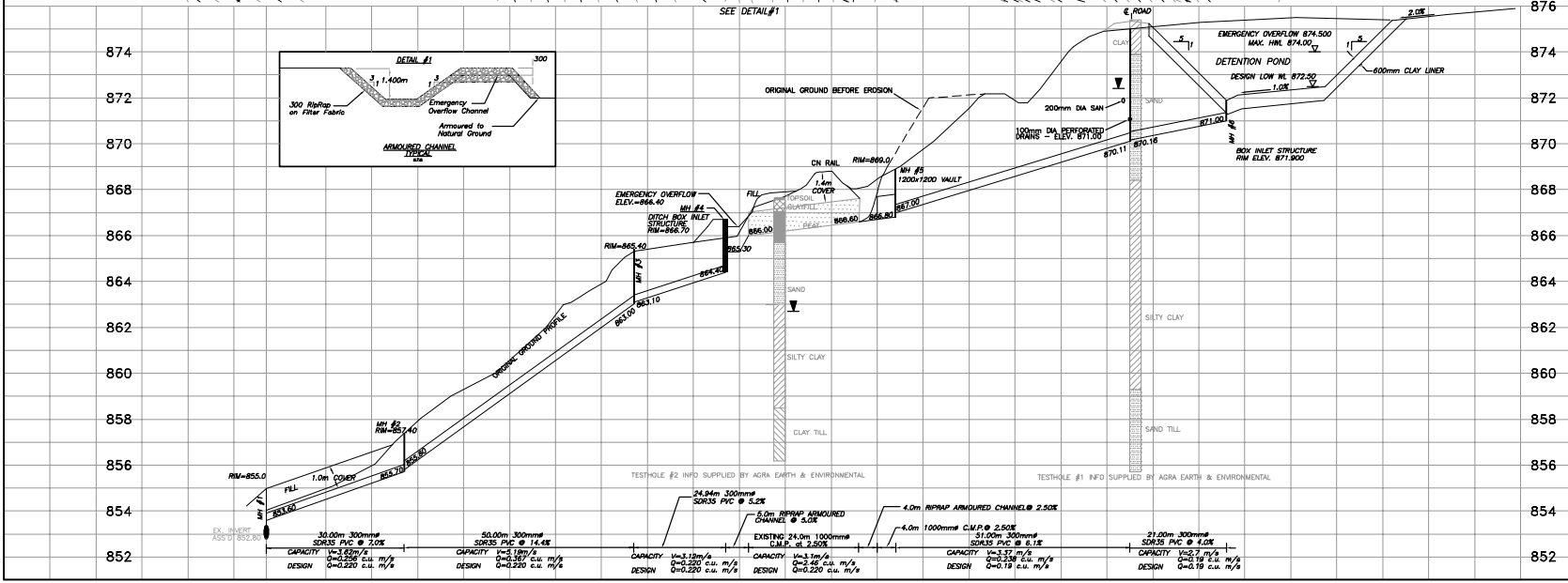
SET No. _____



- NOTES:**
1. DETENTION POND AND STORM SEWER SIZED BY STORM DRAINAGE DESIGN REPORT FOR SE3-39-27-W4M BY ISL ENGINEERING MARCH 9, 2000.
 2. DETENTION POND AND STORM SEWER TO BE CONSTRUCTED WITH THE INDUSTRIAL SUBDIVISION IN SE3-39-27-W4M.

NOTE: THE LOCATION OF THE EXISTING UTILITIES IS APPROXIMATE ONLY, AND THE EXACT LOCATION SHOULD BE DETERMINED BY CONSULTING THE MUNICIPAL AUTHORITIES AND UTILITY COMPANIES CONCERNED. THE CONTRACTOR SHALL ALSO VERIFY THE EXACT LOCATION AND INVERT ELEVATION BY HAND EXAMINATION BEFORE CONSTRUCTION OF THE UTILITY CROSSING AND SHALL BE RESPONSIBLE FOR ADEQUATE PROTECTION FROM DAMAGE.

PLAN SCALE 1:500



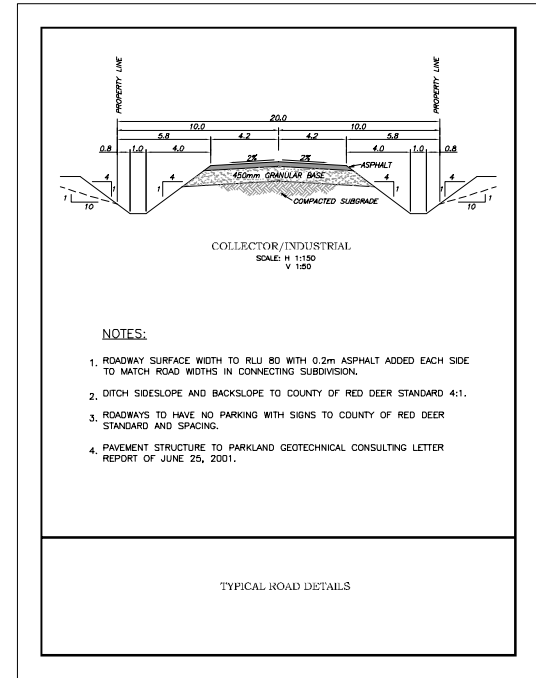
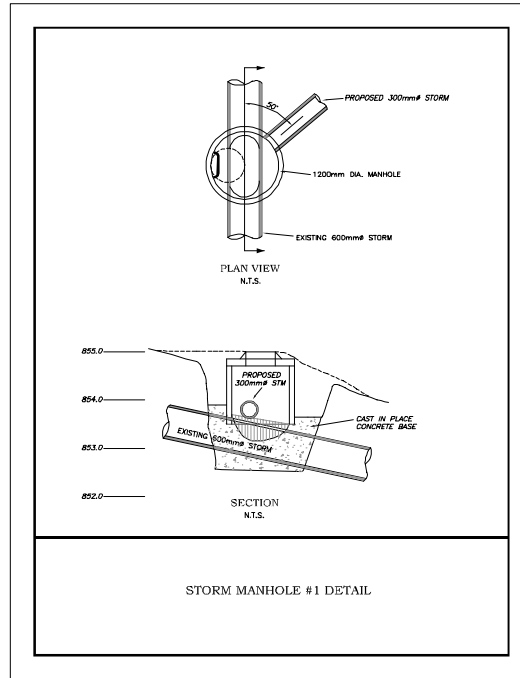
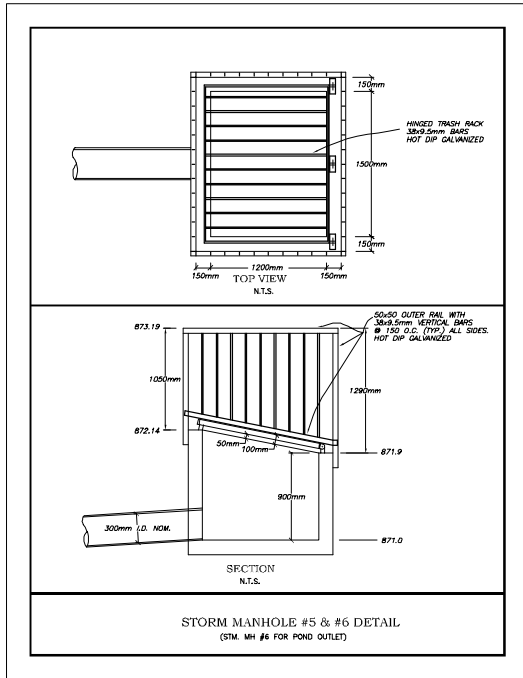
| | | |
|-----------|------------|-------|
| UTILITIES | CONTRACTOR | DATES |
| SANITARY | | |
| WATER | | |
| STORM | | |
| SURFACE | | |
| SIDWALK | | |

| | |
|--|--|
| | PERMIT TO PRACTICE Infrastructure Systems Ltd. Signature _____ Date _____ |
| | PERMIT NUMBER: P 4741 The Association of Professional Engineers, Geologists and Geophysicists of Alberta |

| | | | | |
|-----|--|----------|-----|---------|
| NO. | REVISION | DATE | BY | CHECKED |
| 1 | ISSUE FOR PERMITS | JULY '00 | RPH | RH |
| 2 | ADD NOTES, CHANGE PIPE MATERIAL / SIZE | JULY '01 | RPH | RH |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |

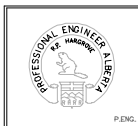
| | |
|---|-----------------------------|
| | |
| CHILES DEVELOPMENT CORPORATION LTD CHILES INDUSTRIAL SUBDIVISION COUNTY OF RED DEER, ALBERTA | |
| DRY DETENTION POND/ STORM SEWER | |
| DESIGNER: R. HARROVE | APPROVED: [Signature] |
| DRAWN: PED | CHECKED: [Signature] |
| DATE: FEBRUARY, 2000 | PROJECT NO.: |
| SCALE: | DRAWING NUMBER: 3684ST02 |

NAME: H01TH-DAY-YEAR-DWGNAME.DWG



NOTES:

1. ROADWAY SURFACE WIDTH TO RLLU 80 WITH 0.2m ASPHALT ADDED EACH SIDE TO MATCH ROAD WIDTHS IN CONNECTING SUBDIVISION.
2. DITCH SIDESLOPE AND BACKSLOPE TO COUNTY OF RED DEER STANDARD 4:1.
3. ROADWAYS TO HAVE NO PARKING WITH SIGNS TO COUNTY OF RED DEER STANDARD AND SPACING.
4. PAVEMENT STRUCTURE TO PARKLAND GEOTECHNICAL CONSULTING LETTER REPORT OF JUNE 25, 2001.



PERMIT TO PRACTICE
Infrastructure Systems Ltd.
Signature _____
Date _____
PERMIT NUMBER: P 4741
The Association of Professional Engineers,
Geologists and Geophysicists of Alberta

| NO. | REVISION | DATE | BY | CHECKED |
|-----|------------------------------|----------|----|---------|
| 1 | ISSUE FOR PERMITS | JULY '00 | RH | RPH |
| 2 | REVISE ROAD DETAIL AND NOTES | JULY '01 | RH | RPH |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |



CHILES DEVELOPMENT CORPORATION LTD
CHILES INDUSTRIAL SUBDIVISION
COUNTY OF RED DEER, ALBERTA
TRUNK
SANITARY SEWER
STANDARD DETAILS

| DESIGNER | APPROVED | DATE |
|-------------|----------|-----------------|
| R. HARGROVE | RPH | FEBRUARY, 1999 |
| DRAWN | CHECKED | ISL PROJECT NO. |
| KJ | RPH | 3685 |
| SCALE: | AS SHOWN | DRAWING NUMBER: |
| | | 3684SD01 |

**Appendix G - Stormwater Management Facilities-
Detailed Calculations**

Summary – APPENDIX G

In order to service the future development area, a series of stormwater management (SWM) facilities are required within the project boundary to provide water quantity control, and to prevent any increase of erosion and downstream flooding to existing receiving streams.

The detention ponds also provide benefits in improving stormwater quality by promoting the settlement of runoff pollutants. Alberta Environment’s stormwater management guidelines require control of water quality in urban stormwater. The minimum requirements are to remove at least 85% of the suspended sediments larger than 75 micron (0.75 mm) in size.

The future stormwater management facilities were conceptually sized by using the modified rational method. The active storage requirements were determined by using the Intensity-duration-frequency (IDF) rainfall data from the Red Deer Industrial Airport (period 1964-2006) for the 1:100 year storm event and a release rate of 2 l/s/ha.

The following runoff coefficients were used for the calculation based on the land used.

| Land Use | Storm Frequency |
|-----------------------------|------------------|
| | 1:100 Year Storm |
| Residential | 0.60 |
| Apartments | 0.80 |
| Downtown Commercial | 0.90 |
| Neighbourhood Commercial | 0.80 |
| Lawns, Parks, Playgrounds | 0.30 |
| Undeveloped Land (Farmland) | 0.20 |
| Paved Streets | 0.95 |
| Gravel Streets | 0.65 |

The preliminary size of the ponds were then calculated by an AE “Wet Pond Design” excel spreadsheet which take in consideration the different ponds depths, minimum freeboard and side slope requirements from the City of Red Deer design standards.

Depth-area curves were developed for each pond, and imported into the PCSWMM model to confirm pond capacity and to determine the pre/post development hydrographs.

The following appendix provides detailed calculations of the modified rational method, pond sizes and pre/post development hydrographs for each future pond. Note that a detailed survey will be required during the design phase to confirm HWL, NWL and pond sizes.

Simplified storage analysis using the Modified Rational Method
 Version 29/09/2008
 For storm durations 1 to 24 hours

Location: **POND1**
 Project # **2015-3382** Date: 03/23/16

Project Number:
 Computed by: **LM**

| IDF Curve | | |
|--------------------------|-------------------|-----|
| Red Deer (2-24 hours) ▼ | | |
| | Area (ha) | Cv |
| Commercial | 4.4 | 0.9 |
| Industrial | | 0.8 |
| Residential | 103.512 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 107.912 ha | |
| Cv = | 0.61 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

| Pipe Design: | |
|---------------|-------------|
| Return Period | 5 years |
| Tc | 10 minutes |
| Q | 86.7 l/s/ha |

| Storage Parameters | | |
|----------------------|---------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 215.824 | l/s |
| Storage volume | 63620 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 164 | hours |
| | 7 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 hours | |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND2**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.8 |
| Residential | 17.73 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 17.73 ha | |
| Cv = | 0.60 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 85.0 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 35.46 | l/s |
| Storage volume | 10210 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 160 | hours |
| | 7 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
 Version 29/09/2008
 For storm durations 1 to 24 hours

Location: **POND3**
 Project # **2015-3382** Date: 03/23/16

Project Number:
 Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | 48.52 | 0.9 |
| Industrial | | 0.8 |
| Residential | 11.5 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 60.02 ha | |
| Cv = | 0.84 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 119.3 l/s/ha

| Storage Parameters | | |
|----------------------|--------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 120.04 | l/s |
| Storage volume | 50650 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 234 | hours |
| | 10 | days |

| Rainfall parameters for storage | | |
|---------------------------------|--------------------------|-------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 (t in hours) | |
| b | -0.52 | |
| c | -0.433333333 hours | |

| Rainfall parameters for pipe design | | |
|-------------------------------------|--------------------------|-------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 (t in hours) | |
| b | -0.6 | |
| c | 0 hours | |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND4**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | 38 | 0.9 |
| Industrial | | 0.8 |
| Residential | 17 | 0.6 |
| Pond | | 1 |
| Parks | 13.4 | 0.3 |
| Total area = | 68.4 ha | |
| Cv = | 0.71 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 100.3 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 136.8 | l/s |
| Storage volume | 47550 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 193 | hours |
| | 8 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND5**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | 44.44 | 0.9 |
| Industrial | | 0.8 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 44.44 ha | |
| Cv = | 0.90 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 127.5 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 88.88 | l/s |
| Storage volume | 40320 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 252 | hours |
| | 11 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND6**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|------------------|-----|
| Commercial | 26.77 | 0.9 |
| Industrial | 7.07 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 33.84 ha | |
| Cv = | 0.86 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 121.6 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 67.68 | l/s |
| Storage volume | 29140 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 239 | hours |
| | 10 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND7**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 26.92 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 26.92 ha | |
| Cv = | 0.70 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 99.1 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 53.84 | l/s |
| Storage volume | 18480 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 191 | hours |
| | 8 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND8**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 19.3 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 19.3 ha | |
| Cv = | 0.70 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 99.1 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 38.6 | l/s |
| Storage volume | 13250 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 191 | hours |
| | 8 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND9**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 19.38 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 19.38 ha | |
| Cv = | 0.70 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 99.1 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 38.76 | l/s |
| Storage volume | 13300 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 191 | hours |
| | 8 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND10**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 34.18 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 34.18 ha | |
| Cv = | 0.70 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 99.1 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 68.36 | l/s |
| Storage volume | 23460 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 191 | hours |
| | 8 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND11**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | |
| Residential | 35.1 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 35.1 ha | |
| Cv = | 0.60 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 85.0 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 70.2 | l/s |
| Storage volume | 20220 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 160 | hours |
| | 7 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
 Version 29/09/2008
 For storm durations 1 to 24 hours

Location: **POND12**
 Project # **2015-3382** Date: 03/23/16

Project Number:
 Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 12.1 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 12.1 ha | |
| Cv = | 0.70 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 99.1 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 24.2 | l/s |
| Storage volume | 8310 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 191 | hours |
| | 8 | days |

| Rainfall parameters for storage | | |
|---------------------------------|--------------------------|-------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 (t in hours) | |
| b | -0.52 | |
| c | -0.433333333 hours | |

| Rainfall parameters for pipe design | | |
|-------------------------------------|--------------------------|-------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 (t in hours) | |
| b | -0.6 | |
| c | 0 hours | |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND13**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 73.7 | 0.6 |
| Pond | | 1 |
| Parks | 34.4 | 0.3 |
| Total area = | 108.1 ha | |
| Cv = | 0.50 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 71.5 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 216.2 | l/s |
| Storage volume | 50880 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 131 | hours |
| | 5 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND14**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 38.7 | 0.6 |
| Pond | | 1 |
| Parks | 12 | 0.3 |
| Total area = | 50.7 ha | |
| Cv = | 0.53 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 74.9 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 101.4 | l/s |
| Storage volume | 25230 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 138 | hours |
| | 6 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
 Version 29/09/2008
 For storm durations 1 to 24 hours

Location: **POND15**
 Project # **2015-3382** Date: 03/23/16
 Red Deer (2-24 hours) ▼

Project Number:
 Computed by: **LM**

| IDF Curve Red Deer (2-24 hours) | | |
|--|------------------|-----------|
| | Area (ha) | Cv |
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 27.3 | 0.6 |
| Pond | | 1 |
| Parks | 16.6 | 0.3 |
| Total area = | 43.9 ha | |
| Cv = | 0.49 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 68.9 l/s/ha

| Storage Parameters | | |
|---------------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 87.8 | l/s |
| Storage volume | 19790 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 125 | hours |
| | 5 | days |

| Rainfall parameters for storage | | |
|--|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|--|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
 Version 29/09/2008
 For storm durations 1 to 24 hours

Location: **POND16**
 Project # **2015-3382** Date: 03/23/16

Project Number:
 Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | 22.8 | 0.9 |
| Industrial | | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 22.8 ha | |
| Cv = | 0.90 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 127.5 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 45.6 | l/s |
| Storage volume | 20690 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 252 | hours |
| | 11 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
 Version 29/09/2008
 For storm durations 1 to 24 hours

Location: **POND17**
 Project # **2015-3382** Date: 03/23/16

Project Number:
 Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 111.6 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 111.6 ha | |
| Cv = | 0.60 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 85.0 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 223.2 | l/s |
| Storage volume | 64290 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 160 | hours |
| | 7 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
 Version 29/09/2008
 For storm durations 1 to 24 hours

Location: **POND18**
 Project # **2015-3382** Date: 03/23/16

Project Number:
 Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 27.2 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 27.2 ha | |
| Cv = | 0.60 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 85.0 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 54.4 | l/s |
| Storage volume | 15670 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 160 | hours |
| | 7 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND19**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 31.8 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 31.8 ha | |
| Cv = | 0.60 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 85.0 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 63.6 | l/s |
| Storage volume | 18320 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 160 | hours |
| | 7 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND20**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 80.8 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 80.8 ha | |
| Cv = | 0.60 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 85.0 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 161.6 | l/s |
| Storage volume | 46550 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 160 | hours |
| | 7 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND21**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 47.8 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 47.8 ha | |
| Cv = | 0.70 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 99.1 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 95.6 | l/s |
| Storage volume | 32810 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 191 | hours |
| | 8 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND22**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 14.57 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 14.57 ha | |
| Cv = | 0.70 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 99.1 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 29.14 | l/s |
| Storage volume | 10000 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 191 | hours |
| | 8 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND23**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 28.01 | 0.7 |
| Residential | 1.09 | 0.6 |
| Pond | | 1 |
| Parks | 11.7 | 0.3 |
| Total area = | 40.8 ha | |
| Cv = | 0.58 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 82.5 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 81.6 | l/s |
| Storage volume | 22720 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 155 | hours |
| | 6 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND24**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 17.3 | 0.7 |
| Residential | 11.74 | 0.6 |
| Pond | | 1 |
| Parks | 9.66 | 0.3 |
| Total area = | 38.7 ha | |
| Cv = | 0.57 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 80.7 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 77.4 | l/s |
| Storage volume | 21000 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 151 | hours |
| | 6 | days |

| Rainfall parameters for storage | | |
|---------------------------------|--------------------------|-------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 (t in hours) | |
| b | -0.52 | |
| c | -0.433333333 hours | |

| Rainfall parameters for pipe design | | |
|-------------------------------------|--------------------------|-------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 (t in hours) | |
| b | -0.6 | |
| c | 0 hours | |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND25**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 51.48 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 51.48 ha | |
| Cv = | 0.70 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 99.1 l/s/ha

Storage Parameters

| | | |
|----------------------|--------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 102.96 | l/s |
| Storage volume | 35340 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 191 | hours |
| | 8 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND26**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 45.32 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 45.32 ha | |
| Cv = | 0.70 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 99.1 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 90.64 | l/s |
| Storage volume | 31110 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 191 | hours |
| | 8 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
 Version 29/09/2008
 For storm durations 1 to 24 hours

Location: **POND27**
 Project # **2015-3382** Date: 03/23/16

Project Number:
 Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 28.7 | 0.7 |
| Residential | 31.8 | 0.6 |
| Pond | | 1 |
| Parks | 5.3 | 0.3 |
| Total area = | 65.8 ha | |
| Cv = | 0.62 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 87.7 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 131.6 | l/s |
| Storage volume | 39320 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 166 | hours |
| | 7 | days |

| Rainfall parameters for storage | | |
|---------------------------------|--------------------------|-------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 (t in hours) | |
| b | -0.52 | |
| c | -0.433333333 hours | |

| Rainfall parameters for pipe design | | |
|-------------------------------------|--------------------------|-------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 (t in hours) | |
| b | -0.6 | |
| c | 0 hours | |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND28**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 40.38 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 40.38 ha | |
| Cv = | 0.60 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 85.0 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 80.76 | l/s |
| Storage volume | 23260 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 160 | hours |
| | 7 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND29**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 59.4 | 0.6 |
| Pond | | 1 |
| Parks | 19.2 | 0.3 |
| Total area = | 78.6 ha | |
| Cv = | 0.53 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 74.6 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 157.2 | l/s |
| Storage volume | 38920 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 138 | hours |
| | 6 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND30**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | 9 | 0.9 |
| Industrial | | 0.7 |
| Residential | 50.3 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 59.3 ha | |
| Cv = | 0.65 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 91.4 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 118.6 | l/s |
| Storage volume | 37140 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 174 | hours |
| | 7 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND31**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | 7 | 0.9 |
| Industrial | | 0.7 |
| Residential | 42.5 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 49.5 ha | |
| Cv = | 0.64 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 91.0 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 99 | l/s |
| Storage volume | 30830 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 173 | hours |
| | 7 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND32**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|------------------|-----|
| Commercial | 20.4 | 0.9 |
| Industrial | | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | 3.14 | 0.3 |
| Total area = | 23.54 ha | |
| Cv = | 0.82 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 116.1 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 47.08 | l/s |
| Storage volume | 19280 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 227 | hours |
| | 9 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
 Version 29/09/2008
 For storm durations 1 to 24 hours

Location: **POND33**
 Project # **2015-3382** Date: 03/23/16

Project Number:
 Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 43.2 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 43.2 ha | |
| Cv = | 0.60 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 85.0 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 86.4 | l/s |
| Storage volume | 24890 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 160 | hours |
| | 7 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
 Version 29/09/2008
 For storm durations 1 to 24 hours

Location: **POND34**
 Project # **2015-3382** Date: 03/23/16

Project Number:
 Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 45.2 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 45.2 ha | |
| Cv = | 0.70 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 99.1 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 90.4 | l/s |
| Storage volume | 31030 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 191 | hours |
| | 8 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
 Version 29/09/2008
 For storm durations 1 to 24 hours

Location: **POND35**
 Project # **2015-3382** Date: 03/23/16

Project Number:
 Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 11.6 | 0.6 |
| Pond | | 1 |
| Parks | 9.4 | 0.3 |
| Total area = | 21 ha | |
| Cv = | 0.47 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 66.0 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 42 | l/s |
| Storage volume | 8980 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 119 | hours |
| | 5 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND36**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 5.2 | 0.7 |
| Residential | 42.2 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 47.4 ha | |
| Cv = | 0.61 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 86.5 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 94.8 | l/s |
| Storage volume | 27880 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 163 | hours |
| | 7 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND37**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 19 | 0.6 |
| Pond | | 1 |
| Parks | 7.1 | 0.3 |
| Total area = | 26.1 ha | |
| Cv = | 0.52 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 73.4 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 52.2 | l/s |
| Storage volume | 12680 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 135 | hours |
| | 6 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND38**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 3.6 | 0.6 |
| Pond | | 1 |
| Parks | 39.2 | 0.3 |
| Total area = | 42.8 ha | |
| Cv = | 0.33 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 46.1 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 85.6 | l/s |
| Storage volume | 11670 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 76 | hours |
| | 3 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND39**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 39.5 | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 39.5 ha | |
| Cv = | 0.60 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 85.0 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 79 | l/s |
| Storage volume | 22750 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 160 | hours |
| | 7 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND40**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | 5.32 | 0.6 |
| Pond | | 1 |
| Parks | 45.78 | 0.3 |
| Total area = | 51.1 ha | |
| Cv = | 0.33 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 46.9 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 102.2 | l/s |
| Storage volume | 14270 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 78 | hours |
| | 3 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND41**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 3 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | 9.4 | 0.3 |
| Total area = | 12.4 ha | |
| Cv = | 0.40 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 56.2 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 24.8 | l/s |
| Storage volume | 4360 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 98 | hours |
| | 4 | days |

| Rainfall parameters for storage | | |
|---------------------------------|--------------------------|-------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 (t in hours) | |
| b | -0.52 | |
| c | -0.433333333 hours | |

| Rainfall parameters for pipe design | | |
|-------------------------------------|--------------------------|-------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 (t in hours) | |
| b | -0.6 | |
| c | 0 hours | |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND42**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 13.5 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | 5.3 | 0.3 |
| Total area = | 18.8 ha | |
| Cv = | 0.59 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 83.2 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 37.6 | l/s |
| Storage volume | 10560 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 156 | hours |
| | 7 | days |

| Rainfall parameters for storage | | |
|---------------------------------|--------------------------|-------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 (t in hours) | |
| b | -0.52 | |
| c | -0.433333333 hours | |

| Rainfall parameters for pipe design | | |
|-------------------------------------|--------------------------|-------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 (t in hours) | |
| b | -0.6 | |
| c | 0 hours | |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND43**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | 21.3 | 0.3 |
| Total area = | 21.3 ha | |
| Cv = | 0.30 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 42.5 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 42.6 | l/s |
| Storage volume | 5210 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 68 | hours |
| | 3 | days |

| Rainfall parameters for storage | | |
|---------------------------------|--------------------------|-------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 (t in hours) | |
| b | -0.52 | |
| c | -0.433333333 hours | |

| Rainfall parameters for pipe design | | |
|-------------------------------------|--------------------------|-------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 (t in hours) | |
| b | -0.6 | |
| c | 0 hours | |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND44**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | 30.4 | 0.3 |
| Total area = | 30.4 ha | |
| Cv = | 0.30 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 42.5 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 60.8 | l/s |
| Storage volume | 7440 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 68 | hours |
| | 3 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND45**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | 20.4 | 0.3 |
| Total area = | 20.4 ha | |
| Cv = | 0.30 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 42.5 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 40.8 | l/s |
| Storage volume | 4990 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 68 | hours |
| | 3 | days |

| Rainfall parameters for storage | | |
|---------------------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

| Rainfall parameters for pipe design | | |
|-------------------------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND46**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | 53.1 | 0.3 |
| Total area = | 53.1 ha | |
| Cv = | 0.30 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 42.5 l/s/ha

Storage Parameters

| | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 106.2 | l/s |
| Storage volume | 13000 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 68 | hours |
| | 3 | days |

Rainfall parameters for storage

| | | |
|------------------|-----------------------|--------------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 | (t in hours) |
| b | -0.52 | |
| c | -0.433333333 | hours |

Rainfall parameters for pipe design

| | | |
|------------------|-----------------------|--------------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 | (t in hours) |
| b | -0.6 | |
| c | 0 | hours |

Simplified storage analysis using the Modified Rational Method
Version 29/09/2008
For storm durations 1 to 24 hours

Location: **POND47**
Project # **2015-3382** Date: 03/23/16

Project Number:
Computed by: **LM**

IDF Curve Red Deer (2-24 hours) ▼

| | Area (ha) | Cv |
|--------------------------|-----------|-----|
| Commercial | | 0.9 |
| Industrial | 85.2 | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | | 0.3 |
| Total area = | 85.2 ha | |
| Cv = | 0.70 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

Pipe Design:
Return Period 5 years
Tc 10 minutes
Q 99.1 l/s/ha

| Storage Parameters | | |
|----------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 170.4 | l/s |
| Storage volume | 58490 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 191 | hours |
| | 8 | days |

| Rainfall parameters for storage | | |
|---------------------------------|--------------------------|-------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 (t in hours) | |
| b | -0.52 | |
| c | -0.433333333 hours | |

| Rainfall parameters for pipe design | | |
|-------------------------------------|--------------------------|-------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 (t in hours) | |
| b | -0.6 | |
| c | 0 hours | |

Simplified storage analysis using the Modified Rational Method
 Version 29/09/2008
 For storm durations 1 to 24 hours

Location: **POND48**
 Project # **2015-3382** Date: 03/23/16
 Red Deer (2-24 hours) ▼

Project Number:
 Computed by: **LM**

| IDF Curve Red Deer (2-24 hours) | | |
|--|------------------|-----------|
| | Area (ha) | Cv |
| Commercial | | 0.9 |
| Industrial | | 0.7 |
| Residential | | 0.6 |
| Pond | | 1 |
| Parks | 28.8 | 0.3 |
| Total area = | 28.8 ha | |
| Cv = | 0.30 | |
| Return period | 100 years | |
| Peak outflow rate | 2 l/s/ha | |

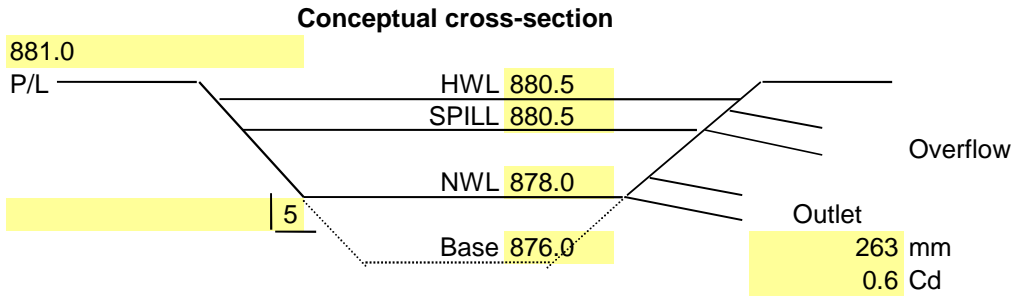
| Pipe Design: | |
|----------------------|-------------|
| Return Period | 5 years |
| Tc | 10 minutes |
| Q | 42.5 l/s/ha |

| Storage Parameters | | |
|---------------------------|-------|-------------------|
| Peak inflow | #NUM! | m ³ /s |
| Peak outflow | 57.6 | l/s |
| Storage volume | 7050 | m ³ |
| Critical storm event | 24 | hours |
| Time to drain | 68 | hours |
| | 3 | days |

| Rainfall parameters for storage | | |
|--|--------------------------|-------|
| Return period | 100 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 21 | |
| a | 23.78983037 (t in hours) | |
| b | -0.52 | |
| c | -0.433333333 hours | |

| Rainfall parameters for pipe design | | |
|--|--------------------------|-------|
| Return period | 5 | years |
| IDF Curve | Red Deer (2-24 hours) | |
| IDF Curve Number | 2 | |
| a | 17.40224536 (t in hours) | |
| b | -0.6 | |
| c | 0 hours | |

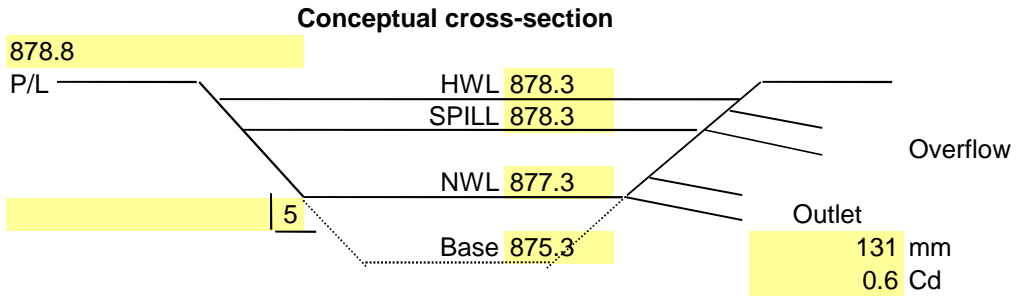
RED DEER
Stormwater Pond Conceptual Design
Pond 1



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 881.0 | 3.1 | 11.6 | 78865 | 0.244 | 5.0 |
| HWL | 880.5 | 2.9 | 10.1 | 63701 | 0.222 | 4.5 |
| Overflow Elev | 880.5 | 2.9 | 10.1 | 63701 | 0.222 | 4.5 |
| Normal water level | 878.0 | 2.2 | 3.8 | 0 | 0.000 | 2.0 |
| Base of pond | 876.0 | 1.6 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 63701 | | |
| Average existing ground | 881.0 | 3.1 | 11.6 | | | |
| Side slope | | 5.0 H:V | | | | |

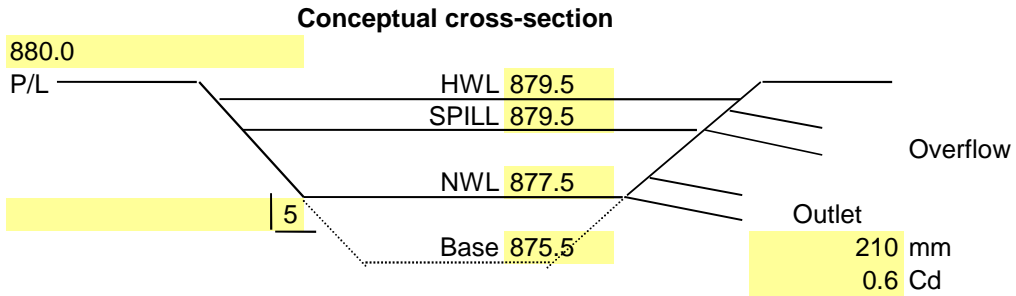
RED DEER
Stormwater Pond Conceptual Design
Pond 2



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 878.8 | 1.3 | 3.3 | 17066 | 0.043 | 3.5 |
| HWL | 878.3 | 1.2 | 2.7 | 10845 | 0.035 | 3.0 |
| Overflow Elev | 878.3 | 1.2 | 2.7 | 10845 | 0.035 | 3.0 |
| Normal water level | 877.3 | 1.0 | 1.6 | 0 | 0.000 | 2.0 |
| Base of pond | 875.3 | 0.6 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 10845 | | |
| Average existing ground | 878.8 | 1.3 | 3.3 | | | |
| Side slope | | 5.0 H:V | | | | |

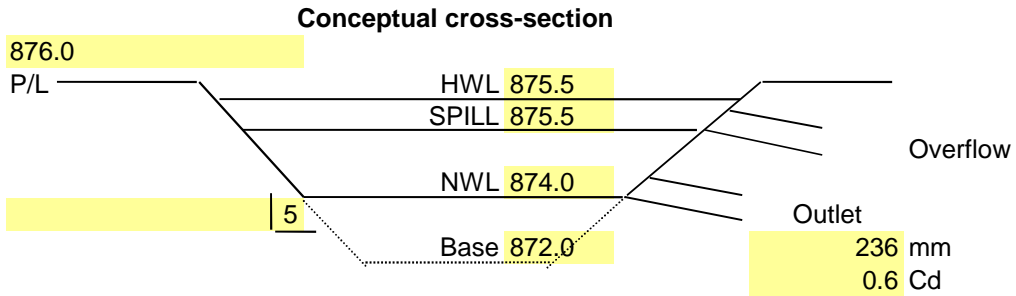
RED DEER
Stormwater Pond Conceptual Design
Pond 3



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 880.0 | 3.0 | 10.4 | 65411 | 0.142 | 4.5 |
| HWL | 879.5 | 2.9 | 9.0 | 50714 | 0.127 | 4.0 |
| Overflow Elev | 879.5 | 2.9 | 9.0 | 50714 | 0.127 | 4.0 |
| Normal water level | 877.5 | 2.2 | 3.9 | 0 | 0.000 | 2.0 |
| Base of pond | 875.5 | 1.7 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 50714 | | |
| Average existing ground | 880.0 | 3.0 | 10.4 | | | |
| Side slope | | 5.0 H:V | | | | |

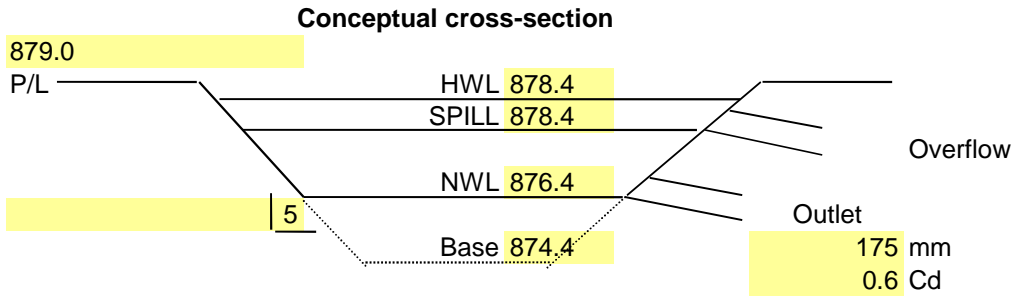
RED DEER
Stormwater Pond Conceptual Design
Pond 4



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 876.0 | 3.62 | 11.7 | 65204 | 0.159 | 4.0 |
| HWL | 875.5 | 3.44 | 9.9 | 47550 | 0.137 | 3.5 |
| Overflow Elev | 875.5 | 3.44 | 9.9 | 47550 | 0.137 | 3.5 |
| Normal water level | 874.0 | 2.90 | 5.2 | 0 | 0.000 | 2.0 |
| Base of pond | 872.0 | 2.26 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 47550 | | |
| Average existing ground | 876.0 | 3.6 | 11.7 | | | |
| Side slope | | 5.0 H:V | | | | |

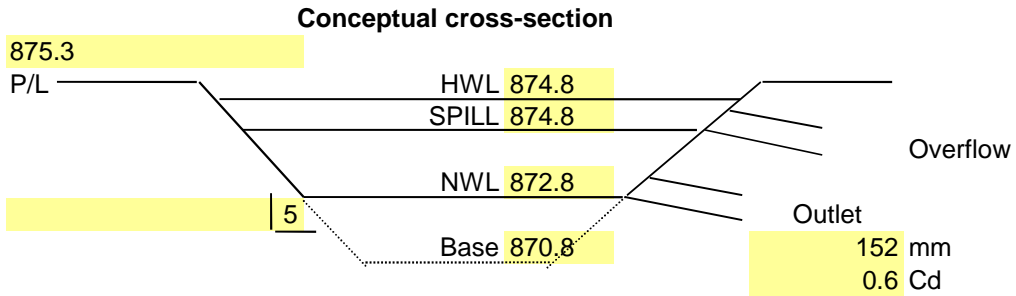
**RED DEER
Stormwater Pond Conceptual Design
Pond 5**



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m3 | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------|--------------------------------|------------|
| Minimum property line | 879.0 | 2.48 | 8.4 | 54672 | 0.101 | 4.6 |
| HWL | 878.4 | 2.30 | 7.0 | 40320 | 0.088 | 4.0 |
| Overflow Elev | 878.4 | 2.30 | 7.0 | 40320 | 0.088 | 4.0 |
| Normal water level | 876.4 | 1.73 | 3.0 | 0 | 0.000 | 2.0 |
| Base of pond | 874.4 | 1.25 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 40320 | | |
| Average existing ground | 879.0 | 2.5 | 8.4 | | | |
| Side slope | | 5.0 H:V | | | | |

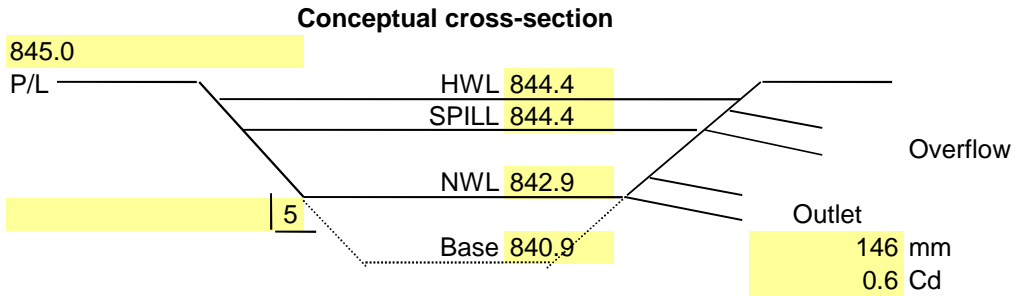
RED DEER
Stormwater Pond Conceptual Design
Pond 6



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 875.3 | 1.83 | 5.8 | 37960 | 0.075 | 4.5 |
| HWL | 874.8 | 1.70 | 4.9 | 29140 | 0.067 | 4.0 |
| Overflow Elev | 874.8 | 1.70 | 4.9 | 29140 | 0.067 | 4.0 |
| Normal water level | 872.8 | 1.22 | 2.0 | 0 | 0.000 | 2.0 |
| Base of pond | 870.8 | 0.82 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 29140 | | |
| Average existing ground | 875.3 | 1.8 | 5.8 | | | |
| Side slope | | 5.0 H:V | | | | |

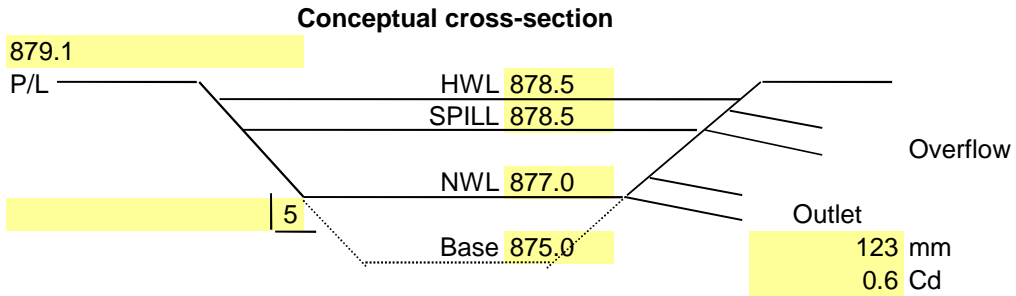
RED DEER
Stormwater Pond Conceptual Design
Pond 7



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 845.0 | 1.54 | 4.5 | 27305 | 0.063 | 4.1 |
| HWL | 844.4 | 1.40 | 3.6 | 18480 | 0.053 | 3.5 |
| Overflow Elev | 844.4 | 1.40 | 3.6 | 18480 | 0.053 | 3.5 |
| Normal water level | 842.9 | 1.07 | 1.8 | 0 | 0.000 | 2.0 |
| Base of pond | 840.9 | 0.69 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 18480 | | |
| Average existing ground | 845.0 | 1.5 | 4.5 | | | |
| Side slope | | 5.0 H:V | | | | |

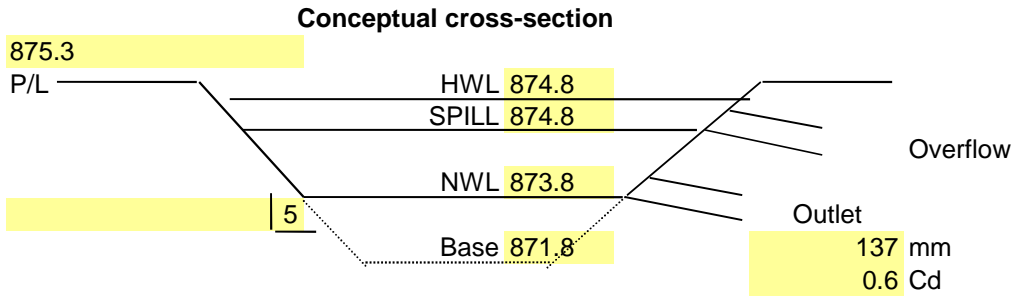
RED DEER
Stormwater Pond Conceptual Design
Pond 8



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m3 | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------|--------------------------------|------------|
| Minimum property line | 879.1 | 1.15 | 3.2 | 19769 | 0.045 | 4.1 |
| HWL | 878.5 | 1.02 | 2.5 | 13250 | 0.038 | 3.5 |
| Overflow Elev | 878.5 | 1.02 | 2.5 | 13250 | 0.038 | 3.5 |
| Normal water level | 877.0 | 0.74 | 1.2 | 0 | 0.000 | 2.0 |
| Base of pond | 875.0 | 0.44 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 13250 | | |
| Average existing ground | 879.1 | 1.1 | 3.2 | | | |
| Side slope | | 5.0 H:V | | | | |

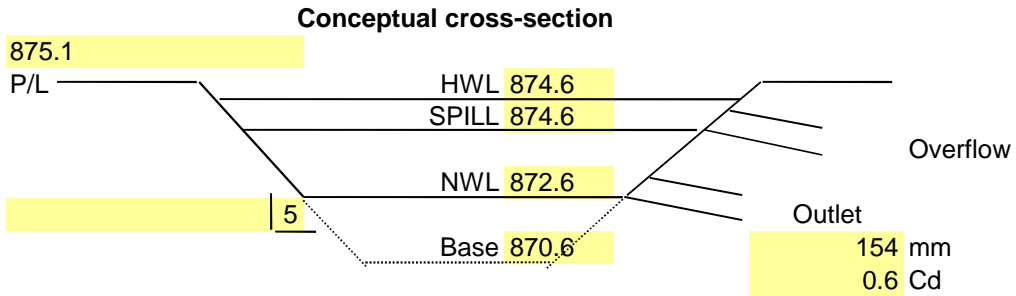
RED DEER
Stormwater Pond Conceptual Design
Pond 9



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 875.3 | 1.57 | 4.1 | 20832 | 0.047 | 3.5 |
| HWL | 874.8 | 1.45 | 3.4 | 13300 | 0.038 | 3.0 |
| Overflow Elev | 874.8 | 1.45 | 3.4 | 13300 | 0.038 | 3.0 |
| Normal water level | 873.8 | 1.21 | 2.0 | 0 | 0.000 | 2.0 |
| Base of pond | 871.8 | 0.81 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 13300 | | |
| Average existing ground | 875.3 | 1.6 | 4.1 | | | |
| Side slope | | 5.0 H:V | | | | |

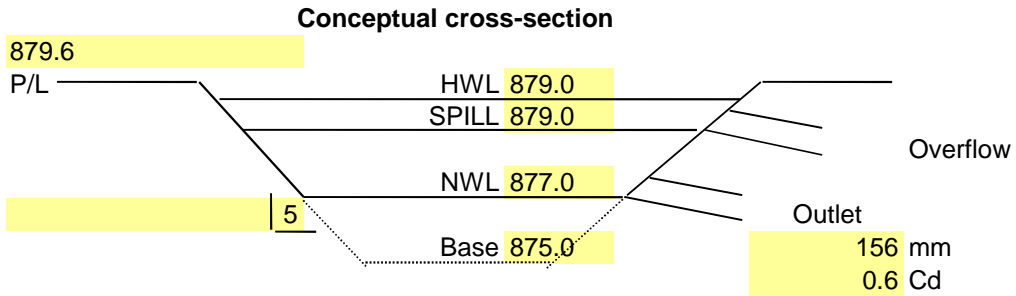
RED DEER
Stormwater Pond Conceptual Design
Pond 10



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 875.1 | 1.51 | 4.6 | 30704 | 0.077 | 4.5 |
| HWL | 874.6 | 1.39 | 3.9 | 23460 | 0.069 | 4.0 |
| Overflow Elev | 874.6 | 1.39 | 3.9 | 23460 | 0.069 | 4.0 |
| Normal water level | 872.6 | 0.96 | 1.6 | 0 | 0.000 | 2.0 |
| Base of pond | 870.6 | 0.61 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 23460 | | |
| Average existing ground | 875.0 | 1.5 | 4.5 | | | |
| Side slope | | 5.0 H:V | | | | |

