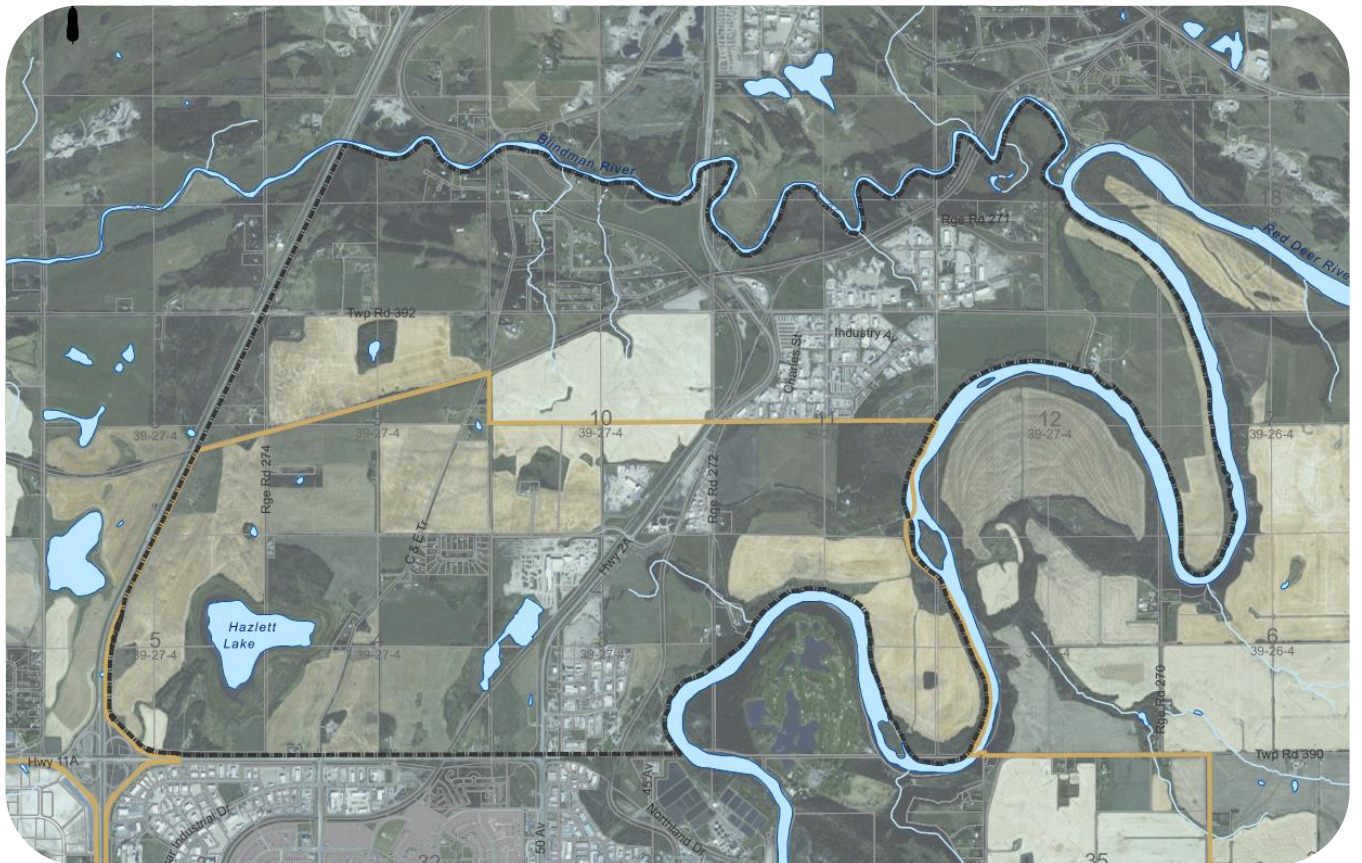


REPORT

City of Red Deer

North of Highway 11A Servicing Study Final Report



June 2016

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REPORT

Table of Contents

SECTION	PAGE NO.
Table of Contents	i
List of Tables	iii
List of Figures	iv
1 Introduction	1-1
1.1 Background	1-1
1.2 Constraints	1-3
1.3 References	1-3
1.4 Abbreviations & Acronyms	1-5
1.5 Metric Conversions	1-6
2 Design Criteria	2-1
2.1 Land Use	2-1
2.2 Water Distribution System	2-3
2.3 Sanitary Sewer	2-7
2.4 Stormwater Servicing	2-9
2.5 Transportation	2-15
3 Desktop Environmental Review	3-1
3.1 List of Acronyms – Environmental Review	3-1
3.2 Introduction	3-1
3.3 Environmental Values	3-2
3.4 Potential Impacts to Environmental Values and Management Recommendations	3-19
3.5 Hazlett Lake	3-24
3.6 General Practices for Identifying Crown Claimable Wetlands	3-26
3.7 Conclusion	3-28
3.8 References – Environmental Assessment	3-29
4 Ultimate Servicing	4-1
4.1 Water Distribution System	4-1
4.2 Sanitary Sewer System	4-16
4.3 Stormwater Drainage System	4-26
4.4 Transportation	4-49
4.5 Ultimate Servicing Concept	4-61
5 Interim Servicing	5-1

5.1	Water Distribution System	5-1
5.2	Sanitary Sewer System	5-6
5.4	Stormwater Drainage System	5-11
5.5	Transportation Network	5-12
6	Conclusions	6-1
6.1	Water Distribution System	6-1
6.2	Sanitary Sewer System	6-2
6.3	Stormwater Management System	6-3
6.4	Transportation	6-4
7	Recommendations	7-1
7.1	Water Distribution System	7-1
7.2	Sanitary Sewer System	7-1
7.3	Stormwater Management System	7-1
7.4	Transportation	7-2
	Closure	1
	Appendix A – Environmental Tables	1
	Appendix B - Cost Estimates - Water	1
	Appendix C - Cost Estimates - Sanitary	1
	Appendix D - Westhoff Model Results	1
	Appendix E - "Existing Overland Drainage Route for Hazlett Lake with Proposed Easements"	
	Drawings - Al Terra Engineering	1
	Appendix F - Chiles Industrial Park Subdivision - ISL As-Built Drawings	1
	Appendix G - Stormwater Management Facilities- Detailed Calculations	1
	Appendix H - Detailed Unit Costs - Stormwater	1
	Appendix I - Transportation Model Results	1
	Appendix J - Cost Estimates for Transportation	1

List of Tables

	PAGE NO.
Table 2 1: Developable and Undevelopable Lands	2-1
Table 2 2: Summary of the Water Demand Projections	2-5
Table 2 3: Red Deer Industrial Airport IDF Parameters – Update to Current Standards	2-9
Table 2 4: Runoff Coefficients (C)	2-10
Table 2 5: PCSWMM Model Parameters	2-11
Table 2 6: Imperviousness Values	2-11
Table 2 7: Roadway Design Criteria	2-15
Table 2 8: Intersection Level of Service	2-16
Table 2 9: Intersection Volume-to-Capacity Criteria	2-16
Table 3 1: Stewart and Kantrud Wetland Classes and Their Potential Crown Claimability (GoA 2014h)	3-28
Table 4 1: North Reservoir Storage Requirements	4-13
Table 4 2: North Reservoir Pumping Requirements	4-13
Table 4 3: WTP Pumping Capacity: Servicing Option 1	4-14
Table 4 4: WTP Pumping Capacity: Servicing Option 2	4-14
Table 4 5: Preliminary Cost Estimate – Water Distribution	4-15
Table 4 6: Summary of Offsite Flows from Future Development Areas	4-16
Table 4 7: Summary of Developable/Developed Area in Each Catchment by Land Use	4-20
Table 4 8: Catchment A – Wastewater Flow Sources	4-21
Table 4 9: Preliminary Costs – Sanitary Sewer	4-25
Table 4 10: Gauge Data and Flows	4-38
Table 4 11: Characteristics of Future Stormwater Management Facilities	4-45
Table 4 12: Preliminary Cost Estimate – Stormwater Management	4-48
Table 4 13: Evaluation Criteria	4-54
Table 4 14: Highway 11 and Gaetz Avenue Evaluation	4-55
Table 4 15: Highway 11 and Taylor Drive Evaluation	4-55
Table 4 16: Highway 2A and Township Road 391 Evaluation	4-56
Table 4 17: Preliminary Cost Estimate - Transportation	4-60
Table 4 18: Preliminary Cost Estimate - Summary	4-61
Table 4 19: Development Phasing Costs	4-63
Table 5 1: Water Interim Servicing Capacity Assessment Summary	5-2
Table 5 2: Preliminary Cost Estimate – Water Distribution System	5-5
Table 5 3: Preliminary Cost Estimate – Sanitary Sewer	5-10
Table 5 4: Preliminary Cost Estimate – Stormwater Drainage System	5-11
Table 5 5: Level of Service for Intersections	5-13
Table 5 6: Capacity Analysis of Existing Traffic Volumes	5-14
Table 5 7: Limitation of Existing Infrastructure	5-15
Table 5 8: Interim Cost Estimate - Transportation	5-16

List of Figures

	PAGE NO.
Figure 1 1: Study Area	1-2
Figure 2 1: Land Use	2-2
Figure 3 1: Alberta and Red Deer County Environmentally Significant Areas (ESA)	3-4
Figure 3 2: Rare Plants, Protected Areas, and Waterbody Classes	3-6
Figure 3 3: Forested Areas, Wetlands, and Potential Wildlife Corridors	3-9
Figure 3 4: Surface Soils	3-13
Figure 3 5: Steep Slopes	3-16
Figure 3 6: Historical Resources	3-17
Figure 3 7: Known Pipelines, Wells, and Area Containing Chemical Storage Tanks	3-18
Figure 3 8: Environmental Values	3-20
Figure 4 1: Ultimate Water Concept - Option 1	4-4
Figure 4 2: Ultimate Water Concept - Option 2	4-5
Figure 4 3: North Reservoir Schematic	4-10
Figure 4 4: Ultimate Wastewater Concept - Option 1	4-18
Figure 4 5: Ultimate Wastewater Concept - Option 2	4-19
Figure 4 6: Option 1 Wastewater Profile: Gravity Trunks Within the Highway 11A Corridor	4-22
Figure 4 7: Option 2 Wastewater Profile: Lift Station and Forcemains Within the Highway 11A Corridor	4-22
Figure 4 8: General Topography	4-28
Figure 4 9: Hazlett Lake Inlet & Outlet Configurations	4-31
Figure 4 10: Catchment Delineation Provided in Westhoff Report	4-32
Figure 4 11: AEP Preliminary 1:100 Pre-Development Release Rate Chart	4-37
Figure 4 12: Regional Flood Frequency Analysis – WSC Gauges	4-38
Figure 4 13: Area of Concern	4-39
Figure 4 14: Conceptual Flood Fringe Elevations	4-40
Figure 4 15: Ultimate Stormwater Concept	4-42
Figure 4 16: Transportation Proposed Network	4-50
Figure 4-16b: Right of Way for Highway 11A Corridor	4-57
Figure 4 17: Conceptual Road Right-of-Way	4-59
Figure 4 18: Phasing Plan	4-62
Figure 5 1: Water - Interim Servicing Plan	5-3
Figure 5 2: Wastewater - Interim Servicing Plan	5-7
Figure 5 3: Interim Servicing HGL Profile	5-8

1 Introduction

1.1 BACKGROUND

The City of Red Deer has retained Associated Engineering to undertake a servicing study for lands located north of Highway 11A. The City has initiated a number of studies to establish future development requirements in the area, and now requires a detailed study which will further define the required infrastructure and will include phasing and estimated costs.

The study area encompasses approximately 2,500 ha and is located north of Highway 11A extending to the Blindman River, and from Highway 2 to the Red Deer River. The area includes lands recently annexed by the City in 2009 as well as lands currently located within Red Deer County. Refer to **Figure 1-1** for the Study Area.

The project objective is to undertake a detailed servicing study for the water distribution system, sanitary collection system, storm drainage system and transportation system, within the study area. The report is also to include comments on shallow utilities in the area as well as provide a desktop environmental overview of the existing conditions in the area.

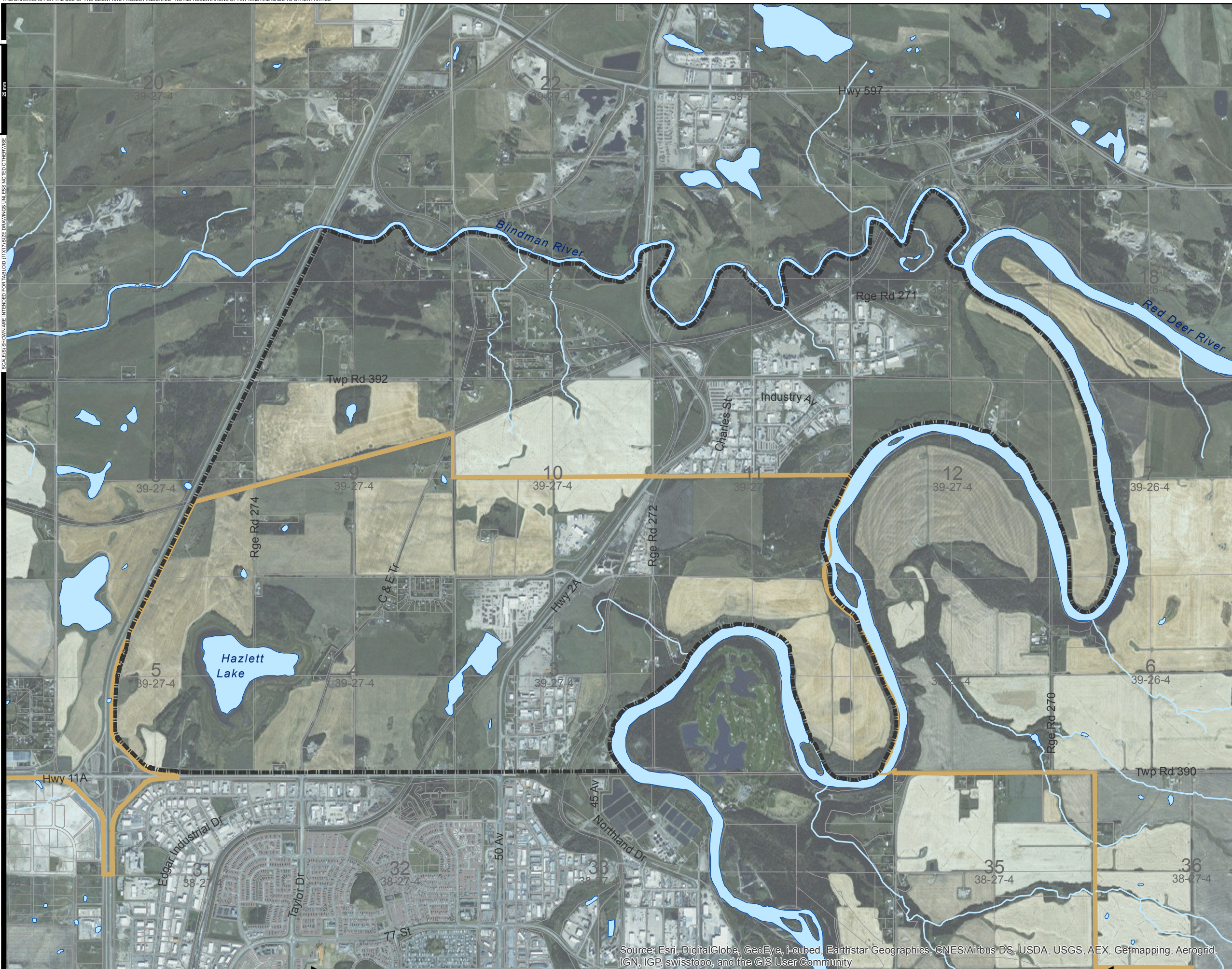
The purpose of the study is to develop servicing concepts in support of the Major Area Structure Plan (MASP, January 2016), neighbourhood area structure plans, and in support of future City capital budget and offsite levy bylaw needs.