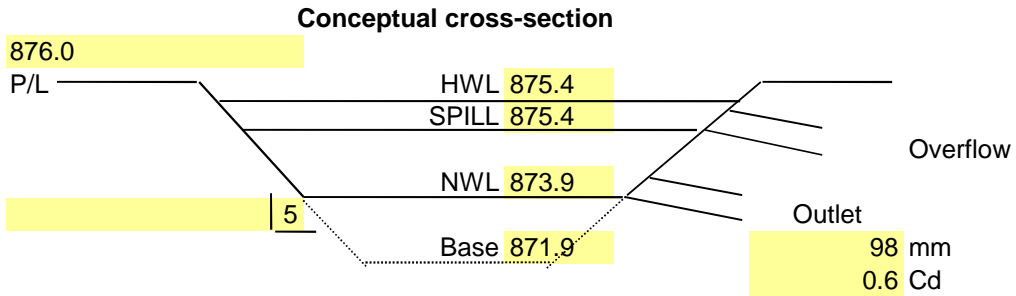
RED DEER
Stormwater Pond Conceptual Design
Pond 11



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 879.6 | 1.35 | 4.1 | 27893 | 0.081 | 4.6 |
| HWL | 879.0 | 1.21 | 3.3 | 20220 | 0.070 | 4.0 |
| Overflow Elev | 879.0 | 1.21 | 3.3 | 20220 | 0.070 | 4.0 |
| Normal water level | 877.0 | 0.81 | 1.3 | 0 | 0.000 | 2.0 |
| Base of pond | 875.0 | 0.49 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 20220 | | |
| Average existing ground | 879.6 | 1.3 | 4.1 | | | |
| Side slope | | 5.0 H:V | | | | |

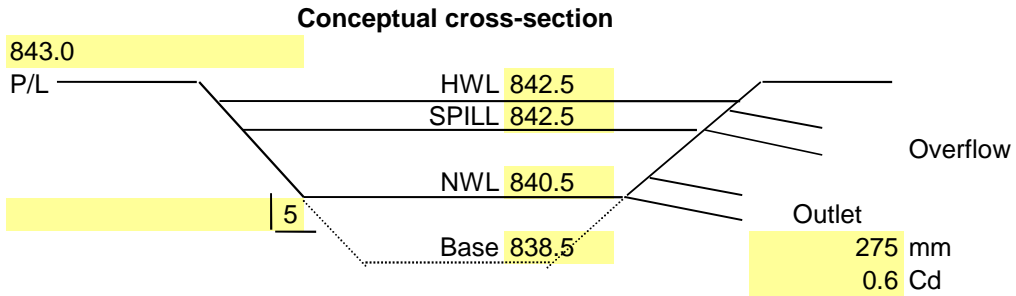
RED DEER
Stormwater Pond Conceptual Design
Pond 12



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 876.0 | 0.77 | 1.9 | 12604 | 0.029 | 4.1 |
| HWL | 875.4 | 0.67 | 1.5 | 8310 | 0.024 | 3.5 |
| Overflow Elev | 875.4 | 0.67 | 1.5 | 8310 | 0.024 | 3.5 |
| Normal water level | 873.9 | 0.44 | 0.7 | 0 | 0.000 | 2.0 |
| Base of pond | 871.9 | 0.22 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 8310 | | |
| Average existing ground | 876.0 | 0.8 | 1.9 | | | |
| Side slope | | 5.0 H:V | | | | |

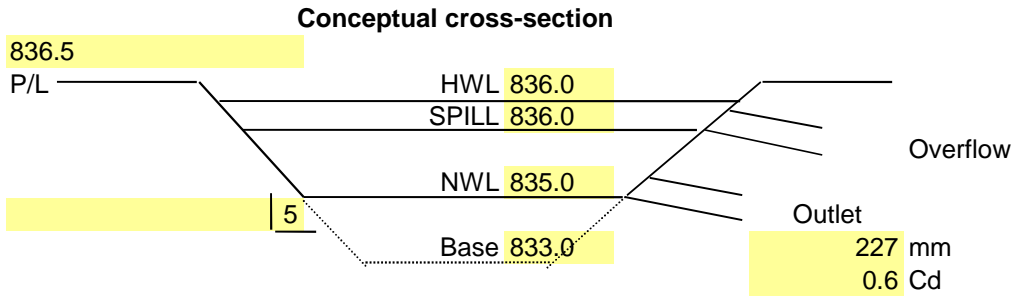
RED DEER
Stormwater Pond Conceptual Design
Pond 13



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 843.0 | 3.03 | 10.5 | 65621 | 0.243 | 4.5 |
| HWL | 842.5 | 2.86 | 9.0 | 50880 | 0.215 | 4.0 |
| Overflow Elev | 842.5 | 2.86 | 9.0 | 50880 | 0.215 | 4.0 |
| Normal water level | 840.5 | 2.23 | 3.9 | 0 | 0.000 | 2.0 |
| Base of pond | 838.5 | 1.67 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 50880 | | |
| Average existing ground | 843.0 | 3.0 | 10.5 | | | |
| Side slope | | 5.0 H:V | | | | |

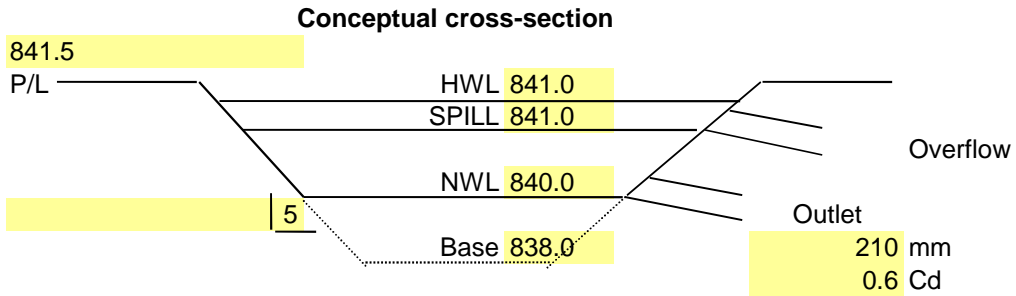
RED DEER
Stormwater Pond Conceptual Design
Pond 14



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 836.5 | 2.85 | 8.1 | 39054 | 0.127 | 3.5 |
| HWL | 836.0 | 2.68 | 6.7 | 25230 | 0.101 | 3.0 |
| Overflow Elev | 836.0 | 2.68 | 6.7 | 25230 | 0.101 | 3.0 |
| Normal water level | 835.0 | 2.36 | 4.2 | 0 | 0.000 | 2.0 |
| Base of pond | 833.0 | 1.79 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 25230 | | |
| Average existing ground | 836.5 | 2.8 | 8.1 | | | |
| Side slope | | 5.0 H:V | | | | |

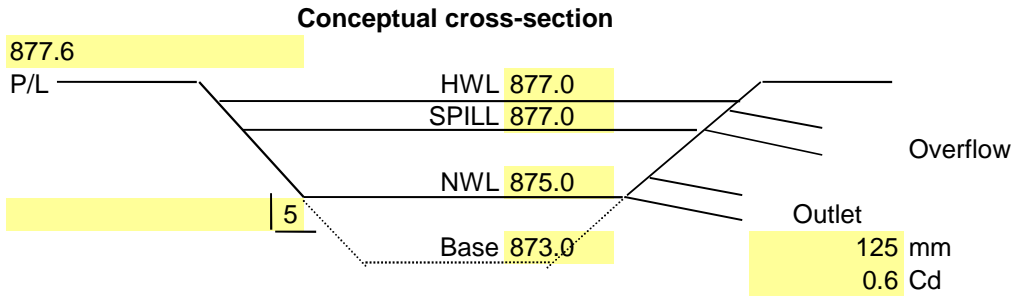
RED DEER
Stormwater Pond Conceptual Design
Pond 15



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m3 | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------|--------------------------------|------------|
| Minimum property line | 841.5 | 2.27 | 6.3 | 30759 | 0.109 | 3.5 |
| HWL | 841.0 | 2.12 | 5.2 | 19790 | 0.087 | 3.0 |
| Overflow Elev | 841.0 | 2.12 | 5.2 | 19790 | 0.087 | 3.0 |
| Normal water level | 840.0 | 1.84 | 3.2 | 0 | 0.000 | 2.0 |
| Base of pond | 838.0 | 1.34 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 19790 | | |
| Average existing ground | 841.5 | 2.3 | 6.3 | | | |
| Side slope | | 5.0 H:V | | | | |

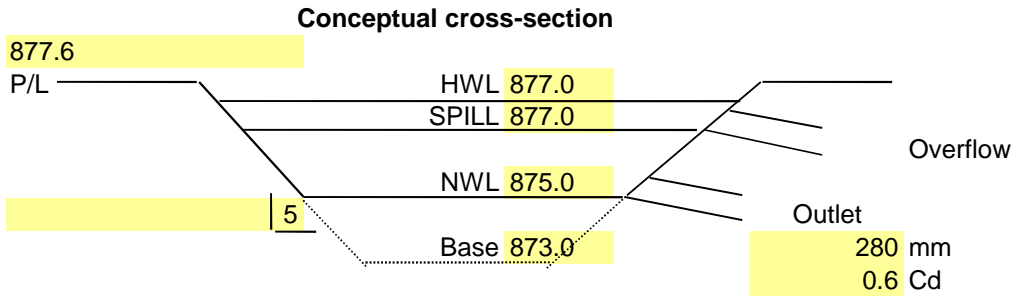
RED DEER
Stormwater Pond Conceptual Design
Pond 16



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 877.6 | 1.37 | 4.2 | 28523 | 0.052 | 4.6 |
| HWL | 877.0 | 1.24 | 3.4 | 20690 | 0.045 | 4.0 |
| Overflow Elev | 877.0 | 1.24 | 3.4 | 20690 | 0.045 | 4.0 |
| Normal water level | 875.0 | 0.83 | 1.3 | 0 | 0.000 | 2.0 |
| Base of pond | 873.0 | 0.51 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 20690 | | |
| Average existing ground | 877.6 | 1.4 | 4.2 | | | |
| Side slope | | 5.0 H:V | | | | |

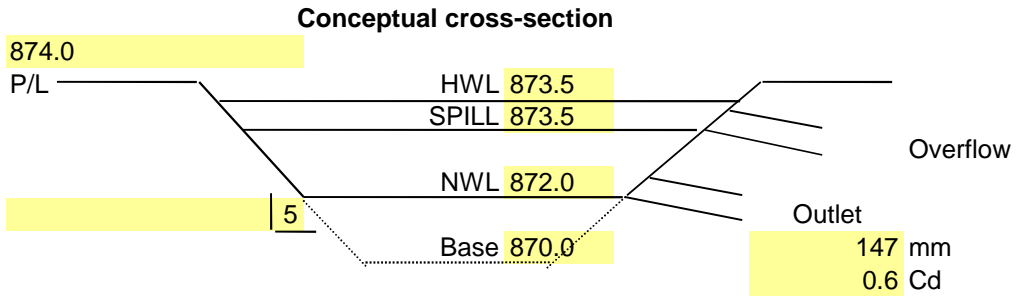
RED DEER
Stormwater Pond Conceptual Design
Pond 17



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 877.6 | 3.80 | 13.7 | 86416 | 0.257 | 4.6 |
| HWL | 877.0 | 3.57 | 11.5 | 64290 | 0.223 | 4.0 |
| Overflow Elev | 877.0 | 3.57 | 11.5 | 64290 | 0.223 | 4.0 |
| Normal water level | 875.0 | 2.86 | 5.1 | 0 | 0.000 | 2.0 |
| Base of pond | 873.0 | 2.22 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 64290 | | |
| Average existing ground | 877.6 | 3.80 | 13.7 | | | |
| Side slope | | 5.0 H:V | | | | |

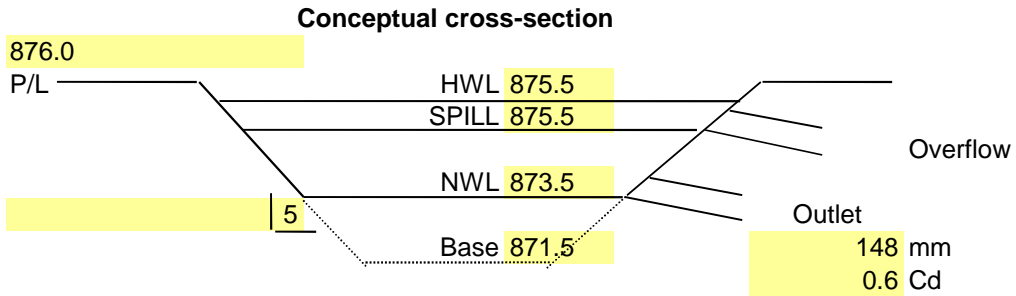
RED DEER
Stormwater Pond Conceptual Design
Pond 18



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 874.0 | 1.31 | 3.6 | 21938 | 0.063 | 4.0 |
| HWL | 873.5 | 1.20 | 3.0 | 15670 | 0.054 | 3.5 |
| Overflow Elev | 873.5 | 1.20 | 3.0 | 15670 | 0.054 | 3.5 |
| Normal water level | 872.0 | 0.89 | 1.4 | 0 | 0.000 | 2.0 |
| Base of pond | 870.0 | 0.55 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 15670 | | |
| Average existing ground | 874.0 | 1.3 | 3.6 | | | |
| Side slope | | 5.0 H:V | | | | |

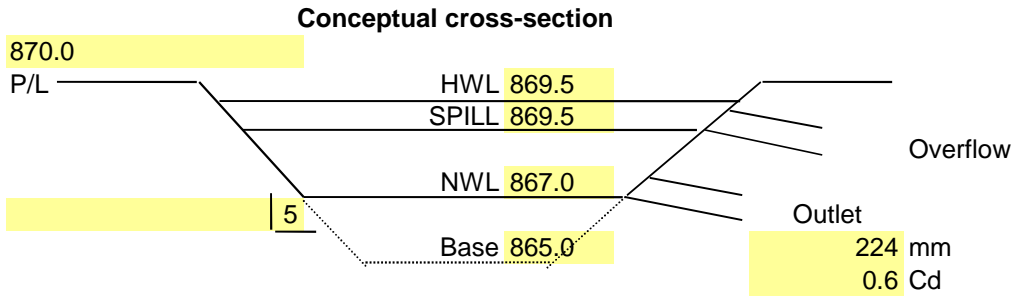
RED DEER
Stormwater Pond Conceptual Design
Pond 19



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 876.0 | 1.21 | 3.6 | 24121 | 0.071 | 4.5 |
| HWL | 875.5 | 1.11 | 3.0 | 18320 | 0.063 | 4.0 |
| Overflow Elev | 875.5 | 1.11 | 3.0 | 18320 | 0.063 | 4.0 |
| Normal water level | 873.5 | 0.73 | 1.2 | 0 | 0.000 | 2.0 |
| Base of pond | 871.5 | 0.42 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 18320 | | |
| Average existing ground | 876.0 | 1.2 | 3.6 | | | |
| Side slope | | 5.0 H:V | | | | |

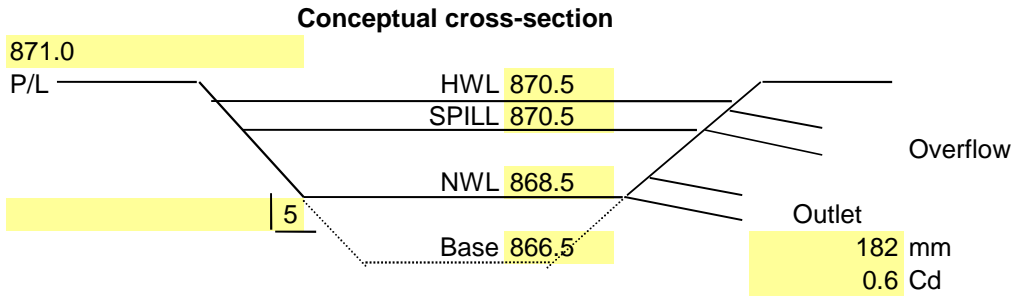
RED DEER
Stormwater Pond Conceptual Design
Pond 20



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 870.0 | 2.35 | 8.4 | 57936 | 0.177 | 5.0 |
| HWL | 869.5 | 2.20 | 7.2 | 46550 | 0.161 | 4.5 |
| Overflow Elev | 869.5 | 2.20 | 7.2 | 46550 | 0.161 | 4.5 |
| Normal water level | 867.0 | 1.52 | 2.6 | 0 | 0.000 | 2.0 |
| Base of pond | 865.0 | 1.07 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 46550 | | |
| Average existing ground | 870.0 | 2.4 | 8.4 | | | |
| Side slope | | 5.0 H:V | | | | |

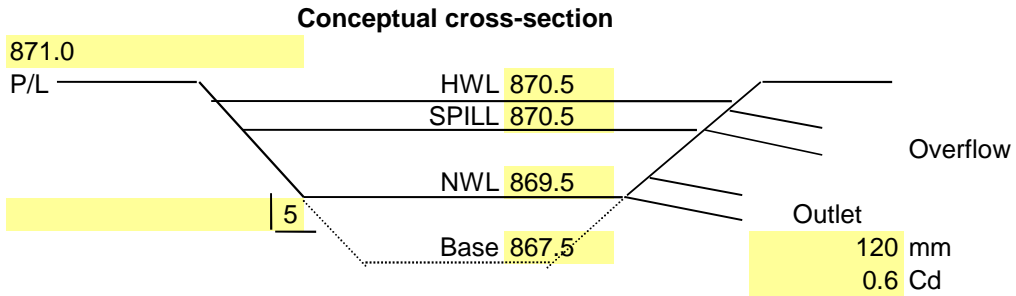
RED DEER
Stormwater Pond Conceptual Design
Pond 21



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 871.0 | 2.04 | 6.6 | 42641 | 0.107 | 4.5 |
| HWL | 870.5 | 1.90 | 5.6 | 32810 | 0.095 | 4.0 |
| Overflow Elev | 870.5 | 1.90 | 5.6 | 32810 | 0.095 | 4.0 |
| Normal water level | 868.5 | 1.39 | 2.3 | 0 | 0.000 | 2.0 |
| Base of pond | 866.5 | 0.95 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 32810 | | |
| Average existing ground | 871.0 | 2.0 | 6.6 | | | |
| Side slope | | 5.0 H:V | | | | |

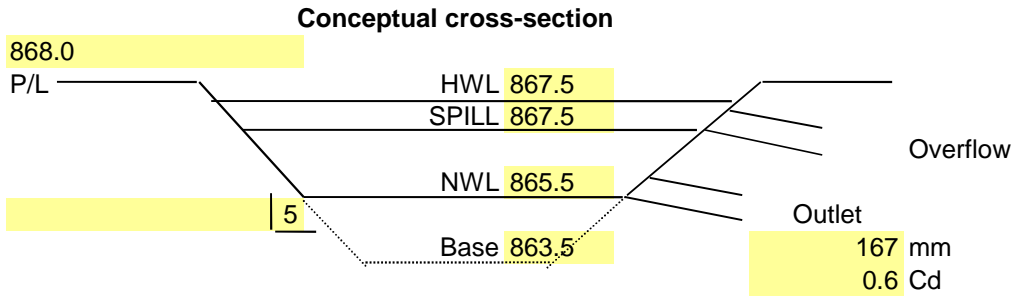
RED DEER
Stormwater Pond Conceptual Design
Pond 22



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 871.0 | 1.21 | 3.0 | 15767 | 0.036 | 3.5 |
| HWL | 870.5 | 1.10 | 2.5 | 10000 | 0.029 | 3.0 |
| Overflow Elev | 870.5 | 1.10 | 2.5 | 10000 | 0.029 | 3.0 |
| Normal water level | 869.5 | 0.90 | 1.5 | 0 | 0.000 | 2.0 |
| Base of pond | 867.5 | 0.56 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 10000 | | |
| Average existing ground | 871.0 | 1.2 | 3.0 | | | |
| Side slope | | 5.0 H:V | | | | |

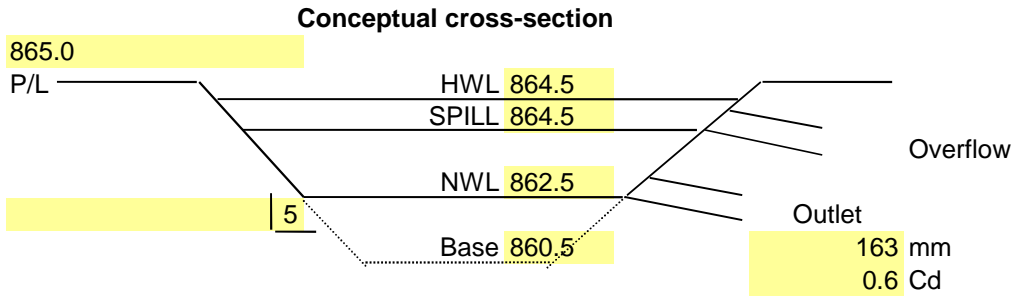
RED DEER
Stormwater Pond Conceptual Design
Pond 23



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 868.0 | 1.47 | 4.5 | 29758 | 0.090 | 4.5 |
| HWL | 867.5 | 1.35 | 3.8 | 22720 | 0.081 | 4.0 |
| Overflow Elev | 867.5 | 1.35 | 3.8 | 22720 | 0.081 | 4.0 |
| Normal water level | 865.5 | 0.92 | 1.5 | 0 | 0.000 | 2.0 |
| Base of pond | 863.5 | 0.58 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 22720 | | |
| Average existing ground | 870.0 | 2.0 | 7.9 | | | |
| Side slope | | 5.0 H:V | | | | |

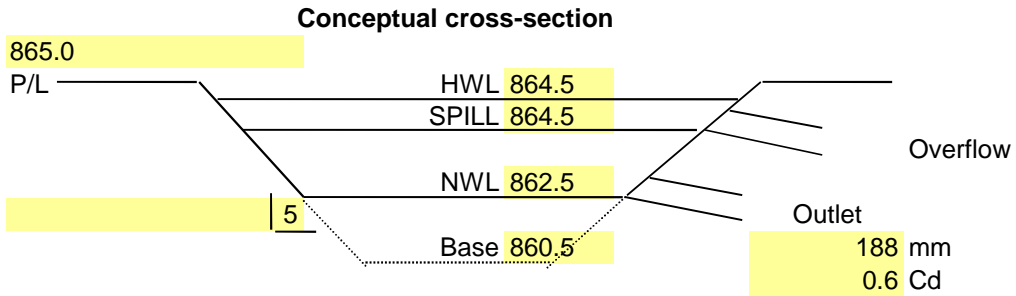
RED DEER
Stormwater Pond Conceptual Design
Pond 24



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 865.0 | 1.37 | 4.1 | 27556 | 0.086 | 4.5 |
| HWL | 864.5 | 1.25 | 3.5 | 21000 | 0.077 | 4.0 |
| Overflow Elev | 864.5 | 1.25 | 3.5 | 21000 | 0.077 | 4.0 |
| Normal water level | 862.5 | 0.85 | 1.4 | 0 | 0.000 | 2.0 |
| Base of pond | 860.5 | 0.52 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 21000 | | |
| Average existing ground | 865.0 | 1.4 | 4.1 | | | |
| Side slope | | 5.0 H:V | | | | |

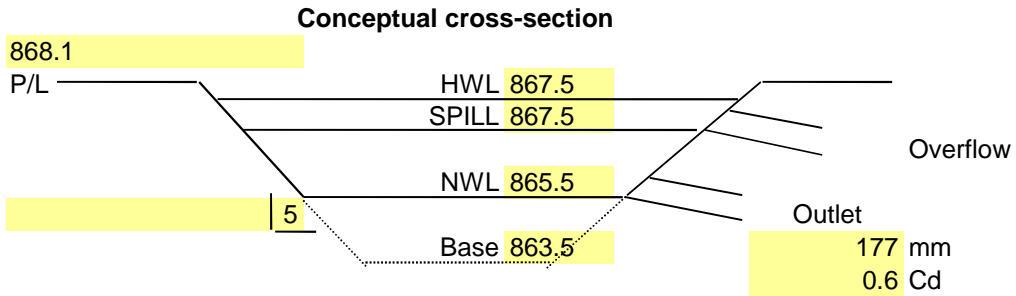
RED DEER
Stormwater Pond Conceptual Design
Pond 25



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 865.0 | 2.18 | 7.1 | 45863 | 0.114 | 4.5 |
| HWL | 864.5 | 2.03 | 6.1 | 35340 | 0.102 | 4.0 |
| Overflow Elev | 864.5 | 2.03 | 6.1 | 35340 | 0.102 | 4.0 |
| Normal water level | 862.5 | 1.50 | 2.6 | 0 | 0.000 | 2.0 |
| Base of pond | 860.5 | 1.05 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 35340 | | |
| Average existing ground | 865.0 | 2.2 | 7.1 | | | |
| Side slope | | 5.0 H:V | | | | |

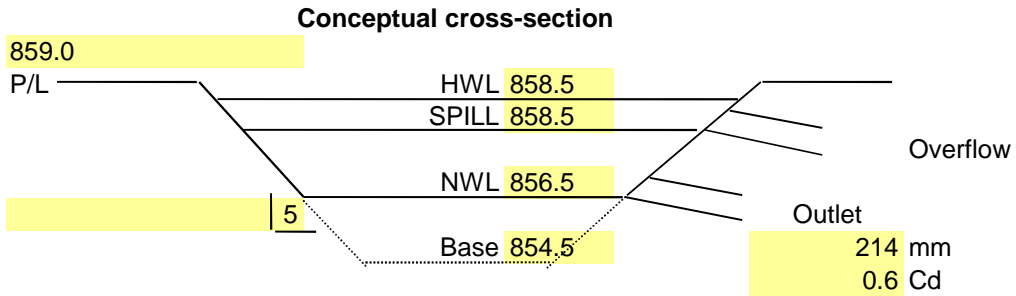
RED DEER
Stormwater Pond Conceptual Design
Pond 26



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m3 | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------|--------------------------------|------------|
| Minimum property line | 868.1 | 1.97 | 6.4 | 42429 | 0.104 | 4.6 |
| HWL | 867.5 | 1.80 | 5.3 | 31110 | 0.090 | 4.0 |
| Overflow Elev | 867.5 | 1.80 | 5.3 | 31110 | 0.090 | 4.0 |
| Normal water level | 865.5 | 1.31 | 2.2 | 0 | 0.000 | 2.0 |
| Base of pond | 863.5 | 0.89 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 31110 | | |
| Average existing ground | 868.1 | 2.0 | 6.4 | | | |
| Side slope | | 5.0 H:V | | | | |

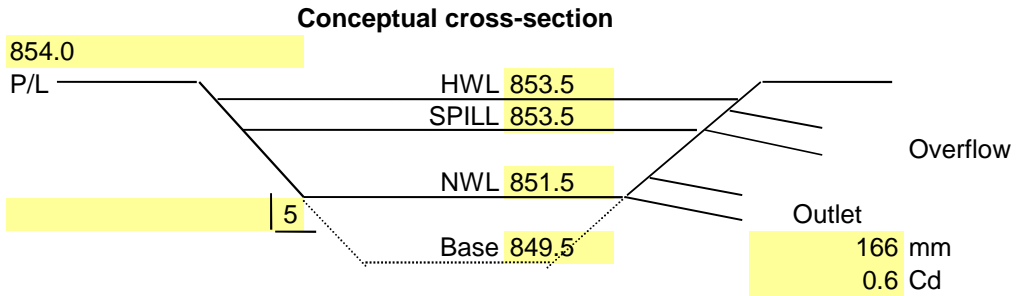
RED DEER
Stormwater Pond Conceptual Design
Pond 27



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 859.0 | 2.40 | 8.0 | 50929 | 0.148 | 4.5 |
| HWL | 858.5 | 2.25 | 6.8 | 39320 | 0.131 | 4.0 |
| Overflow Elev | 858.5 | 2.25 | 6.8 | 39320 | 0.131 | 4.0 |
| Normal water level | 856.5 | 1.69 | 2.9 | 0 | 0.000 | 2.0 |
| Base of pond | 854.5 | 1.21 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 39320 | | |
| Average existing ground | 859.0 | 2.4 | 8.0 | | | |
| Side slope | | 5.0 H:V | | | | |

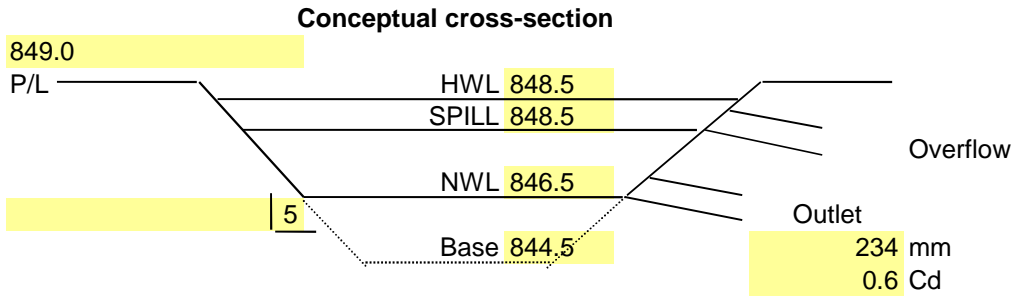
RED DEER
Stormwater Pond Conceptual Design
Pond 28



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 854.0 | 1.50 | 4.6 | 30448 | 0.089 | 4.5 |
| HWL | 853.5 | 1.38 | 3.9 | 23260 | 0.080 | 4.0 |
| Overflow Elev | 853.5 | 1.38 | 3.9 | 23260 | 0.080 | 4.0 |
| Normal water level | 851.5 | 0.95 | 1.5 | 0 | 0.000 | 2.0 |
| Base of pond | 849.5 | 0.60 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 23260 | | |
| Average existing ground | 854.0 | 1.5 | 4.6 | | | |
| Side slope | | 5.0 H:V | | | | |

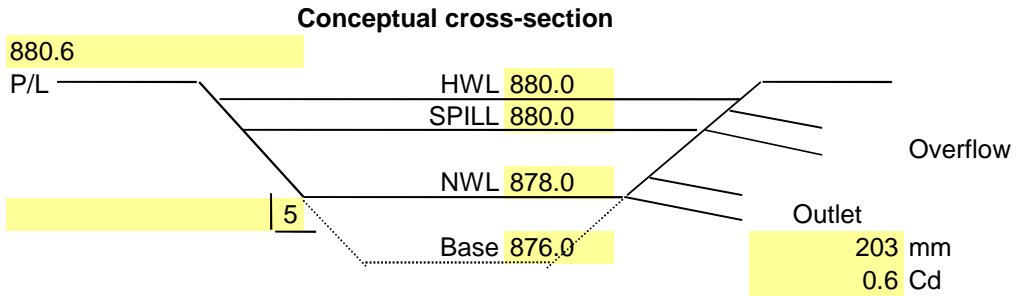
RED DEER
Stormwater Pond Conceptual Design
Pond 29



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 849.0 | 2.38 | 7.9 | 50420 | 0.176 | 4.5 |
| HWL | 848.5 | 2.22 | 6.8 | 38920 | 0.157 | 4.0 |
| Overflow Elev | 848.5 | 2.22 | 6.8 | 38920 | 0.157 | 4.0 |
| Normal water level | 846.5 | 1.67 | 2.9 | 0 | 0.000 | 2.0 |
| Base of pond | 844.5 | 1.19 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 38920 | | |
| Average existing ground | 849.0 | 2.4 | 7.9 | | | |
| Side slope | | 5.0 H:V | | | | |

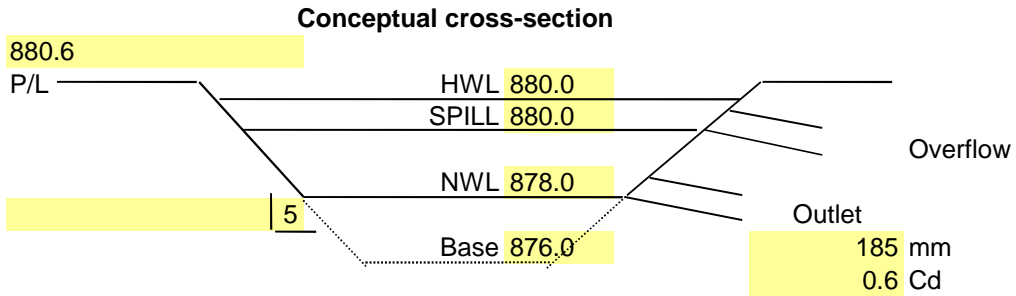
RED DEER
Stormwater Pond Conceptual Design
Pond 30



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 880.6 | 2.31 | 7.8 | 50449 | 0.136 | 4.6 |
| HWL | 880.0 | 2.13 | 6.4 | 37140 | 0.118 | 4.0 |
| Overflow Elev | 880.0 | 2.13 | 6.4 | 37140 | 0.118 | 4.0 |
| Normal water level | 878.0 | 1.59 | 2.7 | 0 | 0.000 | 2.0 |
| Base of pond | 876.0 | 1.12 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 37140 | | |
| Average existing ground | 880.6 | 2.3 | 7.8 | | | |
| Side slope | | 5.0 H:V | | | | |

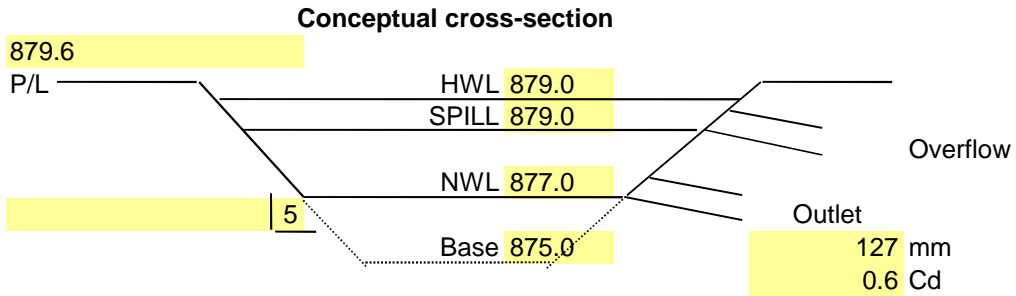
RED DEER
Stormwater Pond Conceptual Design
Pond 31



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 880.6 | 1.95 | 6.4 | 42056 | 0.113 | 4.6 |
| HWL | 880.0 | 1.79 | 5.3 | 30830 | 0.099 | 4.0 |
| Overflow Elev | 880.0 | 1.79 | 5.3 | 30830 | 0.099 | 4.0 |
| Normal water level | 878.0 | 1.29 | 2.2 | 0 | 0.000 | 2.0 |
| Base of pond | 876.0 | 0.88 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 30830 | | |
| Average existing ground | 880.6 | 2.0 | 6.4 | | | |
| Side slope | | 5.0 H:V | | | | |

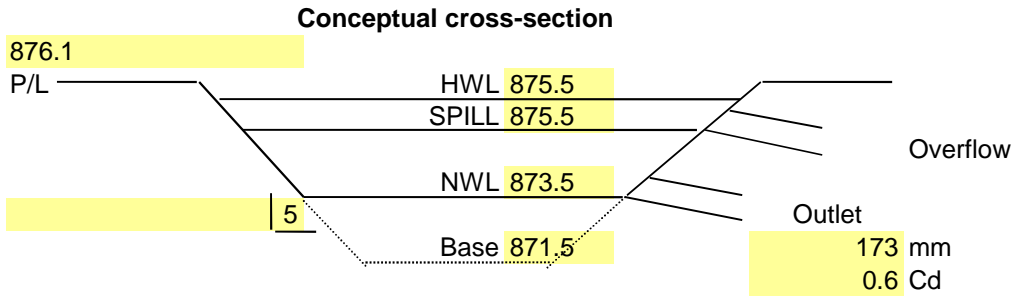
RED DEER
Stormwater Pond Conceptual Design
Pond 32



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 879.6 | 1.29 | 3.9 | 26634 | 0.054 | 4.6 |
| HWL | 879.0 | 1.16 | 3.2 | 19280 | 0.047 | 4.0 |
| Overflow Elev | 879.0 | 1.16 | 3.2 | 19280 | 0.047 | 4.0 |
| Normal water level | 877.0 | 0.77 | 1.2 | 0 | 0.000 | 2.0 |
| Base of pond | 875.0 | 0.46 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 19280 | | |
| Average existing ground | 879.6 | 1.3 | 3.9 | | | |
| Side slope | | 5.0 H:V | | | | |

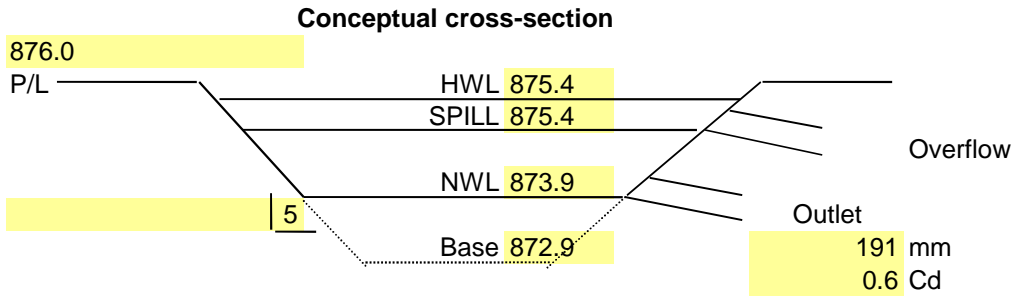
RED DEER
Stormwater Pond Conceptual Design
Pond 33



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 876.1 | 1.62 | 5.1 | 34136 | 0.099 | 4.6 |
| HWL | 875.5 | 1.47 | 4.2 | 24890 | 0.086 | 4.0 |
| Overflow Elev | 875.5 | 1.47 | 4.2 | 24890 | 0.086 | 4.0 |
| Normal water level | 873.5 | 1.02 | 1.7 | 0 | 0.000 | 2.0 |
| Base of pond | 871.5 | 0.66 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 24890 | | |
| Average existing ground | 876.1 | 1.6 | 5.1 | | | |
| Side slope | | 5.0 H:V | | | | |

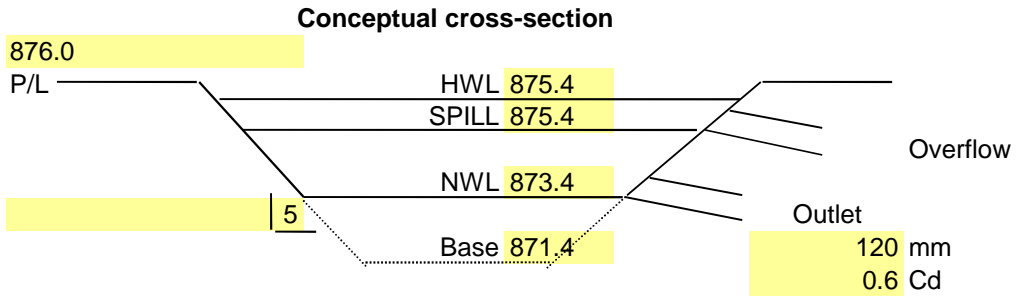
RED DEER
Stormwater Pond Conceptual Design
Pond 34



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 876.0 | 2.47 | 6.3 | 45290 | 0.108 | 3.1 |
| HWL | 875.4 | 2.28 | 4.8 | 31030 | 0.090 | 2.5 |
| Overflow Elev | 875.4 | 2.28 | 4.8 | 31030 | 0.090 | 2.5 |
| Normal water level | 873.9 | 1.85 | 1.7 | 0 | 0.000 | 1.0 |
| Base of pond | 872.9 | 1.59 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 31030 | | |
| Average existing ground | 876.0 | 2.5 | 6.3 | | | |
| Side slope | | 5.0 H:V | | | | |

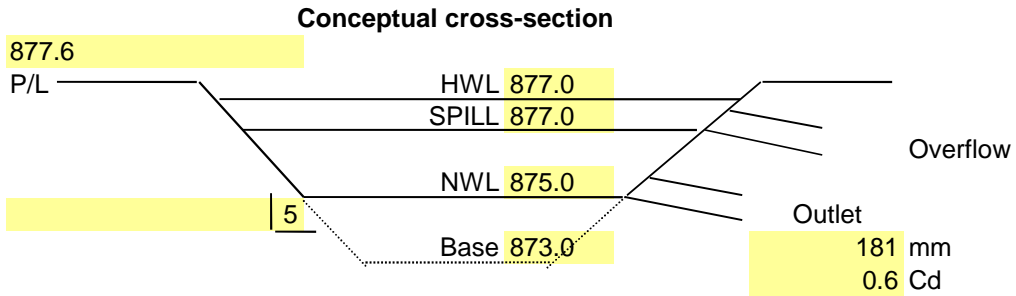
RED DEER
Stormwater Pond Conceptual Design
Pond 35



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 876.0 | 0.68 | 1.7 | 12754 | 0.048 | 4.6 |
| HWL | 875.4 | 0.58 | 1.3 | 8980 | 0.042 | 4.0 |
| Overflow Elev | 875.4 | 0.58 | 1.3 | 8980 | 0.042 | 4.0 |
| Normal water level | 873.4 | 0.32 | 0.4 | 0 | 0.000 | 2.0 |
| Base of pond | 871.4 | 0.13 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 8980 | | |
| Average existing ground | 876.0 | 0.7 | 1.7 | | | |
| Side slope | | 5.0 H:V | | | | |

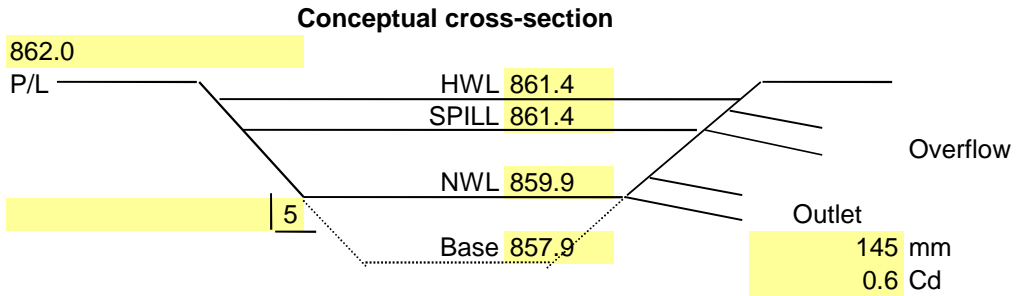
RED DEER
Stormwater Pond Conceptual Design
Pond 36



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 877.6 | 1.79 | 5.7 | 38126 | 0.108 | 4.6 |
| HWL | 877.0 | 1.63 | 4.7 | 27880 | 0.094 | 4.0 |
| Overflow Elev | 877.0 | 1.63 | 4.7 | 27880 | 0.094 | 4.0 |
| Normal water level | 875.0 | 1.16 | 1.9 | 0 | 0.000 | 2.0 |
| Base of pond | 873.0 | 0.77 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 27880 | | |
| Average existing ground | 877.6 | 1.8 | 5.7 | | | |
| Side slope | | 5.0 H:V | | | | |

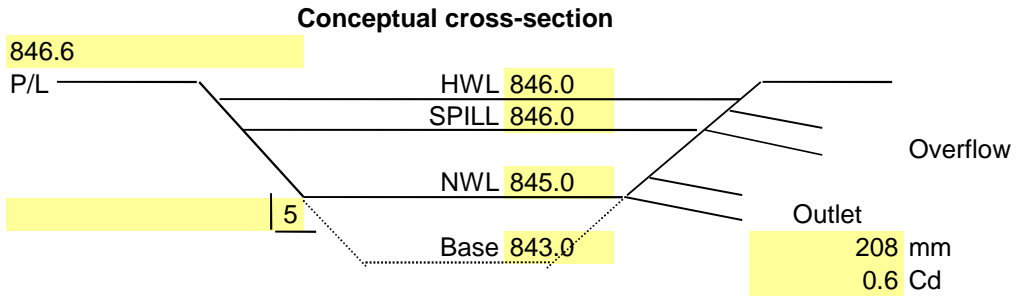
RED DEER
Stormwater Pond Conceptual Design
Pond 37



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 862.0 | 1.11 | 3.0 | 18944 | 0.062 | 4.1 |
| HWL | 861.4 | 0.98 | 2.4 | 12680 | 0.052 | 3.5 |
| Overflow Elev | 861.4 | 0.98 | 2.4 | 12680 | 0.052 | 3.5 |
| Normal water level | 859.9 | 0.71 | 1.1 | 0 | 0.000 | 2.0 |
| Base of pond | 857.9 | 0.41 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 12680 | | |
| Average existing ground | 862.0 | 1.1 | 3.0 | | | |
| Side slope | | 5.0 H:V | | | | |

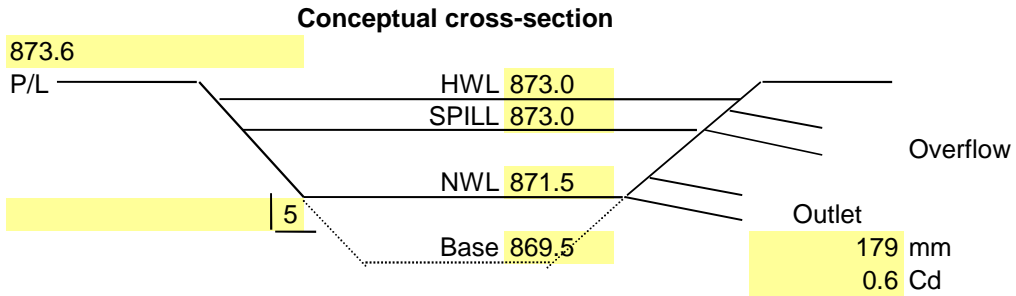
RED DEER
Stormwater Pond Conceptual Design
Pond 38



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 846.6 | 1.41 | 3.7 | 19737 | 0.110 | 3.6 |
| HWL | 846.0 | 1.27 | 2.9 | 11670 | 0.085 | 3.0 |
| Overflow Elev | 846.0 | 1.27 | 2.9 | 11670 | 0.085 | 3.0 |
| Normal water level | 845.0 | 1.06 | 1.7 | 0 | 0.000 | 2.0 |
| Base of pond | 843.0 | 0.69 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 11670 | | |
| Average existing ground | 846.6 | 1.4 | 3.7 | | | |
| Side slope | | 5.0 H:V | | | | |

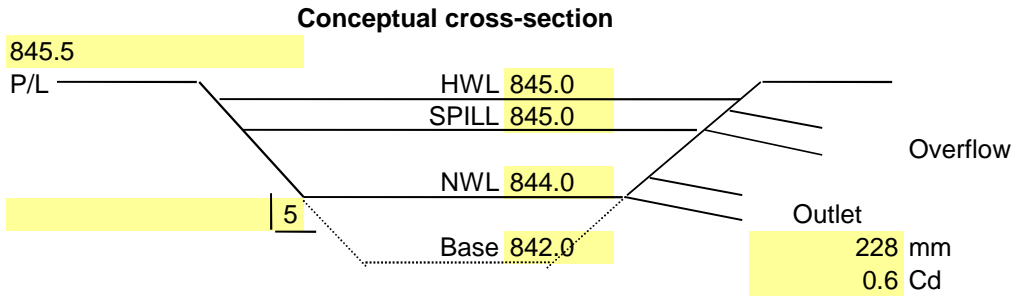
RED DEER
Stormwater Pond Conceptual Design
Pond 39



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 873.6 | 1.86 | 5.6 | 33436 | 0.095 | 4.1 |
| HWL | 873.0 | 1.70 | 4.5 | 22750 | 0.079 | 3.5 |
| Overflow Elev | 873.0 | 1.70 | 4.5 | 22750 | 0.079 | 3.5 |
| Normal water level | 871.5 | 1.33 | 2.2 | 0 | 0.000 | 2.0 |
| Base of pond | 869.5 | 0.91 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 22750 | | |
| Average existing ground | 873.6 | 1.9 | 5.6 | | | |
| Side slope | | 5.0 H:V | | | | |

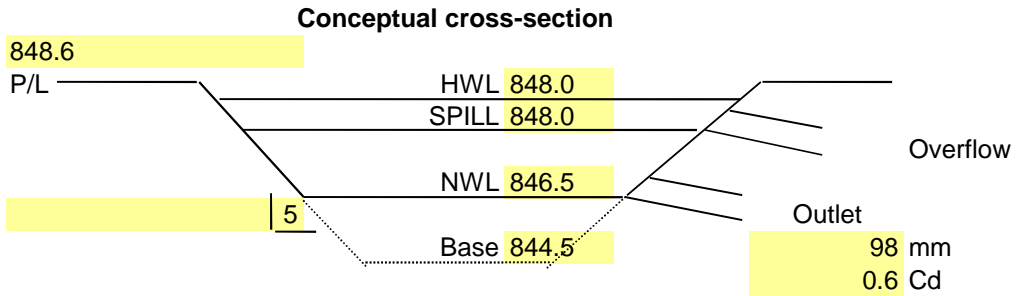
RED DEER
Stormwater Pond Conceptual Design
Pond 40



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 845.5 | 1.67 | 4.4 | 22319 | 0.128 | 3.5 |
| HWL | 845.0 | 1.55 | 3.6 | 14270 | 0.102 | 3.0 |
| Overflow Elev | 845.0 | 1.55 | 3.6 | 14270 | 0.102 | 3.0 |
| Normal water level | 844.0 | 1.31 | 2.2 | 0 | 0.000 | 2.0 |
| Base of pond | 842.0 | 0.89 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 14270 | | |
| Average existing ground | 845.5 | 1.7 | 4.4 | | | |
| Side slope | | 5.0 H:V | | | | |