The land uses identified for areas outside of the City of Red Deer Municipal Boundary are shown for the purpose of establishing future servicing concepts and are not approved land uses at this time.

Please note that the land uses and infrastructure identified for areas outside of the City of Red Deer municipal boundary are shown for the purpose of establishing future servicing concepts for the lands within the City of Red Deer. Any proposed land uses within Red Deer County may or may not reflect any land uses adopted as part of the statutory plans by Red Deer County. For future land use within the City of Red Deer municipal boundary, reference should always be made to the adopted generalized land use concept as amended by the City of Red Deer Council periodically.

IF NOT 20 mm AS SHOWN SCALES

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



- Legend:
- StudyArea
 - City of Red Deer



FIGURE No. 1-1
 NORTH OF HIGHWAY 11A
 MASTER DRAINAGE PLAN
 STUDY AREA

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

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

I:\s-ferm-fe-01\projects\20153382\00_N_of_Hwy_11A_ServWorking_Dwg\010_GIS\wrcMap1-1_StudyArea.mxd
 DATE: 2016-06-13, Kent Richardson

1.2 CONSTRAINTS

A number of constraints were identified by the City, including:

- Existing infrastructure capacity was deemed to be a constraint, and the City's intent is to optimize the use/effectiveness of the existing infrastructure. This will be addressed through determining the interim servicing limits for each utility.
- The recent Transportation Study (Watt, 2014) was identified by the City as the largest and most significant servicing constraint. The study requires review such that the interim service capacity can be established.
- The Servicing Study must be undertaken in support of the MASP (January 2016).
- Hazlett Lake was identified by the City as being integral to storm water servicing in the area. Work previously undertaken by Westhoff Engineering Resources Inc. is to be utilized as a key resource.

1.3 REFERENCES

Significant reference information was provided by the City of Red Deer for use on this project, including:

1. City of Red Deer 2013 Design Guidelines
2. City of Red Deer 2015 Contract Specifications
3. East Hill Major Area Structure Plan, City of Red Deer, 2013
4. River Valley and Tributaries Plan, City of Red Deer, 2010
5. City of Red Deer 2013 Water Distribution Study, Stantec, 2015
6. 2013 Water Distribution Study – WaterCAD Models
7. Various GIS data
8. Contour Data
9. MASP Generalized Land Use (January 2016)
10. 2015 North MASP Engineering Study Ecological Feature Information
11. Long Term Transportation Network Review of Highway 11A, Watt Consulting Group, 2014
12. EVRAZ comments regarding MASP
13. Highway 11A Electric, Light and Power drawings, City of Red Deer
14. Red Deer County comments regarding MASP
15. City of Red Deer 2013 Wastewater System Study, Stantec, 2015
16. 2015 North MASP Engineering Study Ecological Features
17. Queens Industrial Park & Future Industrial lands Sanitary Sewer and Storm Sewer Trunks Project, Al-Terra Engineering Ltd., 2007
18. Alberta Floodplain Mapping Website Path
19. Blindman County Area Structure Plan, Lovatt Planning Consultants and ISL, 2004
20. Central Park County Area Structure Plan, Lovatt Planning Consultants and ISL, 1996
21. City of Red Deer 2009 Greater East Hill Functional Servicing Study, Stantec, 2011
22. Hazlett Lake Management Recommendations, Westhoff Engineering Resources, Inc., 2016

23. Queen's Business Park and Highway Interchange Stormwater Management System Evaluation, Westhoff Engineering Resources Inc., 2015 - Draft
24. Hazlett Lake 2014 Baseline Assessment, Westhoff Engineering Resources Inc. and Earthmaster Environmental Strategies Inc., 2015
25. Hazlett Lake Monitoring Plan, Westhoff Engineering Resources, Inc., 2015
26. Contact information for CP and CN Railways
27. Alberta Transportation comments regarding MASP
28. Red Deer County Construction Specifications
29. Annexed Historical Waste Disposal Site information, Tiamat Environmental Consultants Ltd., 2013
30. Alberta Transportation Highway 2A Plans and Profiles, Genivar, 2012
31. Alberta Transportation Highway 2A Right-of-Way Acquisition Plan, Genivar, 2012
32. Long Term Transportation Network North of Highway 11A, Review of the Right-of-Way Requirements Summary Report, Watts Consulting Group, 2015
33. Long Term Transportation Network North of Highway 11A, Watts Consulting Group, 2014
34. Chile's Subdivision Background Information
35. City of Red Deer, 2004 Growth Study, Parkland Community Planning Services
36. ESDR Preliminary 1:100 Year, Pre-Development Stormwater Runoff Rate Iso-Chart
37. Red Deer County Burnt Lake North Basin Water Management Plan, Tagish Engineering Ltd., 2003
38. Environmentally Significant Areas of the County of Red Deer, Sweetgrass Consultants Ltd., 1990
39. Northland Drive/20 Avenue Functional Planning Study, Stantec, 2008

Associated Engineering gratefully acknowledges the assistance provided by the City's Engineering Department during the preparation of this report.