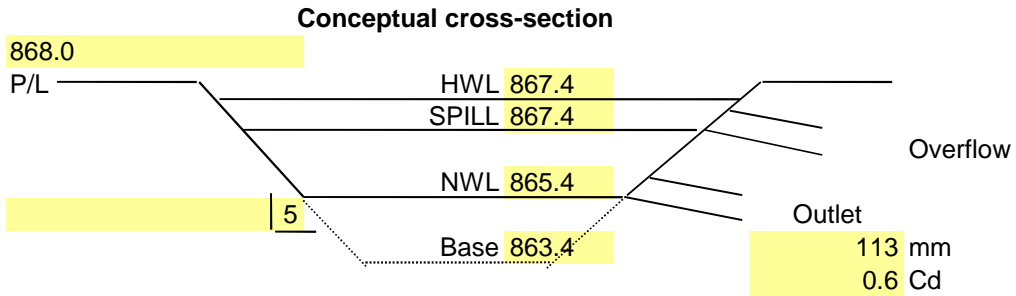
RED DEER
Stormwater Pond Conceptual Design
Pond 41



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 848.6 | 0.45 | 1.0 | 6814 | 0.029 | 4.1 |
| HWL | 848.0 | 0.37 | 0.7 | 4360 | 0.024 | 3.5 |
| Overflow Elev | 848.0 | 0.37 | 0.7 | 4360 | 0.024 | 3.5 |
| Normal water level | 846.5 | 0.21 | 0.3 | 0 | 0.000 | 2.0 |
| Base of pond | 844.5 | 0.07 | 0.0 | 0.000 | 0.000 | 0.0 |
| Storage capacity | | | | 4360 | | |
| Average existing ground | 848.6 | 0.4 | 1.0 | | | |
| Side slope | | 5.0 H:V | | | | |

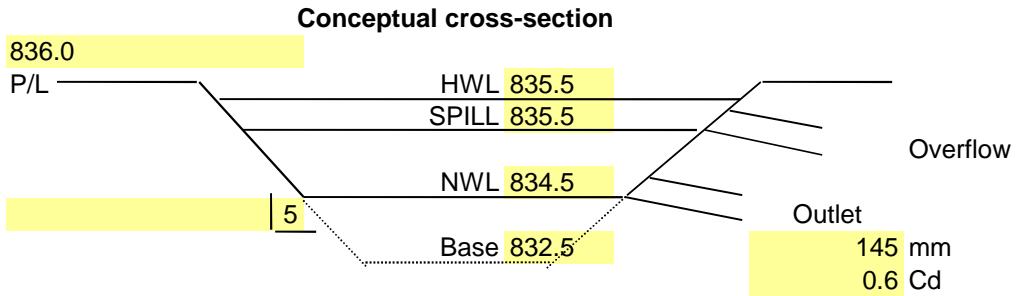
RED DEER
Stormwater Pond Conceptual Design
Pond 42



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 868.0 | 0.77 | 2.0 | 14897 | 0.042 | 4.6 |
| HWL | 867.4 | 0.67 | 1.6 | 10560 | 0.037 | 4.0 |
| Overflow Elev | 867.4 | 0.67 | 1.6 | 10560 | 0.037 | 4.0 |
| Normal water level | 865.4 | 0.38 | 0.6 | 0 | 0.000 | 2.0 |
| Base of pond | 863.4 | 0.18 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 10560 | | |
| Average existing ground | 868.0 | 0.8 | 2.0 | | | |
| Side slope | | 5.0 H:V | | | | |

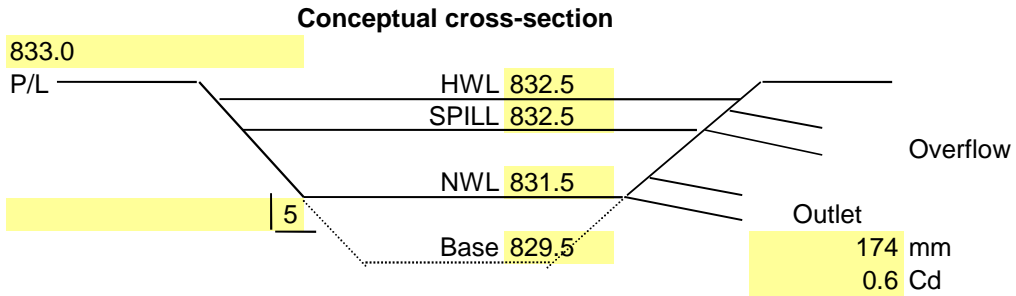
RED DEER
Stormwater Pond Conceptual Design
Pond 43



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 836.0 | 0.67 | 1.5 | 8374 | 0.052 | 3.5 |
| HWL | 835.5 | 0.59 | 1.2 | 5210 | 0.042 | 3.0 |
| Overflow Elev | 835.5 | 0.59 | 1.2 | 5210 | 0.042 | 3.0 |
| Normal water level | 834.5 | 0.45 | 0.7 | 0 | 0.000 | 2.0 |
| Base of pond | 832.5 | 0.22 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 5210 | | |
| Average existing ground | 836.0 | 0.7 | 1.5 | | | |
| Side slope | | 5.0 H:V | | | | |

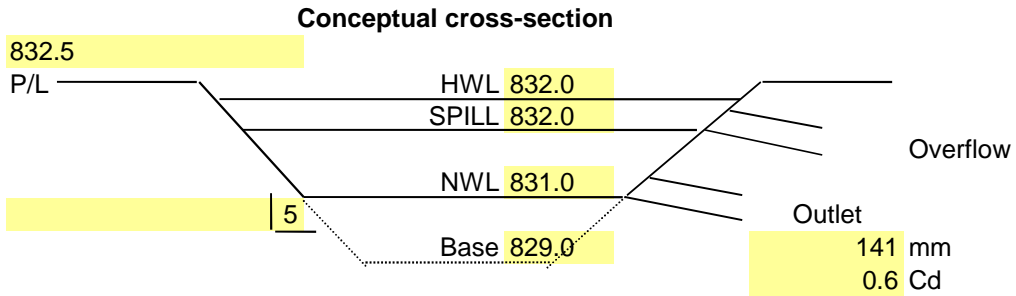
RED DEER
Stormwater Pond Conceptual Design
Pond 44



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 833.0 | 0.92 | 2.2 | 11824 | 0.075 | 3.5 |
| HWL | 832.5 | 0.83 | 1.8 | 7440 | 0.060 | 3.0 |
| Overflow Elev | 832.5 | 0.83 | 1.8 | 7440 | 0.060 | 3.0 |
| Normal water level | 831.5 | 0.66 | 1.0 | 0 | 0.000 | 2.0 |
| Base of pond | 829.5 | 0.37 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 7440 | | |
| Average existing ground | 833.0 | 0.9 | 2.2 | | | |
| Side slope | | 5.0 H:V | | | | |

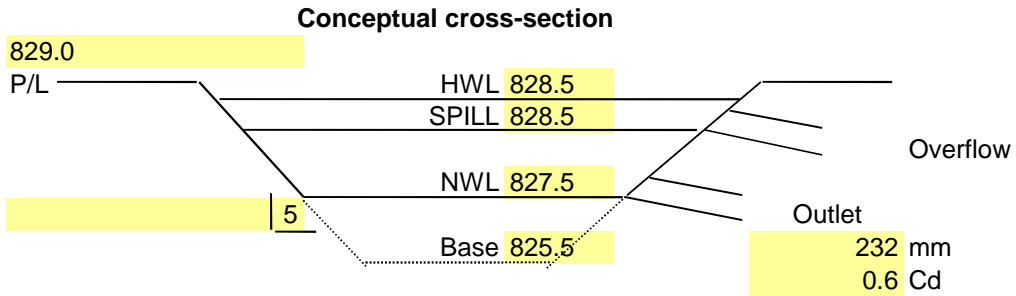
RED DEER
Stormwater Pond Conceptual Design
Pond 45



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 832.5 | 0.65 | 1.4 | 8032 | 0.050 | 3.5 |
| HWL | 832.0 | 0.57 | 1.1 | 4990 | 0.040 | 3.0 |
| Overflow Elev | 832.0 | 0.57 | 1.1 | 4990 | 0.040 | 3.0 |
| Normal water level | 831.0 | 0.43 | 0.6 | 0 | 0.000 | 2.0 |
| Base of pond | 829.0 | 0.21 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 4990 | | |
| Average existing ground | 832.5 | 0.6 | 1.4 | | | |
| Side slope | | 5.0 H:V | | | | |

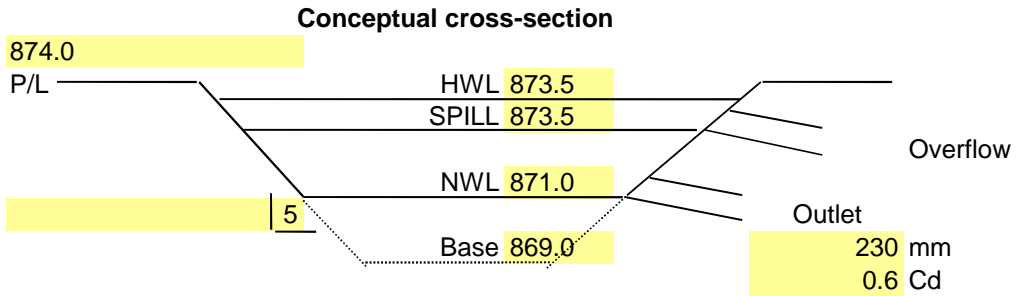
RED DEER
Stormwater Pond Conceptual Design
Pond 46



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 829.0 | 1.54 | 4.0 | 20373 | 0.132 | 3.5 |
| HWL | 828.5 | 1.41 | 3.3 | 13000 | 0.106 | 3.0 |
| Overflow Elev | 828.5 | 1.41 | 3.3 | 13000 | 0.106 | 3.0 |
| Normal water level | 827.5 | 1.19 | 2.0 | 0 | 0.000 | 2.0 |
| Base of pond | 825.5 | 0.79 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 13000 | | |
| Average existing ground | 829.0 | 1.5 | 4.0 | | | |
| Side slope | | 5.0 H:V | | | | |

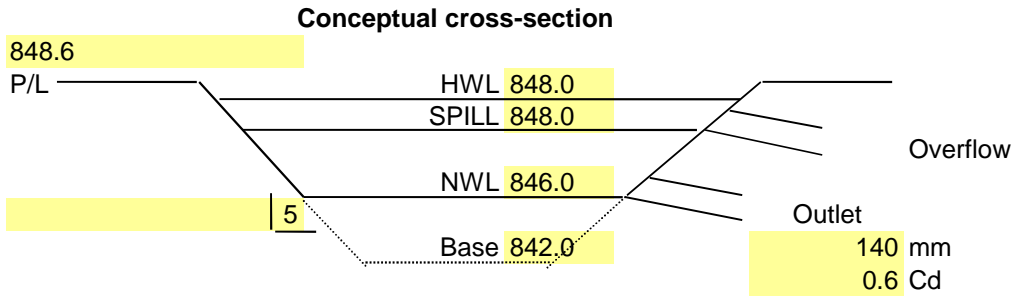
RED DEER
Stormwater Pond Conceptual Design
Pond 47



Design Parameters

| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 874.0 | 2.89 | 10.6 | 72512 | 0.187 | 5.0 |
| HWL | 873.5 | 2.72 | 9.2 | 58490 | 0.170 | 4.5 |
| Overflow Elev | 873.5 | 2.72 | 9.2 | 58490 | 0.170 | 4.5 |
| Normal water level | 871.0 | 1.96 | 3.4 | 0 | 0.000 | 2.0 |
| Base of pond | 869.0 | 1.44 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 58490 | | |
| Average existing ground | 874.0 | 2.9 | 10.6 | | | |
| Side slope | | 5.0 H:V | | | | |

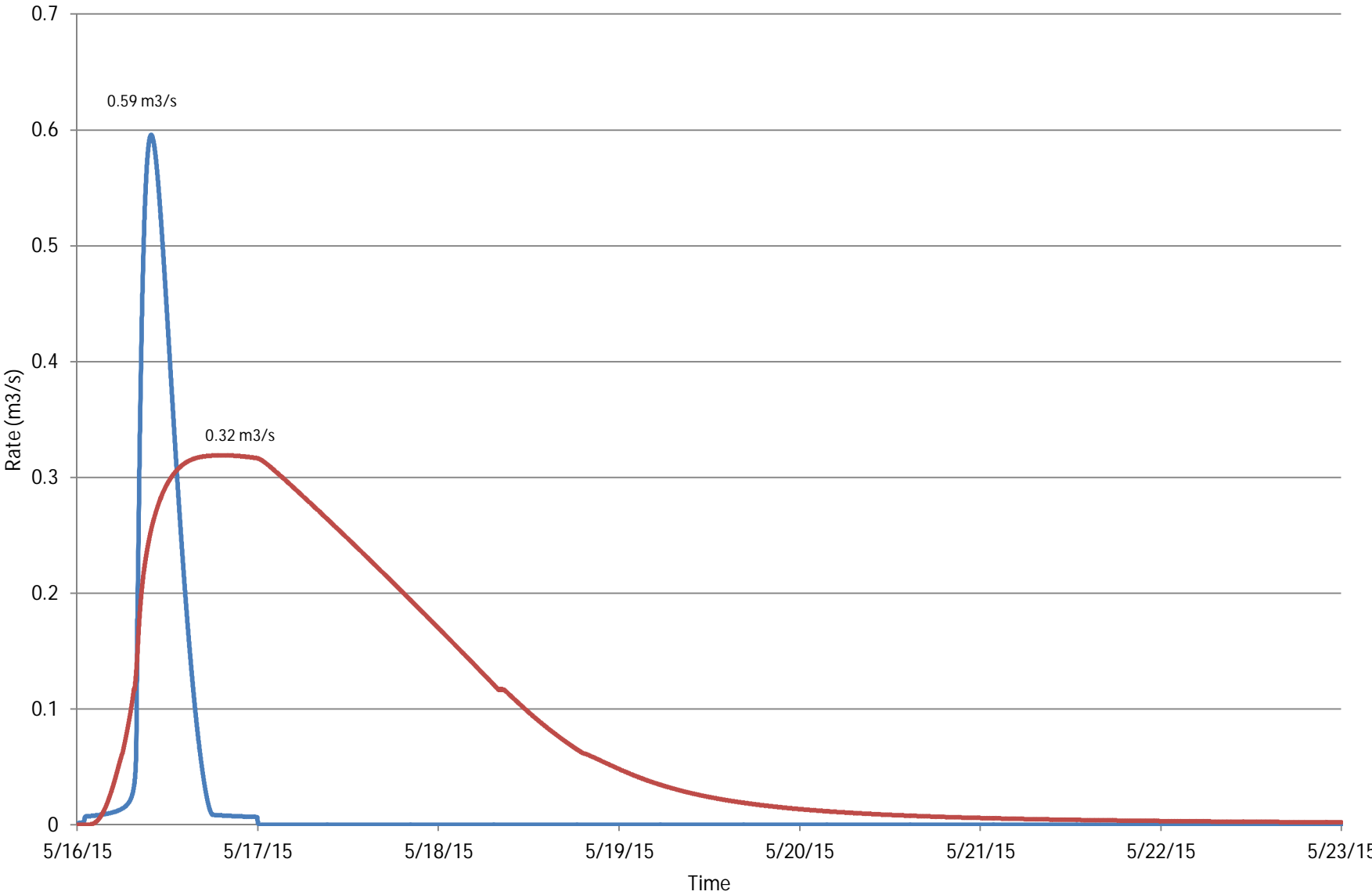
RED DEER
Stormwater Pond Conceptual Design
Pond 48



Design Parameters

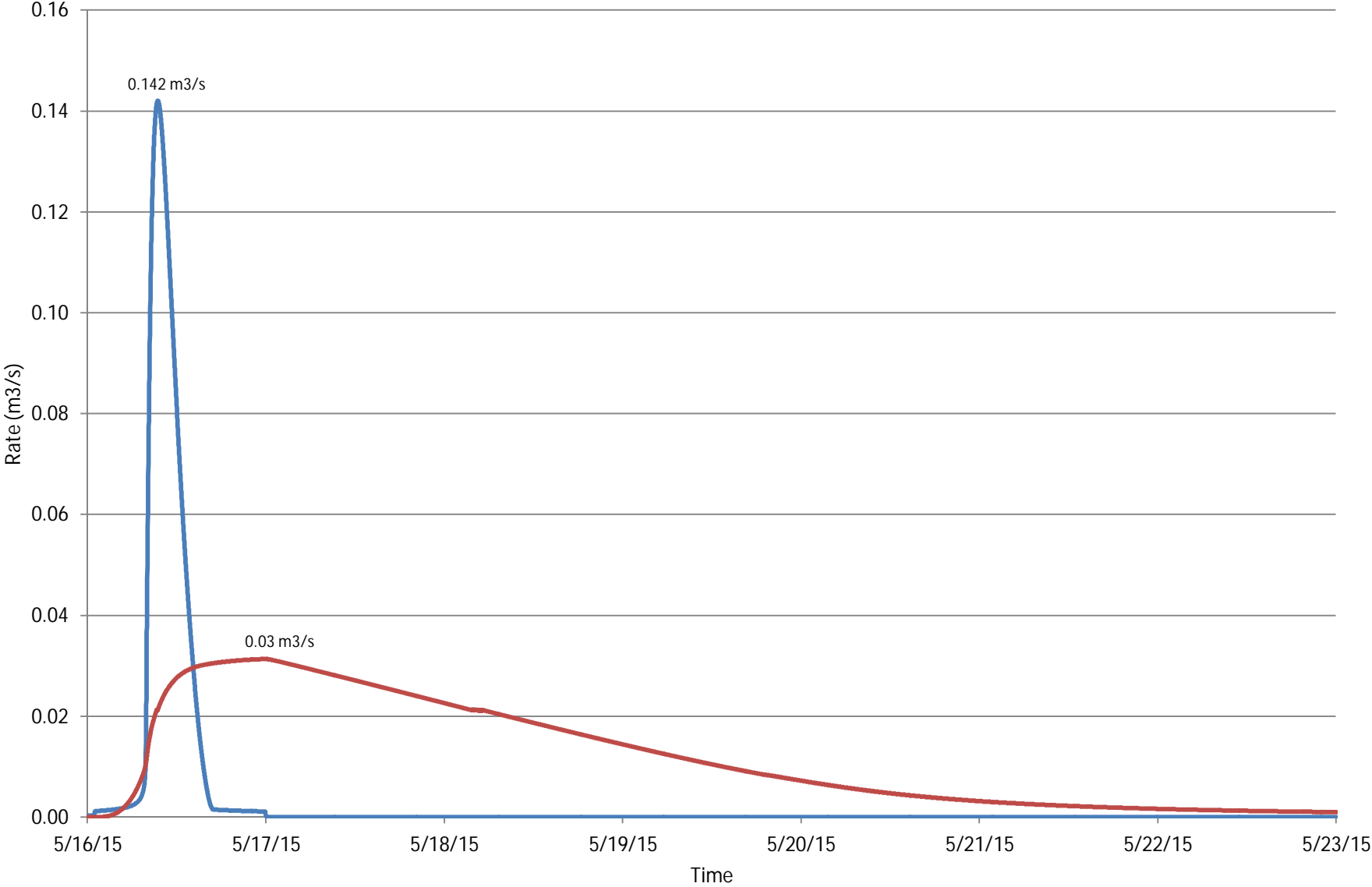
| Item | Elevation m | Area ha | Total Volume ha.m. | Storage Volume m ³ | Discharge m ³ /s | Depth m |
|-------------------------|----------------|------------|--------------------------|-------------------------------------|--------------------------------|------------|
| Minimum property line | 848.6 | 0.56 | 1.5 | 10125 | 0.065 | 6.6 |
| HWL | 848.0 | 0.47 | 1.2 | 7050 | 0.057 | 6.0 |
| Overflow Elev | 848.0 | 0.47 | 1.2 | 7050 | 0.057 | 6.0 |
| Normal water level | 846.0 | 0.24 | 0.5 | 0 | 0.000 | 4.0 |
| Base of pond | 842.0 | 0.01 | 0.0 | | 0.000 | 0.0 |
| Storage capacity | | | | 7050 | | |
| Average existing ground | 848.6 | 0.6 | 1.5 | | | |
| Side slope | | 5.0 H:V | | | | |

Pond 1 - Flow Hydrograph



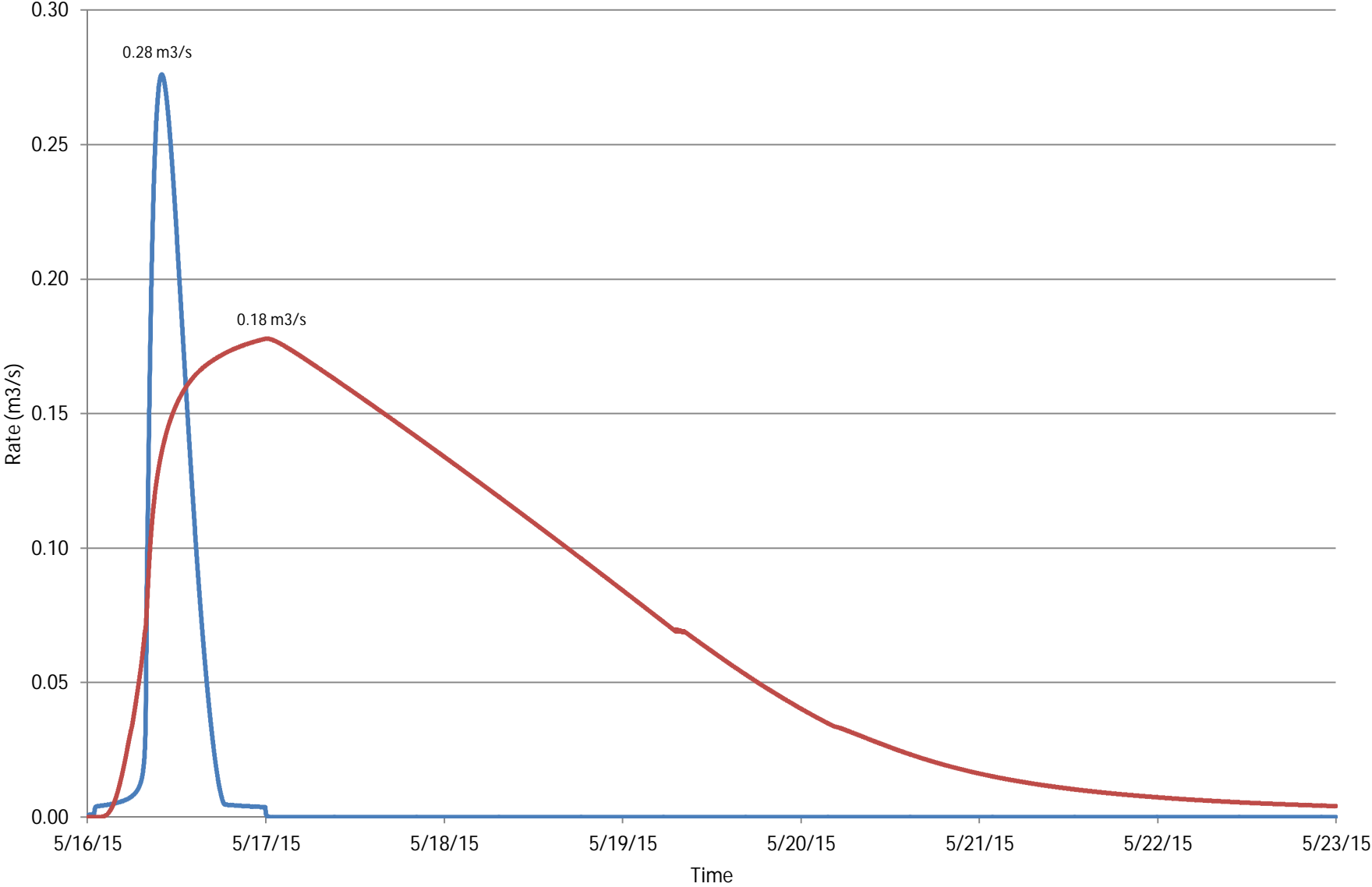
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 2 - Flow Hydrograph



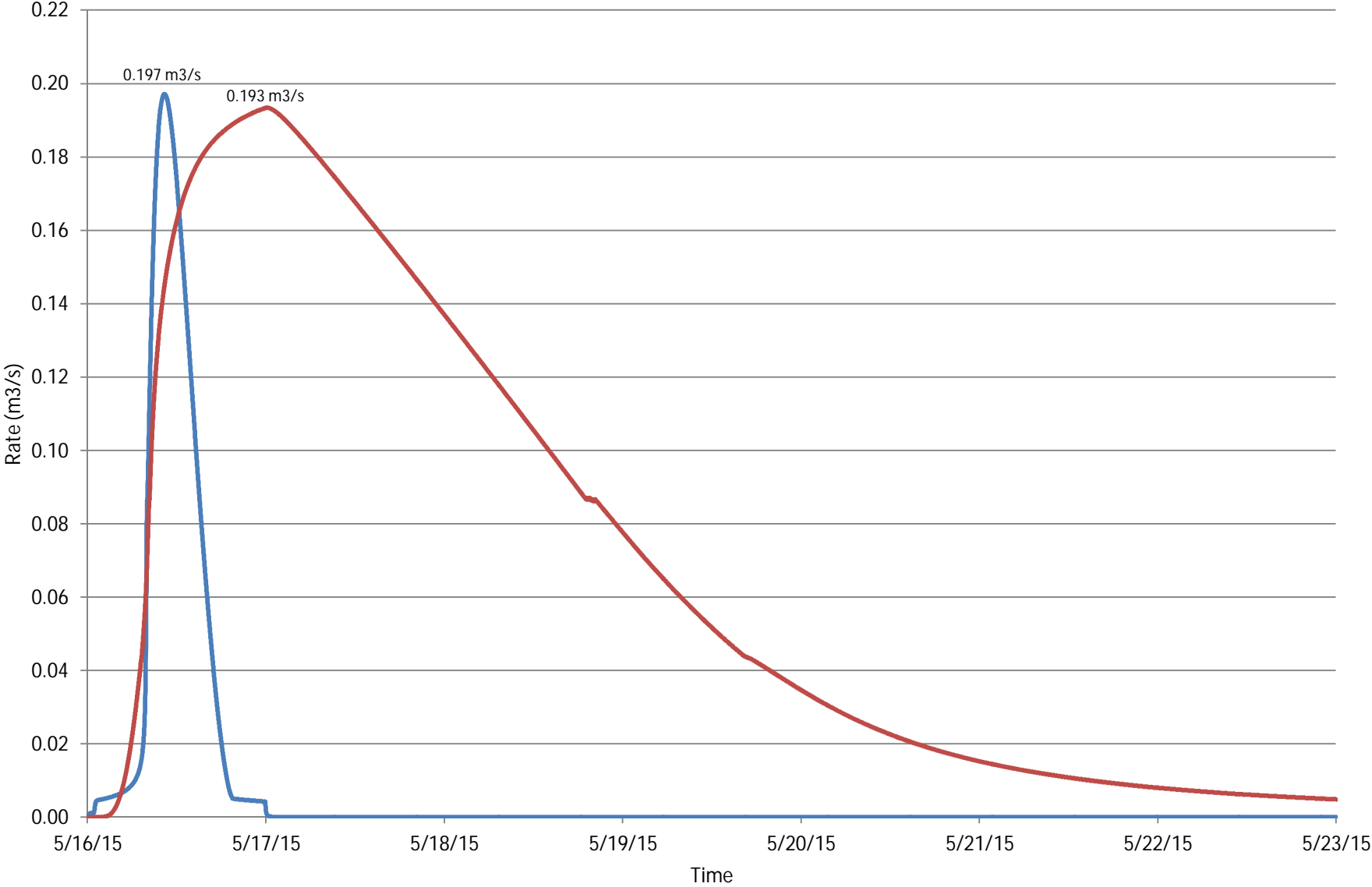
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 3 - Flow Hydrograph



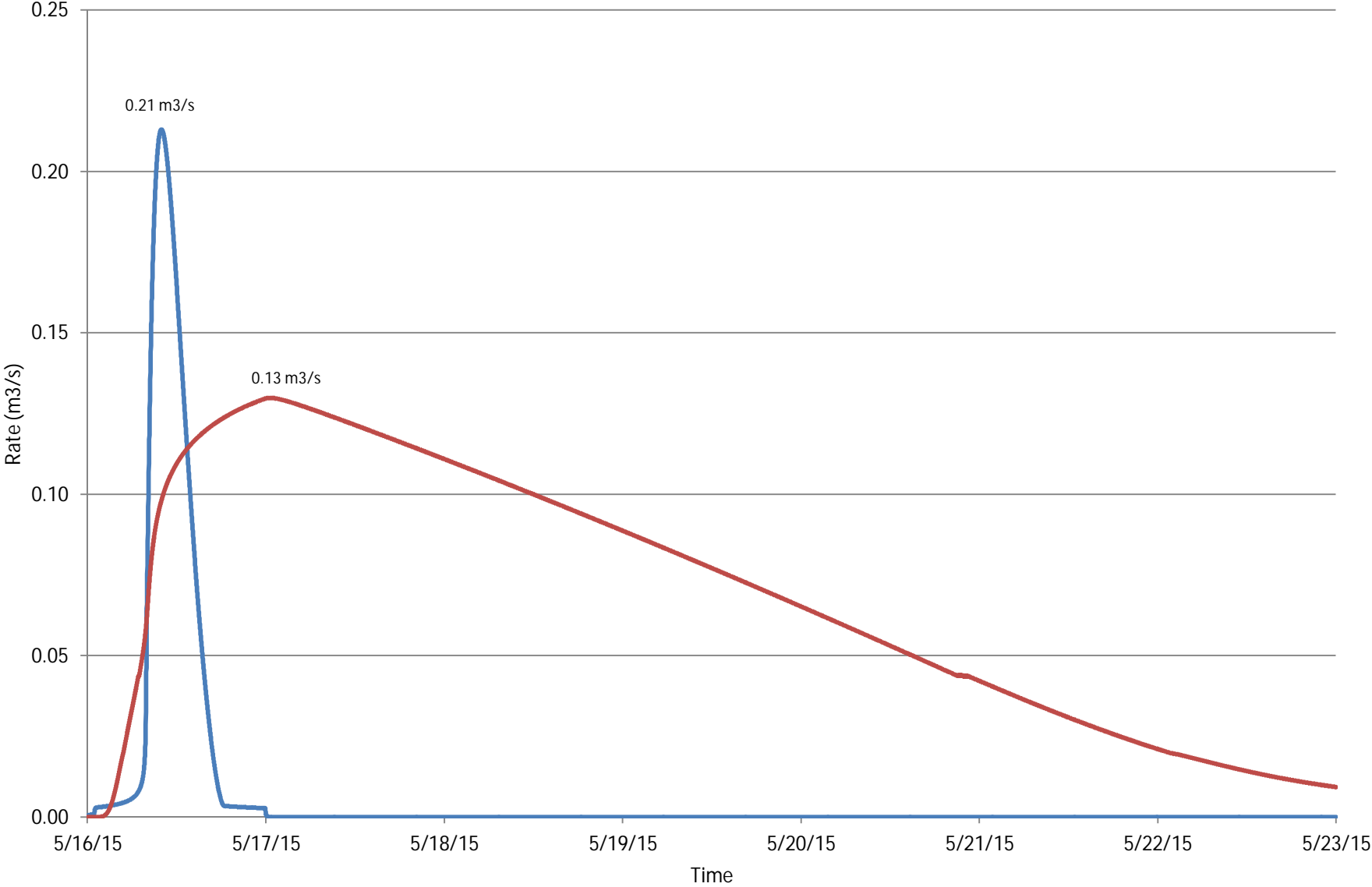
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 4 - Flow Hydrograph



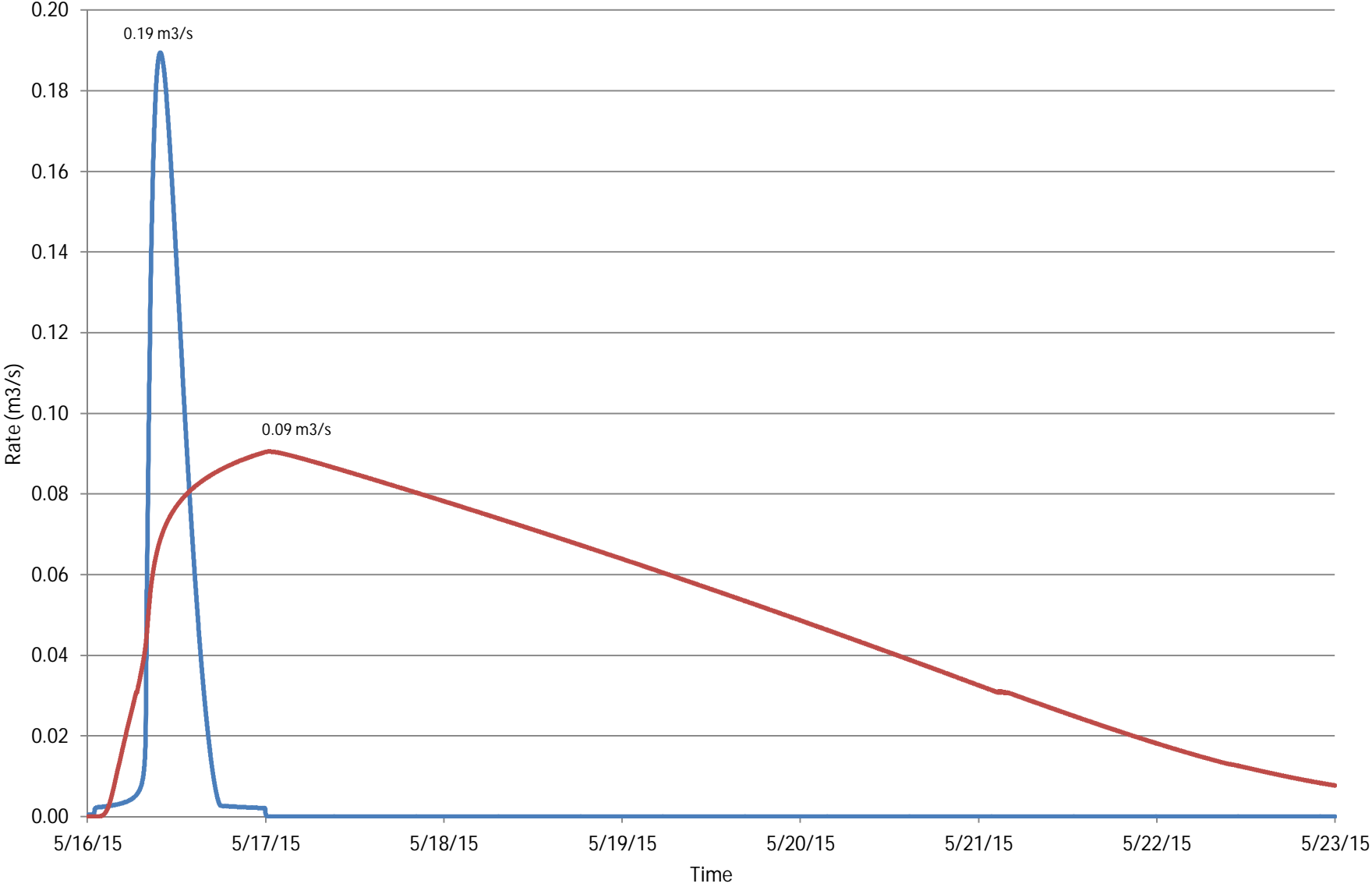
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 5 - Flow Hydrograph



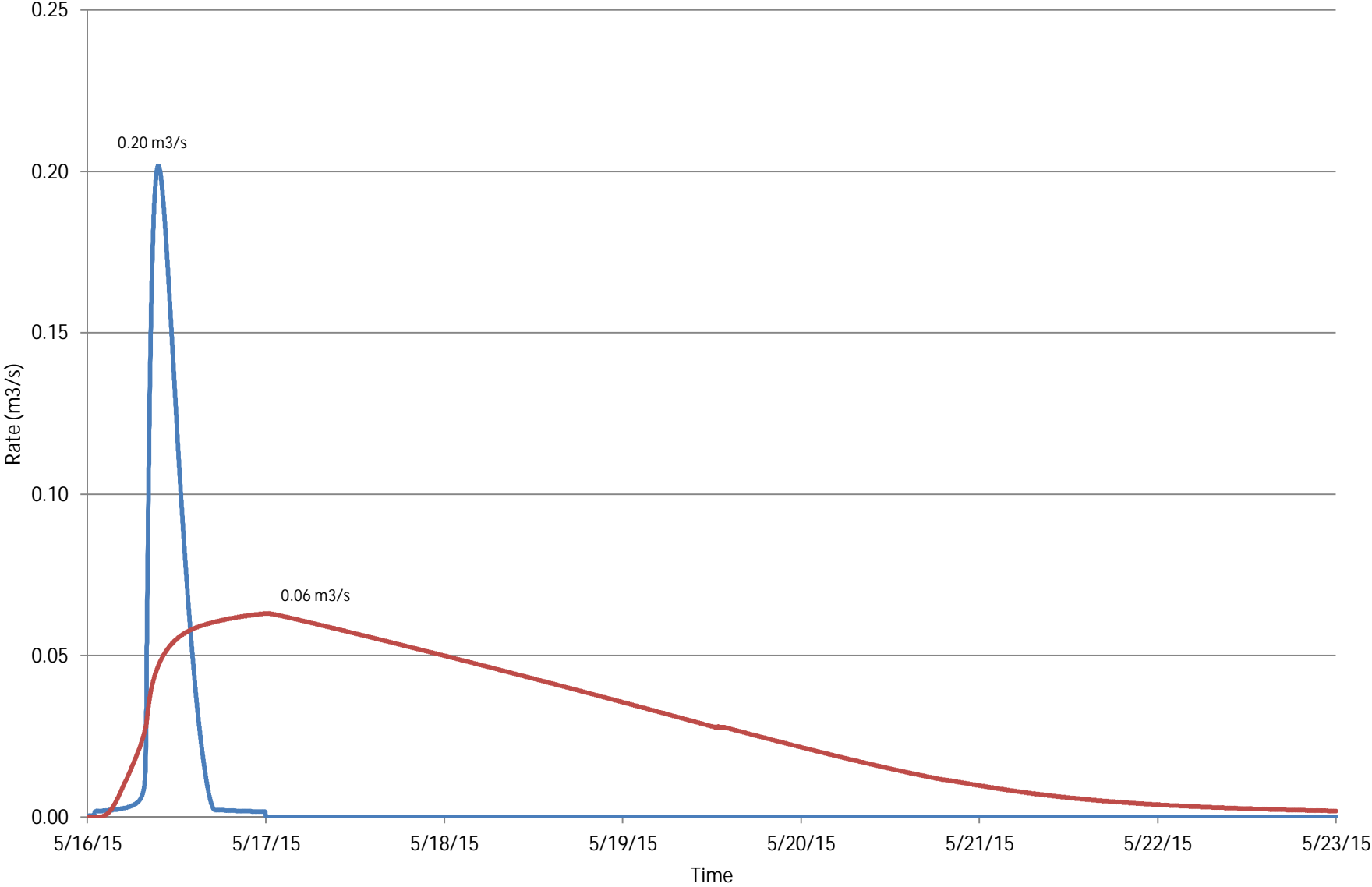
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 6 - Flow Hydrograph



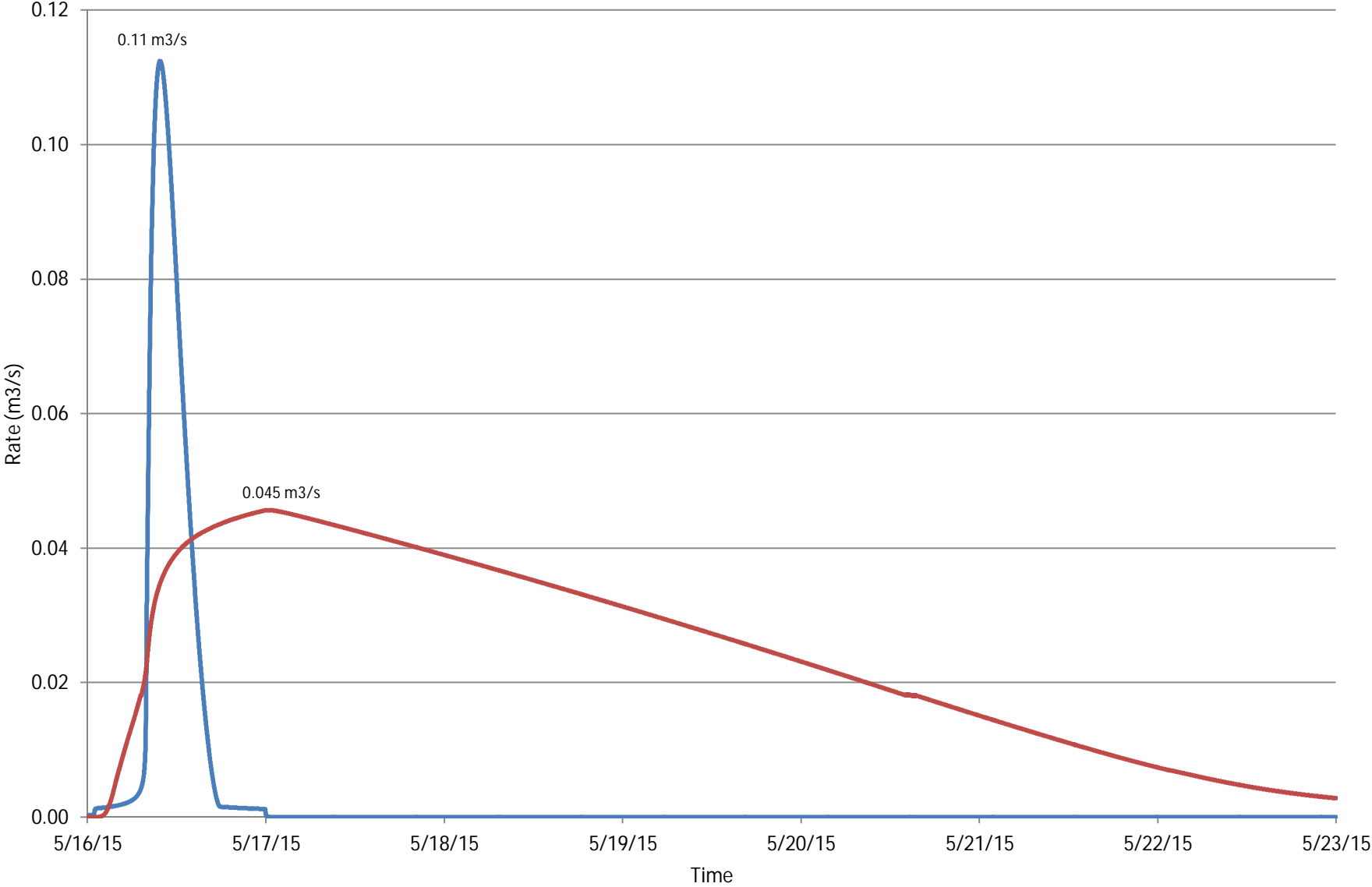
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 7 - Flow Hydrograph



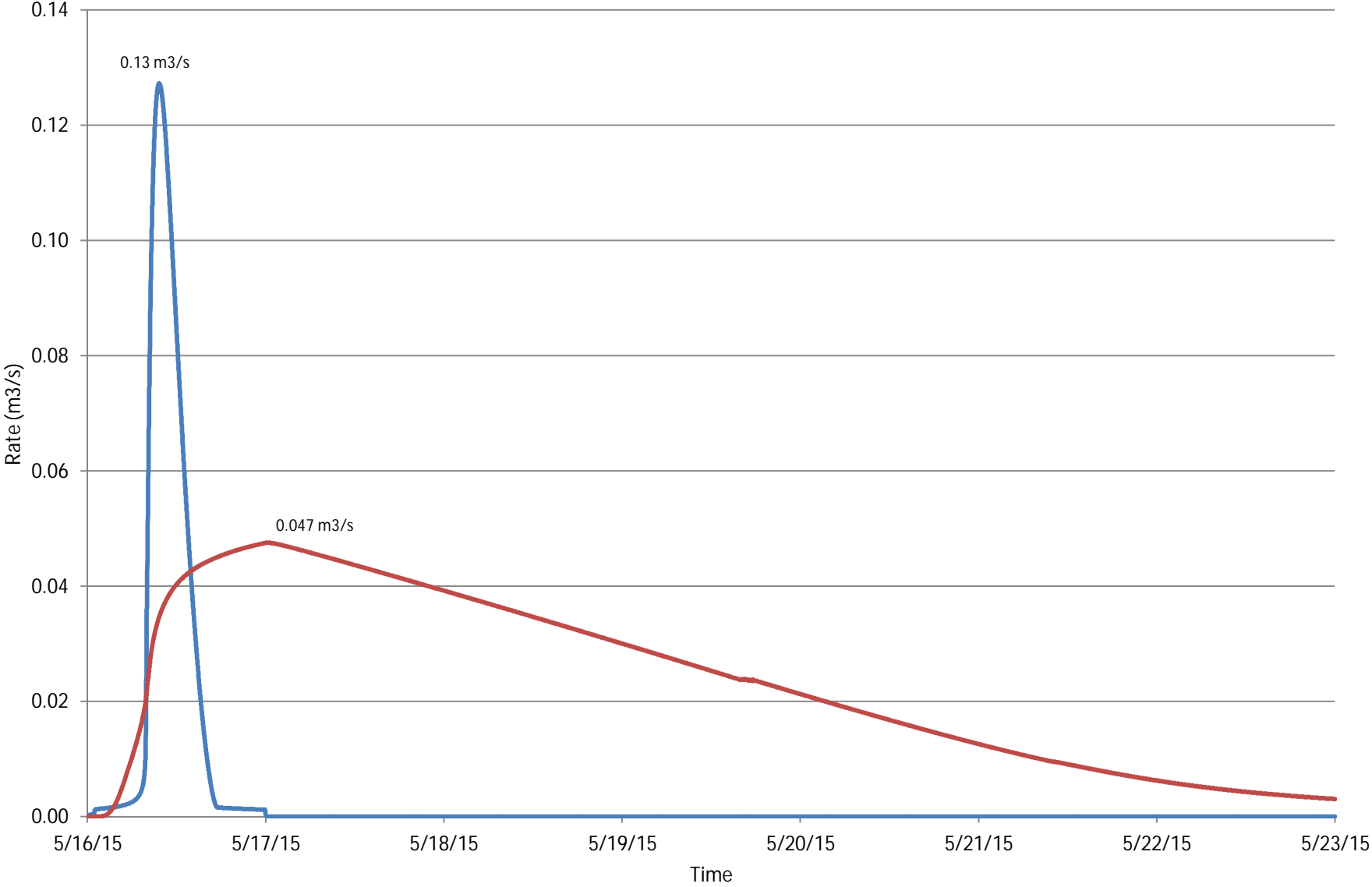
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 8 - Flow Hydrograph



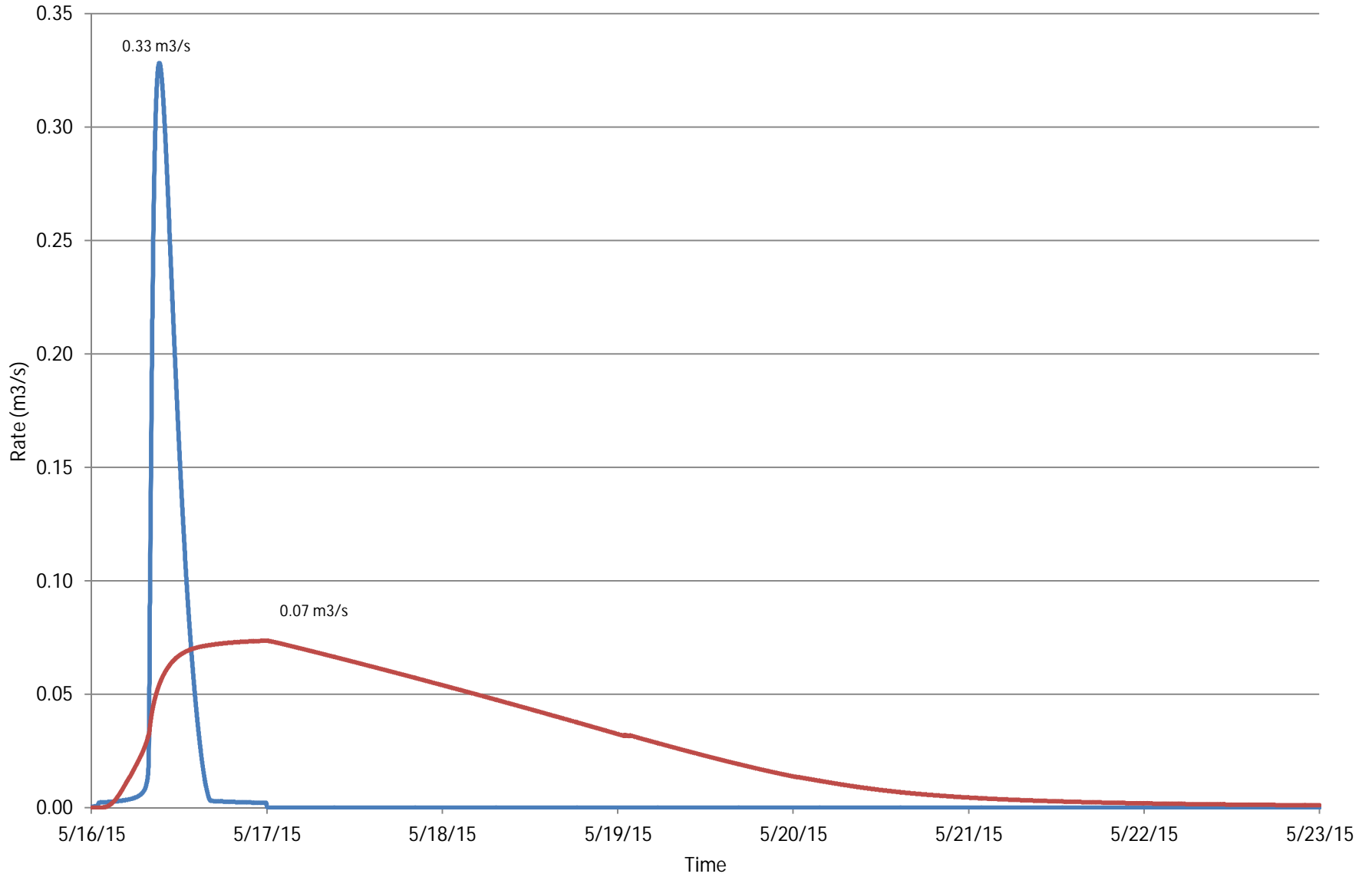
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 9 - Flow Hydrograph