1.4 ABBREVIATIONS & ACRONYMS

AEP	Alberta Environment and Parks
AC	Asbestos cement
ACIMS	Alberta Conservation Information Management System
AE	Associated Engineering Alberta Ltd.
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
ESA	Environmentally Significant Area
fps	Feet per second
ft ³ /s	Cubic feet per second
ft ³	Cubic feet
FWMIS	Fish and Wildlife Management Information System
GoA	Government of Alberta
ha	Hectare
HDPE	High density polyethylene
ig	Imperial gallons
igpcd	Imperial gallons per capita day
igpm	Imperial gallons per minute
km	Kilometre
L/s	Litres per second
L	Litre
Lpcd	Litres per capita day
MASP	Major Area Structure Plan
m	Metre
m/s	Metres per second
m ³ /s	Cubic metres per second
m ³	Cubic metres
mig	Million imperial gallons
mm	Millimetre
NRDRWSC	North Red Deer Regional Water Services Commission
NRDRWWC	North Red Deer Regional Wastewater Commission
PRV	Pressure reducing valve
PVC	Polyvinyl chloride
RAP	Restricted activity period
s	second
USGPM	United States gallons per minute
v/c	volume-to-capacity

1.5 METRIC CONVERSIONS

To Convert From	To	Multiple By
cubic metres (m ³)	cubic feet (ft ³)	35.31
cubic metres (m ³)	imp gal (ig)	219.97
cubic metres/hour (m ³ /hr)	igpm	3.667
kilopascals (kPa)	psi	0.145
kilowatts (kw)	horsepower (hp)	1.341
litres/sec (L/s)	igpm	13.2
megalitres (ML)	imp gal (ig)	219,974
metres (m)	ft	3.281
millimetres (mm)	inches	0.0394

2 Design Criteria

2.1 LAND USE

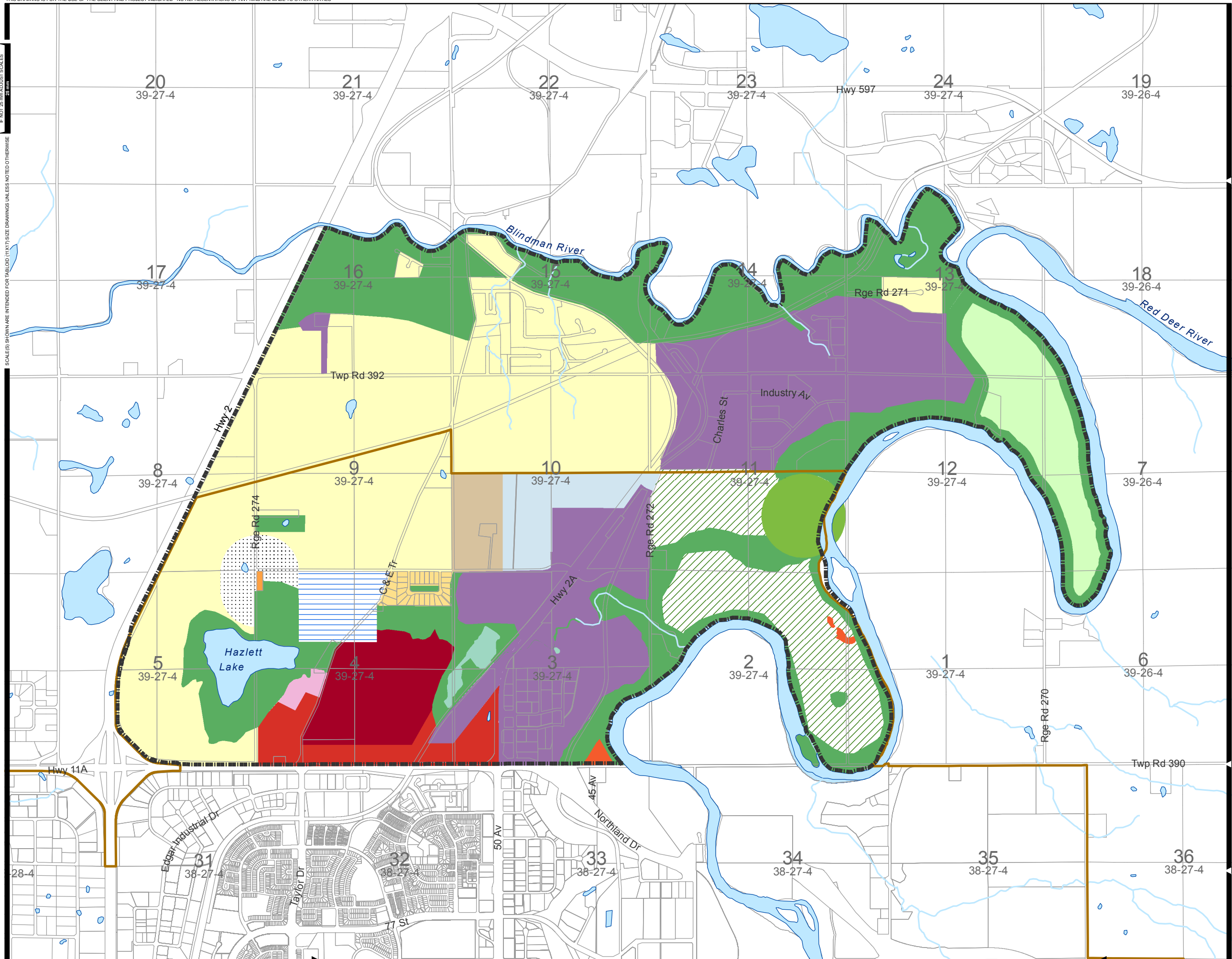
Municipal servicing requirements for the City of Red Deer are based on the projected land uses within the study boundary. A land use plan has been developed which includes the projected land uses as presented in the Generalized Land Use Concept of the North of Hwy 11A Major Area Structure Plan (MASP) (January 2016) for lands within the current City of Red Deer boundary. For lands within Red Deer County, the plan is loosely based on that presented in the 2013 Water Distribution Study (Stantec), however, has been modified to reflect findings of the desktop Biophysical Assessment. **Figure 2-1** presents the Land Use Plan developed for use on this project. Note that all residential lands will be considered to consist of single family residential development for this level of assessment.

Please note that the land uses identified for areas outside of the City of Red Deer Municipal Boundary are shown for the purpose of establishing future servicing concepts and are not approved land uses.

Table 2-1 presents the breakdown of developable and undevelopable lands within the study area.

**Table 2-1
Developable and Undevelopable Lands**

Location	Total Area (ha)	Undevelopable Area (ha) (natural space, parks, wetlands)	Developable Area (ha)
Within City Boundary			
West of Highway 2A	830	146	684
East of Highway 2A	481	153	328
Sub Total	1,311	299	1,012
Outside of City Boundary			
West of Highway 2A	619	148	471
East of Highway 2A	554	316	238
Sub Total	1,173	464	709
Total Area	2,484	763	1,721



- Legend:**
- Natural Space
 - Park
 - Wetland
 - Agriculture
 - Potential Residential and Open Space
 - Country Residential
 - Residential
 - Community Facility
 - Mixed Residential/Commercial
 - Commercial
 - General Commercial and Light Industrial
 - Light Industry
 - Eco-Industrial
 - Industrial
 - Existing Landfill
 - LandFill
 - To Be Determined
 - StudyArea
 - City of Red Deer

Note:
Land use data within existing city boundary has been derived from MASP.
Land uses shown outside of the city boundary are not approved at this time (and are not within the scope of the MASP), but they have been added to this Servicing Study for the purpose of determining ultimate servicing requirements of the area.