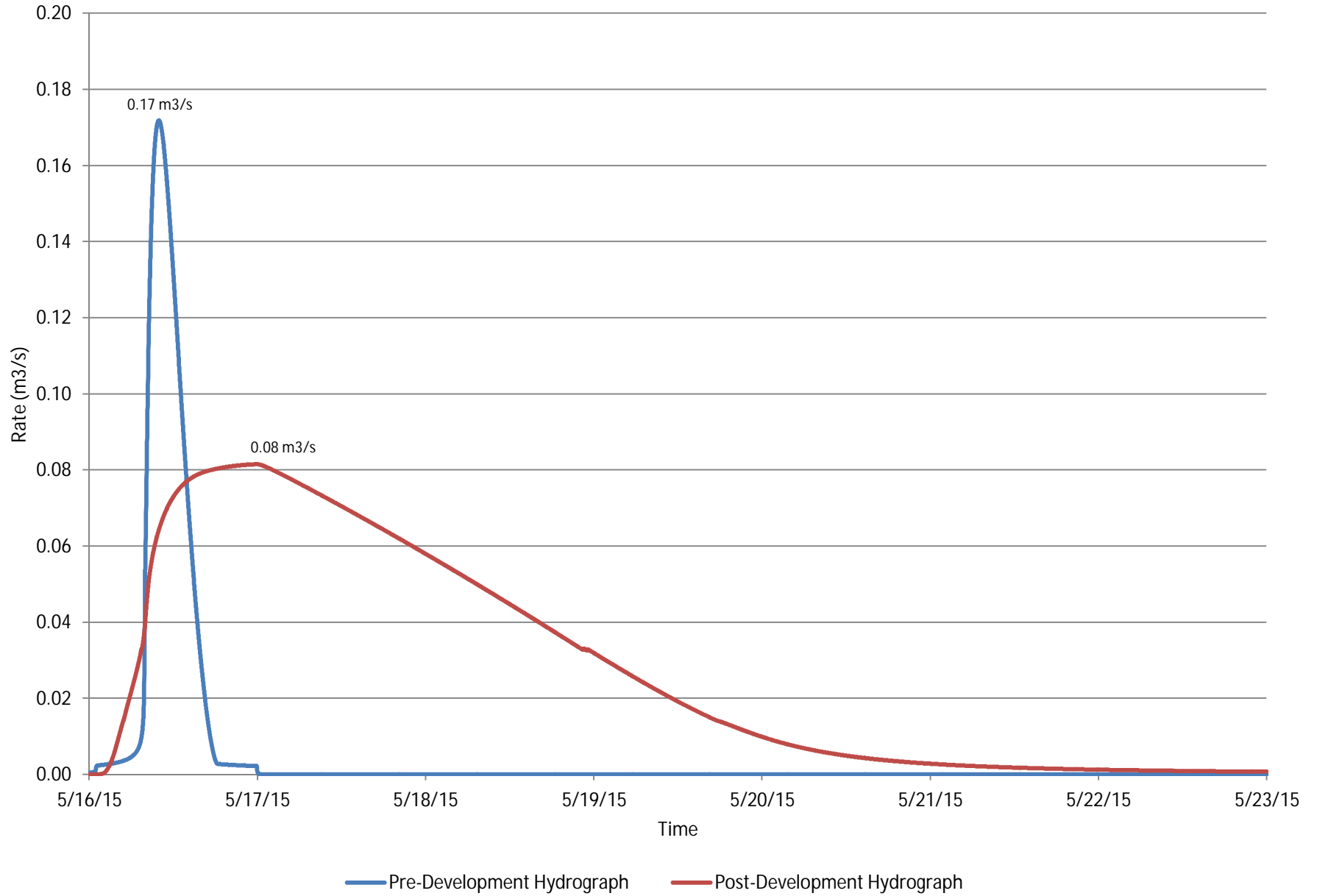
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 10 - Flow Hydrograph

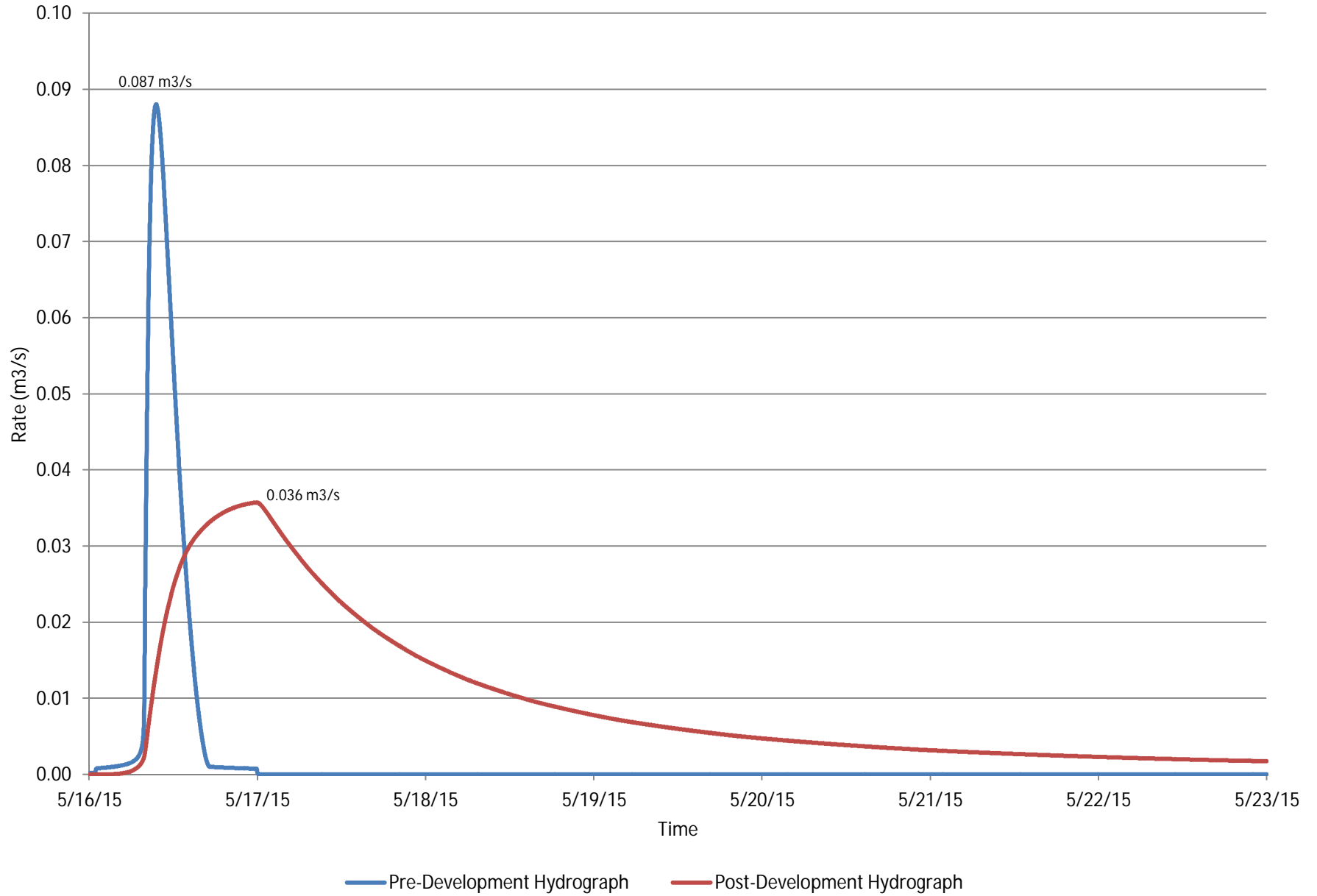


— Pre-Development Hydrograph — Post-Development Hydrograph

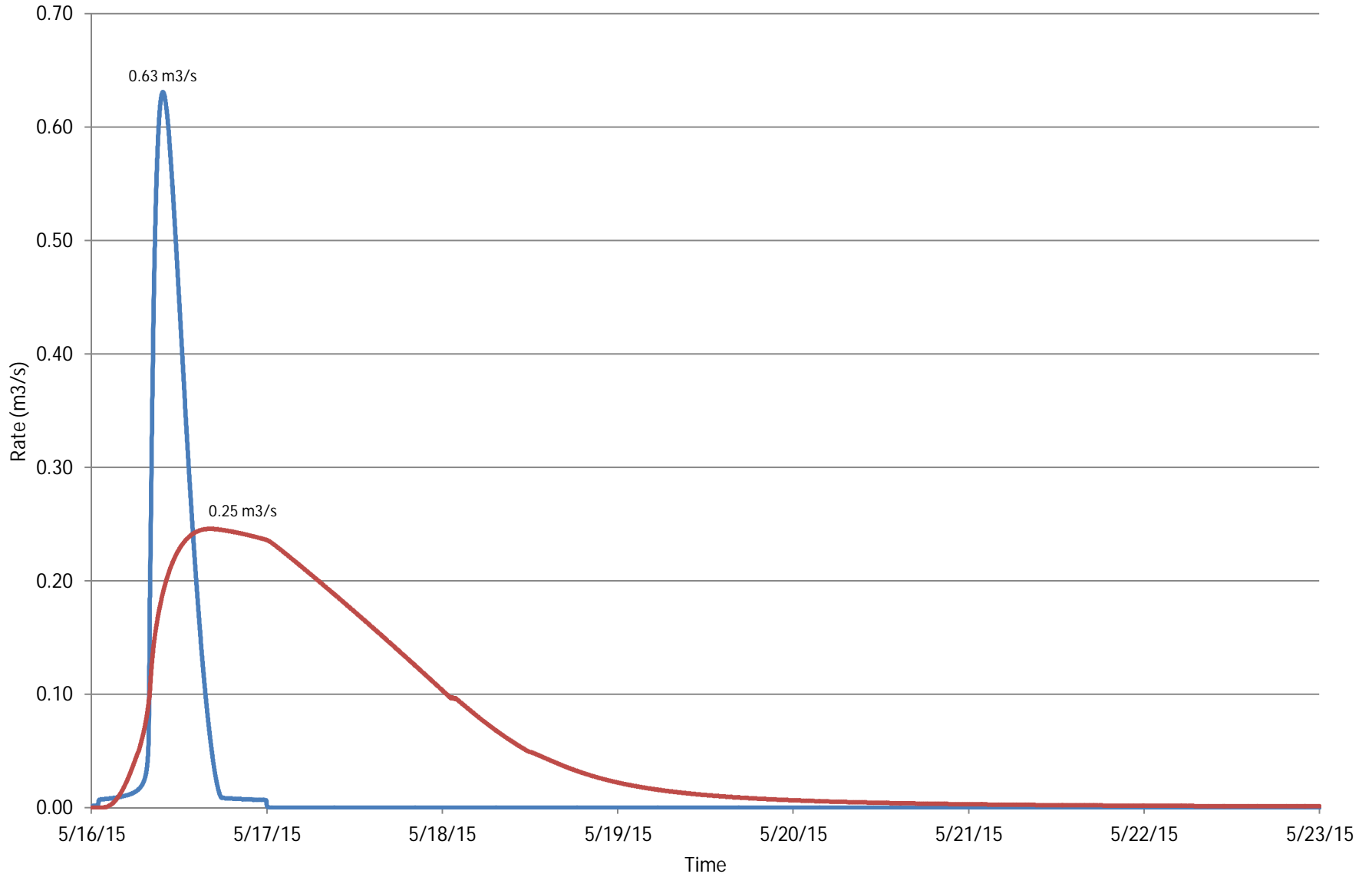
Pond 11 - Flow Hydrograph



Pond 12 - Flow Hydrograph

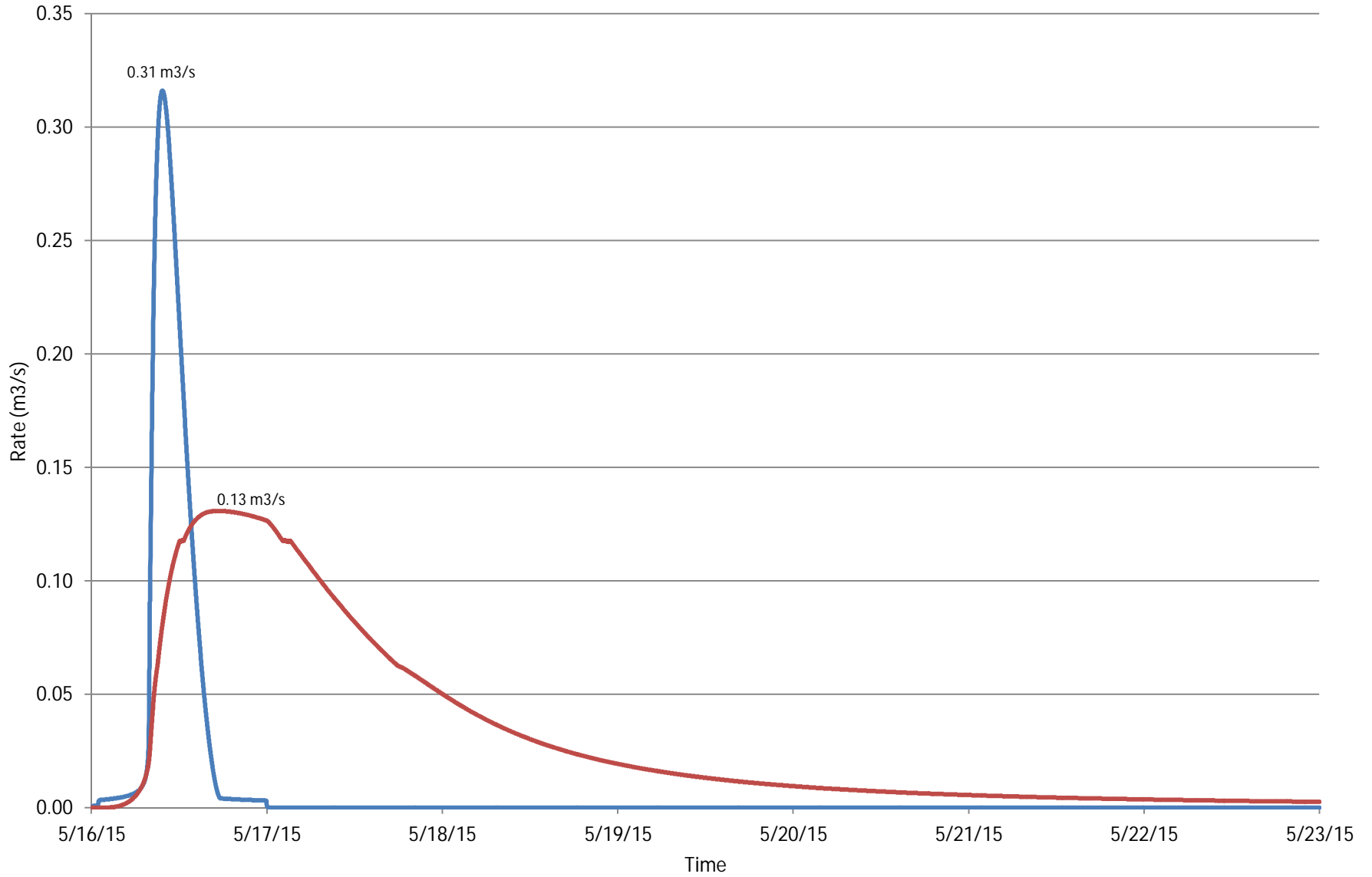


Pond 13 - Flow Hydrograph



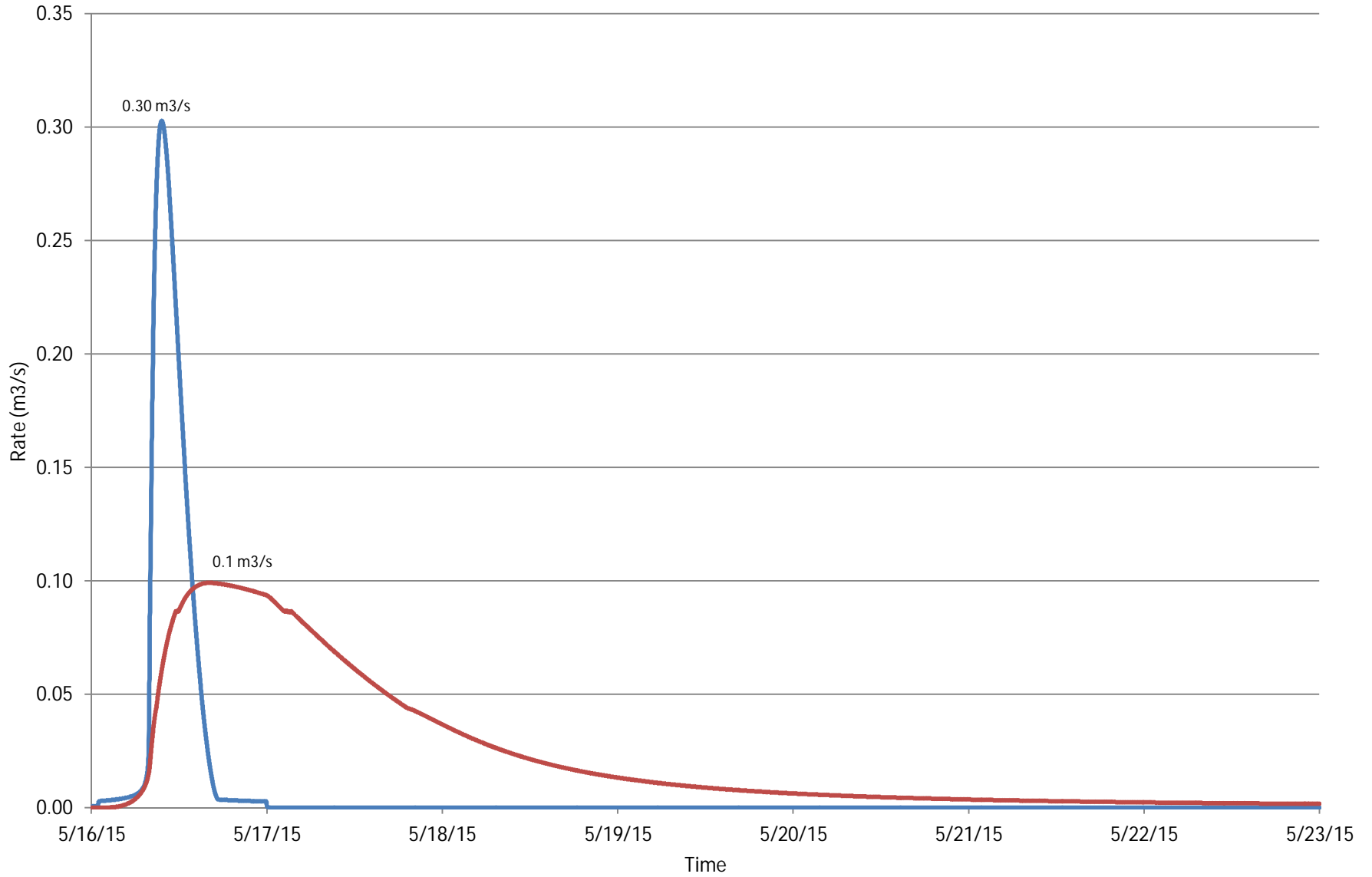
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 14 - Flow Hydrograph



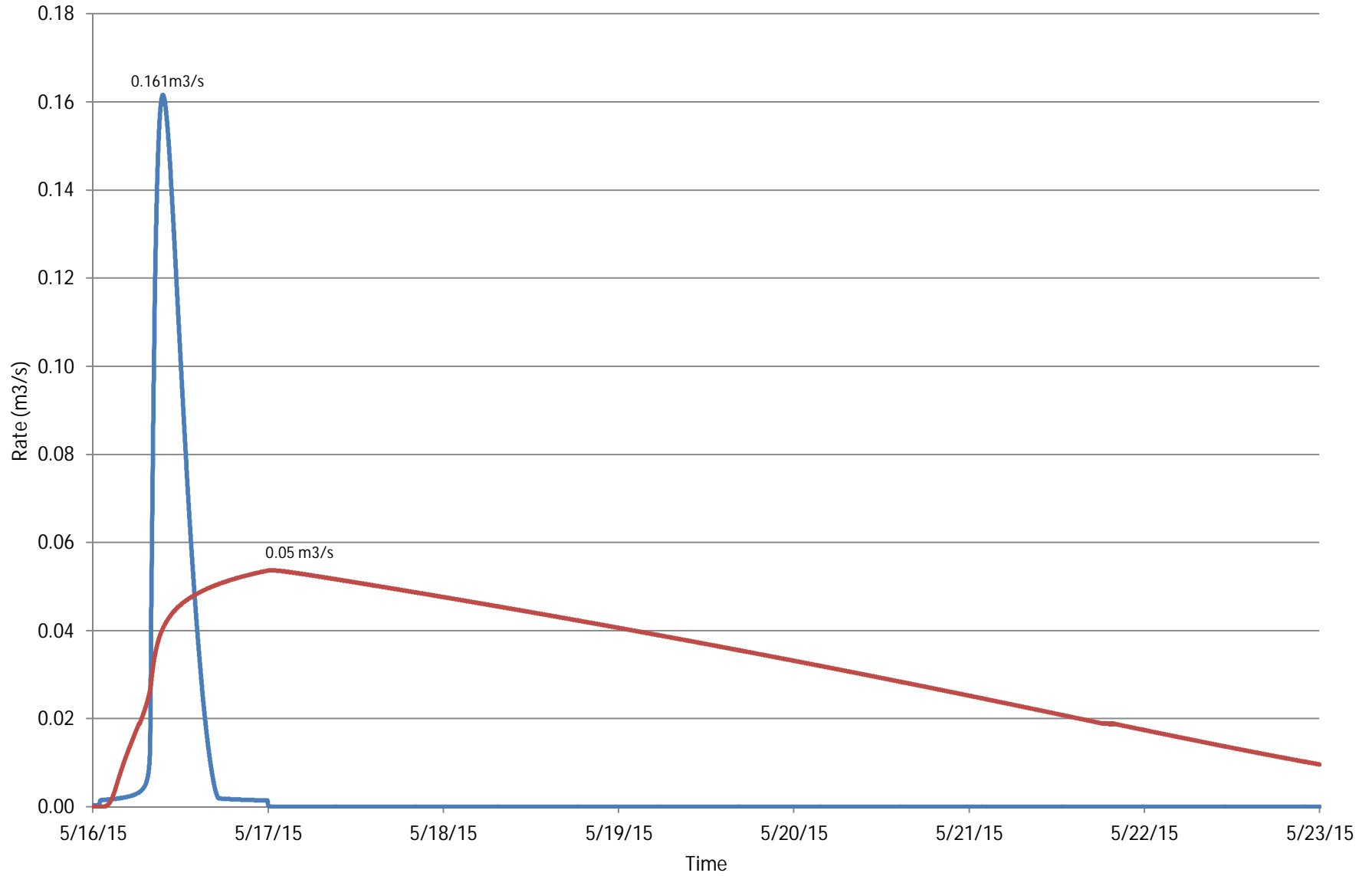
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 15 - Flow Hydrograph



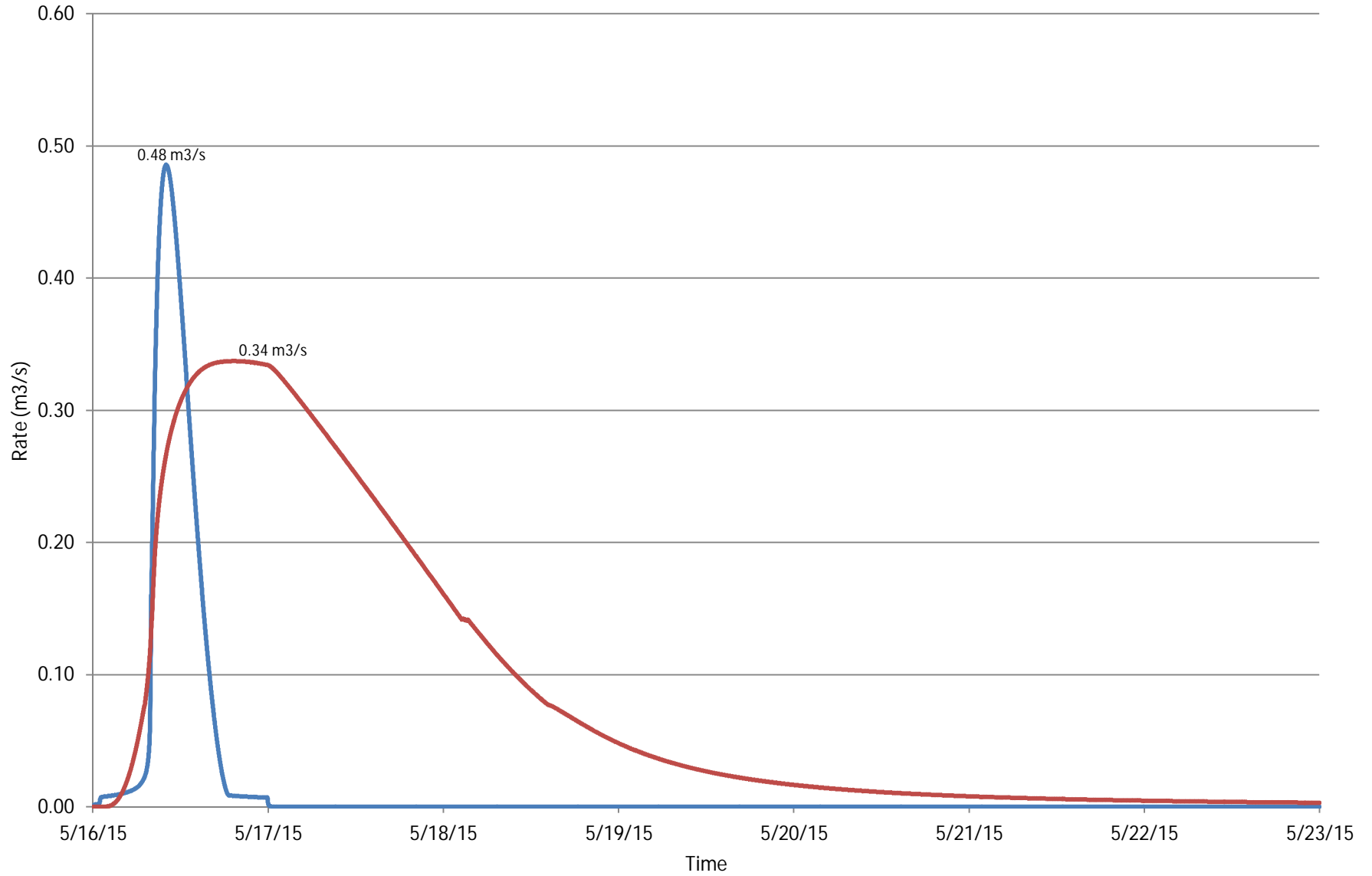
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 16 - Flow Hydrograph



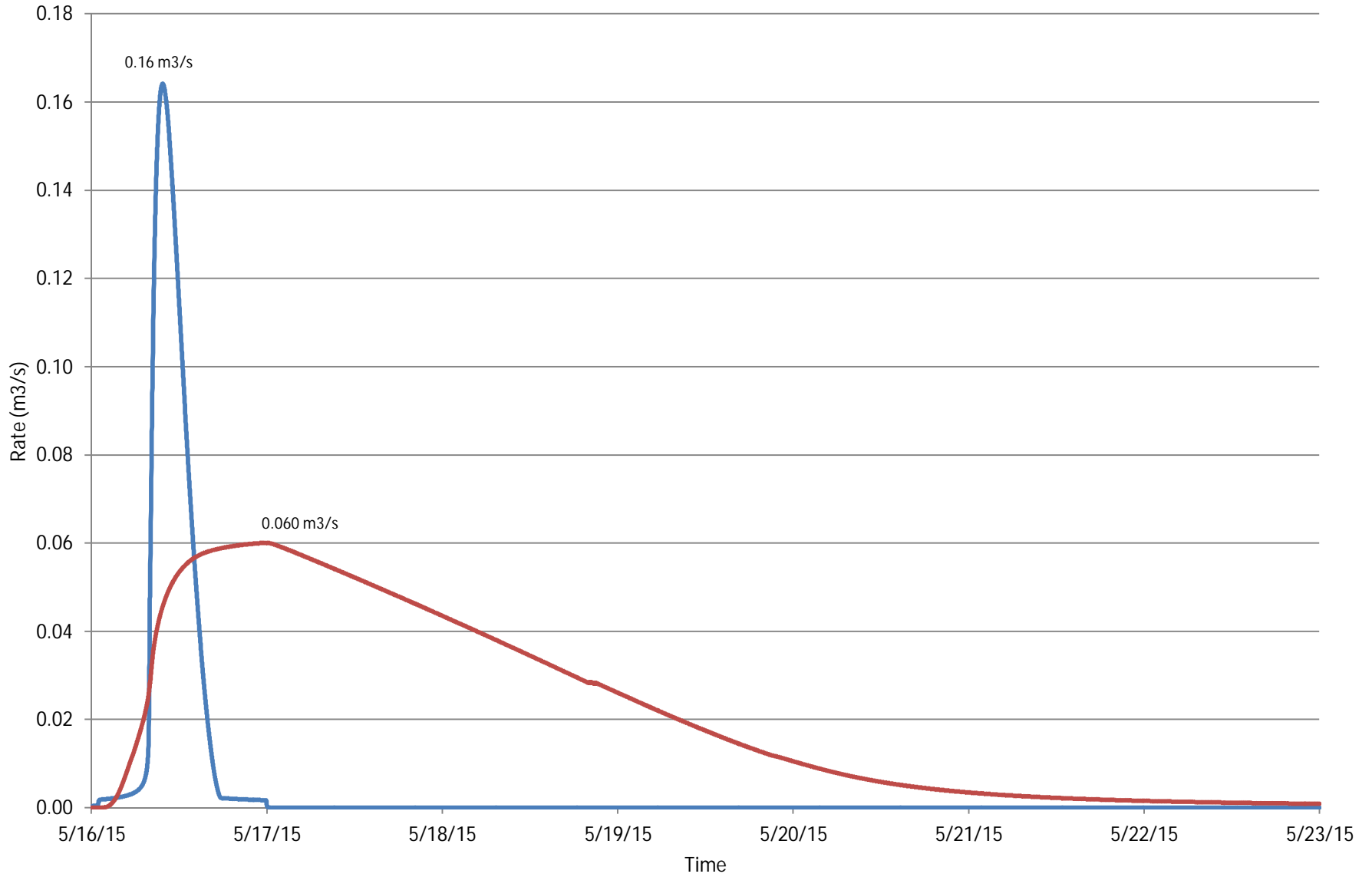
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 17 - Flow Hydrograph



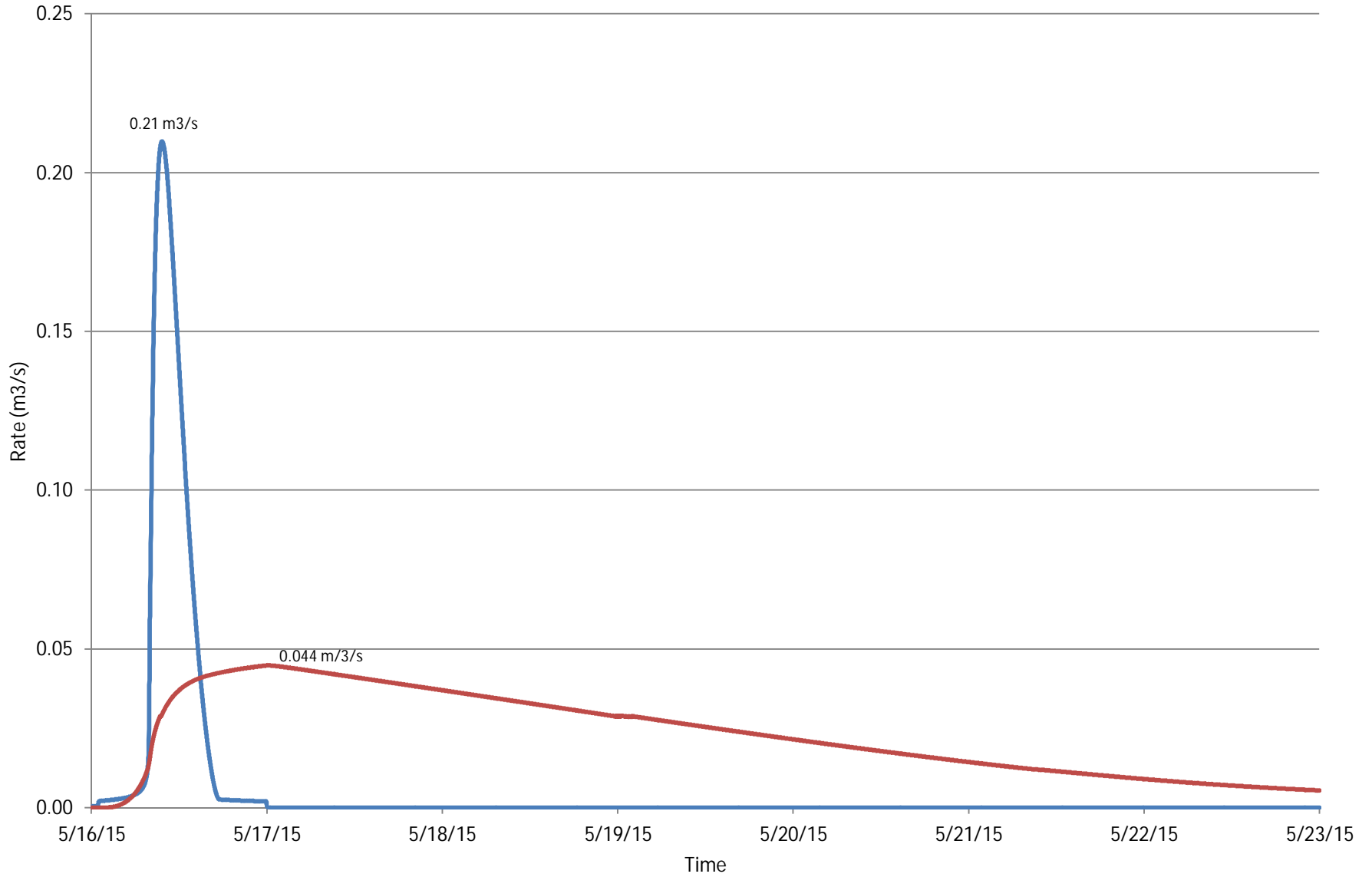
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 18 - Flow Hydrograph



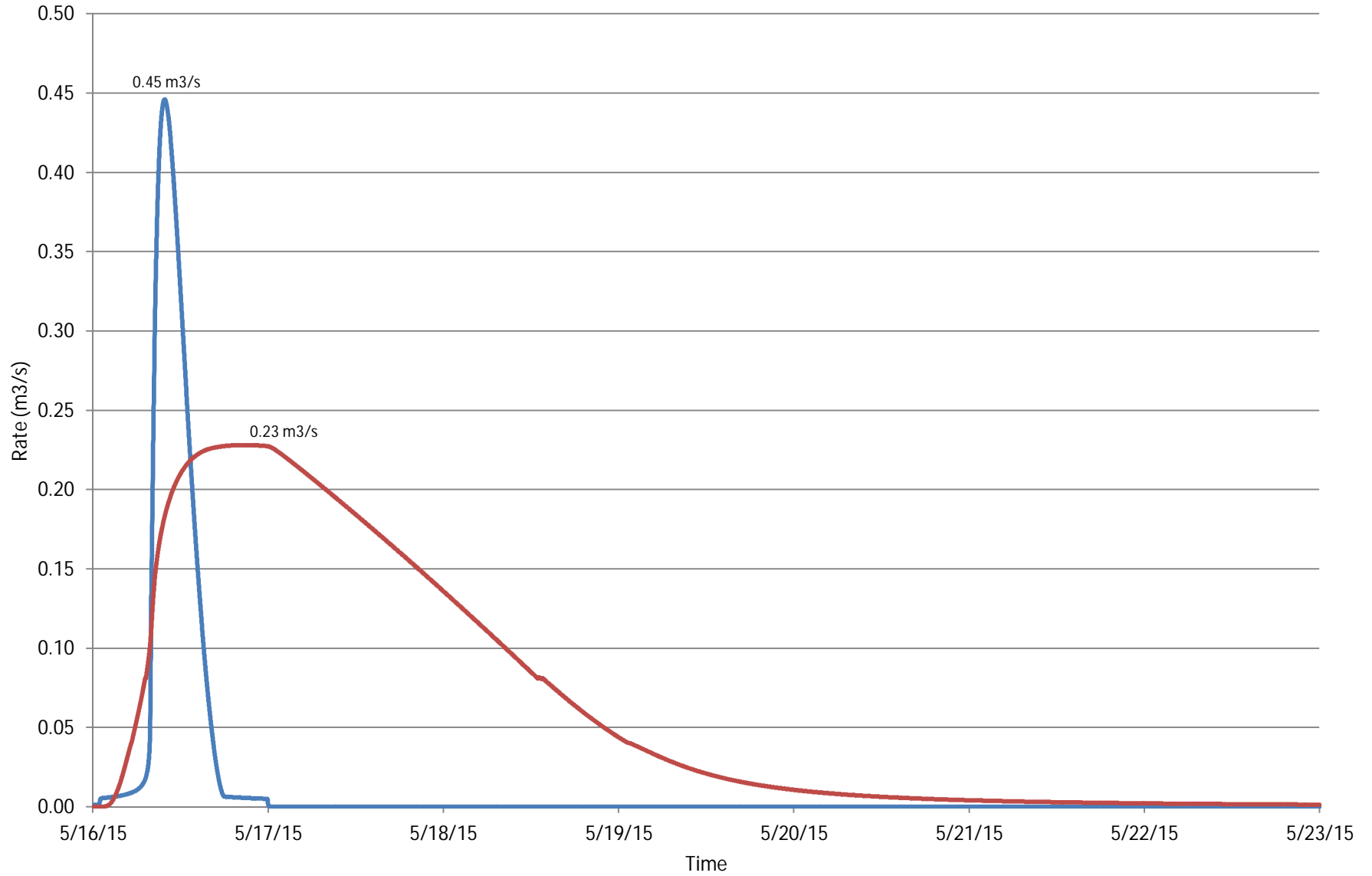
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 19 - Flow Hydrograph



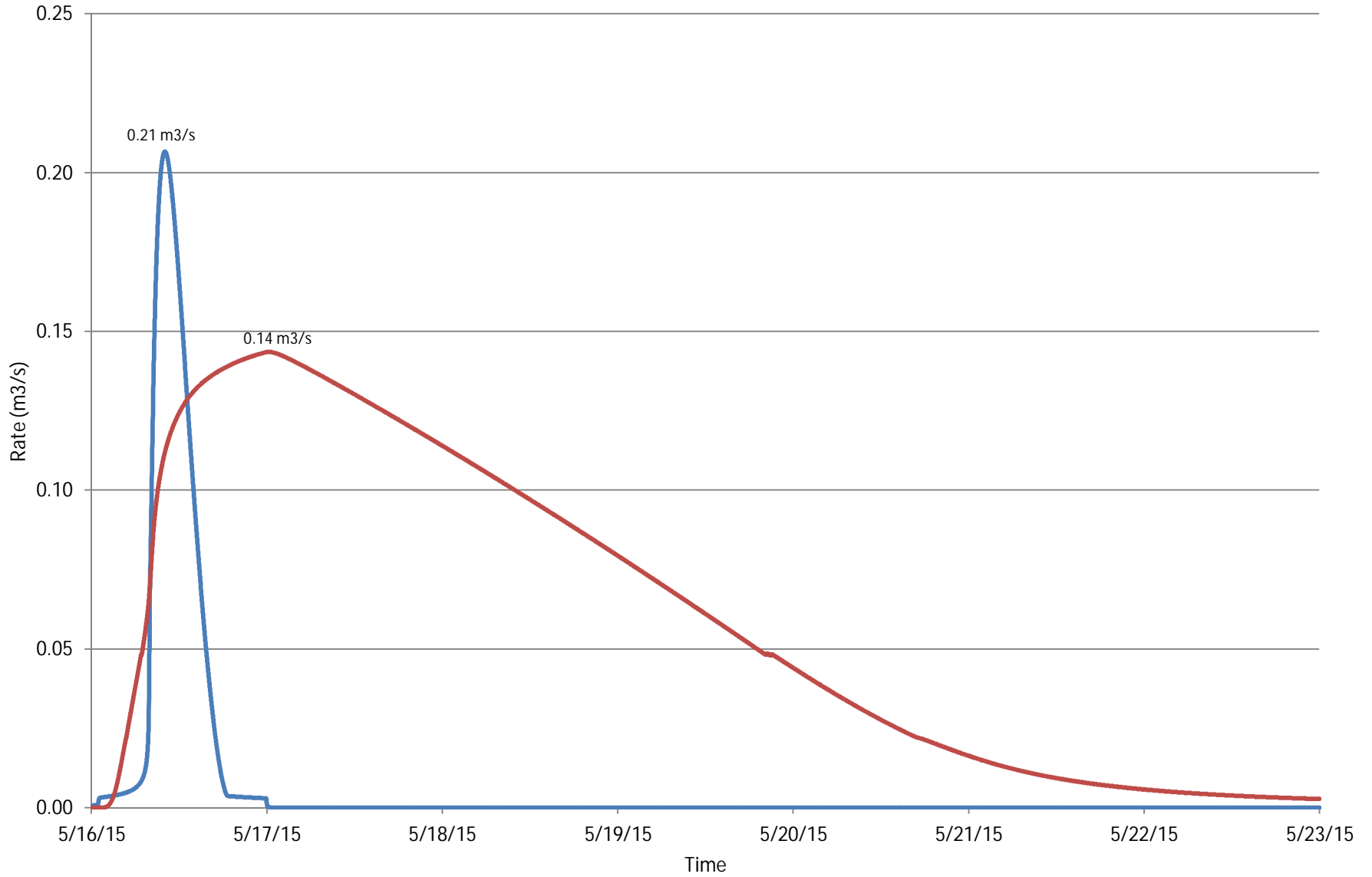
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 20 - Flow Hydrograph



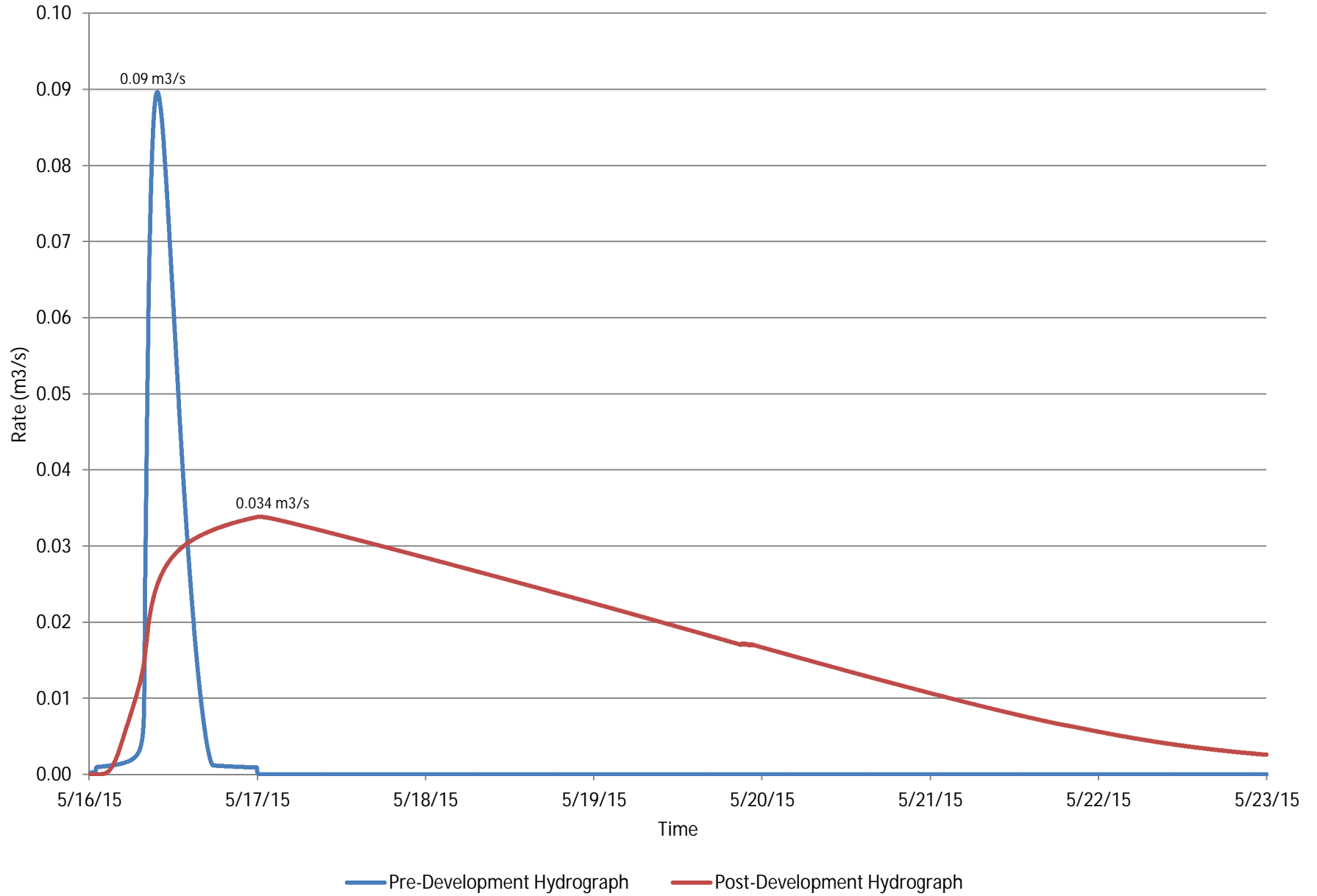
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 21 - Flow Hydrograph

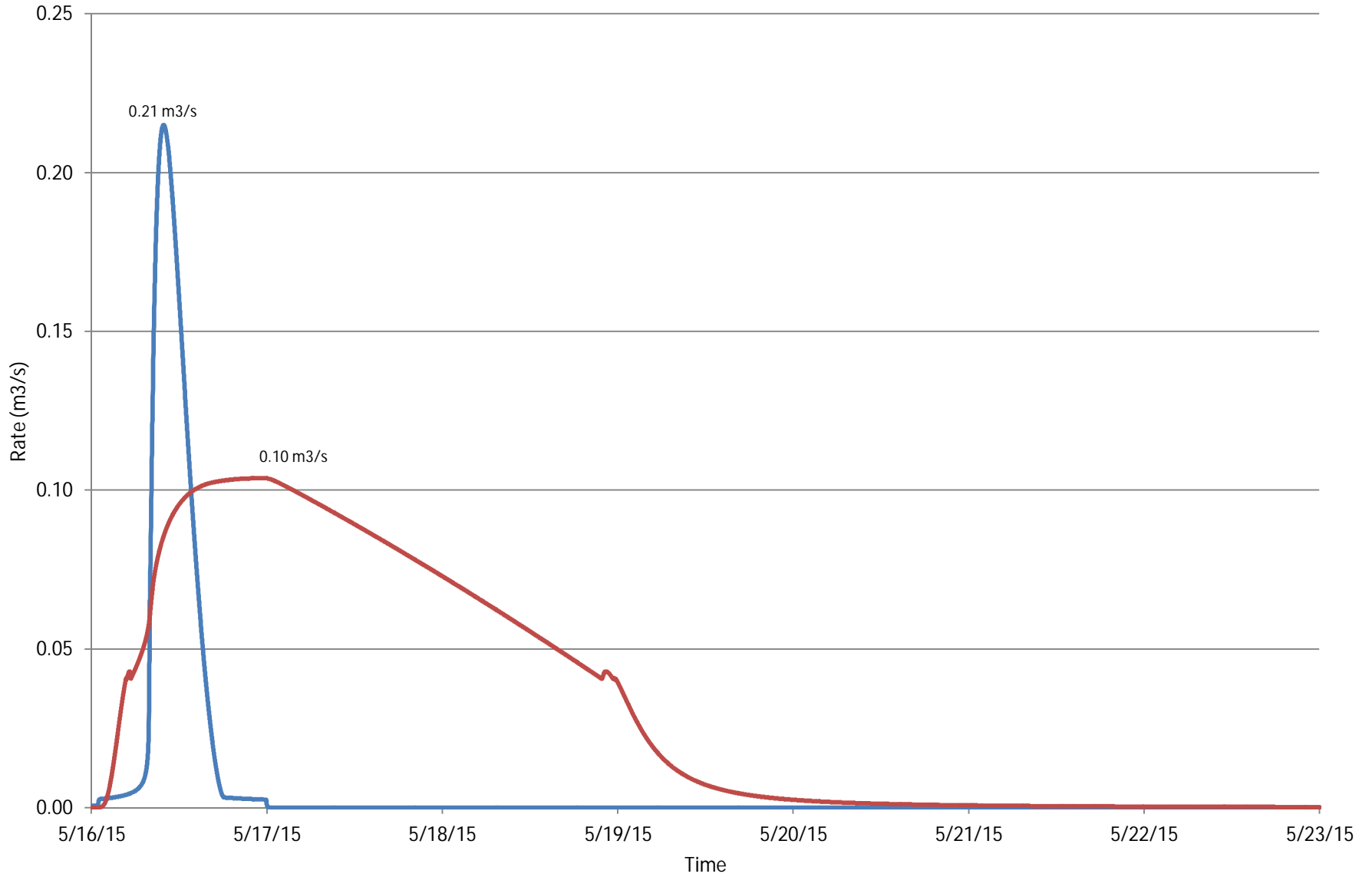


— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 22 - Flow Hydrograph

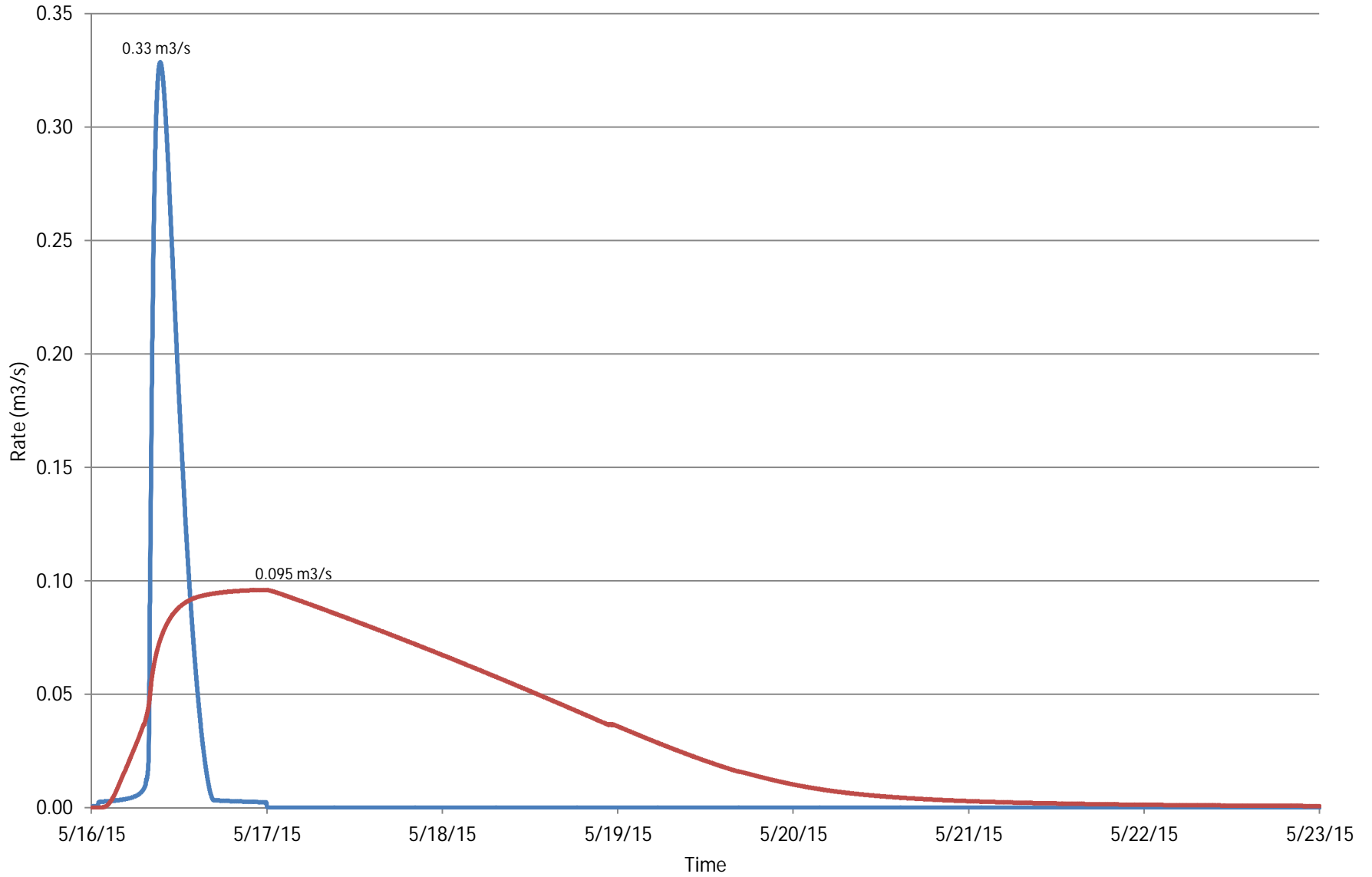


Pond 23 - Flow Hydrograph



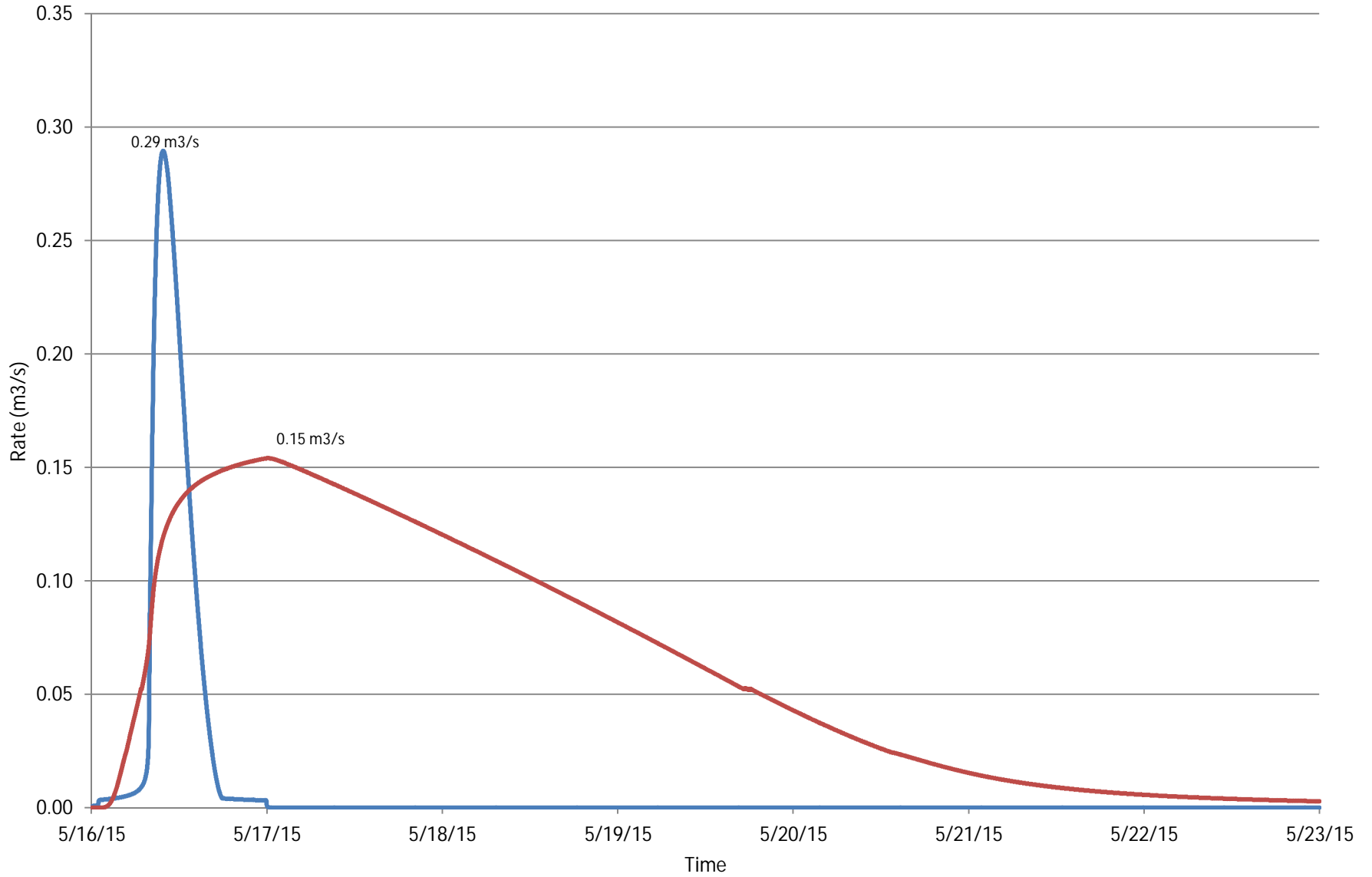
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 24 - Flow Hydrograph



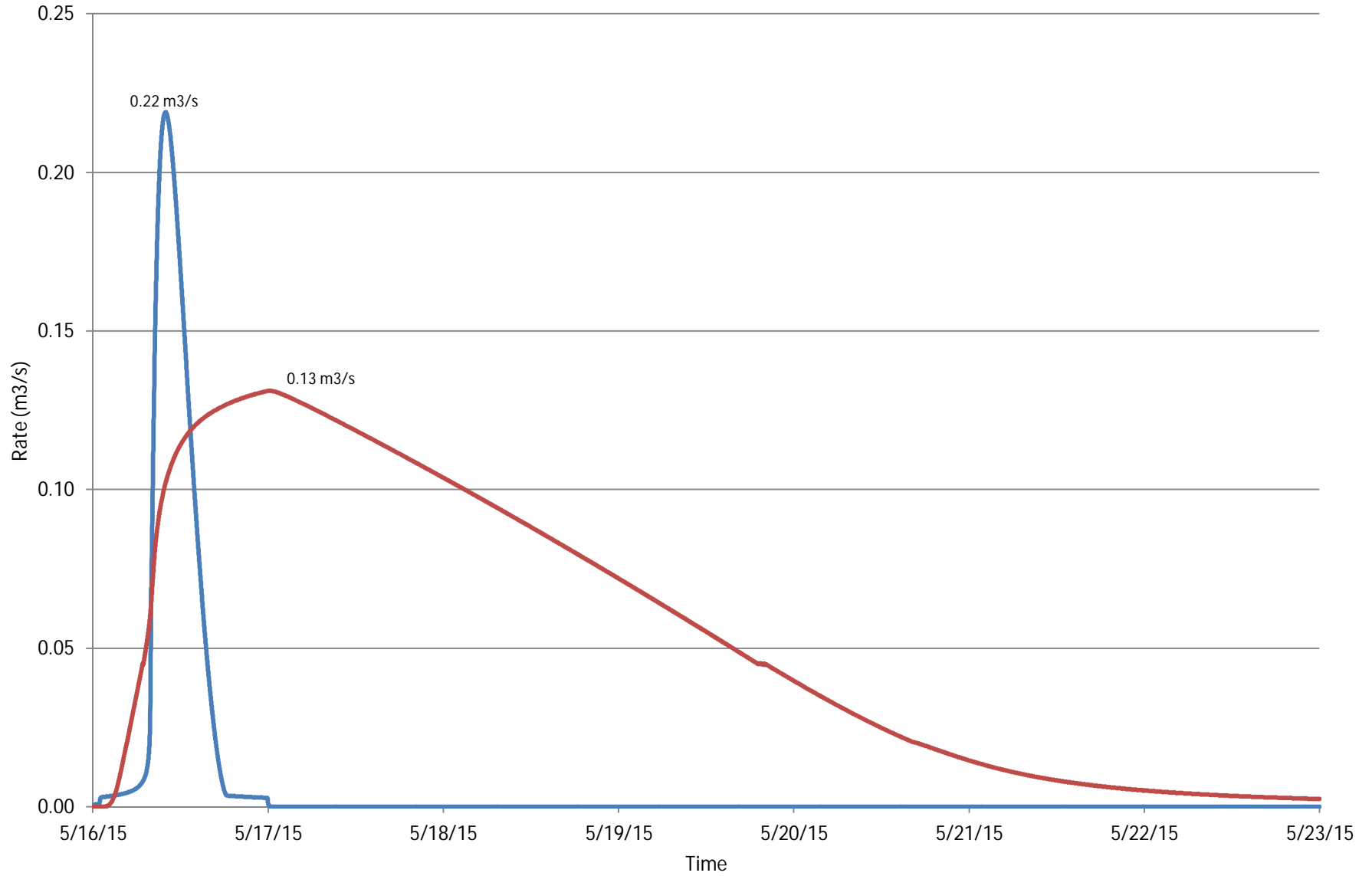
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 25 - Flow Hydrograph



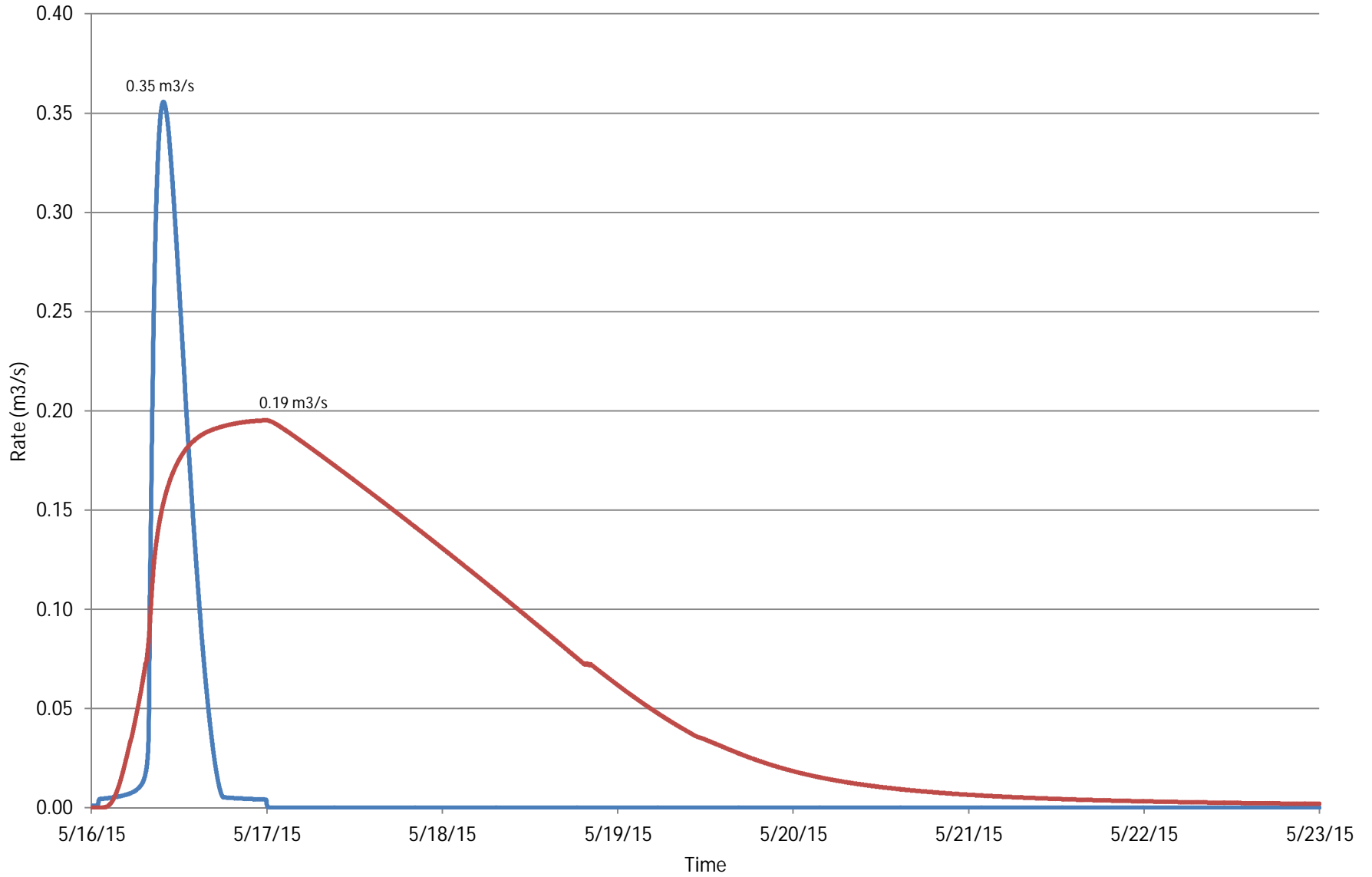
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 26 - Flow Hydrograph



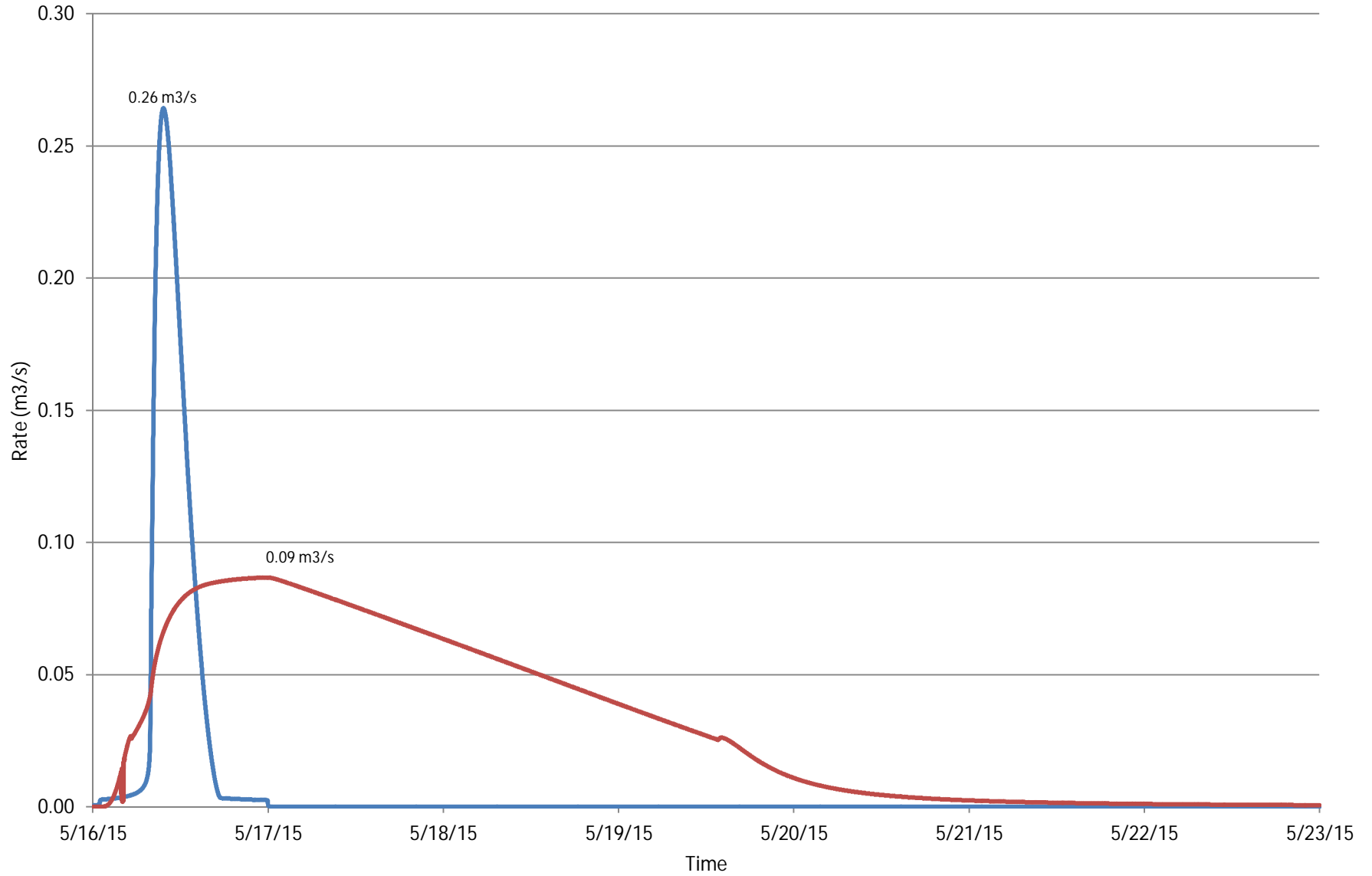
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 27 - Flow Hydrograph



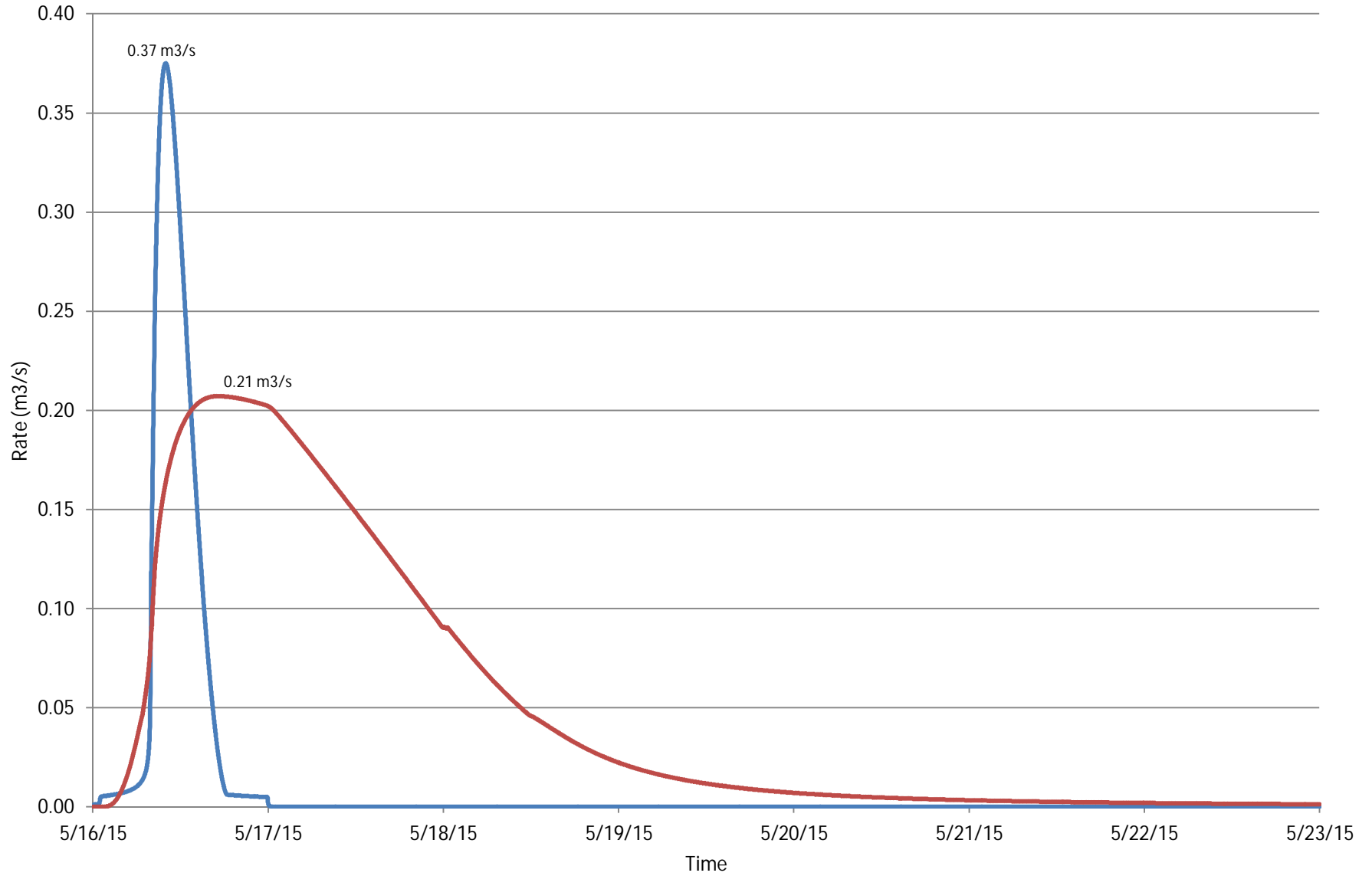
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 28 - Flow Hydrograph



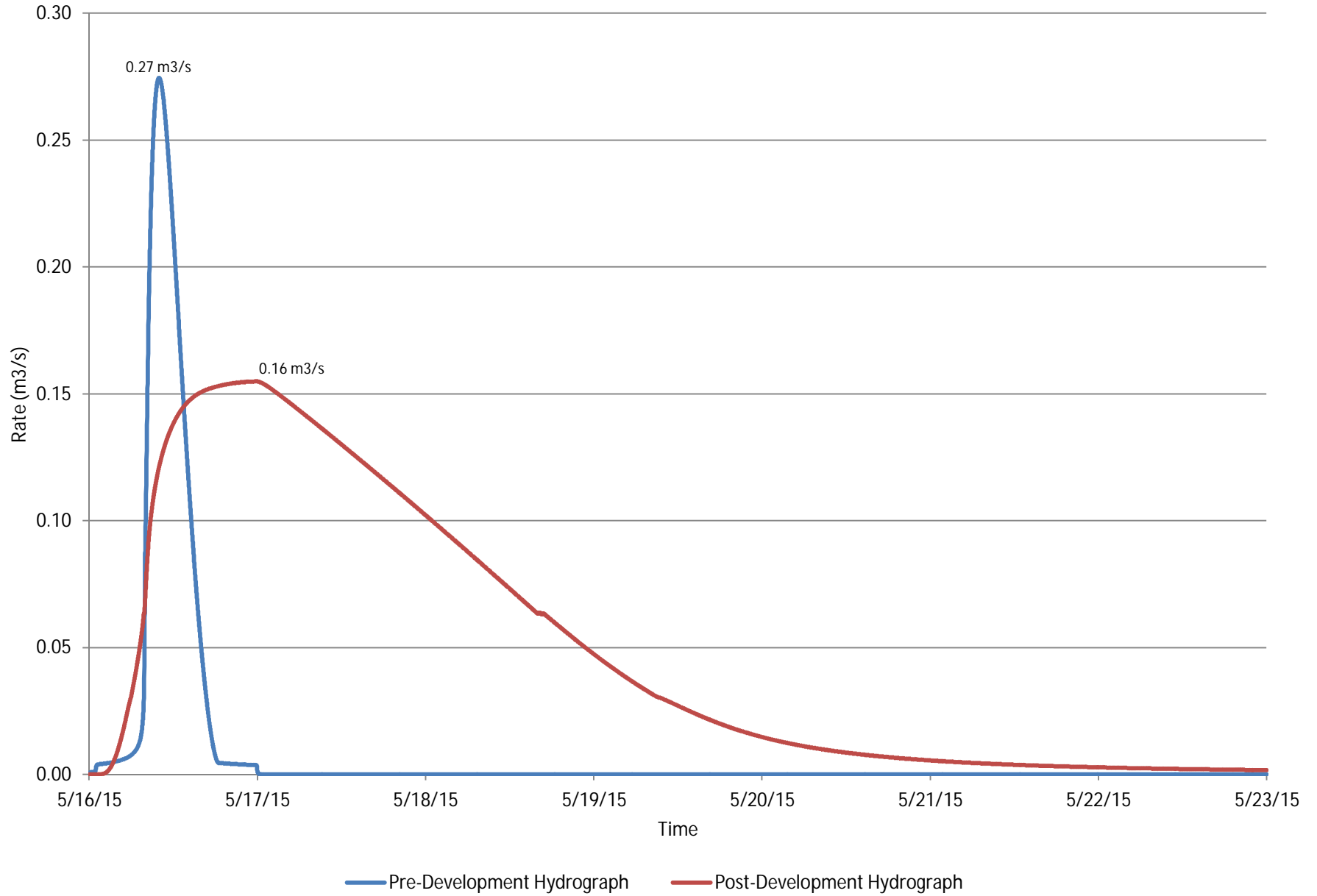
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 29 - Flow Hydrograph

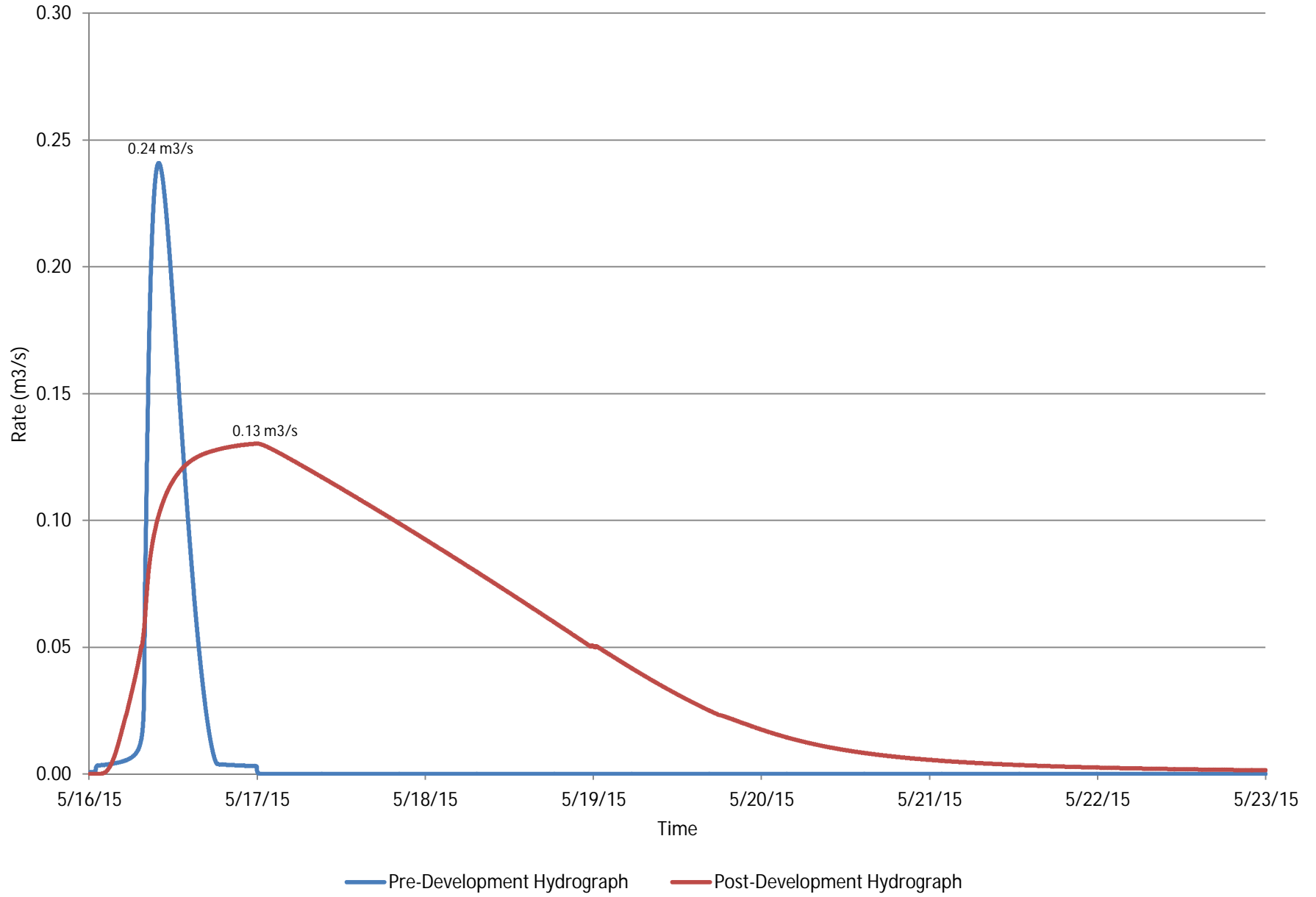


— Pre-Development Hydrograph — Post-Development Hydrograph

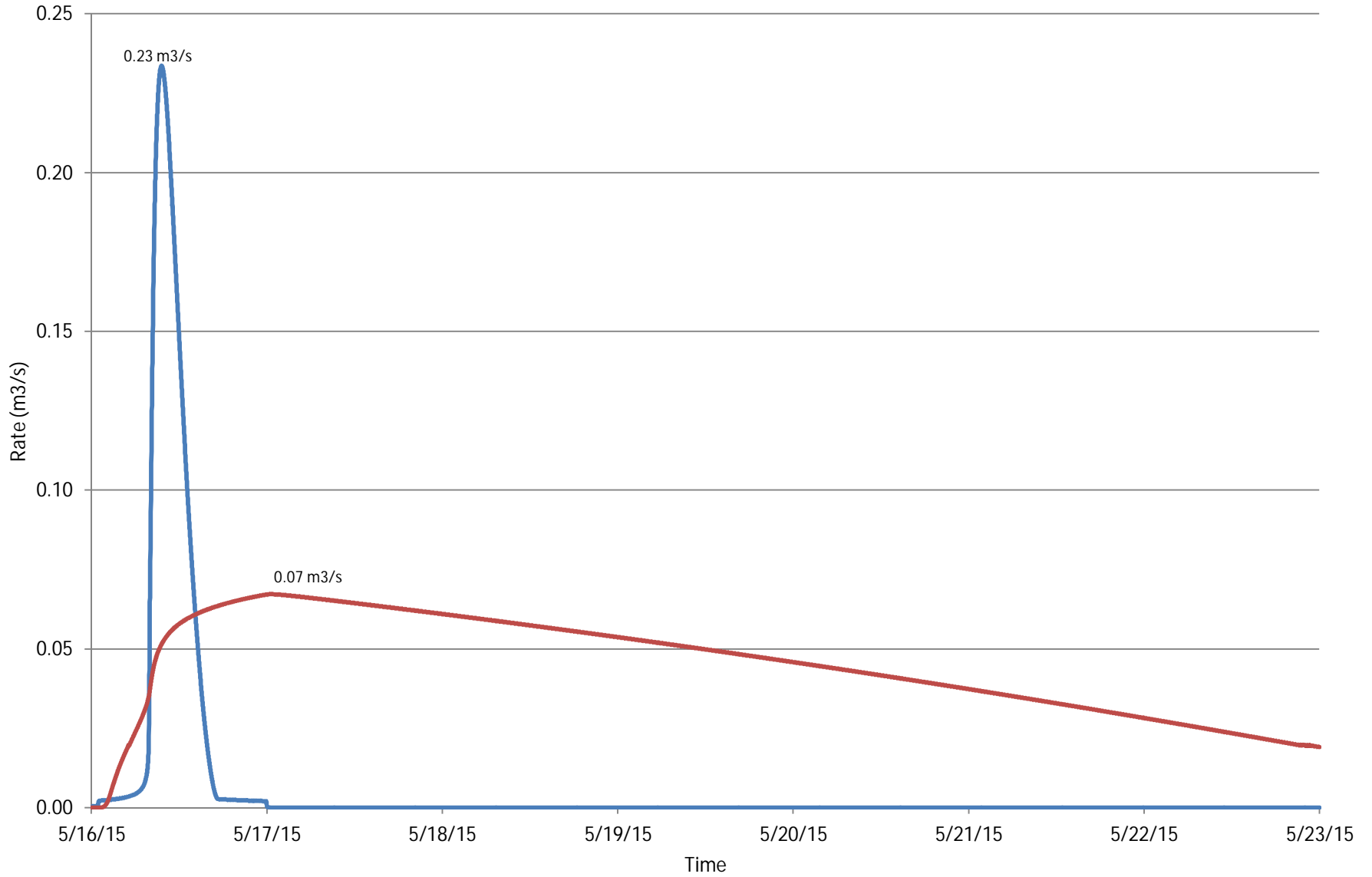
Pond 30 - Flow Hydrograph



Pond 31 - Flow Hydrograph

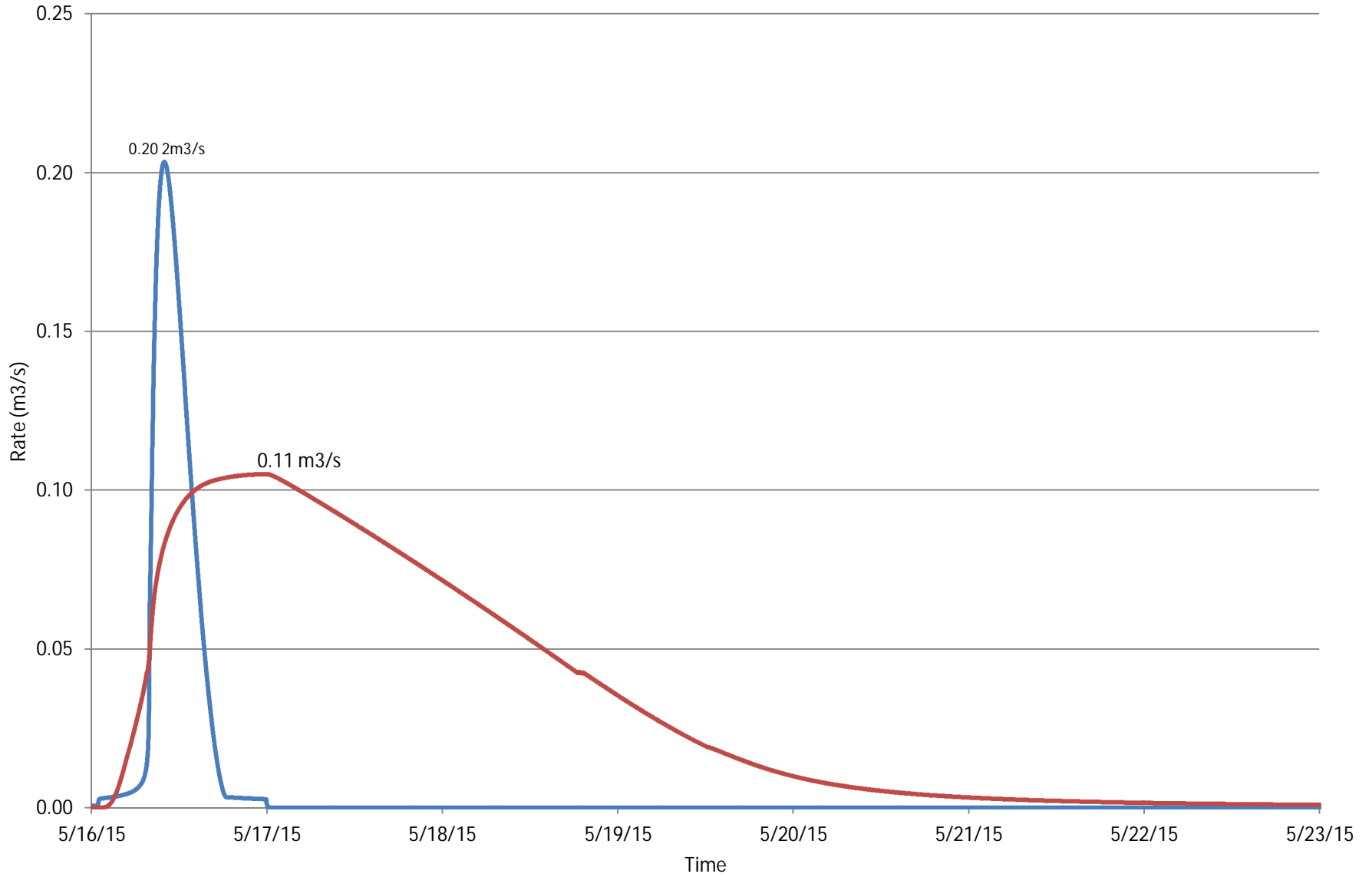


Pond 32 - Flow Hydrograph



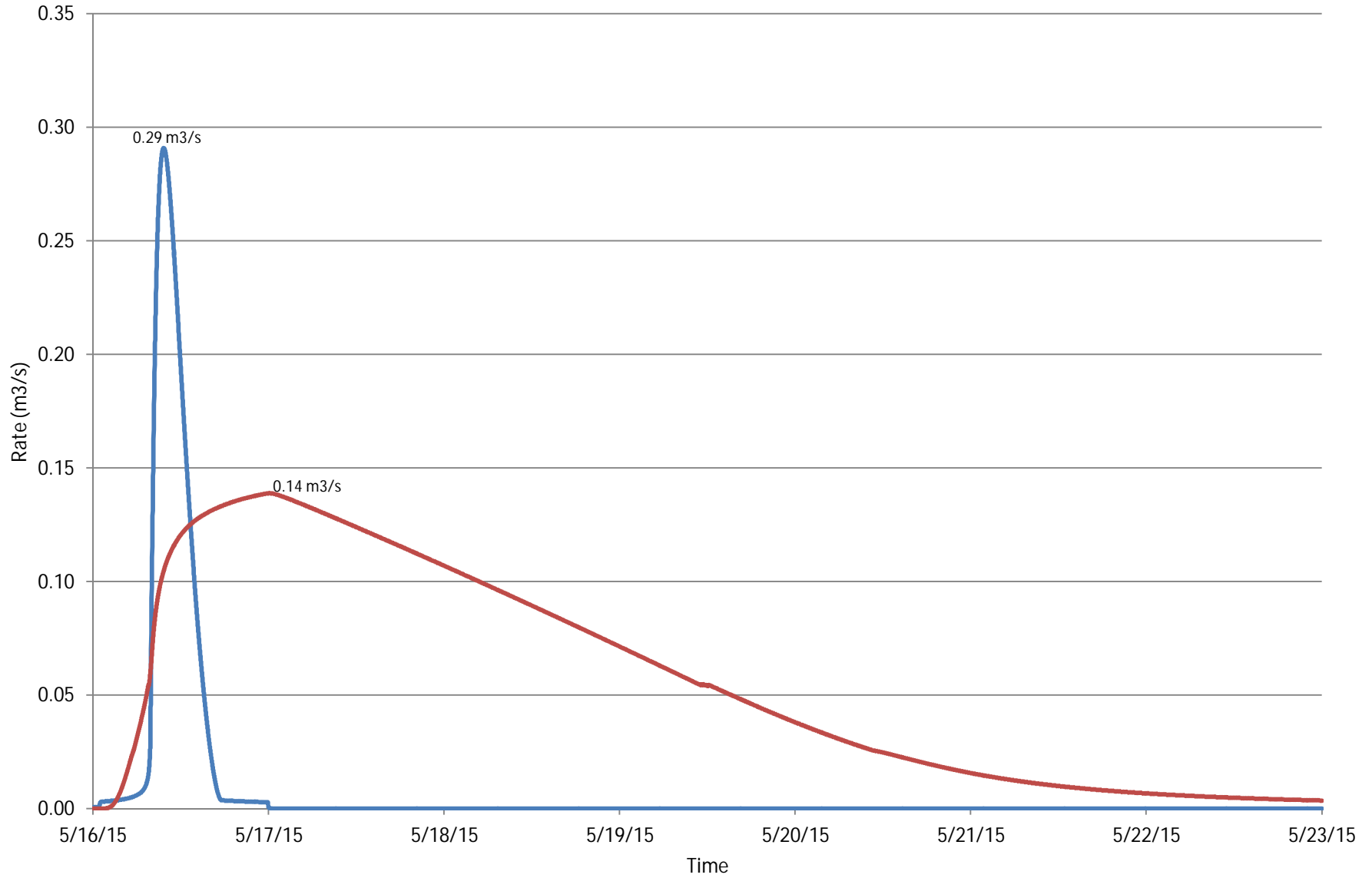
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 33 - Flow Hydrograph



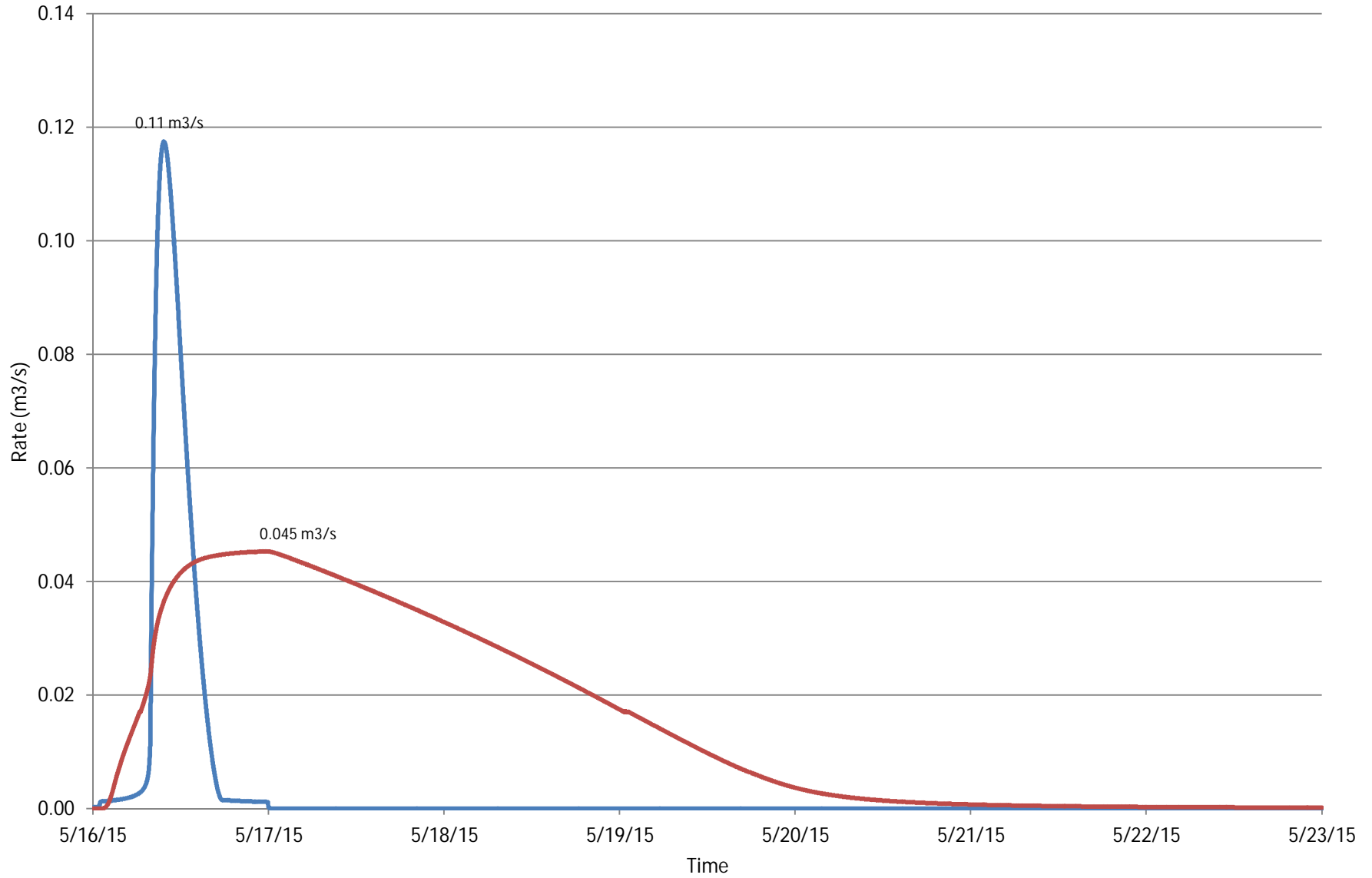
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 34 - Flow Hydrograph