FIGURE No. 2-1
NORTH OF HIGHWAY 11A
MASTER DRAINAGE PLAN

LAND USE

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

2.2 WATER DISTRIBUTION SYSTEM

2.2.1 General

The proposed water distribution system design criteria, considers the following sources of information:

- City of Red Deer 2013 Design Guidelines
- City of Red Deer 2013 Water Distribution Study, Stantec, 2015, (2013 Water Study)
- 2013 Water Study WaterCAD models

The existing 2013 WaterCAD model will be utilized as provided and is assumed to be both current and accurate. The design criteria outlined below relates only to future development within the North of Highway 11A study area.

2.2.2 Population

One of the key variables in assessing the water system of a community is the population to be served. The population will:

- Provide a basis to measure the required water quantity;
- Impact the peaking factor;
- impact the distribution system based on population density; and
- determine the requirements for fire flows.

2.2.3 Growth Rate

The City of Red Deer has requested that AE apply a specialized approach for determining the interim development scenario in terms of the water distribution system. The growth rate will relate to the Queens Business Park development rate as well as the Study Area residential development rate. Two growth scenarios are to be assessed:

- **Option A:**
 - Development within the Queens Business Park will proceed at 18.2 ha/year (all industrial).
 - Development within the study area (north of Hwy 11A) will proceed at 68 ha/year (all residential).
- **Option B:**
 - Development within the Queens Business Park will proceed at 18.2 ha/year (all industrial).
 - Development within the study area (north of Hwy 11A) will proceed at 34 ha/year (all residential).

2.2.4 Population Density

Population densities are utilized to estimate the population or equivalent population based on land use. These values are used in conjunction with the per capita daily water consumption rates to estimate the demands on the water system. A residential density of 45 people/ha will be applied as per the 2013 Water Study.

2.2.5 Water Demand

Water demand is critical in determining the distribution network, pumping capability and storage required for a water system. Three critical rates of demand, Average Day, Peak Day (Max Day) and Peak Hour flow are normally used. Fire flows, in conjunction with the Peak Day flows are also used to test the water system's capability to deliver water and meet system demands.

The design water demands for the future development area will be based on the following water consumption rates:

Residential:

- Average Day Demand: 375 L/c/d
- Peak Day Demand: 600 L/c/d
- Peak Hour Demand: 1,200 L/c/d

Non-Residential:

- Average Day Demand: 0.15 L/s/ha
- Peak Day Demand: 1.6 x Average Day Demand
- Peak Hour Demand: Calculated Peaking Factor x Average Day Demand

2.2.6 Peaking Factors

Peaking factors for the future development area were established in the 2013 Water Study as follows:

Residential:

- Peak Day Factor: 1.6 x Average Day Demand
- Peak Hour Factor: 2.0 x Peak Day Demand

Non-Residential:

- Peak Day Factor: 1.6 x Average Day Demand
- Peak Hour Factor: $10(Q^{-0.45})$ to a minimum of 2.5 and a maximum of 25 (Q in L/s)

2.2.7 Projected Water Demands

Projected water demands for the study area are based on land use, population projections, the design per capita demands, and the peak day and peak hour factors.

The Ultimate System demands for the study area are as follows:

- Average Day Demand 347 L/s
- Maximum Day Demand 555 L/s
- Peak Hour Demand 1,000 L/s

Table 2-2 presents a summary of the water demand projections for the study area.

Table 2-2
Summary of the Water Demand Projections

Demand Scenario	Water Demand (L/s)		
	West of Highway 2A	East of Highway 2A	Total
Average Day Demand	208	139	347
Maximum Day Demand	335	220	555
Peak Hour Demand	632	368	1,000

2.2.8 Fire Flows

Design fire flows applied in the 2013 Water Study were based on 75 L/s for low density residential land and 180 L/s for high density residential lands. For the purpose of the North of 11A Study, it is proposed that a unified value of 180 L/s be applied throughout all new residential development lands within the study area. This will allow for greater flexibility in the design of the future residential neighbourhoods, and will accommodate increased density if desired. The exception is that a fire flow of 75 L/s will be applied to small pockets of existing residential development located adjacent to the Blindman River.

The 2013 Water Study identifies a fire flow of 300 L/s for future commercial/industrial development areas and will be adopted for the purpose of this report.

2.2.9 Operating Pressures

The recommended minimum system pressures for the study area are as follows:

- Minimum system pressure during peak hour: 300 kPa (43.5 psi)
- Minimum system pressure during peak day + fire flow: 150 kPa (21.8 psi)
- The City has requested that pressures generally remain below 551 kPa (80 psi) but can go as high as 585 kPa (85 psi) where necessary

2.2.10 Water Storage

It is a good practice to provide adequate storage in a water system for operational needs (peak hours), supply interruption and fire flow demand. Design guidelines vary depending on the size of the community and the capital cost involved. The appropriate level of storage must consider how fast the system can be

restored to be fully operational when impacted by an interruption such as power failure, plant failure, scheduled plant shutdown, watermain breaks, etc.

The following treated water storage requirements are based on AEP Standards, using the following empirical formula:

$S = A + B + \text{the greater of C or D}$:

- S = total storage requirement, m^3
- A = Fire protection storage, m^3
- B = Equalization storage = 25% Peak Day, m^3
- C = Emergency storage = 15% of Average Day, m^3
- D = Disinfection contact (CT) storage, m^3

Based on the maximum fire flow criteria of 300 L/s, the resultant storage volume required for fire protection is 4,320 m^3 . This volume is based on a fire flow of 300 L/s for duration of 4.0 hours.

2.2.11 Pipe Roughness Coefficient (C- Factor)

The roughness coefficient is one of the many variables in the Hazen-Williams equation when determining liquid flow through pipe. It represents the material and the condition of the pipe. The City of Red Deer requested that AE apply a C-Factor of 120 (assumes PVC pipe material) for future pipes within the study area, rather than 140 as per the City of Red Deer Design Guidelines.

2.2.12 Velocity

The Red Deer Design Guidelines identify that main line flow velocities are not to exceed 1.5 m/s during peak hour flow and 2.5 m/s during peak day plus fire flow. The 2013 Water Study indicates that velocity limits were not applied in the existing and infill conditions. All new mains within the study area will be sized to meet a maximum velocity of 2.5 m/s during peak day plus fire flow and 1.5 m/s during peak hour flow.

2.2.13 Minimum Pipe Size

The Red Deer Design Guidelines indicate minimum pipe sizes of 150 mm in residential areas and 200 mm in non-residential areas. For the purpose of this study, it is recommended that minimum pipe sizes be increased in order to meet the maximum velocity criteria of 2.5 m/s during peak day plus fire flow. As such, the minimum pipe size for residential areas with a fire flow of 180 L/s will be 250 mm in diameter, and for non-residential areas with a fire flow of 300 L/s will be 300 mm in diameter.

2.3 SANITARY SEWER

The Design Criteria for the following study have been established from the following:

- City of Red Deer Design Guidelines 2013 edition
- City of Red Deer Wastewater System Study 2013
- Alberta Environment Standards and Guidelines for Municipal Water Supply, Wastewater and Storm Drainage Systems

2.3.1 Design Flows

The design flow rates for the future development area will be based on the following sewage generation rates:

Residential:

- $Q_{PDW} = (G * P * Pf) / 86.4$
- Where: Q_{PDW} = Peak Dry Weather flow rate (L/s)
- $G = 320$ L/day/person
- P = design contributing population in thousands
- Pf = Harmon's Peaking factor = $1 + 14 / (4 + P^{0.5})$
- Residential density of 45 people/ha

Note: The 2013 Wastewater Master Plan has used a Peaking factor of 2.58 for future development and will be used for this study.