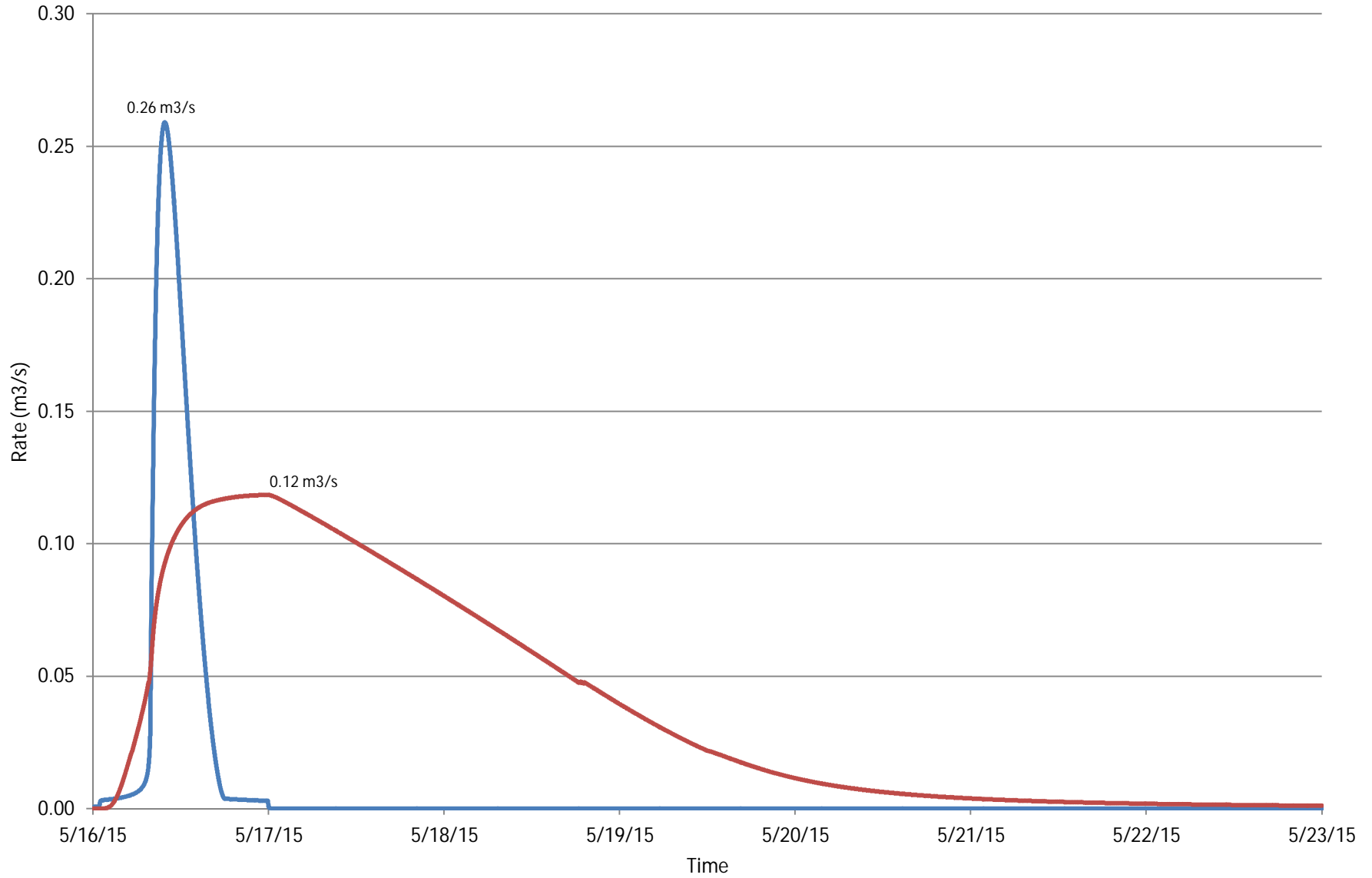
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 35 - Flow Hydrograph



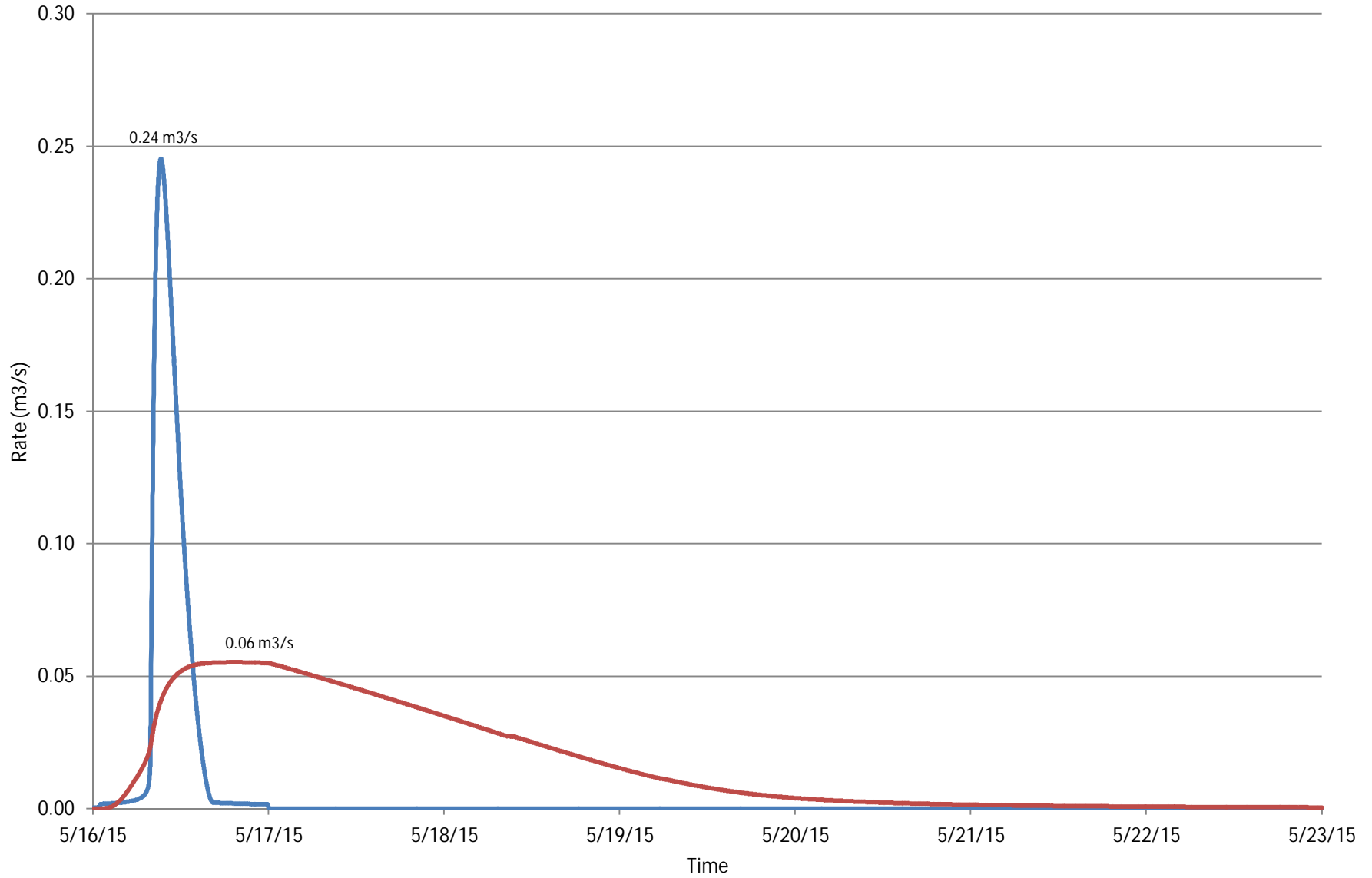
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 36 - Flow Hydrograph



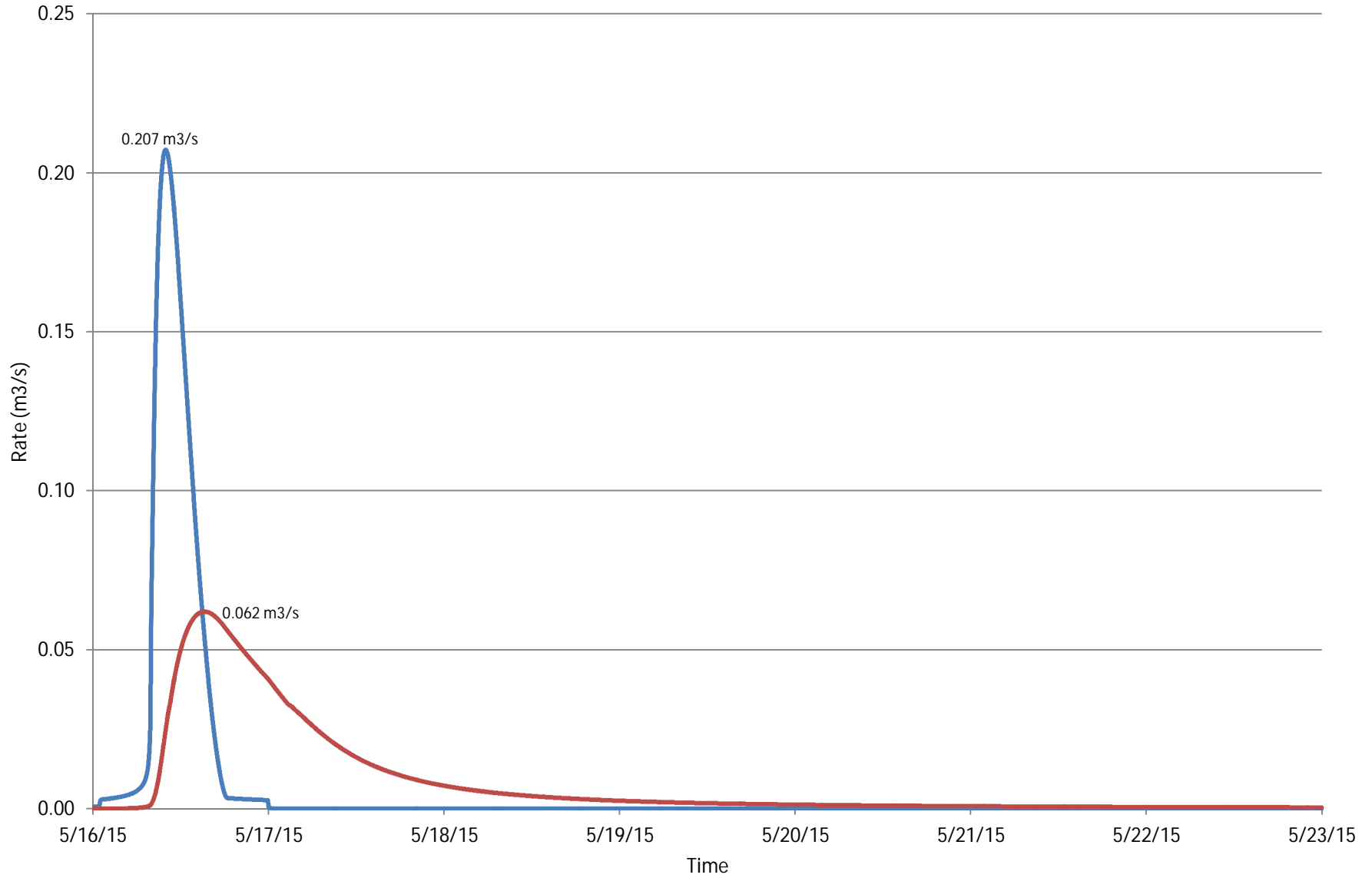
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 37 - Flow Hydrograph



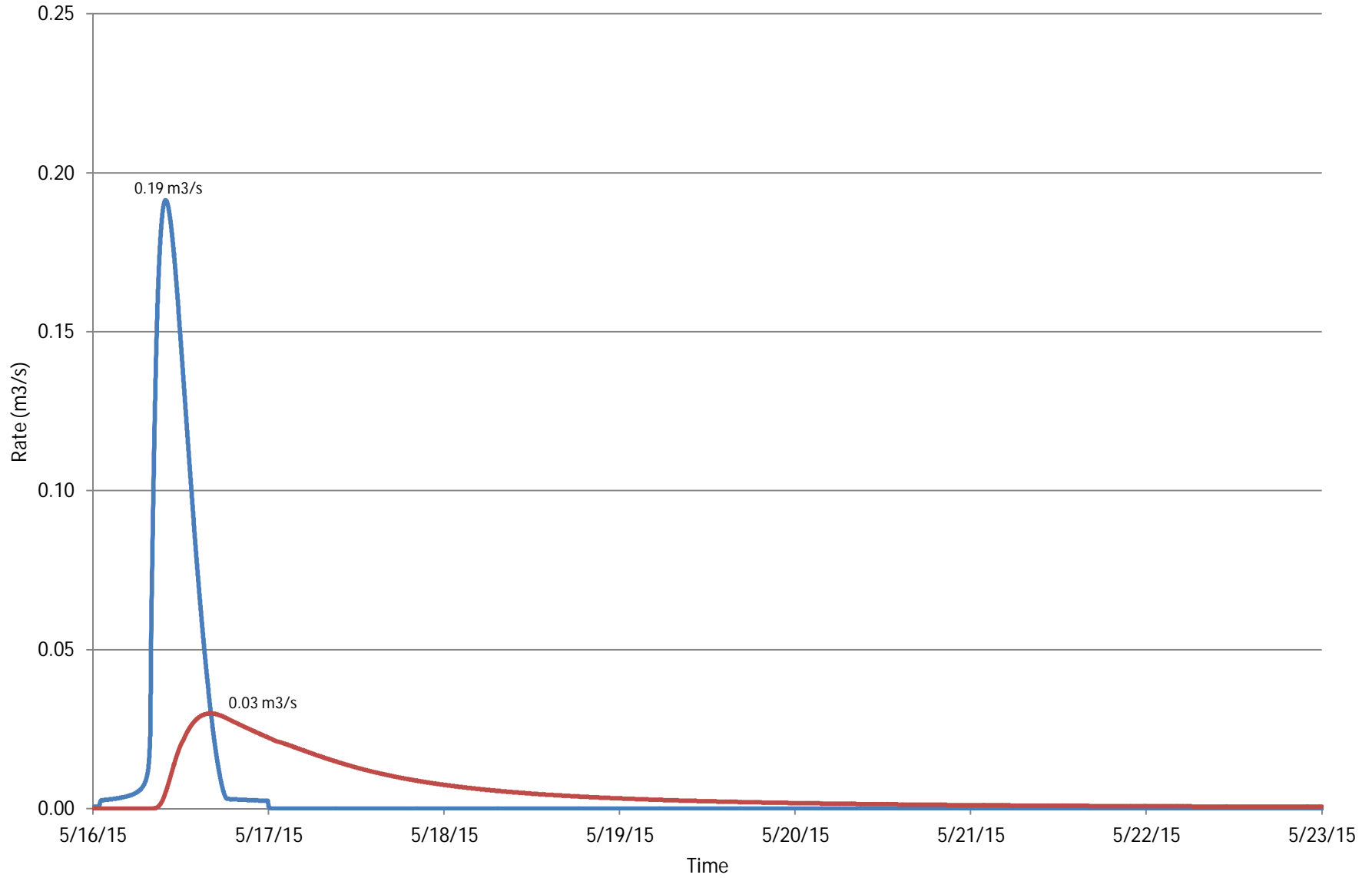
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 38 - Flow Hydrograph



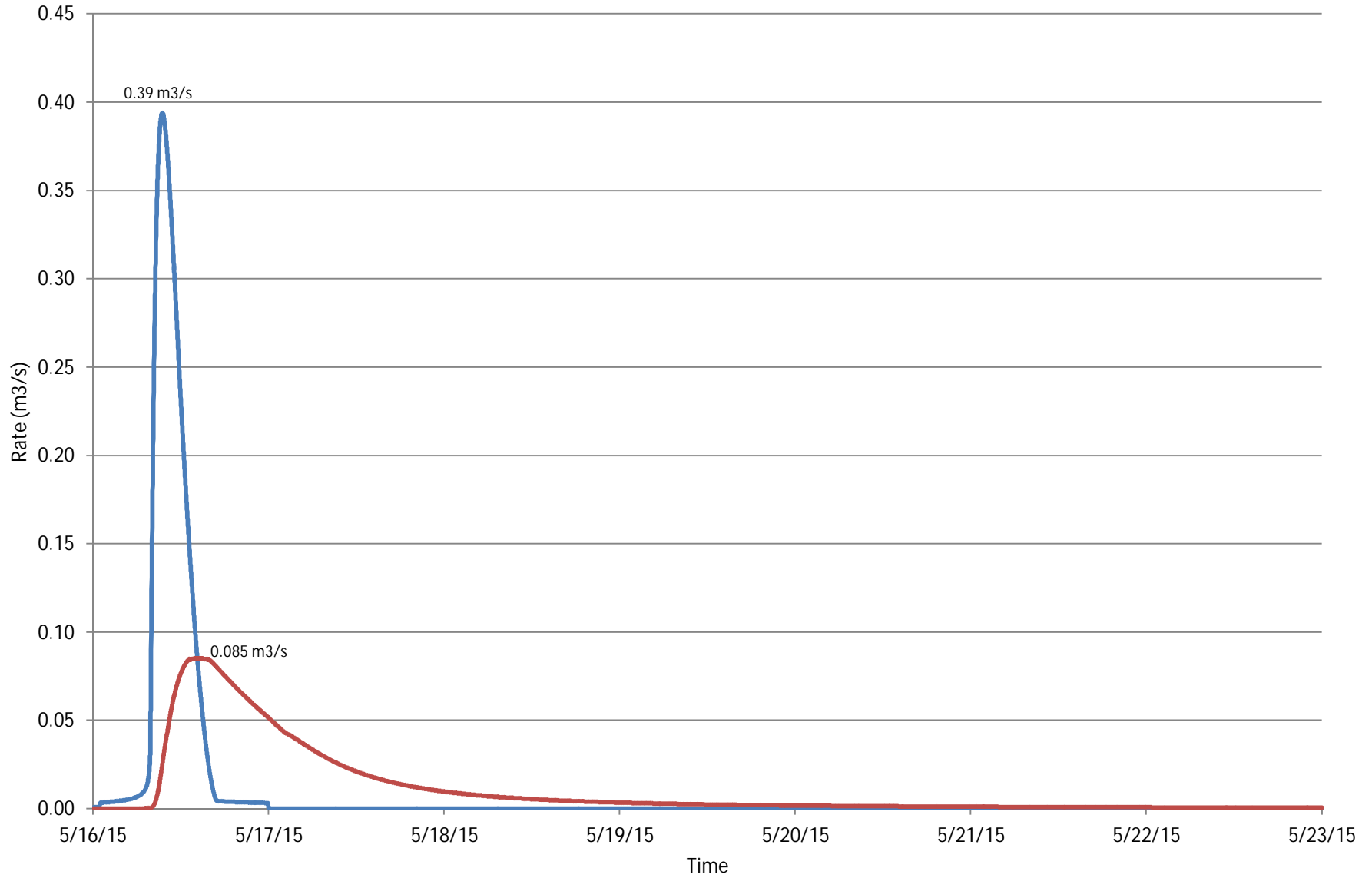
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 39 - Flow Hydrograph



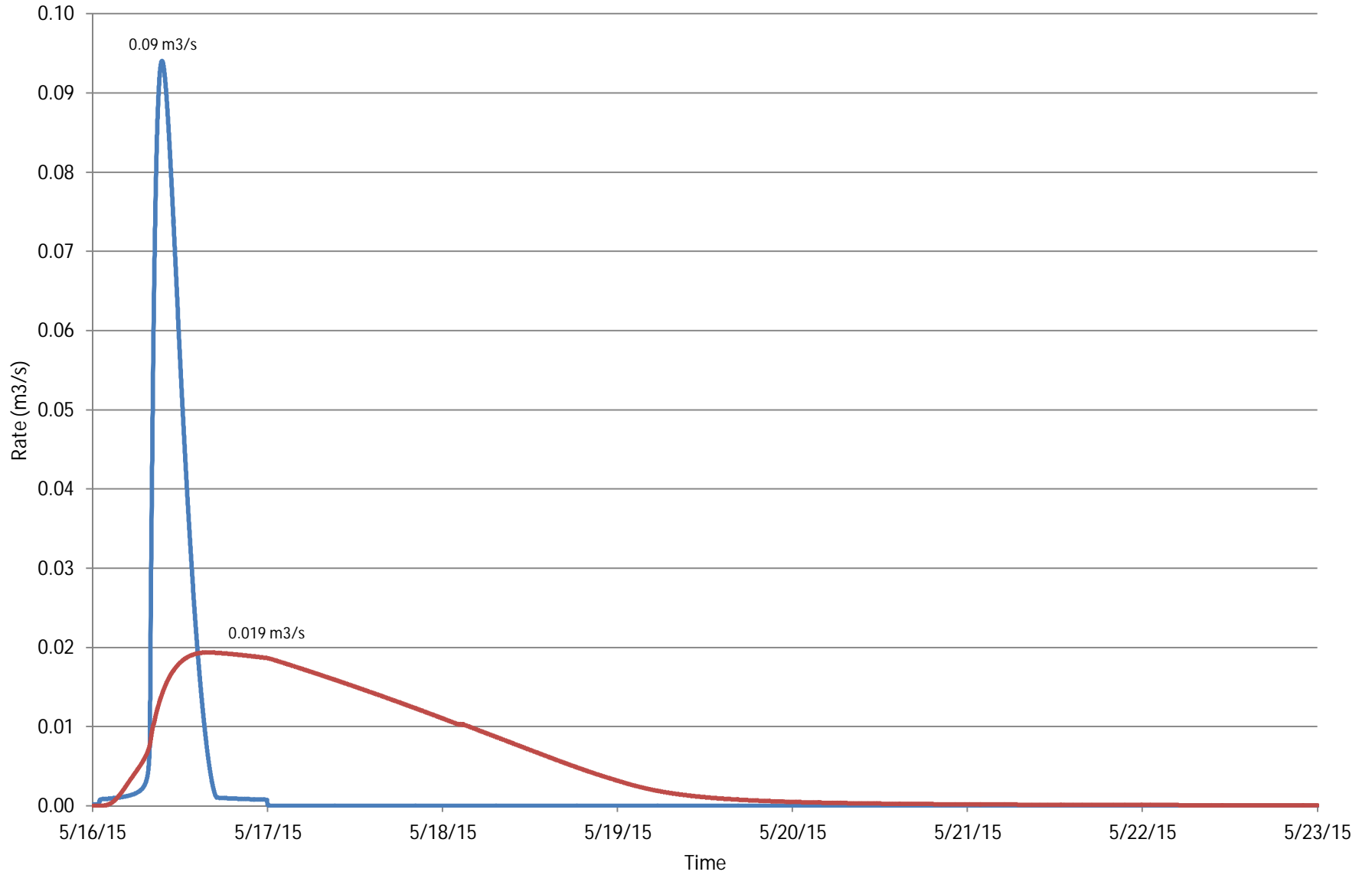
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 40 - Flow Hydrograph



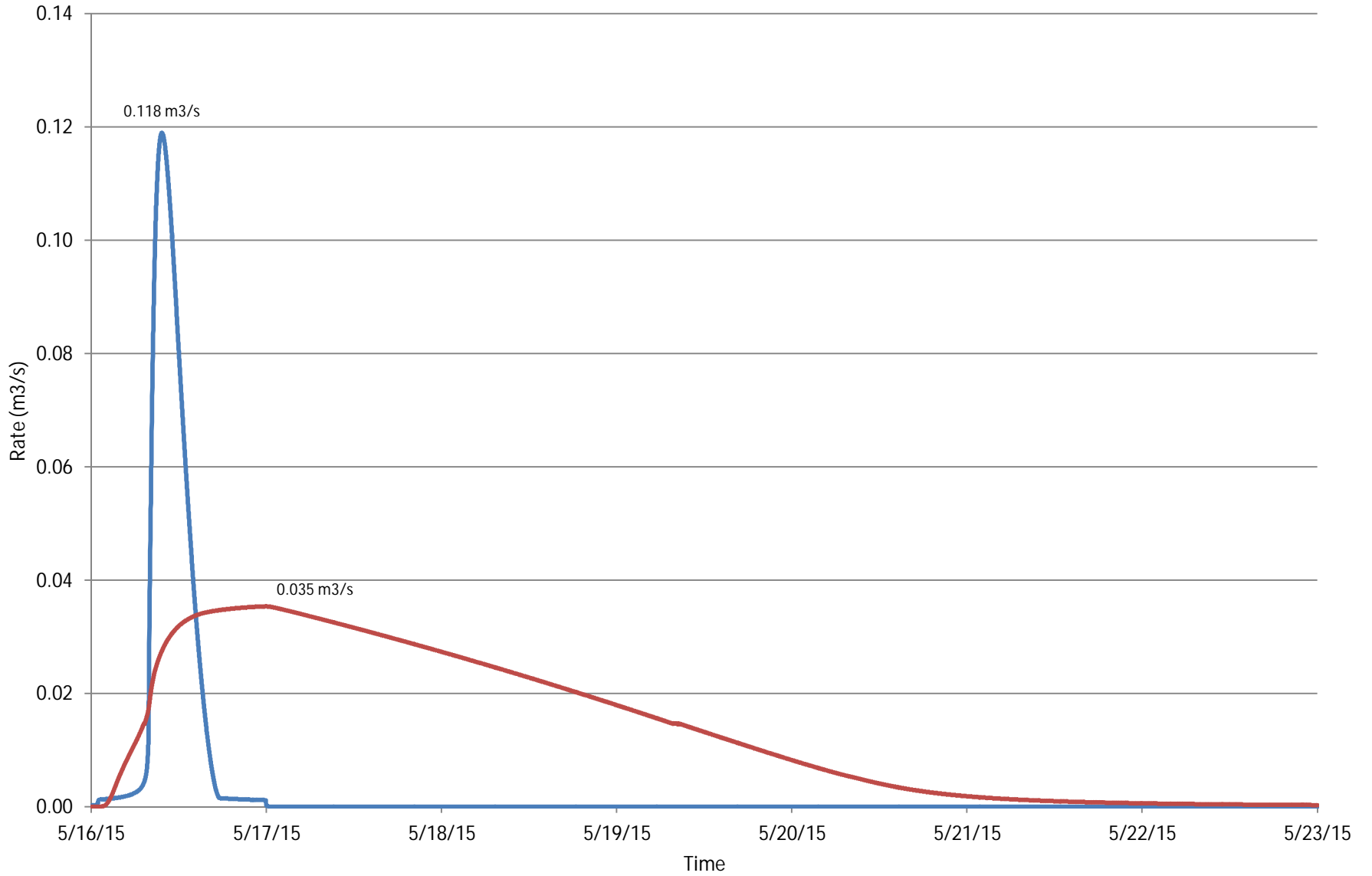
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 41 - Flow Hydrograph



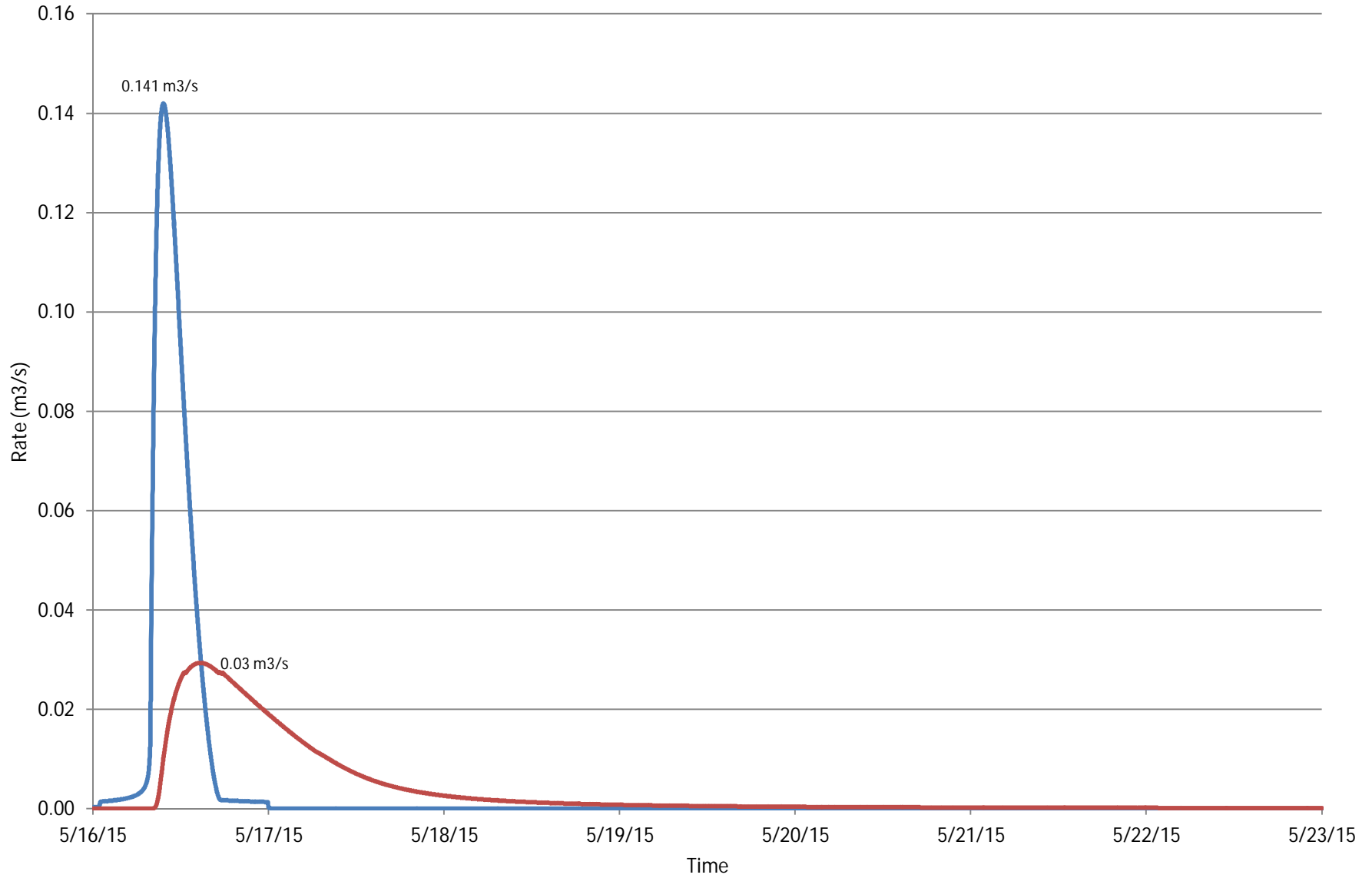
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 42 - Flow Hydrograph



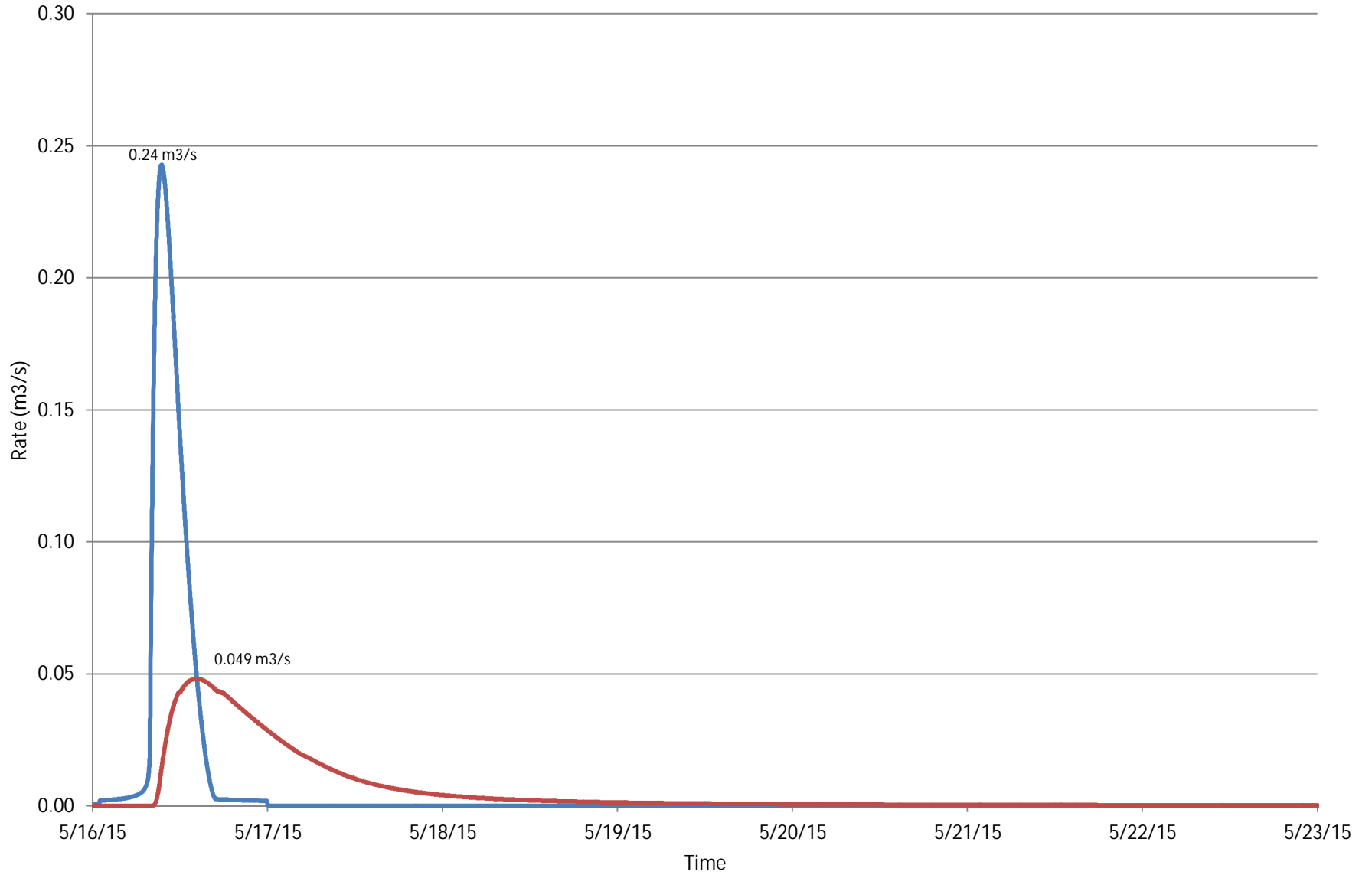
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 43 - Flow Hydrograph



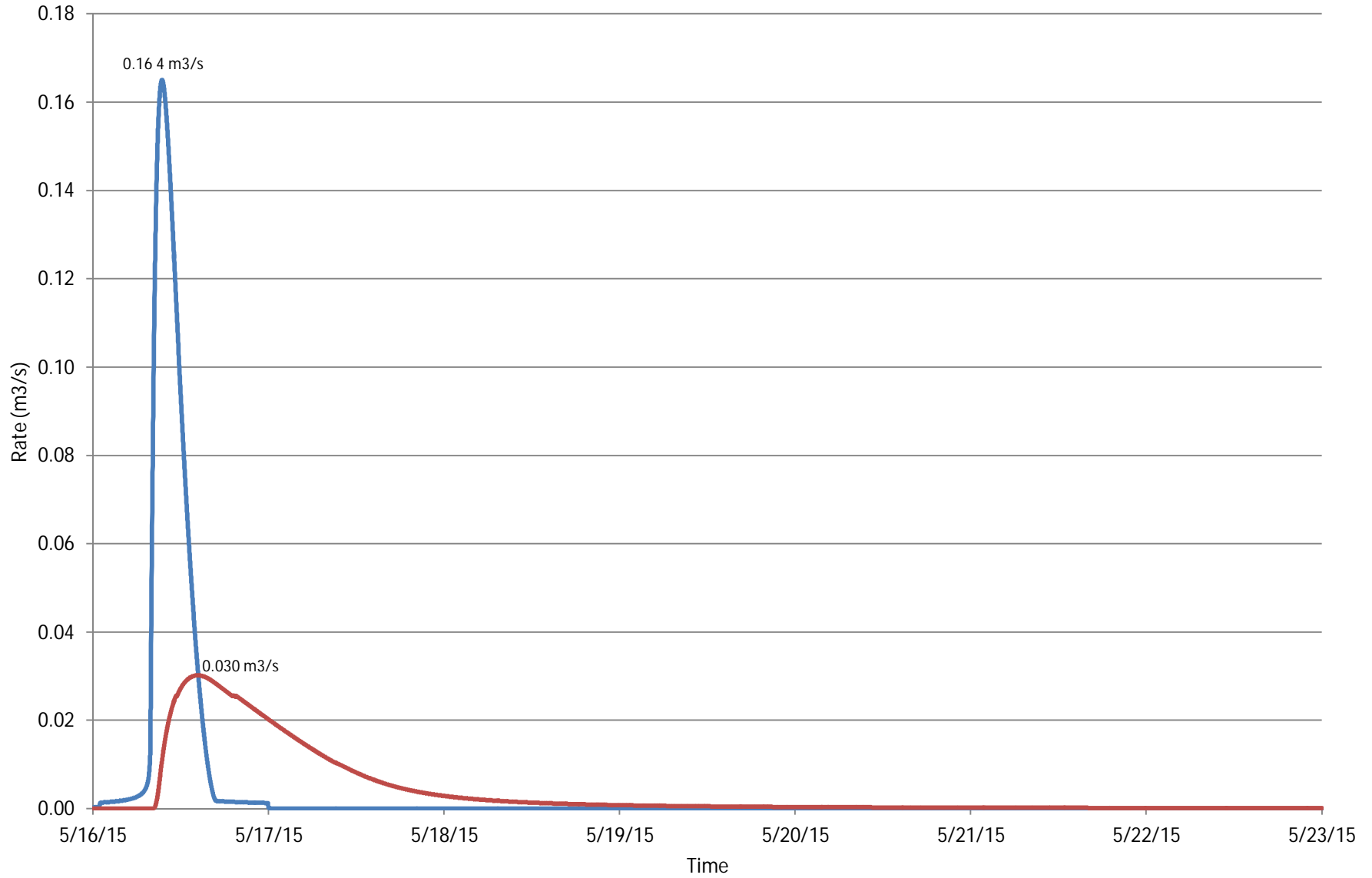
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 44 - Flow Hydrograph



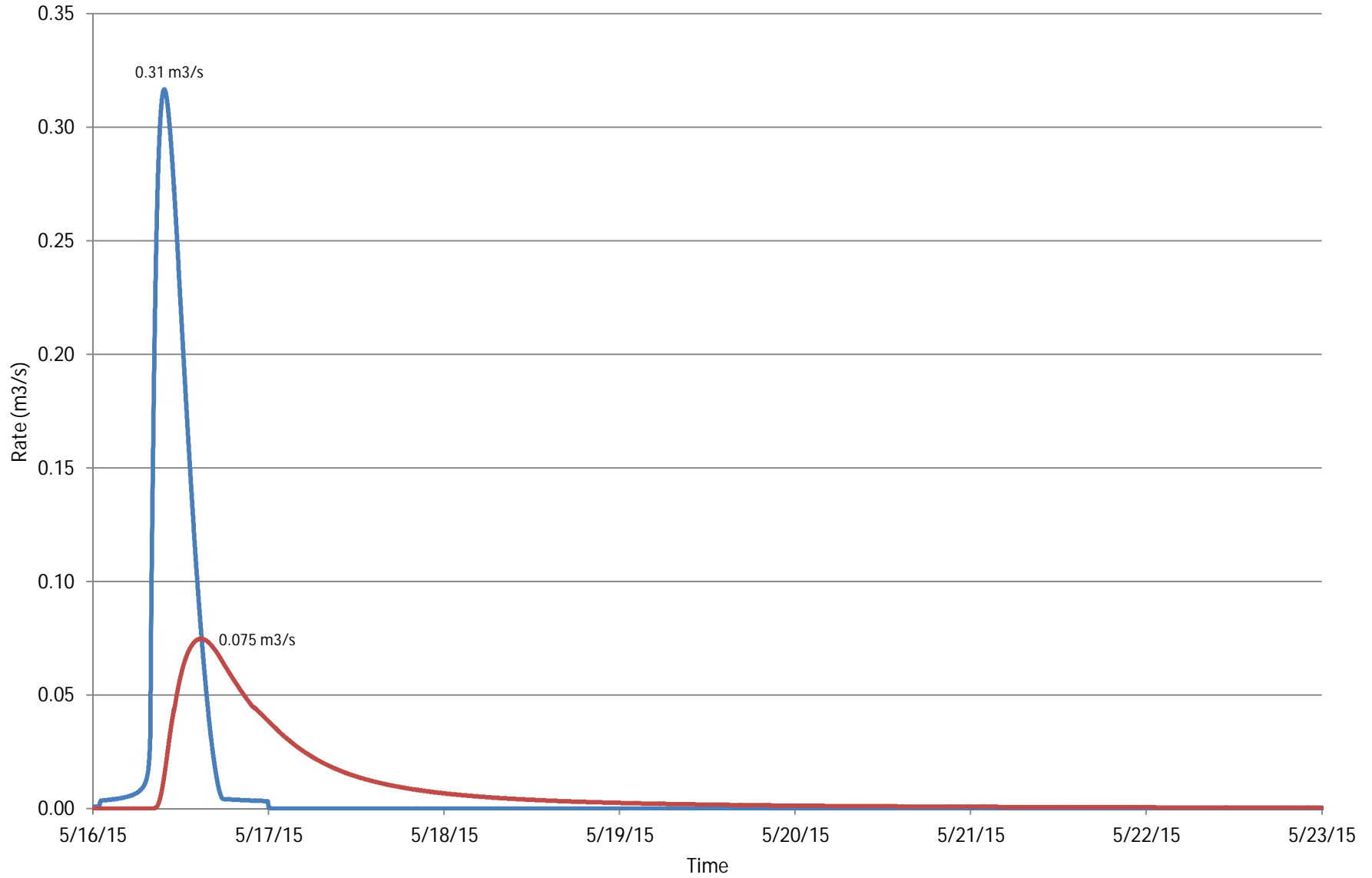
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 45 - Flow Hydrograph



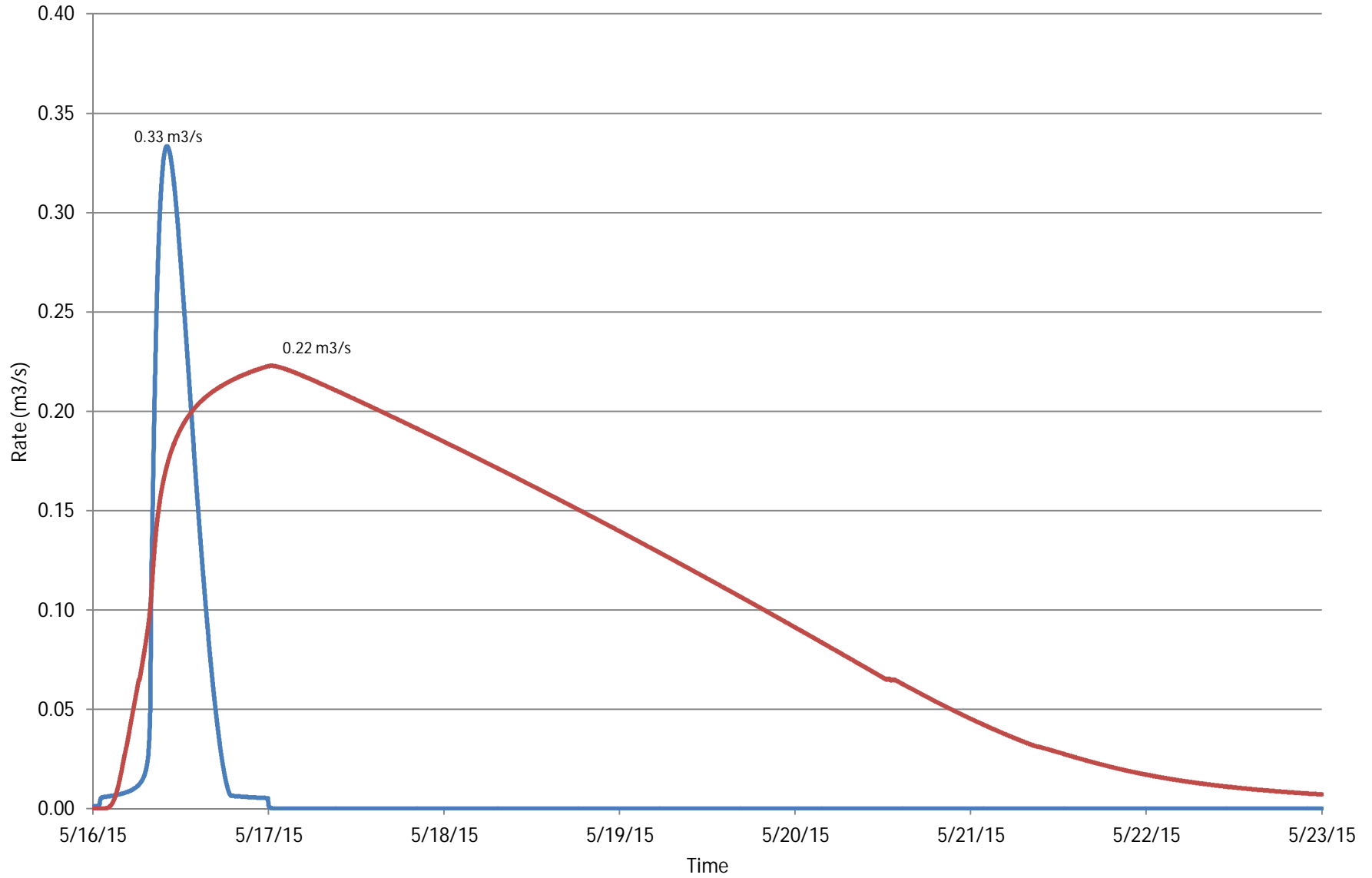
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 46 - Flow Hydrograph



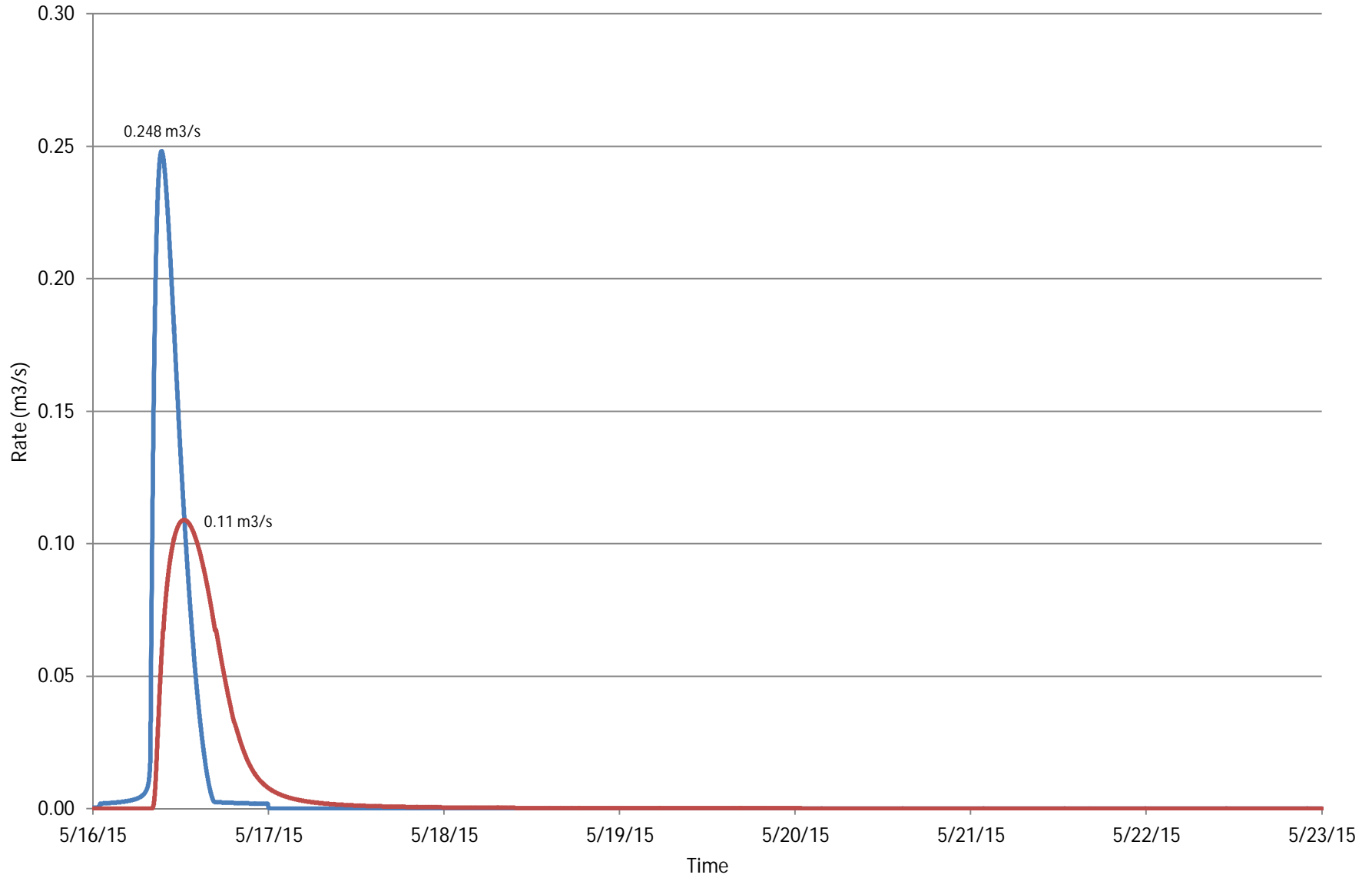
— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 47 - Flow Hydrograph