Non-Residential:

- $Q_{PDW} = Q_{AVG} \times Pf$
- Where: Q_{PDW} = Peak Dry Weather flow rate (L/s)
 $Q_{AVG} = 0.15$ L/s/ha
 Pf = Peaking factor = $10 \times Q_{AVG}^{-0.45}$ to a minimum of 2.5 and a maximum of 25 (Q_{AVG} in L/s)

A more detailed estimate of average wastewater flows are described in the Alberta Environment Standards and Guidelines for Municipal Water Supply, Wastewater and Storm Drainage Systems. However since this is a very high level study where the exact type of land use is unavailable, the design criteria identified by the City guidelines will be used.

The same design criteria were used for the 2013 Wastewater Master Plan.

2.3.2 Extraneous Flow Allowances

A general allowance of 0.2 L/s/ha irrespective of land use classification will be applied to account for wet weather inflow and infiltration (I/I) into pipes and manholes. This value is slightly lower than the 0.28 L/s/ha used widely across Alberta and specified in the Alberta Environment design standards.

The City's Design Guidelines indicate that an effort should be made to locate sanitary manholes away from the sags. This would minimize the potential for I/I entering the sanitary system and hence the 0.6 L/s/ha usually used for inflow through sag manholes will not be used for this study.

2.3.3 Minimum Pipe Slopes

Minimum pipe slopes shall be maintained as specified in Section 3.2 of the City's design guidelines, to maintain a minimum cleansing velocity of 0.6 m/s.

2.3.4 Depth of Cover

The minimum and maximum depths of cover as specified in the design guidelines are 2.7 and 5.5 m, respectively. For pipes shallower than 2.7 m, insulation is required for the main.

2.4 STORMWATER SERVICING

Design criteria from the City of Red Deer Design Standards (2013) and Alberta Environment stormwater management guidelines will be adopted for the analysis of the existing and proposed conditions.

The following section summarizes the design criteria relevant to this project.

2.4.1 Design Storm

The design standard for the City of Red Deer requires that the minor system be designed to have capacity for the 1:5 year storm and the major drainage system be designed to accommodate the 1:100 year storm.

Upgrades will be proposed to meet the following criteria:

- Prevent storm sewer from surcharging to ground during a minor storm event (1:5 year storm event), and
- Limit the potential for flooding of private property in a major event (1:100 event storm event).

The Intensity-duration-frequency (IDF) rainfall data from the Red Deer Industrial Airport (period 1964-2006) will be used for the analysis of the proposed systems. **Table 2-3** provides the IDF parameters used in the model for the 1:5 and 1:100 return frequencies.

Table 2-3
Red Deer Industrial Airport IDF Parameters – Update to Current Standards

Frequency (Year)	a	b	c	Formula
5	203	0	-0.60	$203(t+0)^{-0.60}$
100	200	-26	-0.52	$200(t-26)^{-0.52}$

“a”, “b” and “c” – Constants developed for each IDF curve.

“t” – Storm duration in minutes

Source: City of Red Deer 2013 Design Standards

Design storm hyetograph will be developed using the Chicago Method. The duration of the storm will depend on the type of system being analysed.

- Storm sewer system - 4 hours storm
- Detention pond and major system components - 24 hours storm

2.4.2 Runoff Coefficients

The runoff coefficients, shown in **Table 2-4**, were used for the conceptual sizing of the future stormwater management facilities using the Modified Rational Method.

**Table 2-4
Runoff Coefficients (C)**

Land Use	Storm Frequency	
	1:5 Year Storm	1:100 Year Storm
Residential	0.35	0.60
Apartments	0.70	0.80
Downtown Commercial	0.85	0.90
Neighbourhood Commercial	0.65	0.80
Lawns, Parks, Playgrounds	0.20	0.30
Undeveloped Land (Farmland)	0.10	0.20
Paved Streets	0.90	0.95
Gravel Streets	0.25	0.65

A weighted average of impervious and pervious area runoff coefficients will be used in developed areas where mixtures of lands uses are proposed.

2.4.3 Model Development

A PCSWMM model was used to evaluate the capacity of the existing and proposed storm drainage systems and alternatives to improve its performance. PCSWMM is a fully dynamic computer model designed for simulating flows and water levels in sewer systems. It is capable of simulating real storm events, design flows, surcharging and backwater conditions, as well as stormwater pond operation and reverse flows in complicated storm systems. **Table 2-5** outlines the model parameters that will be used in the PCSWMM model for the proposed systems.

Table 2-5
PCSWMM Model Parameters

Parameter	Value
Ground Slope	Average catchment slope calculated based on DEM
Impervious Area Manning's n	0.015
Pervious Area Manning's n	0.25
Impervious Depression Storage	2 mm
Pervious Depression Storage	5 mm
Percent of area with zero detention	25%
Maximum Infiltration Rate	75 mm/hr
Minimum Infiltration Rate	5 mm/hr
Decay Constant	4 (1/hr)

Horton infiltration parameters depend on the type of soil and their saturated hydraulic conductivity. Values shown in Table 2-3 were referenced from the "User's Guide to SWMMS, 2010" and "Rawls, W.J. et al., 1983".

Table 2-6 provides the imperviousness values used in the computer modeling of the proposed drainage system.

Table 2-6
Imperviousness Values

Land Use Description	Percentage Impervious
General Residential	40
Commercial	90
Industrial	70
Public/Park/Recreation	0
Agriculture	0

The percent imperviousness refers to the anticipated amount of surface runoff generated based on the land use of an area. Development of land (paving, buildings, etc.) increases the imperviousness of an area, thus reducing the surface runoff infiltrating into the ground. The increased volume and rate of runoff produces larger peak discharges in developed watersheds than would have occurred before development.

The percent imperviousness values provided in **Table 2-6** are based on the type of soil, and they are typical values for the land uses applicable to the project area.

The following Manning's "n" values are used in the assessment of the storm drainage system:

- Impervious areas: 0.015
- Pervious areas: 0.25 - 0.50 (typical for agricultural/undeveloped areas)
- Grassed ditches: 0.035

Manning's "n" value describes the resistance of the bed of a channel (or the surface of a pipe) to the flow of water in it.

2.4.4 Model Catchments

Catchment areas will be delineated from the LIDAR 15 DEM data obtained from AltaLIS. As the name suggested, the data comprises 15 m resolution Digital Elevation Model (DEM), with a vertical accuracy of 0.3 m. Manifold GIS software was used to calculate the average slope for each catchment.

The impervious percentage for each catchment will be calculated by overlaying the land-use map over the catchment map in PCSWMM and calculating the weighted impervious area based on land-use.

2.4.5 Stormwater Management Facilities

Stormwater management ponds will be required for all new developments to control flows and prevent any increase of erosion and downstream flooding to existing receiving streams. Detention ponds also provide benefits in improving stormwater quality by promoting the settlement of runoff pollutants.

Existing wetlands and waterbodies should be preserved and incorporated into stormwater management plans.