— Pre-Development Hydrograph — Post-Development Hydrograph

Pond 48 - Flow Hydrograph



— Pre-Development Hydrograph — Post-Development Hydrograph

Appendix H - Detailed Unit Costs - Stormwater



Note:
The locations and sizes of stormwater management facilities have been conceptually developed based on catchment areas. Please note that developers will be required to provide stormwater management facilities to meet pre-development release rates.

| Pond ID | Contributing Area (ha) | Required Storage (m ³) | Pond Footprint Area (ha) | Average Storage per hectare (m ³ /ha) |
|---------|------------------------|------------------------------------|--------------------------|--|
| P1 | 107.91 | 63620 | 3.10 | 589.6 |
| P2 | 17.73 | 10210 | 1.30 | 575.9 |
| P3 | 60.02 | 50650 | 3.00 | 843.0 |
| P4 | 68.40 | 47550 | 3.62 | 695.2 |
| P5 | 44.44 | 40320 | 2.48 | 907.3 |
| P6 | 33.84 | 29140 | 1.83 | 861.1 |
| P7 | 26.92 | 18480 | 1.54 | 686.5 |
| P8 | 19.30 | 13250 | 1.15 | 686.5 |
| P9 | 19.38 | 13300 | 1.57 | 686.3 |
| P10 | 34.18 | 23460 | 1.51 | 686.4 |
| P11 | 35.10 | 20220 | 1.35 | 576.1 |
| P12 | 12.10 | 8310 | 0.77 | 686.8 |
| P13 | 108.10 | 50680 | 3.03 | 470.7 |
| P14 | 50.70 | 25230 | 2.85 | 437.6 |
| P15 | 43.90 | 19790 | 2.27 | 450.8 |
| P16 | 17.45 | 15630 | 1.37 | 907.2 |
| P17 | 111.60 | 64290 | 3.80 | 576.1 |
| P18 | 27.20 | 15670 | 1.31 | 576.1 |
| P19 | 31.80 | 18320 | 1.21 | 576.1 |
| P20 | 80.80 | 46550 | 2.35 | 576.1 |
| P21 | 47.80 | 32610 | 2.04 | 686.4 |
| P22 | 14.57 | 10000 | 1.21 | 686.3 |
| P23 | 40.80 | 22720 | 1.47 | 556.9 |
| P24 | 38.70 | 21000 | 1.37 | 842.6 |
| P25 | 51.48 | 35340 | 2.18 | 686.5 |
| P26 | 45.32 | 31110 | 1.97 | 686.5 |
| P27 | 65.80 | 39320 | 2.40 | 597.6 |
| P28 | 40.38 | 23260 | 1.50 | 576.0 |
| P29 | 78.60 | 38920 | 2.38 | 495.2 |
| P30 | 59.30 | 37140 | 2.31 | 626.3 |
| P31 | 49.50 | 30630 | 1.95 | 622.8 |
| P32 | 23.54 | 19280 | 1.29 | 819.0 |
| P33 | 43.20 | 24690 | 1.62 | 576.2 |
| P34 | 45.20 | 31030 | 2.47 | 686.5 |
| P35 | 21.00 | 8980 | 0.68 | 427.6 |
| P36 | 47.40 | 27880 | 1.79 | 588.2 |
| P37 | 26.10 | 12680 | 1.11 | 485.8 |
| P38 | 42.80 | 11670 | 1.41 | 272.7 |
| P39 | 39.50 | 22750 | 1.86 | 575.9 |
| P40 | 51.10 | 14270 | 1.67 | 279.3 |
| P41 | 12.40 | 4360 | 0.45 | 351.6 |
| P42 | 18.80 | 10560 | 0.77 | 561.7 |
| P43 | 21.30 | 5210 | 0.67 | 244.6 |
| P44 | 30.40 | 7440 | 0.92 | 244.7 |
| P45 | 20.40 | 4990 | 0.65 | 244.6 |
| P46 | 53.10 | 13090 | 1.54 | 244.8 |
| P47 | 67.50 | 46340 | 2.89 | 686.5 |
| P48 | 28.80 | 7050 | 0.55 | 244.8 |

† Estimate: Emissions based on DSM conditions.
 ** Storage calculated based on the Modified Rational Method and Future Land Use.
 *** Peak Flow outfall are based on a release rate of 2 l/s/ha

- Legend:
- ▲ Preliminary Outfall
 - Possible Future Pond Location (Ponds to be designed to meet pre-development rates)
 - Ultimate Manhole
 - ▶▶▶▶ Ultimate Ditch
 - Ultimate Stormwater Trunk
 - Ultimate SWMF
 - Pond Outlet
 - Pond Catchment Area
 - Existing Drainage Route
 - Existing Stormwater Trunk
 - Existing Stormwater Pond
 - Proposed Transportation
 - Existing Transportation
 - Blindman River Catchment
 - Red Deer River Catchment
 - StudyArea

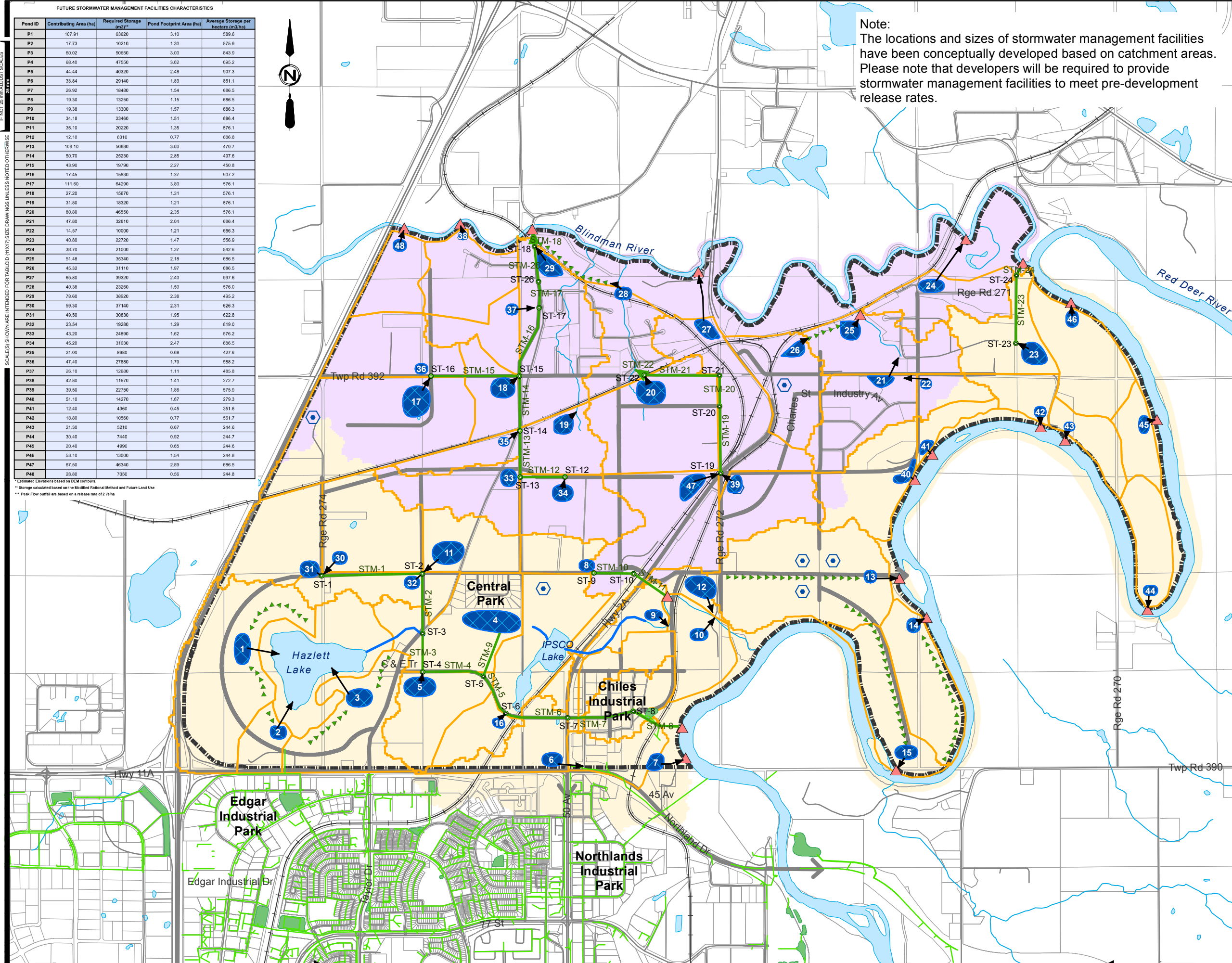
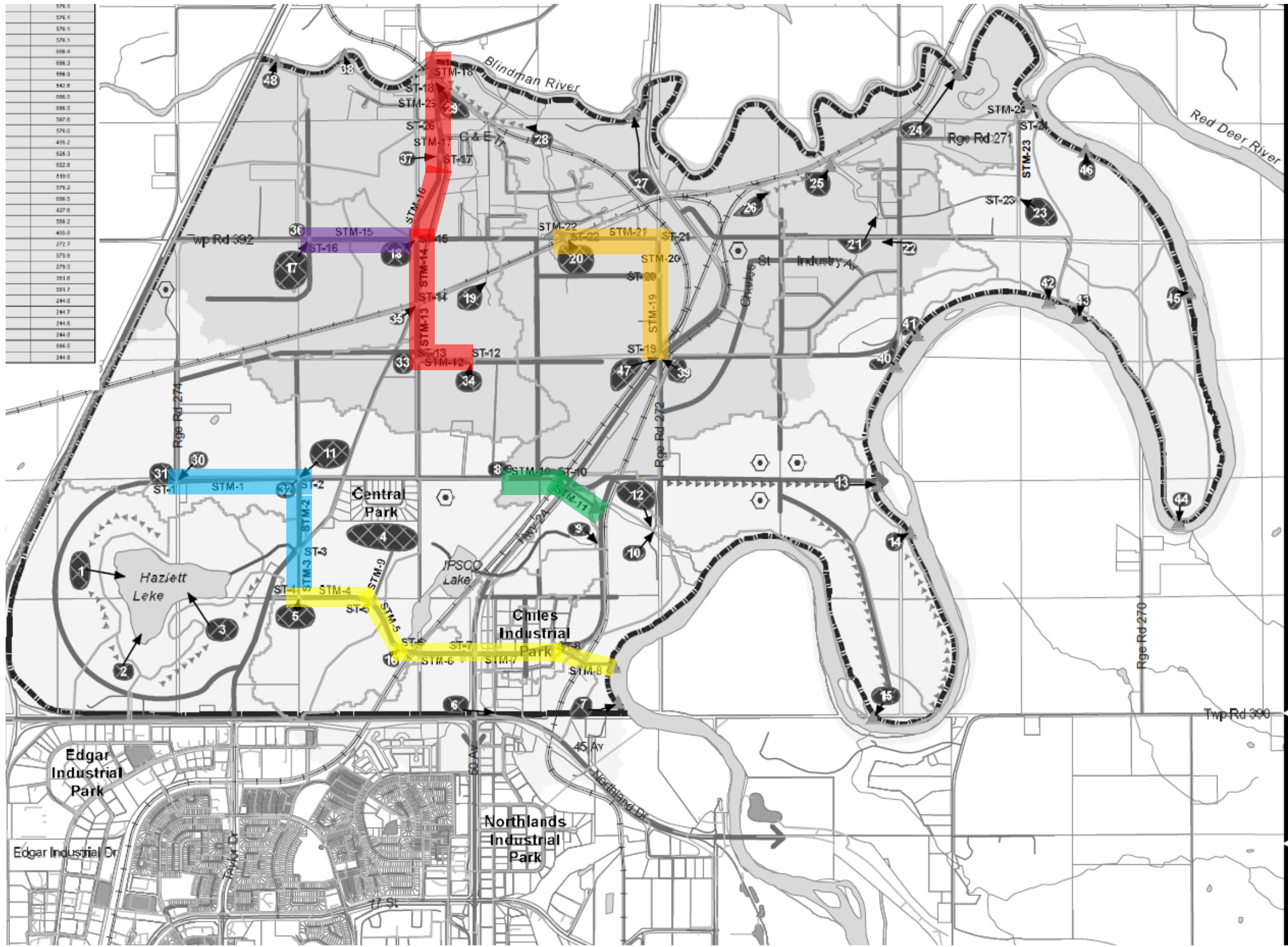


FIGURE No. H-1
NORTH OF HIGHWAY 11A SERVICING STUDY

STORMWATER
ULTIMATE STORMWATER CONCEPT

| | |
|-----------------|-------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED DATE | 2016 JUNE |
| REV DESCRIPTION | ISSUED FOR REPORT |



- Phase 1
- Phase 2
- Phase 3
- Phase 4
- Phase 5
- Phase 6



FIGURE No. H-2
 NORTH OF HIGHWAY 11A SERVICING STUDY

STORMWATER
 ULTIMATE STORMWATER CONCEPT

Phasing Plan

| | |
|----------------|-------------------------|
| AE PROJECT No. | 20153382 |
| SCALE | 1:30,000 |
| APPROVED | |
| DATE | JUNE 2016 |
| REV | |
| DESCRIPTION | ISSUED FOR FINAL REPORT |

APPENDIX H - Table H-1

PROPOSED STORMWATER MANAGEMENT FACILITIES - COST ESTIMATE

| Description | Unit | Pond 1 | | | Pond 2 | | | Pond 3 | | | Pond 4 | | | Pond 5 | | | Pond 6 | | |
|--|------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|
| | | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost |
| Clearing and grubbing | ha | 3.10 | \$ 50,000.00 | \$ 155,000.00 | 1.30 | \$ 50,000.00 | \$ 65,000.00 | 3.00 | \$ 50,000.00 | \$ 150,000.00 | 3.62 | \$ 50,000.00 | \$ 181,000.00 | 2.48 | \$ 50,000.00 | \$ 124,000.00 | 1.83 | \$ 50,000.00 | \$ 91,500.00 |
| Stripping | ha | 3.10 | \$ 50,000.00 | \$ 155,000.00 | 1.30 | \$ 50,000.00 | \$ 65,000.00 | 3.00 | \$ 50,000.00 | \$ 150,000.00 | 3.62 | \$ 50,000.00 | \$ 181,000.00 | 2.48 | \$ 50,000.00 | \$ 124,000.00 | 1.83 | \$ 50,000.00 | \$ 91,500.00 |
| Excavation and grading | m3 | 116400 | \$ 15.00 | \$ 1,746,000.00 | 33100 | \$ 15.00 | \$ 496,500.00 | 104200 | \$ 15.00 | \$ 1,563,000.00 | 116900 | \$ 15.00 | \$ 1,753,500.00 | 84500 | \$ 15.00 | \$ 1,267,500.00 | 58300 | \$ 15.00 | \$ 874,500.00 |
| Topsoil Replacement | ha | 3.10 | \$ 50,000.00 | \$ 155,000.00 | 1.30 | \$ 50,000.00 | \$ 65,000.00 | 3.00 | \$ 50,000.00 | \$ 150,000.00 | 3.62 | \$ 50,000.00 | \$ 181,000.00 | 2.48 | \$ 50,000.00 | \$ 124,000.00 | 1.83 | \$ 50,000.00 | \$ 91,500.00 |
| Landscaping | ls | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 |
| Control Structure c/w inlet and outlet pipes | unit | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 |
| Sub-Total | | | | \$ 2,361,000.00 | | | \$ 841,500.00 | | | \$ 2,163,000.00 | | | \$ 2,446,500.00 | | | \$ 1,789,500.00 | | | \$ 1,299,000.00 |
| Contingency and Engineering (30%) | | | | \$ 708,300.00 | | | \$ 252,450.00 | | | \$ 648,900.00 | | | \$ 733,950.00 | | | \$ 536,850.00 | | | \$ 389,700.00 |
| Total Cost | | | | \$ 3,069,300.00 | | | \$ 1,093,950.00 | | | \$ 2,811,900.00 | | | \$ 3,180,450.00 | | | \$ 2,326,350.00 | | | \$ 1,688,700.00 |

| Description | Unit | Pond 7 | | | Pond 8 | | | Pond 9 | | | Pond 10 | | | Pond 11 | | | Pond 12 | | |
|--|------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|---------------|
| | | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost |
| Clearing and grubbing | ha | 1.54 | \$ 50,000.00 | \$ 77,000.00 | 1.15 | \$ 50,000.00 | \$ 57,500.00 | 1.57 | \$ 50,000.00 | \$ 78,500.00 | 1.51 | \$ 50,000.00 | \$ 75,500.00 | 1.35 | \$ 50,000.00 | \$ 67,500.00 | 0.77 | \$ 50,000.00 | \$ 38,500.00 |
| Stripping | ha | 1.54 | \$ 50,000.00 | \$ 77,000.00 | 1.15 | \$ 50,000.00 | \$ 57,500.00 | 1.57 | \$ 50,000.00 | \$ 78,500.00 | 1.51 | \$ 50,000.00 | \$ 75,500.00 | 1.35 | \$ 50,000.00 | \$ 67,500.00 | 0.77 | \$ 50,000.00 | \$ 38,500.00 |
| Excavation and grading | m3 | 44900 | \$ 15.00 | \$ 673,500.00 | 31600 | \$ 15.00 | \$ 474,000.00 | 41100 | \$ 15.00 | \$ 616,500.00 | 44800 | \$ 15.00 | \$ 672,000.00 | 40900 | \$ 15.00 | \$ 613,500.00 | 19200 | \$ 15.00 | \$ 288,000.00 |
| Topsoil Replacement | ha | 1.54 | \$ 50,000.00 | \$ 77,000.00 | 1.15 | \$ 50,000.00 | \$ 57,500.00 | 1.57 | \$ 50,000.00 | \$ 78,500.00 | 1.51 | \$ 50,000.00 | \$ 75,500.00 | 1.35 | \$ 50,000.00 | \$ 67,500.00 | 0.77 | \$ 50,000.00 | \$ 38,500.00 |
| Landscaping | ls | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 |
| Control Structure c/w inlet and outlet pipes | unit | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 |
| Sub-Total | | | | \$ 1,054,500.00 | | | \$ 796,500.00 | | | \$ 1,002,000.00 | | | \$ 1,048,500.00 | | | \$ 966,000.00 | | | \$ 553,500.00 |
| Contingency and Engineering (30%) | | | | \$ 316,350.00 | | | \$ 238,950.00 | | | \$ 300,600.00 | | | \$ 314,550.00 | | | \$ 289,800.00 | | | \$ 166,050.00 |
| Total Cost | | | | \$ 1,370,850.00 | | | \$ 1,035,450.00 | | | \$ 1,302,600.00 | | | \$ 1,363,050.00 | | | \$ 1,255,800.00 | | | \$ 719,550.00 |

| Description | Unit | Pond 13 | | | Pond 14 | | | Pond 15 | | | Pond 16 | | | Pond 17 | | | Pond 18 | | |
|--|------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|
| | | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost |
| Clearing and grubbing | ha | 3.03 | \$ 50,000.00 | \$ 151,500.00 | 2.85 | \$ 50,000.00 | \$ 142,500.00 | 2.27 | \$ 50,000.00 | \$ 113,500.00 | 1.37 | \$ 50,000.00 | \$ 68,500.00 | 3.8 | \$ 50,000.00 | \$ 190,000.00 | 1.31 | \$ 50,000.00 | \$ 65,500.00 |
| Stripping | ha | 3.03 | \$ 50,000.00 | \$ 151,500.00 | 2.85 | \$ 50,000.00 | \$ 142,500.00 | 2.27 | \$ 50,000.00 | \$ 113,500.00 | 1.37 | \$ 50,000.00 | \$ 68,500.00 | 3.8 | \$ 50,000.00 | \$ 190,000.00 | 1.31 | \$ 50,000.00 | \$ 65,500.00 |
| Excavation and grading | m3 | 104600 | \$ 15.00 | \$ 1,569,000.00 | 80600 | \$ 15.00 | \$ 1,209,000.00 | 62500 | \$ 15.00 | \$ 937,500.00 | 41900 | \$ 15.00 | \$ 628,500.00 | 137200 | \$ 15.00 | \$ 2,058,000.00 | 36400 | \$ 15.00 | \$ 546,000.00 |
| Topsoil Replacement | ha | 3.03 | \$ 50,000.00 | \$ 151,500.00 | 2.85 | \$ 50,000.00 | \$ 142,500.00 | 2.27 | \$ 50,000.00 | \$ 113,500.00 | 1.37 | \$ 50,000.00 | \$ 68,500.00 | 3.8 | \$ 50,000.00 | \$ 190,000.00 | 1.31 | \$ 50,000.00 | \$ 65,500.00 |
| Landscaping | ls | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 |
| Control Structure c/w inlet and outlet pipes | unit | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 |
| Sub-Total | | | | \$ 2,173,500.00 | | | \$ 1,786,500.00 | | | \$ 1,428,000.00 | | | \$ 984,000.00 | | | \$ 2,778,000.00 | | | \$ 892,500.00 |
| Contingency and Engineering (30%) | | | | \$ 652,050.00 | | | \$ 535,950.00 | | | \$ 428,400.00 | | | \$ 295,200.00 | | | \$ 833,400.00 | | | \$ 267,750.00 |
| Total Cost | | | | \$ 2,825,550.00 | | | \$ 2,322,450.00 | | | \$ 1,856,400.00 | | | \$ 1,279,200.00 | | | \$ 3,611,400.00 | | | \$ 1,160,250.00 |

| Description | Unit | Pond 19 | | | Pond 20 | | | Pond 21 | | | Pond 22 | | | Pond 23 | | | Pond 24 | | |
|--|------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|
| | | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost |
| Clearing and grubbing | ha | 1.21 | \$ 50,000.00 | \$ 60,500.00 | 2.35 | \$ 50,000.00 | \$ 117,500.00 | 2.04 | \$ 50,000.00 | \$ 102,000.00 | 1.21 | \$ 50,000.00 | \$ 60,500.00 | 1.47 | \$ 50,000.00 | \$ 73,500.00 | 1.37 | \$ 50,000.00 | \$ 68,500.00 |
| Stripping | ha | 1.21 | \$ 50,000.00 | \$ 60,500.00 | 2.35 | \$ 50,000.00 | \$ 117,500.00 | 2.04 | \$ 50,000.00 | \$ 102,000.00 | 1.21 | \$ 50,000.00 | \$ 60,500.00 | 1.47 | \$ 50,000.00 | \$ 73,500.00 | 1.37 | \$ 50,000.00 | \$ 68,500.00 |
| Excavation and grading | m3 | 35600 | \$ 15.00 | \$ 534,000.00 | 83800 | \$ 15.00 | \$ 1,257,000.00 | 66000 | \$ 15.00 | \$ 990,000.00 | 30400 | \$ 15.00 | \$ 456,000.00 | 79400 | \$ 15.00 | \$ 1,191,000.00 | 41200 | \$ 15.00 | \$ 618,000.00 |
| Topsoil Replacement | ha | 1.21 | \$ 50,000.00 | \$ 60,500.00 | 2.35 | \$ 50,000.00 | \$ 117,500.00 | 2.04 | \$ 50,000.00 | \$ 102,000.00 | 1.21 | \$ 50,000.00 | \$ 60,500.00 | 1.47 | \$ 50,000.00 | \$ 73,500.00 | 1.37 | \$ 50,000.00 | \$ 68,500.00 |
| Landscaping | ls | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 |
| Control Structure c/w inlet and outlet pipes | unit | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 |
| Sub-Total | | | | \$ 865,500.00 | | | \$ 1,759,500.00 | | | \$ 1,446,000.00 | | | \$ 787,500.00 | | | \$ 1,561,500.00 | | | \$ 973,500.00 |
| Contingency and Engineering (30%) | | | | \$ 259,650.00 | | | \$ 527,850.00 | | | \$ 433,800.00 | | | \$ 236,250.00 | | | \$ 468,450.00 | | | \$ 292,050.00 |
| Total Cost | | | | \$ 1,125,150.00 | | | \$ 2,287,350.00 | | | \$ 1,879,800.00 | | | \$ 1,023,750.00 | | | \$ 2,029,950.00 | | | \$ 1,265,550.00 |

| Description | Unit | Pond 25 | | | Pond 26 | | | Pond 27 | | | Pond 28 | | | Pond 29 | | | Pond 30 | | |
|--|------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|
| | | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost |
| Clearing and grubbing | ha | 2.18 | \$ 50,000.00 | \$ 109,000.00 | 1.97 | \$ 50,000.00 | \$ 98,500.00 | 2.40 | \$ 50,000.00 | \$ 120,000.00 | 1.50 | \$ 50,000.00 | \$ 75,000.00 | 2.38 | \$ 50,000.00 | \$ 119,000.00 | 2.31 | \$ 50,000.00 | \$ 115,500.00 |
| Stripping | ha | 2.18 | \$ 50,000.00 | \$ 109,000.00 | 1.97 | \$ 50,000.00 | \$ 98,500.00 | 2.40 | \$ 50,000.00 | \$ 120,000.00 | 1.50 | \$ 50,000.00 | \$ 75,000.00 | 2.38 | \$ 50,000.00 | \$ 119,000.00 | 2.31 | \$ 50,000.00 | \$ 115,500.00 |
| Excavation and grading | m3 | 71400 | \$ 15.00 | \$ 1,071,000.00 | 64400 | \$ 15.00 | \$ 966,000.00 | 79900 | \$ 15.00 | \$ 1,198,500.00 | 45900 | \$ 15.00 | \$ 688,500.00 | 79000 | \$ 15.00 | \$ 1,185,000.00 | 77500 | \$ 15.00 | \$ 1,162,500.00 |
| Topsoil Replacement | ha | 2.18 | \$ 50,000.00 | \$ 109,000.00 | 1.97 | \$ 50,000.00 | \$ 98,500.00 | 2.40 | \$ 50,000.00 | \$ 120,000.00 | 1.50 | \$ 50,000.00 | \$ 75,000.00 | 2.38 | \$ 50,000.00 | \$ 119,000.00 | 2.31 | \$ 50,000.00 | \$ 115,500.00 |
| Landscaping | ls | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 |
| Control Structure c/w inlet and outlet pipes | unit | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 |
| Sub-Total | | | | \$ 1,548,000.00 | | | \$ 1,411,500.00 | | | \$ 1,708,500.00 | | | \$ 1,063,500.00 | | | \$ 1,692,000.00 | | | \$ 1,659,000.00 |
| Contingency and Engineering (30%) | | | | \$ 464,400.00 | | | \$ 423,450.00 | | | \$ 512,550.00 | | | | | | | | | |

APPENDIX H - Table H-1

PROPOSED STORMWATER MANAGEMENT FACILITIES - COST ESTIMATE

| Description | Unit | Pond 31 | | | Pond 32 | | | Pond 33 | | | Pond 34 | | | Pond 35 | | | Pond 36 | | |
|--|------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|---------------|----------|---------------|-----------------|
| | | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost |
| Clearing and grubbing | ha | 1.95 | \$ 50,000.00 | \$ 97,500.00 | 1.29 | \$ 50,000.00 | \$ 64,500.00 | 1.62 | \$ 50,000.00 | \$ 81,000.00 | 2.47 | \$ 50,000.00 | \$ 123,500.00 | 0.68 | \$ 50,000.00 | \$ 34,000.00 | 1.79 | \$ 50,000.00 | \$ 89,500.00 |
| Stripping | ha | 1.95 | \$ 50,000.00 | \$ 97,500.00 | 1.29 | \$ 50,000.00 | \$ 64,500.00 | 1.62 | \$ 50,000.00 | \$ 81,000.00 | 2.47 | \$ 50,000.00 | \$ 123,500.00 | 0.68 | \$ 50,000.00 | \$ 34,000.00 | 1.79 | \$ 50,000.00 | \$ 89,500.00 |
| Excavation and grading | m3 | 63800 | \$ 15.00 | \$ 957,000.00 | 38900 | \$ 15.00 | \$ 583,500.00 | 50900 | \$ 15.00 | \$ 763,500.00 | 62500 | \$ 15.00 | \$ 937,500.00 | 17200 | \$ 15.00 | \$ 258,000.00 | 57400 | \$ 15.00 | \$ 861,000.00 |
| Topsoil Replacement | ha | 1.95 | \$ 50,000.00 | \$ 97,500.00 | 1.29 | \$ 50,000.00 | \$ 64,500.00 | 1.62 | \$ 50,000.00 | \$ 81,000.00 | 2.47 | \$ 50,000.00 | \$ 123,500.00 | 0.68 | \$ 50,000.00 | \$ 34,000.00 | 1.79 | \$ 50,000.00 | \$ 89,500.00 |
| Landscaping | ls | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 |
| Control Structure c/w inlet and outlet pipes | unit | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 |
| Sub-Total | | | | \$ 1,399,500.00 | | | \$ 927,000.00 | | | \$ 1,156,500.00 | | | \$ 1,458,000.00 | | | \$ 510,000.00 | | | \$ 1,279,500.00 |
| Contingency and Engineering (30%) | | | | \$ 419,850.00 | | | \$ 278,100.00 | | | \$ 346,950.00 | | | \$ 437,400.00 | | | \$ 153,000.00 | | | \$ 383,850.00 |
| Total Cost | | | | \$ 1,819,350.00 | | | \$ 1,205,100.00 | | | \$ 1,503,450.00 | | | \$ 1,895,400.00 | | | \$ 663,000.00 | | | \$ 1,663,350.00 |

| Description | Unit | Pond 37 | | | Pond 38 | | | Pond 39 | | | Pond 40 | | | Pond 41 | | | Pond 42 | | |
|--|------|----------|---------------|---------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|---------------|----------|---------------|---------------|
| | | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost |
| Clearing and grubbing | ha | 1.11 | \$ 50,000.00 | \$ 55,500.00 | 1.41 | \$ 50,000.00 | \$ 70,500.00 | 1.86 | \$ 50,000.00 | \$ 93,000.00 | 1.7 | \$ 50,000.00 | \$ 85,000.00 | 0.45 | \$ 50,000.00 | \$ 22,500.00 | 0.77 | \$ 50,000.00 | \$ 38,500.00 |
| Stripping | ha | 1.11 | \$ 50,000.00 | \$ 55,500.00 | 1.41 | \$ 50,000.00 | \$ 70,500.00 | 1.86 | \$ 50,000.00 | \$ 93,000.00 | 1.7 | \$ 50,000.00 | \$ 85,000.00 | 0.45 | \$ 50,000.00 | \$ 22,500.00 | 0.77 | \$ 50,000.00 | \$ 38,500.00 |
| Excavation and grading | m3 | 30100 | \$ 15.00 | \$ 451,500.00 | 37200 | \$ 15.00 | \$ 558,000.00 | 55900 | \$ 15.00 | \$ 838,500.00 | 44300 | \$ 15.00 | \$ 664,500.00 | 9600 | \$ 15.00 | \$ 144,000.00 | 20500 | \$ 15.00 | \$ 307,500.00 |
| Topsoil Replacement | ha | 1.11 | \$ 50,000.00 | \$ 55,500.00 | 1.41 | \$ 50,000.00 | \$ 70,500.00 | 1.86 | \$ 50,000.00 | \$ 93,000.00 | 1.7 | \$ 50,000.00 | \$ 85,000.00 | 0.45 | \$ 50,000.00 | \$ 22,500.00 | 0.77 | \$ 50,000.00 | \$ 38,500.00 |
| Landscaping | ls | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 |
| Control Structure c/w inlet and outlet pipes | unit | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 |
| Sub-Total | | | | \$ 768,000.00 | | | \$ 919,500.00 | | | \$ 1,267,500.00 | | | \$ 1,069,500.00 | | | \$ 361,500.00 | | | \$ 573,000.00 |
| Contingency and Engineering (30%) | | | | \$ 230,400.00 | | | \$ 275,850.00 | | | \$ 380,250.00 | | | \$ 320,850.00 | | | \$ 108,450.00 | | | \$ 171,900.00 |
| Total Cost | | | | \$ 998,400.00 | | | \$ 1,195,350.00 | | | \$ 1,647,750.00 | | | \$ 1,390,350.00 | | | \$ 469,950.00 | | | \$ 744,900.00 |

| Description | Unit | Pond 43 | | | Pond 44 | | | Pond 45 | | | Pond 46 | | | Pond 47 | | | Pond 48 | | |
|--|------|----------|---------------|---------------|----------|---------------|---------------|----------|---------------|---------------|----------|---------------|-----------------|----------|---------------|-----------------|----------|---------------|---------------|
| | | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost | Quantity | Unit Cost | Cost |
| Clearing and grubbing | ha | 0.67 | \$ 50,000.00 | \$ 33,500.00 | 0.92 | \$ 50,000.00 | \$ 46,000.00 | 0.65 | \$ 50,000.00 | \$ 32,500.00 | 1.54 | \$ 50,000.00 | \$ 77,000.00 | 2.89 | \$ 50,000.00 | \$ 144,500.00 | 0.56 | \$ 50,000.00 | \$ 28,000.00 |
| Stripping | ha | 0.67 | \$ 50,000.00 | \$ 33,500.00 | 0.92 | \$ 50,000.00 | \$ 46,000.00 | 0.65 | \$ 50,000.00 | \$ 32,500.00 | 1.54 | \$ 50,000.00 | \$ 77,000.00 | 2.89 | \$ 50,000.00 | \$ 144,500.00 | 0.56 | \$ 50,000.00 | \$ 28,000.00 |
| Excavation and grading | m3 | 15100 | \$ 15.00 | \$ 226,500.00 | 22100 | \$ 15.00 | \$ 331,500.00 | 14400 | \$ 15.00 | \$ 216,000.00 | 40100 | \$ 15.00 | \$ 601,500.00 | 106500 | \$ 15.00 | \$ 1,597,500.00 | 15000 | \$ 15.00 | \$ 225,000.00 |
| Topsoil Replacement | ha | 0.67 | \$ 50,000.00 | \$ 33,500.00 | 0.92 | \$ 50,000.00 | \$ 46,000.00 | 0.65 | \$ 50,000.00 | \$ 32,500.00 | 1.54 | \$ 50,000.00 | \$ 77,000.00 | 2.89 | \$ 50,000.00 | \$ 144,500.00 | 0.56 | \$ 50,000.00 | \$ 28,000.00 |
| Landscaping | ls | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 | 1 | \$ 50,000.00 | \$ 50,000.00 |
| Control Structure c/w inlet and outlet pipes | unit | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 | 1 | \$ 100,000.00 | \$ 100,000.00 |
| Sub-Total | | | | \$ 477,000.00 | | | \$ 619,500.00 | | | \$ 463,500.00 | | | \$ 982,500.00 | | | \$ 2,181,000.00 | | | \$ 459,000.00 |
| Contingency and Engineering (30%) | | | | \$ 143,100.00 | | | \$ 185,850.00 | | | \$ 139,050.00 | | | \$ 294,750.00 | | | \$ 654,300.00 | | | \$ 137,700.00 |
| Total Cost | | | | \$ 620,100.00 | | | \$ 805,350.00 | | | \$ 602,550.00 | | | \$ 1,277,250.00 | | | \$ 2,835,300.00 | | | \$ 596,700.00 |

**APPENDIX H - Table H-2
PROPOSED STORM TRUNKS - COST ESTIMATE**

STORM TRUNK - SOUTH

| STORM ID | From MH | To MH | Diameter (mm) | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|-------------------|---------|-----------|---------------|------------|------------------|----------------------|-----------------------------------|----------------------|
| STM1 | ST1 | ST2 | 1500 | 831 | \$ 2,280 | \$ 1,894,680 | \$ 568,404 | \$ 2,463,084 |
| STM2 | ST2 | ST3 | 1500 | 491 | \$ 2,280 | \$ 1,119,480 | \$ 335,844 | \$ 1,455,324 |
| STM3 | ST3 | ST4 | 1500 | 318 | \$ 2,280 | \$ 725,040 | \$ 217,512 | \$ 942,552 |
| STM4 | ST4 | ST5 | 1500 | 508 | \$ 2,280 | \$ 1,158,240 | \$ 347,472 | \$ 1,505,712 |
| STM5 | ST5 | ST6 | 1800 | 365 | \$ 2,280 | \$ 832,200 | \$ 249,660 | \$ 1,081,860 |
| STM6 | ST6 | ST7 | 1800 | 516 | \$ 2,280 | \$ 1,176,480 | \$ 352,944 | \$ 1,529,424 |
| STM7 | ST7 | ST8 | 1800 | 548 | \$ 2,280 | \$ 1,249,440 | \$ 374,832 | \$ 1,624,272 |
| STM8 | ST8 | SOUTFALL1 | 1800 | 253 | \$ 2,280 | \$ 576,840 | \$ 173,052 | \$ 749,892 |
| STM9 | ST25 | ST5 | 1050 | 390 | \$ 2,110 | \$ 822,900 | \$ 246,870 | \$ 1,069,770 |
| STM10 | ST9 | ST10 | 750 | 329 | \$ 2,040 | \$ 671,160 | \$ 201,348 | \$ 872,508 |
| STM11 | ST10 | ST11 | 750 | 315 | \$ 2,040 | \$ 642,600 | \$ 192,780 | \$ 835,380 |
| Total Cost | | | | | | \$ 10,869,060 | \$ 3,260,718 | \$ 14,129,778 |
























STORM TRUNK - NORTH





















| STORM ID | From MH | To MH | Diameter (mm) | Length (m) | Unit Cost (\$/m) | Pipe Cost (\$) | Contingency and Engineering (30%) | Total Cost |
|-------------------|---------|-----------|---------------|------------|------------------|----------------------|-----------------------------------|----------------------|
| STM12 | ST12 | ST13 | 1200 | 370 | \$ 2,250 | \$ 832,500 | \$ 249,750 | \$ 1,082,250 |
| STM13 | ST13 | ST14 | 1200 | 383 | \$ 2,250 | \$ 861,750 | \$ 258,525 | \$ 1,120,275 |
| STM14 | ST14 | ST15 | 1500 | 454 | \$ 2,280 | \$ 1,035,120 | \$ 310,536 | \$ 1,345,656 |
| STM15 | ST16 | ST15 | 1050 | 731 | \$ 2,110 | \$ 1,542,410 | \$ 462,723 | \$ 2,005,133 |
| STM16 | ST15 | ST17 | 1500 | 606 | \$ 2,280 | \$ 1,381,680 | \$ 414,504 | \$ 1,796,184 |
| STM17 | ST17 | ST26 | 1500 | 253 | \$ 2,280 | \$ 576,840 | \$ 173,052 | \$ 749,892 |
| STM 26 | ST26 | ST18 | 1800 | 253 | \$ 2,280 | \$ 576,840 | \$ 173,052 | \$ 749,892 |
| STM18 | ST18 | NOUTFALL1 | 1800 | 131 | \$ 2,280 | \$ 298,680 | \$ 89,604 | \$ 388,284 |
| STM19 | ST19 | ST20 | 1200 | 556 | \$ 2,250 | \$ 1,251,000 | \$ 375,300 | \$ 1,626,300 |
| STM20 | ST20 | ST21 | 1500 | 251 | \$ 2,280 | \$ 572,280 | \$ 171,684 | \$ 743,964 |
| STM21 | ST21 | ST22 | 1500 | 620 | \$ 2,280 | \$ 1,413,600 | \$ 424,080 | \$ 1,837,680 |
| STM22 | ST22 | NOUTFALL2 | 1500 | 88 | \$ 2,280 | \$ 200,640 | \$ 60,192 | \$ 260,832 |
| STM23 | ST23 | ST24 | 750 | 561 | \$ 2,040 | \$ 1,144,440 | \$ 343,332 | \$ 1,487,772 |
| STM24 | ST24 | NOUTFALL3 | 750 | 54 | \$ 2,040 | \$ 110,160 | \$ 33,048 | \$ 143,208 |
| Total Cost | | | | | | \$ 11,797,940 | \$ 3,539,382 | \$ 15,337,322 |



















| | | | |
|---------------|----------------------|---------------------|----------------------|
| Totals | \$ 22,667,000 | \$ 6,800,100 | \$ 29,467,100 |
|---------------|----------------------|---------------------|----------------------|

REPORT

Appendix I - Transportation Model Results

| |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  |  |  |  |  |  |  |  |  | |  |  |
| Traffic Volume (vph) | 17 | 330 | 745 | 157 | 104 | 6 | 229 | 26 | 143 | 4 | 97 | 8 |
| Future Volume (vph) | 17 | 330 | 745 | 157 | 104 | 6 | 229 | 26 | 143 | 4 | 97 | 8 |
| Ideal Flow (vphpl) | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 |
| Storage Length (m) | 50.0 | | 50.0 | 50.0 | | 50.0 | 50.0 | | 0.0 | 0.0 | | 0.0 |
| Storage Lanes | 1 | | 1 | 1 | | 1 | 1 | | 1 | 0 | | 0 |
| Taper Length (m) | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | | 0.850 | | | 0.850 | | 0.990 | |
| Flt Protected | 0.950 | | | 0.950 | | | 0.950 | | | | 0.998 | |
| Satd. Flow (prot) | 1676 | 1765 | 1514 | 1545 | 1485 | 1590 | 1445 | 1871 | 1371 | 0 | 1753 | 0 |
| Flt Permitted | 0.684 | | | 0.465 | | | 0.701 | | | | 0.996 | |
| Satd. Flow (perm) | 1207 | 1765 | 1514 | 756 | 1485 | 1590 | 1066 | 1871 | 1371 | 0 | 1749 | 0 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 781 | | | 14 | | | 155 | | 6 | |
| Link Speed (k/h) | | 70 | | | 70 | | | 60 | | | 60 | |
| Link Distance (m) | | 261.4 | | | 335.7 | | | 240.8 | | | 222.6 | |
| Travel Time (s) | | 13.4 | | | 17.3 | | | 14.4 | | | 13.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Heavy Vehicles (%) | 6% | 6% | 5% | 15% | 26% | 0% | 23% | 0% | 16% | 0% | 5% | 13% |
| Adj. Flow (vph) | 18 | 359 | 810 | 171 | 113 | 7 | 249 | 28 | 155 | 4 | 105 | 9 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 18 | 359 | 810 | 171 | 113 | 7 | 249 | 28 | 155 | 0 | 118 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(m) | | 3.7 | | | 3.7 | | | 3.7 | | | 3.7 | |
| Link Offset(m) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Crosswalk Width(m) | | 1.6 | | | 1.6 | | | 1.6 | | | 1.6 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Turning Speed (k/h) | 24 | | 14 | 24 | | 14 | 24 | | 14 | 24 | | 14 |
| Turn Type | Perm | NA | Perm | Perm | NA | Perm | Perm | NA | Perm | Perm | NA | |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 36.0 | 36.0 | 36.0 | 36.0 | 36.0 | 36.0 |
| Total Split (%) | 55.0% | 55.0% | 55.0% | 55.0% | 55.0% | 55.0% | 45.0% | 45.0% | 45.0% | 45.0% | 45.0% | 45.0% |
| Maximum Green (s) | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | |
| Total Lost Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | |
| Lead/Lag | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | |
| Walk Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Flash Dont Walk (s) | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Act Effct Green (s) | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 32.0 | 32.0 | 32.0 | | 32.0 | |
| Actuated g/C Ratio | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.40 | 0.40 | 0.40 | | 0.40 | |

| |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------------------|---|---|---|---|---|---|--|---|---|---|---|---|
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations | |  |  | |  | |  |  | |  |  |  |
| Traffic Volume (vph) | 163 | 3 | 259 | 11 | 13 | 2 | 131 | 622 | 12 | 1 | 686 | 69 |
| Future Volume (vph) | 163 | 3 | 259 | 11 | 13 | 2 | 131 | 622 | 12 | 1 | 686 | 69 |
| Ideal Flow (vphpl) | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 |
| Storage Length (m) | 0.0 | | 0.0 | 0.0 | | 0.0 | 75.0 | | 0.0 | 75.0 | | 25.0 |
| Storage Lanes | 0 | | 1 | 0 | | 0 | 2 | | 0 | 1 | | 1 |
| Taper Length (m) | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 0.95 | 0.95 | 1.00 | 0.95 | 1.00 |
| Frt | | | 0.850 | | 0.990 | | | 0.997 | | | | 0.850 |
| Flt Protected | | 0.953 | | | 0.979 | | 0.950 | | | 0.950 | | |
| Satd. Flow (prot) | 0 | 1659 | 1486 | 0 | 1346 | 0 | 2715 | 3346 | 0 | 1777 | 3484 | 1336 |
| Flt Permitted | | 0.709 | | | 0.895 | | 0.950 | | | 0.390 | | |
| Satd. Flow (perm) | 0 | 1234 | 1486 | 0 | 1230 | 0 | 2715 | 3346 | 0 | 730 | 3484 | 1336 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 282 | | 2 | | | 4 | | | | 68 |
| Link Speed (k/h) | | 70 | | | 50 | | | 60 | | | 60 | |
| Link Distance (m) | | 276.5 | | | 218.5 | | | 217.0 | | | 203.0 | |
| Travel Time (s) | | 14.2 | | | 15.7 | | | 13.0 | | | 12.2 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Heavy Vehicles (%) | 7% | 33% | 7% | 18% | 54% | 0% | 27% | 6% | 0% | 0% | 2% | 19% |
| Adj. Flow (vph) | 177 | 3 | 282 | 12 | 14 | 2 | 142 | 676 | 13 | 1 | 746 | 75 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 180 | 282 | 0 | 28 | 0 | 142 | 689 | 0 | 1 | 746 | 75 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(m) | | 0.0 | | | 0.0 | | | 7.4 | | | 7.4 | |
| Link Offset(m) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Crosswalk Width(m) | | 1.6 | | | 1.6 | | | 1.6 | | | 1.6 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Turning Speed (k/h) | 24 | | 14 | 24 | | 14 | 24 | | 14 | 24 | | 14 |
| Turn Type | Perm | NA | Perm | Perm | NA | | Prot | NA | | Perm | NA | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | | | | | 6 | | 6 |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | | 8.0 | 20.0 | | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 29.0 | 29.0 | 29.0 | 29.0 | 29.0 | | 14.0 | 51.0 | | 37.0 | 37.0 | 37.0 |
| Total Split (%) | 36.3% | 36.3% | 36.3% | 36.3% | 36.3% | | 17.5% | 63.8% | | 46.3% | 46.3% | 46.3% |
| Maximum Green (s) | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | | 10.0 | 47.0 | | 33.0 | 33.0 | 33.0 |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | | 0.5 | 0.5 | | 0.5 | 0.5 | 0.5 |
| Lost Time Adjust (s) | | 0.0 | 0.0 | | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | | 4.0 | 4.0 | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Lead/Lag | | | | | | | Lead | | | Lag | Lag | Lag |
| Lead-Lag Optimize? | | | | | | | Yes | | | Yes | Yes | Yes |
| Walk Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | | | 5.0 | | 5.0 | 5.0 | 5.0 |
| Flash Dont Walk (s) | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | 0 | 0 | 0 | 0 | 0 | | | 0 | | 0 | 0 | 0 |
| Act Effct Green (s) | | 25.0 | 25.0 | | 25.0 | | 10.0 | 47.0 | | 33.0 | 33.0 | 33.0 |
| Actuated g/C Ratio | | 0.31 | 0.31 | | 0.31 | | 0.12 | 0.59 | | 0.41 | 0.41 | 0.41 |



















| |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations | |  | | |  | |  |  | |  |  | |
| Traffic Volume (vph) | 6 | 2 | 16 | 6 | 2 | 0 | 27 | 628 | 44 | 1 | 793 | 55 |
| Future Volume (vph) | 6 | 2 | 16 | 6 | 2 | 0 | 27 | 628 | 44 | 1 | 793 | 55 |
| Ideal Flow (vphpl) | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 |
| Storage Length (m) | 0.0 | | 0.0 | 0.0 | | 0.0 | 75.0 | | 0.0 | 75.0 | | 0.0 |
| Storage Lanes | 0 | | 0 | 0 | | 0 | 1 | | 0 | 1 | | 0 |
| Taper Length (m) | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.912 | | | | | | 0.990 | | | 0.990 | |
| Flt Protected | | 0.987 | | | 0.963 | | 0.950 | | | 0.950 | | |
| Satd. Flow (prot) | 0 | 1684 | 0 | 0 | 1317 | 0 | 1777 | 1718 | 0 | 1777 | 1781 | 0 |
| Flt Permitted | | 0.987 | | | 0.963 | | 0.950 | | | 0.950 | | |
| Satd. Flow (perm) | 0 | 1684 | 0 | 0 | 1317 | 0 | 1777 | 1718 | 0 | 1777 | 1781 | 0 |
| Link Speed (k/h) | | 50 | | | 50 | | | 80 | | | 80 | |
| Link Distance (m) | | 118.7 | | | 64.3 | | | 446.9 | | | 432.0 | |
| Travel Time (s) | | 8.5 | | | 4.6 | | | 20.1 | | | 19.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Heavy Vehicles (%) | 0% | 0% | 0% | 33% | 50% | 0% | 0% | 8% | 5% | 0% | 4% | 4% |
| Adj. Flow (vph) | 7 | 2 | 17 | 7 | 2 | 0 | 29 | 683 | 48 | 1 | 862 | 60 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 26 | 0 | 0 | 9 | 0 | 29 | 731 | 0 | 1 | 922 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(m) | | 0.0 | | | 0.0 | | | 3.7 | | | 3.7 | |
| Link Offset(m) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Crosswalk Width(m) | | 1.6 | | | 1.6 | | | 1.6 | | | 1.6 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Turning Speed (k/h) | 24 | | 14 | 24 | | 14 | 24 | | 14 | 24 | | 14 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
