For the design of the stormwater management facilities, the following criteria were used, derived from the City of Red Deer design standards:

2.4.6 Dry Detention Ponds

- Design storage volume: 1:100 year – 24 hour storm
- Maximum storage depth: 1.5 m
- Pond side slopes: 5H:1V
- Minimum freeboard: 0.6 m
- Minimum longitudinal slope: 1%

2.4.7 Wet Detention Ponds

- Design storage volume: 1:100 year – 24 hour storm
- Permanent pool depth: 2 m
- Maximum active storage depth: above normal water level (NWL) 1.5 m.
- Minimum freeboard: 0.6 m
- Pond side slope: 5H:1V

2.4.8 Forebay Design

According to AEP, wet pond water quality control can be improved by providing pre-treatment sump or forebay. The following is the general design parameters to determine sizing and dimensions of sedimentation forebay as per Alberta Environment and Parks Guidelines.

- Length to width of 2:1 or greater
- Surface area not to exceed one-third of the permanent pool surface area
- Forebay length, $L_{fb} =$

$$L_{fb} = [rQ_p/V_s]^{0.5}$$

Where:

r = Length to width ratio of forebay

Q_p = Peak flow rate from the pond during the design quality storm (m^3/s)

V_s = Settling velocity (dependent on the desired particle size to settle).

- Dispersion length, $L_{dis} =$

$$L_{dis} = (8Q)/(dV_f)$$

Where:

Q = Inlet flow rate (m^3/s)

D = Depth of permanent pool in the forebay (m)

V_f = Desired velocity at the end of the forebay

- Forebay bottom width, $W = L_{dis}/8$
- Forebay berm = 0.15 to 0.3 m below permanent pool elevation



2.4.9 Culverts and Ditches

- Manning's "n" for grassed ditches: 0.035
- Design Storm 1:100 year: 4 hour storm
- Manning "n" value of: 0.013 for concrete culverts, and 0.024 for corrugated steel pipe (CSP)
- Culvert minimum nominal diameter 400 mm

2.4.10 New Storm Sewers

- Minimum manning "n" value of 0.013 for concrete and PVC pipes
- Design storm: 1:5 year – 4 hour storm
- Flow velocity range: 0.6 – 3.0 m/s
- Storm sewer inverts to be set at an elevation at least 2.7 m below finished grade
- Spacing between manholes no greater than 150 m along the length of the sewer
- Obvert elevation of the lowest upstream pipe equal to or higher than obvert of the downstream pipe
- Depth of water at curbside should be less than 300 mm during the 1:100 year storm event

2.5 TRANSPORTATION

2.5.1 Roadway Design Criteria

Using the City of Red Deer Roadway Design Standards and the Transportation Association of Canada's Geometric Design Guide for Canadian Roads, Associated Engineering developed the following design criteria for roads within the study area:

**Table 2-7
Roadway Design Criteria**

	Arterial		Collector	
	Divided	Undivided	Residential	Industrial
Traffic service function	traffic movement primary consideration		traffic movement and land access of equal importance	
TAC design classification	UAD 70	UAD 70	UCU 60	UCU 60
Daily traffic volume	> 20,000	< 20,000	< 10,000	<10,000
Flow characteristics	uninterrupted flow except at traffic signals or crosswalks		interrupted flow resulting from intersections and driveway accesses	
Desirable connections	collector, arterial		local, collector, arterial	
Design speed (km/h)	70 km/h	70 km/h	60 km/h	60 km/h
Posted speed (km/h)	60 km/h	60 km/h	50 km/h	50 km/h
Right-of-way width (m)	60 m	48 m	30 -32 m	30 m
City standard drawing reference	5.03	5.05	5.07	5.11
Parking restrictions	typically prohibited		few restrictions (possibly peak hour)	

2.5.2 Intersection Design Criteria

The Synchro/SimTraffic 7 and SIDRA traffic analysis programs are based on the Institute of Transportation Engineers Highway Capacity Manual and were used by the project team to analyze the study intersections and determine the lane configurations and capacity requirements. These programs apply 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 LOS A. A low level of service is a result of a large average delay; typically, the lowest level of service is identified as LOS F. The level of service categories also vary 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 following table identifies the level of service criteria for intersections.

**Table 2-8
Intersection Level of Service**

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 physical capacity of the road configuration and traffic control. A v/c ratio less than 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. The following table identifies the volume-to-capacity criteria for intersections.

**Table 2-9
Intersection Volume-to-Capacity Criteria**

Volume to Capacity Ratio	Indication
less than 0.9	sufficient intersection capacity
0.9 to 1.0	volumes approaching intersection capacity
greater than 1.0	volumes exceed theoretical intersection capacity

The City of Red Deer Traffic Impact Assessment Guidelines indicate that for long term analysis (described as 10 years and beyond), depending upon the area and the type of development, a v/c ratio of 0.90 or less and LOS E or better may be acceptable. For this study Associated Engineering proposes that LOS E as the

minimum for intersection operation and through movements; if necessary turning movements will be allowed to operate at LOS F during the peak hour.

3 Desktop Environmental Review

3.1 LIST OF ACRONYMS – ENVIRONMENTAL REVIEW

•	ACIMS	Alberta Conservation Information Management System
•	AEP	Alberta Environment and Parks
•	AGRASID	Agricultural Region of Alberta Soil Inventory Database
•	COSEWIC	Committee on the Status of Endangered Wildlife in Canada
•	ESA	Ecologically Significant Area
•	FWMIS	Fish and Wildlife Management Information System
•	GoA	Government of Alberta
•	HVR	Historical Resources Value
•	MASP	Master Area Structure Plan
•	PNT	Protective Notation
•	PTMAA	Petroleum Tank Management Association of Alberta
•	RAP	Restricted Activity Period

3.2 INTRODUCTION

This desktop environmental review is for lands contained in the servicing study area (study area, [Figure 1-1](#)). This review includes a discussion of numerous environmental values, potential sources of contamination, mapping, and recommendations for managing environmental values, and/or mitigating impacts to those values.

A number of information sources were used as part of this review to assess the study area. These include:

- Environmentally Significant Areas of Alberta: 2014 Update (Government of Alberta [GoA] 2014a);
- Environmentally Significant Areas Master Plan (Golder Associates 2010);
- City of Red Deer Land Use Bylaw (City of Red Deer 2006);
- Red Deer County Land Use Bylaw (Red Deer County 2010);
- Fish and Wildlife Management Information System (FWMIS; GoA 2014b);
- Alberta Conservation Information Management System (ACIMS; GoA 2014c);
- NatureServe scientific global database (NatureServe 2015);
- Hazlett Lake 2014 Baseline Assessment (Westhoff Engineering Resources, Inc. 2015a; 2015b);
- North of 11A MASP (January 2016);
- Water Act Code of Practice Area Maps (GoA 2006);
- Alberta Flood Hazard Identification Program (GoA 2014d);
- River Valley + Tributaries Park Concept Plan (O2 Planning + Design Inc. 2010);
- Natural Regions and Subregions of Alberta (Natural Regions Committee 2006);
- Agricultural Region of Alberta Soil Inventory Database (AGRASID; GoA 2014e);
- Petroleum Tank Management Association of Alberta database;
- AbaData 2.0 (pipelines, utilities, spills, etc.; AbaData 2 n.d.); and
- Alberta Historical Resources database (GoA 2015).