Intersection Summary

| | |
|-----------------------------------|--------------|
| Area Type: | Other |
| Control Type: | Unsignalized |
| Intersection Capacity Utilization | 56.3% |
| ICU Level of Service | B |
| Analysis Period (min) | 15 |

HCM Unsignalized Intersection Capacity Analysis
 3: Hwy 2A & Twp Rd 391

Existing configuration - AM peak hour
 2015 peak hour data from Alberta Transportation

| |  |  |  |  |  |  |  |  |  |  |  |  |
|-----------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations | |  | | |  | |  |  | |  |  | |
| Traffic Volume (veh/h) | 6 | 2 | 16 | 6 | 2 | 0 | 27 | 628 | 44 | 1 | 793 | 55 |
| Future Volume (Veh/h) | 6 | 2 | 16 | 6 | 2 | 0 | 27 | 628 | 44 | 1 | 793 | 55 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 7 | 2 | 17 | 7 | 2 | 0 | 29 | 683 | 48 | 1 | 862 | 60 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | None | | | None | |
| Median storage (veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 1636 | 1683 | 892 | 1647 | 1689 | 707 | 922 | | | 731 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 1636 | 1683 | 892 | 1647 | 1689 | 707 | 922 | | | 731 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.4 | 7.0 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.8 | 4.5 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 91 | 98 | 95 | 88 | 97 | 100 | 96 | | | 100 | | |
| cM capacity (veh/h) | 77 | 92 | 344 | 61 | 69 | 439 | 749 | | | 883 | | |
| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | | | | | | |
| Volume Total | 26 | 9 | 29 | 731 | 1 | 922 | | | | | | |
| Volume Left | 7 | 7 | 29 | 0 | 1 | 0 | | | | | | |
| Volume Right | 17 | 0 | 0 | 48 | 0 | 60 | | | | | | |
| cSH | 161 | 62 | 749 | 1700 | 883 | 1700 | | | | | | |
| Volume to Capacity | 0.16 | 0.14 | 0.04 | 0.43 | 0.00 | 0.54 | | | | | | |
| Queue Length 95th (m) | 4.3 | 3.6 | 0.9 | 0.0 | 0.0 | 0.0 | | | | | | |
| Control Delay (s) | 31.7 | 72.3 | 10.0 | 0.0 | 9.1 | 0.0 | | | | | | |
| Lane LOS | D | F | B | | A | | | | | | | |
| Approach Delay (s) | 31.7 | 72.3 | 0.4 | | 0.0 | | | | | | | |
| Approach LOS | D | F | | | | | | | | | | |
| Intersection Summary | | | | | | | | | | | | |
| Average Delay | | | 1.0 | | | | | | | | | |
| Intersection Capacity Utilization | | | 56.3% | | ICU Level of Service | | | | | B | | |
| Analysis Period (min) | | | 15 | | | | | | | | | |

| |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  |  |  |  |  |  |  |  |  | |  |  |
| Traffic Volume (vph) | 16 | 172 | 416 | 208 | 325 | 5 | 469 | 52 | 183 | 5 | 69 | 32 |
| Future Volume (vph) | 16 | 172 | 416 | 208 | 325 | 5 | 469 | 52 | 183 | 5 | 69 | 32 |
| Ideal Flow (vphpl) | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 |
| Storage Length (m) | 50.0 | | 50.0 | 50.0 | | 50.0 | 50.0 | | 0.0 | 0.0 | | 0.0 |
| Storage Lanes | 1 | | 1 | 1 | | 1 | 1 | | 1 | 0 | | 0 |
| Taper Length (m) | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | | 0.850 | | | 0.850 | | 0.959 | |
| Flt Protected | 0.950 | | | 0.950 | | | 0.950 | | | | 0.998 | |
| Satd. Flow (prot) | 1777 | 1406 | 1347 | 1615 | 1748 | 1590 | 1676 | 1871 | 1445 | 0 | 1732 | 0 |
| Flt Permitted | 0.368 | | | 0.589 | | | 0.723 | | | | 0.994 | |
| Satd. Flow (perm) | 688 | 1406 | 1347 | 1002 | 1748 | 1590 | 1276 | 1871 | 1445 | 0 | 1725 | 0 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 452 | | | 14 | | | 199 | | 35 | |
| Link Speed (k/h) | | 70 | | | 70 | | | 60 | | | 60 | |
| Link Distance (m) | | 261.4 | | | 335.7 | | | 240.8 | | | 222.6 | |
| Travel Time (s) | | 13.4 | | | 17.3 | | | 14.4 | | | 13.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Heavy Vehicles (%) | 0% | 33% | 18% | 10% | 7% | 0% | 6% | 0% | 10% | 0% | 1% | 9% |
| Adj. Flow (vph) | 17 | 187 | 452 | 226 | 353 | 5 | 510 | 57 | 199 | 5 | 75 | 35 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 17 | 187 | 452 | 226 | 353 | 5 | 510 | 57 | 199 | 0 | 115 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(m) | | 3.7 | | | 3.7 | | | 3.7 | | | 3.7 | |
| Link Offset(m) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Crosswalk Width(m) | | 1.6 | | | 1.6 | | | 1.6 | | | 1.6 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Turning Speed (k/h) | 24 | | 14 | 24 | | 14 | 24 | | 14 | 24 | | 14 |
| Turn Type | Perm | NA | Perm | Perm | NA | Perm | Perm | NA | Perm | Perm | NA | |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 31.0 | 31.0 | 31.0 | 31.0 | 31.0 | 31.0 | 49.0 | 49.0 | 49.0 | 49.0 | 49.0 | 49.0 |
| Total Split (%) | 38.8% | 38.8% | 38.8% | 38.8% | 38.8% | 38.8% | 61.3% | 61.3% | 61.3% | 61.3% | 61.3% | 61.3% |
| Maximum Green (s) | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 45.0 | 45.0 | 45.0 | 45.0 | 45.0 | 45.0 |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | |
| Total Lost Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | |
| Lead/Lag | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | |
| Walk Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Flash Dont Walk (s) | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Act Effct Green (s) | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 27.0 | 45.0 | 45.0 | 45.0 | | 45.0 | |
| Actuated g/C Ratio | 0.34 | 0.34 | 0.34 | 0.34 | 0.34 | 0.34 | 0.56 | 0.56 | 0.56 | | 0.56 | |

Lanes, Volumes, Timings
1: Taylor Drive & Hwy 11A

Existing configuration - PM peak hour
2015 peak hour data from Alberta Transportation





















| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|----------------|------|------|------|------|------|------|------|------|------|-----|------|-----|
| v/c Ratio | 0.07 | 0.39 | 0.60 | 0.67 | 0.60 | 0.01 | 0.71 | 0.05 | 0.22 | | 0.12 | |
| Control Delay | 19.2 | 23.4 | 5.9 | 34.3 | 27.1 | 4.2 | 19.7 | 8.1 | 2.0 | | 6.2 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | |
| Total Delay | 19.2 | 23.4 | 5.9 | 34.3 | 27.1 | 4.2 | 19.7 | 8.1 | 2.0 | | 6.2 | |
| LOS | B | C | A | C | C | A | B | A | A | | A | |
| Approach Delay | | 11.2 | | | 29.7 | | | 14.2 | | | 6.2 | |
| Approach LOS | | B | | | C | | | B | | | A | |



















Intersection Summary

| | |
|-----------------------------------|---|
| Area Type: | Other |
| Cycle Length: | 80 |
| Actuated Cycle Length: | 80 |
| Offset: | 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green |
| Natural Cycle: | 50 |
| Control Type: | Pretimed |
| Maximum v/c Ratio: | 0.71 |
| Intersection Signal Delay: | 17.1 |
| Intersection LOS: | B |
| Intersection Capacity Utilization | 64.5% |
| ICU Level of Service | C |
| Analysis Period (min) | 15 |

Splits and Phases: 1: Taylor Drive & Hwy 11A












































| |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations | |  |  | |  | |  |  | |  |  |  |
| Traffic Volume (vph) | 135 | 4 | 171 | 49 | 12 | 2 | 219 | 624 | 10 | 0 | 647 | 141 |
| Future Volume (vph) | 135 | 4 | 171 | 49 | 12 | 2 | 219 | 624 | 10 | 0 | 647 | 141 |
| Ideal Flow (vphpl) | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 |
| Storage Length (m) | 0.0 | | 0.0 | 0.0 | | 0.0 | 75.0 | | 0.0 | 75.0 | | 25.0 |
| Storage Lanes | 0 | | 1 | 0 | | 0 | 2 | | 0 | 1 | | 1 |
| Taper Length (m) | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 0.95 | 0.95 | 1.00 | 0.95 | 1.00 |
| Frt | | | 0.850 | | 0.996 | | | 0.998 | | | | 0.850 |
| Flt Protected | | 0.954 | | | 0.962 | | 0.950 | | | | | |
| Satd. Flow (prot) | 0 | 1612 | 1303 | 0 | 1738 | 0 | 3106 | 3413 | 0 | 1871 | 3385 | 1347 |
| Flt Permitted | | 0.718 | | | 0.742 | | 0.950 | | | | | |
| Satd. Flow (perm) | 0 | 1213 | 1303 | 0 | 1341 | 0 | 3106 | 3413 | 0 | 1871 | 3385 | 1347 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 186 | | 2 | | | 4 | | | | 136 |
| Link Speed (k/h) | | 70 | | | 50 | | | 60 | | | 60 | |
| Link Distance (m) | | 276.5 | | | 218.5 | | | 217.0 | | | 203.0 | |
| Travel Time (s) | | 14.2 | | | 15.7 | | | 13.0 | | | 12.2 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Heavy Vehicles (%) | 11% | 0% | 22% | 4% | 0% | 0% | 11% | 4% | 0% | 0% | 5% | 18% |
| Adj. Flow (vph) | 147 | 4 | 186 | 53 | 13 | 2 | 238 | 678 | 11 | 0 | 703 | 153 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 151 | 186 | 0 | 68 | 0 | 238 | 689 | 0 | 0 | 703 | 153 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(m) | | 0.0 | | | 0.0 | | | 7.4 | | | 7.4 | |
| Link Offset(m) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Crosswalk Width(m) | | 1.6 | | | 1.6 | | | 1.6 | | | 1.6 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Turning Speed (k/h) | 24 | | 14 | 24 | | 14 | 24 | | 14 | 24 | | 14 |
| Turn Type | Perm | NA | Perm | Perm | NA | | Prot | NA | | Perm | NA | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | | | | | 6 | | 6 |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | | 8.0 | 20.0 | | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | | 17.0 | 54.0 | | 37.0 | 37.0 | 37.0 |
| Total Split (%) | 32.5% | 32.5% | 32.5% | 32.5% | 32.5% | | 21.3% | 67.5% | | 46.3% | 46.3% | 46.3% |
| Maximum Green (s) | 22.0 | 22.0 | 22.0 | 22.0 | 22.0 | | 13.0 | 50.0 | | 33.0 | 33.0 | 33.0 |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | | 0.5 | 0.5 | | 0.5 | 0.5 | 0.5 |
| Lost Time Adjust (s) | | 0.0 | 0.0 | | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | | 4.0 | 4.0 | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Lead/Lag | | | | | | | Lead | | | Lag | Lag | Lag |
| Lead-Lag Optimize? | | | | | | | Yes | | | Yes | Yes | Yes |
| Walk Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | | | 5.0 | | 5.0 | 5.0 | 5.0 |
| Flash Dont Walk (s) | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | 0 | 0 | 0 | 0 | 0 | | | 0 | | 0 | 0 | 0 |
| Act Effct Green (s) | | 22.0 | 22.0 | | 22.0 | | 13.0 | 50.0 | | 33.0 | 33.0 | |
| Actuated g/C Ratio | | 0.28 | 0.28 | | 0.28 | | 0.16 | 0.62 | | 0.41 | 0.41 | |

| |  |  |  |  |  |  |  |  |  |  |  |  |
|-----------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations | |  | | |  | |  |  | |  |  | |
| Traffic Volume (vph) | 15 | 0 | 22 | 25 | 1 | 4 | 11 | 719 | 14 | 0 | 721 | 10 |
| Future Volume (vph) | 15 | 0 | 22 | 25 | 1 | 4 | 11 | 719 | 14 | 0 | 721 | 10 |
| Ideal Flow (vphpl) | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 |
| Storage Length (m) | 0.0 | | 0.0 | 0.0 | | 0.0 | 75.0 | | 0.0 | 75.0 | | 0.0 |
| Storage Lanes | 0 | | 0 | 0 | | 0 | 1 | | 0 | 1 | | 0 |
| Taper Length (m) | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.919 | | | 0.983 | | | 0.997 | | | 0.998 | |
| Flt Protected | | 0.980 | | | 0.960 | | 0.950 | | | | | |
| Satd. Flow (prot) | 0 | 1636 | 0 | 0 | 1765 | 0 | 1725 | 1811 | 0 | 1871 | 1796 | 0 |
| Flt Permitted | | 0.980 | | | 0.960 | | 0.950 | | | | | |
| Satd. Flow (perm) | 0 | 1636 | 0 | 0 | 1765 | 0 | 1725 | 1811 | 0 | 1871 | 1796 | 0 |
| Link Speed (k/h) | | 50 | | | 50 | | | 80 | | | 80 | |
| Link Distance (m) | | 118.7 | | | 64.3 | | | 446.9 | | | 432.0 | |
| Travel Time (s) | | 8.5 | | | 4.6 | | | 20.1 | | | 19.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Heavy Vehicles (%) | 0% | 0% | 5% | 0% | 0% | 0% | 3% | 3% | 3% | 0% | 4% | 0% |
| Adj. Flow (vph) | 16 | 0 | 24 | 27 | 1 | 4 | 12 | 782 | 15 | 0 | 784 | 11 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 40 | 0 | 0 | 32 | 0 | 12 | 797 | 0 | 0 | 795 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(m) | | 0.0 | | | 0.0 | | | 3.7 | | | 3.7 | |
| Link Offset(m) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Crosswalk Width(m) | | 1.6 | | | 1.6 | | | 1.6 | | | 1.6 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Turning Speed (k/h) | 24 | | 14 | 24 | | 14 | 24 | | 14 | 24 | | 14 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Intersection Summary | | | | | | | | | | | | |
| Area Type: | Other | | | | | | | | | | | |
| Control Type: | Unsignalized | | | | | | | | | | | |
| Intersection Capacity Utilization | 49.7% | | | | | | ICU Level of Service A | | | | | |
| Analysis Period (min) | 15 | | | | | | | | | | | |

HCM Unsignalized Intersection Capacity Analysis
 3: Hwy 2A & Twp Rd 391

Existing configuration - PM peak hour
 2015 peak hour data from Alberta Transportation

| |  |  |  |  |  |  |  |  |  |  |  |  |
|-----------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations | |  | | |  | |  |  | |  |  | |
| Traffic Volume (veh/h) | 15 | 0 | 22 | 25 | 1 | 4 | 11 | 719 | 14 | 0 | 721 | 10 |
| Future Volume (Veh/h) | 15 | 0 | 22 | 25 | 1 | 4 | 11 | 719 | 14 | 0 | 721 | 10 |
| Sign Control | | Stop | | | Stop | | | Free | | | Free | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 16 | 0 | 24 | 27 | 1 | 4 | 12 | 782 | 15 | 0 | 784 | 11 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (m) | | | | | | | | | | | | |
| Walking Speed (m/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | |
| Median type | | | | | | | | | | | | |
| | | | | | | | | None | | | None | |
| Median storage (veh) | | | | | | | | | | | | |
| Upstream signal (m) | | | | | | | | | | | | |
| pX, platoon unblocked | | | | | | | | | | | | |
| vC, conflicting volume | 1600 | 1610 | 790 | 1622 | 1608 | 790 | 795 | | | 797 | | |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 1600 | 1610 | 790 | 1622 | 1608 | 790 | 795 | | | 797 | | |
| tC, single (s) | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 | 4.1 | | | 4.1 | | |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 | 2.2 | | | 2.2 | | |
| p0 queue free % | 81 | 100 | 94 | 65 | 99 | 99 | 99 | | | 100 | | |
| cM capacity (veh/h) | 84 | 104 | 386 | 77 | 104 | 394 | 822 | | | 834 | | |
| Direction, Lane # | EB 1 | WB 1 | NB 1 | NB 2 | SB 1 | SB 2 | | | | | | |
| Volume Total | 40 | 32 | 12 | 797 | 0 | 795 | | | | | | |
| Volume Left | 16 | 27 | 12 | 0 | 0 | 0 | | | | | | |
| Volume Right | 24 | 4 | 0 | 15 | 0 | 11 | | | | | | |
| cSH | 158 | 87 | 822 | 1700 | 1700 | 1700 | | | | | | |
| Volume to Capacity | 0.25 | 0.37 | 0.01 | 0.47 | 0.00 | 0.47 | | | | | | |
| Queue Length 95th (m) | 7.2 | 11.0 | 0.3 | 0.0 | 0.0 | 0.0 | | | | | | |
| Control Delay (s) | 35.3 | 68.9 | 9.4 | 0.0 | 0.0 | 0.0 | | | | | | |
| Lane LOS | E | F | A | | | | | | | | | |
| Approach Delay (s) | 35.3 | 68.9 | 0.1 | 0.0 | | | | | | | | |
| Approach LOS | E | F | | | | | | | | | | |
| Intersection Summary | | | | | | | | | | | | |
| Average Delay | | | 2.2 | | | | | | | | | |
| Intersection Capacity Utilization | | | 49.7% | ICU Level of Service | | A | | | | | | |
| Analysis Period (min) | | | 15 | | | | | | | | | |

| |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  |  |  |  |  |  |  |  |  | |  |  |
| Traffic Volume (vph) | 51 | 330 | 745 | 157 | 104 | 18 | 229 | 79 | 143 | 13 | 322 | 27 |
| Future Volume (vph) | 51 | 330 | 745 | 157 | 104 | 18 | 229 | 79 | 143 | 13 | 322 | 27 |
| Ideal Flow (vphpl) | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 |
| Storage Length (m) | 50.0 | | 50.0 | 50.0 | | 50.0 | 50.0 | | 0.0 | 0.0 | | 0.0 |
| Storage Lanes | 1 | | 1 | 1 | | 1 | 1 | | 1 | 0 | | 0 |
| Taper Length (m) | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | | 0.850 | | | 0.850 | | 0.990 | |
| Flt Protected | 0.950 | | | 0.950 | | | 0.950 | | | | 0.998 | |
| Satd. Flow (prot) | 1676 | 1765 | 1514 | 1545 | 1485 | 1590 | 1445 | 1871 | 1371 | 0 | 1753 | 0 |
| Flt Permitted | 0.684 | | | 0.419 | | | 0.245 | | | | 0.991 | |
| Satd. Flow (perm) | 1207 | 1765 | 1514 | 682 | 1485 | 1590 | 373 | 1871 | 1371 | 0 | 1741 | 0 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 535 | | | 68 | | | 155 | | 5 | |
| Link Speed (k/h) | | 70 | | | 70 | | | 60 | | | 60 | |
| Link Distance (m) | | 261.4 | | | 335.7 | | | 240.8 | | | 222.6 | |
| Travel Time (s) | | 13.4 | | | 17.3 | | | 14.4 | | | 13.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Heavy Vehicles (%) | 6% | 6% | 5% | 15% | 26% | 0% | 23% | 0% | 16% | 0% | 5% | 13% |
| Adj. Flow (vph) | 55 | 359 | 810 | 171 | 113 | 20 | 249 | 86 | 155 | 14 | 350 | 29 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 55 | 359 | 810 | 171 | 113 | 20 | 249 | 86 | 155 | 0 | 393 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(m) | | 3.7 | | | 3.7 | | | 3.7 | | | 3.7 | |
| Link Offset(m) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Crosswalk Width(m) | | 1.6 | | | 1.6 | | | 1.6 | | | 1.6 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Turning Speed (k/h) | 24 | | 14 | 24 | | 14 | 24 | | 14 | 24 | | 14 |
| Turn Type | Perm | NA | Perm | Perm | NA | Perm | pm+pt | NA | Perm | Perm | NA | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 8.0 | 20.0 | 20.0 | 20.0 | 20.0 | |
| Total Split (s) | 37.0 | 37.0 | 37.0 | 37.0 | 37.0 | 37.0 | 17.0 | 43.0 | 43.0 | 26.0 | 26.0 | |
| Total Split (%) | 46.3% | 46.3% | 46.3% | 46.3% | 46.3% | 46.3% | 21.3% | 53.8% | 53.8% | 32.5% | 32.5% | |
| Maximum Green (s) | 33.0 | 33.0 | 33.0 | 33.0 | 33.0 | 33.0 | 13.0 | 39.0 | 39.0 | 22.0 | 22.0 | |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | |
| Total Lost Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | |
| Lead/Lag | | | | | | | Lead | | | Lag | Lag | |
| Lead-Lag Optimize? | | | | | | | Yes | | | Yes | Yes | |
| Walk Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | |
| Flash Dont Walk (s) | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | | 11.0 | 11.0 | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| Act Effct Green (s) | 33.0 | 33.0 | 33.0 | 33.0 | 33.0 | 33.0 | 39.0 | 39.0 | 39.0 | | 22.0 | |
| Actuated g/C Ratio | 0.41 | 0.41 | 0.41 | 0.41 | 0.41 | 0.41 | 0.49 | 0.49 | 0.49 | | 0.28 | |

Lanes, Volumes, Timings
 1: Taylor Drive & Highway 11A

Existing configuration - AM peak hour
 Limitation of existing infrastructure

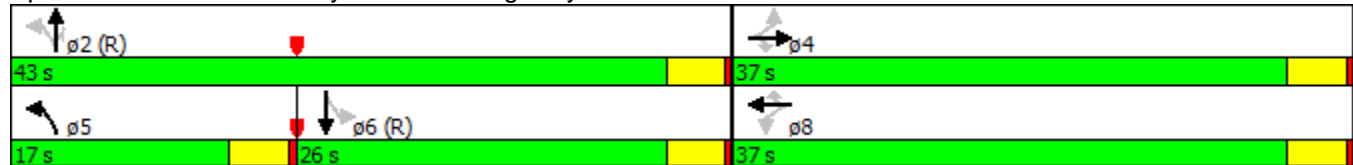






















| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|----------------|------|------|------|------|------|------|------|------|------|-----|------|-----|
| v/c Ratio | 0.11 | 0.49 | 0.86 | 0.61 | 0.18 | 0.03 | 0.70 | 0.09 | 0.21 | | 0.82 | |
| Control Delay | 15.3 | 20.2 | 18.7 | 29.6 | 16.0 | 0.1 | 25.0 | 11.4 | 2.8 | | 42.4 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | |
| Total Delay | 15.3 | 20.2 | 18.7 | 29.6 | 16.0 | 0.1 | 25.0 | 11.4 | 2.8 | | 42.4 | |
| LOS | B | C | B | C | B | A | C | B | A | | D | |
| Approach Delay | | 19.0 | | | 22.6 | | | 15.6 | | | 42.4 | |
| Approach LOS | | B | | | C | | | B | | | D | |

Intersection Summary

| | |
|-----------------------------------|---|
| Area Type: | Other |
| Cycle Length: | 80 |
| Actuated Cycle Length: | 80 |
| Offset: | 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green |
| Natural Cycle: | 60 |
| Control Type: | Pretimed |
| Maximum v/c Ratio: | 0.86 |
| Intersection Signal Delay: | 22.6 |
| Intersection LOS: | C |
| Intersection Capacity Utilization | 86.1% |
| ICU Level of Service | E |
| Analysis Period (min) | 15 |

Splits and Phases: 1: Taylor Drive & Highway 11A



| |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations | |  |  | |  | |  |  | |  |  |  |
| Traffic Volume (vph) | 163 | 3 | 259 | 11 | 13 | 2 | 131 | 622 | 12 | 1 | 686 | 69 |
| Future Volume (vph) | 163 | 3 | 259 | 11 | 13 | 2 | 131 | 622 | 12 | 1 | 686 | 69 |
| Ideal Flow (vphpl) | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 |
| Storage Length (m) | 0.0 | | 0.0 | 0.0 | | 0.0 | 75.0 | | 0.0 | 75.0 | | 25.0 |
| Storage Lanes | 0 | | 1 | 0 | | 0 | 2 | | 0 | 1 | | 1 |
| Taper Length (m) | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 0.95 | 0.95 | 1.00 | 0.95 | 1.00 |
| Frt | | | 0.850 | | 0.989 | | | 0.997 | | | | 0.850 |
| Flt Protected | | 0.953 | | | 0.980 | | 0.950 | | | 0.950 | | |
| Satd. Flow (prot) | 0 | 1658 | 1486 | 0 | 1348 | 0 | 2715 | 3346 | 0 | 1777 | 3484 | 1336 |
| Flt Permitted | | 0.695 | | | 0.845 | | 0.950 | | | 0.242 | | |
| Satd. Flow (perm) | 0 | 1209 | 1486 | 0 | 1162 | 0 | 2715 | 3346 | 0 | 453 | 3484 | 1336 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 256 | | 4 | | | 4 | | | | 61 |
| Link Speed (k/h) | | 70 | | | 50 | | | 60 | | | | 60 |
| Link Distance (m) | | 276.5 | | | 218.5 | | | 217.0 | | | | 203.0 |
| Travel Time (s) | | 14.2 | | | 15.7 | | | 13.0 | | | | 12.2 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 170% | 170% | 170% | 170% | 170% | 170% | 170% | 170% | 170% | 170% | 170% | 170% |
| Heavy Vehicles (%) | 7% | 33% | 7% | 18% | 54% | 0% | 27% | 6% | 0% | 0% | 2% | 19% |
| Adj. Flow (vph) | 301 | 6 | 479 | 20 | 24 | 4 | 242 | 1149 | 22 | 2 | 1268 | 128 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 307 | 479 | 0 | 48 | 0 | 242 | 1171 | 0 | 2 | 1268 | 128 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(m) | | 0.0 | | | 0.0 | | | 7.4 | | | 7.4 | |
| Link Offset(m) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Crosswalk Width(m) | | 1.6 | | | 1.6 | | | 1.6 | | | 1.6 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Turning Speed (k/h) | 24 | | 14 | 24 | | 14 | 24 | | 14 | 24 | | 14 |
| Turn Type | Perm | NA | Perm | Perm | NA | | Prot | NA | | Perm | NA | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | | | | | 6 | | 6 |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | | 8.0 | 20.0 | | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 | | 15.0 | 58.0 | | 43.0 | 43.0 | 43.0 |
| Total Split (%) | 35.6% | 35.6% | 35.6% | 35.6% | 35.6% | | 16.7% | 64.4% | | 47.8% | 47.8% | 47.8% |
| Maximum Green (s) | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 | | 11.0 | 54.0 | | 39.0 | 39.0 | 39.0 |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | | 0.5 | 0.5 | | 0.5 | 0.5 | 0.5 |
| Lost Time Adjust (s) | | 0.0 | 0.0 | | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | | 4.0 | 4.0 | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Lead/Lag | | | | | | | Lead | | | Lag | Lag | Lag |
| Lead-Lag Optimize? | | | | | | | Yes | | | Yes | Yes | Yes |
| Walk Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | | | 5.0 | | 5.0 | 5.0 | 5.0 |
| Flash Dont Walk (s) | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | 0 | 0 | 0 | 0 | 0 | | | 0 | | 0 | 0 | 0 |
| Act Effct Green (s) | | 28.0 | 28.0 | | 28.0 | | 11.0 | 54.0 | | 39.0 | 39.0 | 39.0 |



















| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|--------------------|-----|------|------|-----|------|-----|------|------|-----|------|------|------|
| Actuated g/C Ratio | | 0.31 | 0.31 | | 0.31 | | 0.12 | 0.60 | | 0.43 | 0.43 | 0.43 |
| v/c Ratio | | 0.82 | 0.75 | | 0.13 | | 0.73 | 0.58 | | 0.01 | 0.84 | 0.21 |
| Control Delay | | 48.0 | 21.2 | | 22.1 | | 52.3 | 12.5 | | 15.0 | 29.1 | 9.7 |
| Queue Delay | | 0.0 | 0.0 | | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Delay | | 48.0 | 21.2 | | 22.1 | | 52.3 | 12.5 | | 15.0 | 29.1 | 9.7 |
| LOS | | D | C | | C | | D | B | | B | C | A |
| Approach Delay | | 31.7 | | | 22.1 | | | 19.3 | | | 27.3 | |
| Approach LOS | | C | | | C | | | B | | | C | |
























Intersection Summary

| | |
|-----------------------------------|--|
| Area Type: | Other |
| Cycle Length: | 90 |
| Actuated Cycle Length: | 90 |
| Offset: | 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green |
| Natural Cycle: | 60 |
| Control Type: | Pretimed |
| Maximum v/c Ratio: | 0.84 |
| Intersection Signal Delay: | 25.1 |
| Intersection LOS: | C |
| Intersection Capacity Utilization | 74.4% |
| ICU Level of Service | D |
| Analysis Period (min) | 15 |

Splits and Phases: 2: Highway 2A & Highway 11A/Twp Rd 390



| |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations | |  | | |  | |  |  | |  |  | |
| Traffic Volume (vph) | 66 | 22 | 177 | 66 | 22 | 0 | 58 | 628 | 75 | 2 | 793 | 118 |
| Future Volume (vph) | 66 | 22 | 177 | 66 | 22 | 0 | 58 | 628 | 75 | 2 | 793 | 118 |
| Ideal Flow (vphpl) | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 |
| Storage Length (m) | 0.0 | | 0.0 | 0.0 | | 0.0 | 75.0 | | 0.0 | 75.0 | | 0.0 |
| Storage Lanes | 0 | | 0 | 0 | | 0 | 1 | | 0 | 1 | | 0 |
| Taper Length (m) | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.910 | | | | | | 0.984 | | | 0.981 | |
| Flt Protected | | 0.988 | | | 0.964 | | 0.950 | | | 0.950 | | |
| Satd. Flow (prot) | 0 | 1682 | 0 | 0 | 1314 | 0 | 1777 | 1709 | 0 | 1777 | 1764 | 0 |
| Flt Permitted | | 0.907 | | | 0.529 | | 0.148 | | | 0.270 | | |
| Satd. Flow (perm) | 0 | 1544 | 0 | 0 | 721 | 0 | 277 | 1709 | 0 | 505 | 1764 | 0 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 116 | | | | | | 17 | | | 21 | |
| Link Speed (k/h) | | 50 | | | 50 | | | 80 | | | 80 | |
| Link Distance (m) | | 118.7 | | | 64.3 | | | 446.9 | | | 432.0 | |
| Travel Time (s) | | 8.5 | | | 4.6 | | | 20.1 | | | 19.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Heavy Vehicles (%) | 0% | 0% | 0% | 33% | 50% | 0% | 0% | 8% | 5% | 0% | 4% | 4% |
| Adj. Flow (vph) | 72 | 24 | 192 | 72 | 24 | 0 | 63 | 683 | 82 | 2 | 862 | 128 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 288 | 0 | 0 | 96 | 0 | 63 | 765 | 0 | 2 | 990 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(m) | | 0.0 | | | 0.0 | | | 3.7 | | | 3.7 | |
| Link Offset(m) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Crosswalk Width(m) | | 1.6 | | | 1.6 | | | 1.6 | | | 1.6 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Turning Speed (k/h) | 24 | | 14 | 24 | | 14 | 24 | | 14 | 24 | | 14 |
| Turn Type | Perm | NA | | Perm | NA | | Perm | NA | | Perm | NA | |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | |
| Minimum Split (s) | 20.0 | 20.0 | | 20.0 | 20.0 | | 20.0 | 20.0 | | 20.0 | 20.0 | |
| Total Split (s) | 22.0 | 22.0 | | 22.0 | 22.0 | | 58.0 | 58.0 | | 58.0 | 58.0 | |
| Total Split (%) | 27.5% | 27.5% | | 27.5% | 27.5% | | 72.5% | 72.5% | | 72.5% | 72.5% | |
| Maximum Green (s) | 18.0 | 18.0 | | 18.0 | 18.0 | | 54.0 | 54.0 | | 54.0 | 54.0 | |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | |
| All-Red Time (s) | 0.5 | 0.5 | | 0.5 | 0.5 | | 0.5 | 0.5 | | 0.5 | 0.5 | |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Lost Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lead/Lag | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | |
| Walk Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Flash Dont Walk (s) | 11.0 | 11.0 | | 11.0 | 11.0 | | 11.0 | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Act Effct Green (s) | | 18.0 | | | 18.0 | | 54.0 | 54.0 | | 54.0 | 54.0 | |
| Actuated g/C Ratio | | 0.22 | | | 0.22 | | 0.68 | 0.68 | | 0.68 | 0.68 | |

| |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  |  |  |  |  |  |  |  |  | |  |  |
| Traffic Volume (vph) | 48 | 172 | 416 | 208 | 325 | 15 | 468 | 157 | 183 | 14 | 191 | 88 |
| Future Volume (vph) | 48 | 172 | 416 | 208 | 325 | 15 | 468 | 157 | 183 | 14 | 191 | 88 |
| Ideal Flow (vphpl) | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 |
| Storage Length (m) | 50.0 | | 50.0 | 50.0 | | 50.0 | 50.0 | | 0.0 | 0.0 | | 0.0 |
| Storage Lanes | 1 | | 1 | 1 | | 1 | 1 | | 1 | 0 | | 0 |
| Taper Length (m) | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | | 0.850 | | | 0.850 | | | 0.850 | | 0.959 | |
| Flt Protected | 0.950 | | | 0.950 | | | 0.950 | | | | 0.998 | |
| Satd. Flow (prot) | 1777 | 1406 | 1347 | 1615 | 1748 | 1590 | 1676 | 1871 | 1445 | 0 | 1732 | 0 |
| Flt Permitted | 0.356 | | | 0.584 | | | 0.300 | | | | 0.984 | |
| Satd. Flow (perm) | 666 | 1406 | 1347 | 993 | 1748 | 1590 | 529 | 1871 | 1445 | 0 | 1708 | 0 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 452 | | | 68 | | | 199 | | 26 | |
| Link Speed (k/h) | | 70 | | | 70 | | | 60 | | | 60 | |
| Link Distance (m) | | 261.4 | | | 335.7 | | | 240.8 | | | 222.6 | |
| Travel Time (s) | | 13.4 | | | 17.3 | | | 14.4 | | | 13.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Heavy Vehicles (%) | 0% | 33% | 18% | 10% | 7% | 0% | 6% | 0% | 10% | 0% | 1% | 9% |
| Adj. Flow (vph) | 52 | 187 | 452 | 226 | 353 | 16 | 509 | 171 | 199 | 15 | 208 | 96 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 52 | 187 | 452 | 226 | 353 | 16 | 509 | 171 | 199 | 0 | 319 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(m) | | 3.7 | | | 3.7 | | | 3.7 | | | 3.7 | |
| Link Offset(m) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Crosswalk Width(m) | | 1.6 | | | 1.6 | | | 1.6 | | | 1.6 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Turning Speed (k/h) | 24 | | 14 | 24 | | 14 | 24 | | 14 | 24 | | 14 |
| Turn Type | Perm | NA | Perm | Perm | NA | Perm | pm+pt | NA | Perm | Perm | NA | |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | 2 | | 2 | 6 | | |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 8.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 25.0 | 50.0 | 50.0 | 25.0 | 25.0 | |
| Total Split (%) | 37.5% | 37.5% | 37.5% | 37.5% | 37.5% | 37.5% | 31.3% | 62.5% | 62.5% | 31.3% | 31.3% | |
| Maximum Green (s) | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 21.0 | 46.0 | 46.0 | 21.0 | 21.0 | |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | |
| All-Red Time (s) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | |
| Total Lost Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | |
| Lead/Lag | | | | | | | Lead | | | Lag | Lag | |
| Lead-Lag Optimize? | | | | | | | Yes | | | Yes | Yes | |
| Walk Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | |
| Flash Dont Walk (s) | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | | 11.0 | 11.0 | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| Act Effct Green (s) | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 46.0 | 46.0 | 46.0 | | 21.0 | |
| Actuated g/C Ratio | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.58 | 0.58 | 0.58 | | 0.26 | |

Lanes, Volumes, Timings
1: Taylor Drive & Hwy 11A

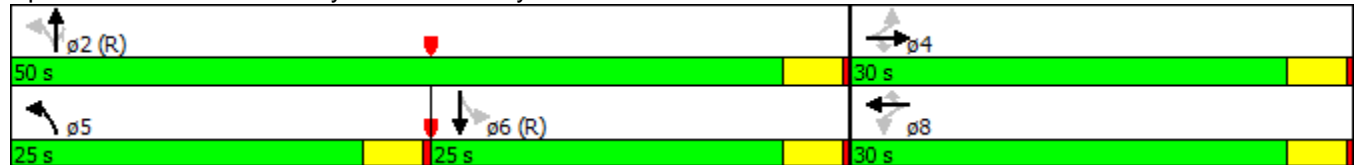
Existing configuration - PM peak hour
Limitation of existing infrastructure





















| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|----------------|------|------|------|------|------|------|------|------|------|-----|------|-----|
| v/c Ratio | 0.24 | 0.41 | 0.61 | 0.70 | 0.62 | 0.03 | 0.84 | 0.16 | 0.22 | | 0.68 | |
| Control Delay | 23.5 | 24.4 | 6.2 | 37.6 | 28.6 | 0.1 | 26.8 | 8.4 | 1.9 | | 32.9 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | 0.0 | |
| Total Delay | 23.5 | 24.4 | 6.2 | 37.6 | 28.6 | 0.1 | 26.8 | 8.4 | 1.9 | | 32.9 | |
| LOS | C | C | A | D | C | A | C | A | A | | C | |
| Approach Delay | | 12.4 | | | 31.2 | | | 17.6 | | | 32.9 | |
| Approach LOS | | B | | | C | | | B | | | C | |

Intersection Summary

| | |
|-----------------------------------|---|
| Area Type: | Other |
| Cycle Length: | 80 |
| Actuated Cycle Length: | 80 |
| Offset: | 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green |
| Natural Cycle: | 60 |
| Control Type: | Pretimed |
| Maximum v/c Ratio: | 0.84 |
| Intersection Signal Delay: | 21.4 |
| Intersection LOS: | C |
| Intersection Capacity Utilization | 77.7% |
| ICU Level of Service | D |
| Analysis Period (min) | 15 |

Splits and Phases: 1: Taylor Drive & Hwy 11A



| |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations | |  |  | |  | |  |  | |  |  |  |
| Traffic Volume (vph) | 135 | 4 | 171 | 49 | 12 | 2 | 219 | 624 | 10 | 0 | 647 | 141 |
| Future Volume (vph) | 135 | 4 | 171 | 49 | 12 | 2 | 219 | 624 | 10 | 0 | 647 | 141 |
| Ideal Flow (vphpl) | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 |
| Storage Length (m) | 0.0 | | 0.0 | 0.0 | | 0.0 | 75.0 | | 0.0 | 75.0 | | 25.0 |
| Storage Lanes | 0 | | 1 | 0 | | 0 | 2 | | 0 | 1 | | 1 |
| Taper Length (m) | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.97 | 0.95 | 0.95 | 1.00 | 0.95 | 1.00 |
| Frt | | | 0.850 | | 0.995 | | | 0.998 | | | | 0.850 |
| Flt Protected | | 0.954 | | | 0.963 | | 0.950 | | | | | |
| Satd. Flow (prot) | 0 | 1612 | 1303 | 0 | 1738 | 0 | 3106 | 3413 | 0 | 1871 | 3385 | 1347 |
| Flt Permitted | | 0.676 | | | 0.526 | | 0.950 | | | | | |
| Satd. Flow (perm) | 0 | 1142 | 1303 | 0 | 949 | 0 | 3106 | 3413 | 0 | 1871 | 3385 | 1347 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | | 316 | | 2 | | | 3 | | | | 123 |
| Link Speed (k/h) | | 70 | | | 50 | | | 60 | | | 60 | |
| Link Distance (m) | | 276.5 | | | 218.5 | | | 217.0 | | | 203.0 | |
| Travel Time (s) | | 14.2 | | | 15.7 | | | 13.0 | | | 12.2 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Growth Factor | 170% | 170% | 170% | 170% | 170% | 170% | 170% | 170% | 170% | 170% | 170% | 170% |
| Heavy Vehicles (%) | 11% | 0% | 22% | 4% | 0% | 0% | 11% | 4% | 0% | 0% | 5% | 18% |
| Adj. Flow (vph) | 249 | 7 | 316 | 91 | 22 | 4 | 405 | 1153 | 18 | 0 | 1196 | 261 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 256 | 316 | 0 | 117 | 0 | 405 | 1171 | 0 | 0 | 1196 | 261 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(m) | | 0.0 | | | 0.0 | | | 7.4 | | | 7.4 | |
| Link Offset(m) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Crosswalk Width(m) | | 1.6 | | | 1.6 | | | 1.6 | | | 1.6 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Turning Speed (k/h) | 24 | | 14 | 24 | | 14 | 24 | | 14 | 24 | | 14 |
| Turn Type | Perm | NA | Perm | Perm | NA | | Prot | NA | | Perm | NA | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | | | | | 6 | | 6 |
| Minimum Split (s) | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | | 8.0 | 20.0 | | 20.0 | 20.0 | 20.0 |
| Total Split (s) | 29.0 | 29.0 | 29.0 | 29.0 | 29.0 | | 19.0 | 61.0 | | 42.0 | 42.0 | 42.0 |
| Total Split (%) | 32.2% | 32.2% | 32.2% | 32.2% | 32.2% | | 21.1% | 67.8% | | 46.7% | 46.7% | 46.7% |
| Maximum Green (s) | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | | 15.0 | 57.0 | | 38.0 | 38.0 | 38.0 |
| Yellow Time (s) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | 3.5 |
| All-Red Time (s) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | | 0.5 | 0.5 | | 0.5 | 0.5 | 0.5 |
| Lost Time Adjust (s) | | 0.0 | 0.0 | | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | | 4.0 | 4.0 | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Lead/Lag | | | | | | | Lead | | | Lag | Lag | Lag |
| Lead-Lag Optimize? | | | | | | | Yes | | | Yes | Yes | Yes |
| Walk Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | | | 5.0 | | 5.0 | 5.0 | 5.0 |
| Flash Dont Walk (s) | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | | | 11.0 | | 11.0 | 11.0 | 11.0 |
| Pedestrian Calls (#/hr) | 0 | 0 | 0 | 0 | 0 | | | 0 | | 0 | 0 | 0 |
| Act Effct Green (s) | | 25.0 | 25.0 | | 25.0 | | 15.0 | 57.0 | | | 38.0 | 38.0 |



















| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|--------------------|-----|------|------|-----|------|-----|------|------|-----|-----|------|------|
| Actuated g/C Ratio | | 0.28 | 0.28 | | 0.28 | | 0.17 | 0.63 | | | 0.42 | 0.42 |
| v/c Ratio | | 0.81 | 0.54 | | 0.44 | | 0.78 | 0.54 | | | 0.84 | 0.41 |
| Control Delay | | 51.7 | 6.9 | | 32.6 | | 48.0 | 10.3 | | | 29.8 | 11.4 |
| Queue Delay | | 0.0 | 0.0 | | 0.0 | | 0.0 | 0.0 | | | 0.0 | 0.0 |
| Total Delay | | 51.7 | 6.9 | | 32.6 | | 48.0 | 10.3 | | | 29.8 | 11.4 |
| LOS | | D | A | | C | | D | B | | | C | B |
| Approach Delay | | 26.9 | | | 32.6 | | 20.0 | | | | 26.5 | |
| Approach LOS | | C | | | C | | C | | | | C | |

Intersection Summary

Area Type: Other
 Cycle Length: 90
 Actuated Cycle Length: 90
 Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green
 Natural Cycle: 65
 Control Type: Pretimed
 Maximum v/c Ratio: 0.84
 Intersection Signal Delay: 24.0 Intersection LOS: C
 Intersection Capacity Utilization 67.9% ICU Level of Service C
 Analysis Period (min) 15

Splits and Phases: 2: Highway 2A & Highway 11A/Twp Rd 390



| |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Group | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations | |  | | |  | |  |  | |  |  | |
| Traffic Volume (vph) | 87 | 0 | 128 | 75 | 3 | 12 | 179 | 719 | 121 | 0 | 721 | 163 |
| Future Volume (vph) | 87 | 0 | 128 | 75 | 3 | 12 | 179 | 719 | 121 | 0 | 721 | 163 |
| Ideal Flow (vphpl) | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 | 1850 |
| Storage Length (m) | 0.0 | | 0.0 | 0.0 | | 0.0 | 75.0 | | 0.0 | 75.0 | | 0.0 |
| Storage Lanes | 0 | | 0 | 0 | | 0 | 1 | | 0 | 1 | | 0 |
| Taper Length (m) | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | | |
| Lane Util. Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 0.920 | | | 0.982 | | | 0.978 | | | 0.972 | |
| Flt Protected | | 0.980 | | | 0.960 | | 0.950 | | | | | |
| Satd. Flow (prot) | 0 | 1638 | 0 | 0 | 1763 | 0 | 1725 | 1776 | 0 | 1871 | 1761 | 0 |
| Flt Permitted | | 0.849 | | | 0.557 | | 0.181 | | | | | |
| Satd. Flow (perm) | 0 | 1419 | 0 | 0 | 1023 | 0 | 329 | 1776 | 0 | 1871 | 1761 | 0 |
| Right Turn on Red | | | Yes | | | Yes | | | Yes | | | Yes |
| Satd. Flow (RTOR) | | 82 | | | 9 | | | 25 | | | 34 | |
| Link Speed (k/h) | | 50 | | | 50 | | | 80 | | | 80 | |
| Link Distance (m) | | 118.7 | | | 64.3 | | | 446.9 | | | 432.0 | |
| Travel Time (s) | | 8.5 | | | 4.6 | | | 20.1 | | | 19.4 | |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Heavy Vehicles (%) | 0% | 0% | 5% | 0% | 0% | 0% | 3% | 3% | 3% | 0% | 4% | 0% |
| Adj. Flow (vph) | 95 | 0 | 139 | 82 | 3 | 13 | 195 | 782 | 132 | 0 | 784 | 177 |
| Shared Lane Traffic (%) | | | | | | | | | | | | |
| Lane Group Flow (vph) | 0 | 234 | 0 | 0 | 98 | 0 | 195 | 914 | 0 | 0 | 961 | 0 |
| Enter Blocked Intersection | No | No | No | No | No | No | No | No | No | No | No | No |
| Lane Alignment | Left | Left | Right | Left | Left | Right | Left | Left | Right | Left | Left | Right |
| Median Width(m) | | 0.0 | | | 0.0 | | | 3.7 | | | 3.7 | |
| Link Offset(m) | | 0.0 | | | 0.0 | | | 0.0 | | | 0.0 | |
| Crosswalk Width(m) | | 1.6 | | | 1.6 | | | 1.6 | | | 1.6 | |
| Two way Left Turn Lane | | | | | | | | | | | | |
| Headway Factor | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| Turning Speed (k/h) | 24 | | 14 | 24 | | 14 | 24 | | 14 | 24 | | 14 |
| Turn Type | Perm | NA | | Perm | NA | | Perm | NA | | Perm | NA | |
| Protected Phases | | 4 | | | 8 | | | 2 | | | 6 | |
| Permitted Phases | 4 | | | 8 | | | 2 | | | 6 | | |
| Minimum Split (s) | 20.0 | 20.0 | | 20.0 | 20.0 | | 20.0 | 20.0 | | 20.0 | 20.0 | |
| Total Split (s) | 20.0 | 20.0 | | 20.0 | 20.0 | | 60.0 | 60.0 | | 60.0 | 60.0 | |
| Total Split (%) | 25.0% | 25.0% | | 25.0% | 25.0% | | 75.0% | 75.0% | | 75.0% | 75.0% | |
| Maximum Green (s) | 16.0 | 16.0 | | 16.0 | 16.0 | | 56.0 | 56.0 | | 56.0 | 56.0 | |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | | 3.5 | 3.5 | |
| All-Red Time (s) | 0.5 | 0.5 | | 0.5 | 0.5 | | 0.5 | 0.5 | | 0.5 | 0.5 | |
| Lost Time Adjust (s) | | 0.0 | | | 0.0 | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| Total Lost Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lead/Lag | | | | | | | | | | | | |
| Lead-Lag Optimize? | | | | | | | | | | | | |
| Walk Time (s) | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Flash Dont Walk (s) | 11.0 | 11.0 | | 11.0 | 11.0 | | 11.0 | 11.0 | | 11.0 | 11.0 | |
| Pedestrian Calls (#/hr) | 0 | 0 | | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| Act Effct Green (s) | | 16.0 | | | 16.0 | | 56.0 | 56.0 | | | 56.0 | |
| Actuated g/C Ratio | | 0.20 | | | 0.20 | | 0.70 | 0.70 | | | 0.70 | |

Appendix J - Cost Estimates for Transportation