3.3 ENVIRONMENTAL VALUES

The study area is located in the Central Parkland Subregion of the Parkland Natural Region. Although estimates vary, it is thought that only 5% of the expected native vegetation remains in this Subregion; and conversion to agricultural land use is predominant in the Subregion. Aspen forest and plains rough fescue comprise the bulk of native vegetation. River valleys capable of retaining moisture also support spruce forests and provide cool microclimates for wildlife (Natural Regions Committee 2006).

Numerous environmental values were identified during this review. These values have a range of policy implications based on municipal, provincial, and federal policies/legislation. For this review, environmental values were considered in several contexts:

- Environmentally Significant Areas (ESAs) designated provincially and/or municipally;
- Environmentally sensitive areas;
- Sensitive species, habitats, and movement corridors;
- Water courses, wetlands, ephemeral draws and flood prone areas;
- Soils, slopes, and vegetation; and
- Historical resources, existing land use, and potential sources of contamination.

Each category is described in more detail in the following Sections 3.3.1 to 3.3.6.

3.3.1 Environmentally Significant Areas (ESAs)

Environmentally Significant Areas (ESAs) are defined provincially by Alberta Environment and Parks (AEP), and in some cases by municipalities using similar or more stringent criteria (GoA 2014a). Fiera Biological Consulting (2014) produced updated criteria used by AEP for determining ESAs in Alberta. Four criteria are used provincially:

- **Criterion 1:** Areas that contain focal species, species groups, or their habitats. This criterion has three components; a) conservation hotspots, b) focal species groups, and c) focal species habitat;
- **Criterion 2:** Areas that contain rare, unique, or focal habitat. This criterion has three components; a) rare habitats, b) unique habitats and landforms, and c) focal habitats;
- **Criterion 3:** Areas with ecological integrity. This criterion has two components; a) habitat patch size, and b) habitat intactness and connectivity;
- **Criterion 4:** Areas that contribute to water quality & quantity. This criterion has two components; a) rivers and stream, and b) wetlands and lakes.

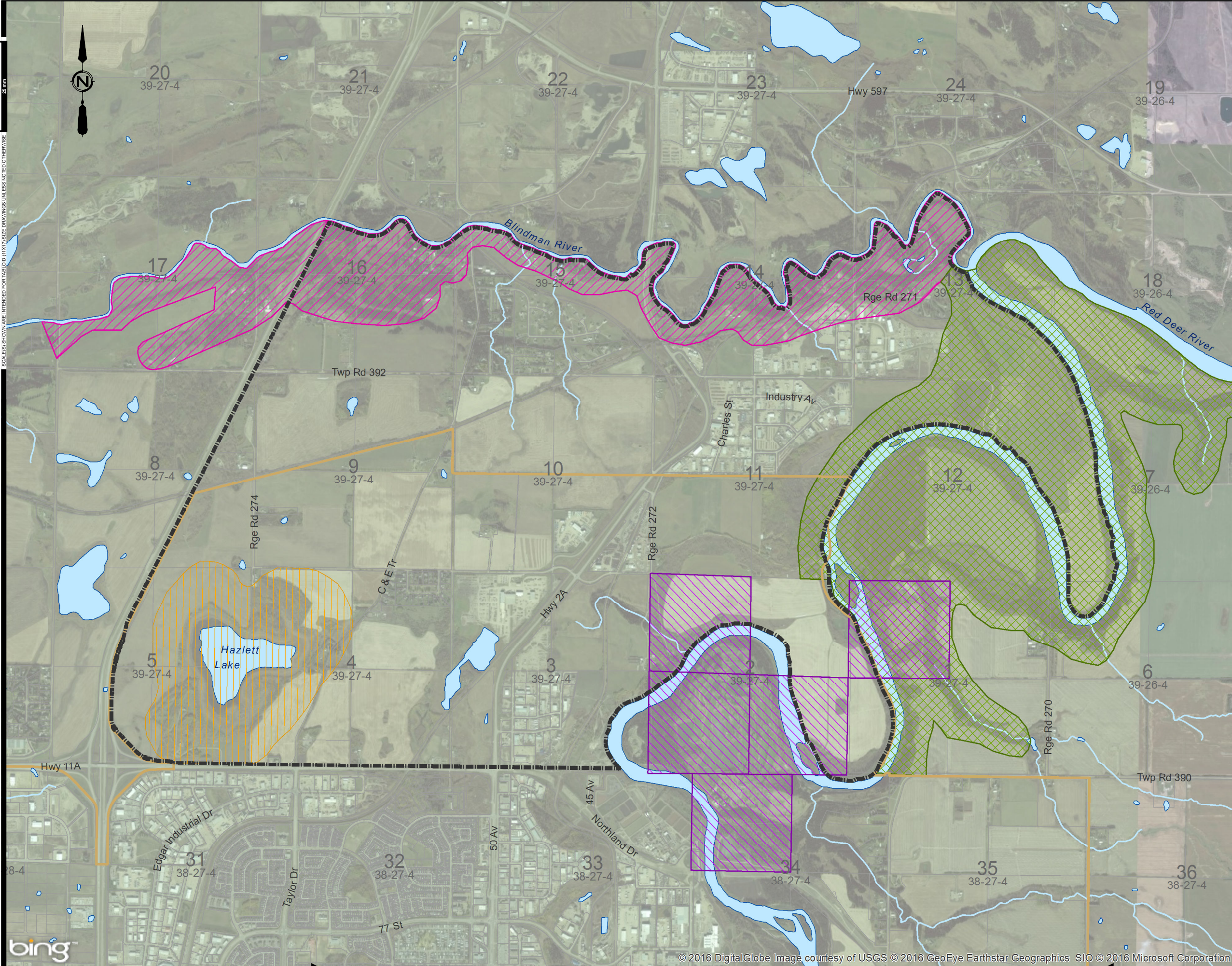
Land use planning documents typically require the review and assessment of ESAs within municipal development areas. Municipal policy documents which frequently reference ESAs include land use bylaws, area structure and municipal development plans. The City of Red Deer Land Use Bylaw does not directly reference ESAs, but does layout development requirements for areas deemed to be environmentally sensitive by the City (City of Red Deer 2006). The Red Deer County Land Use Bylaw references ESAs under Part 7 (Section 48a) requiring a range of actions for development within an ESA. These requisite actions range from basic to full environmental review of proposed projects, and approval by the development authority (Red Deer County 2010).

At the provincial scale, ESAs are assessed by legal quarter section. Fiera Biological Consulting (2014) identified five quarter section units within the study area that are considered ESAs (**Figure 3-1**). None of these quarter sections are located entirely within the study area but straddle the boundary and are concentrated in the southeast portion of the study area in the Red Deer River Valley. These ESAs are located at: NW / SW / SE-2-39-27-W4M, and NW-1-39-27-W4M. Fiera Biological Consulting (2014) listed a variety of limitations to the provincial analysis model including data gaps, varying levels of accuracy in data, and the province-wide project scope (and inherent coarse scale of analysis). Chiefly among these limitations is the lack of a province-wide wetland assessment and delineation model, and unified wetland inventory. Because of the coarse scale of analysis employed, little information (beyond location) regarding the nature of the identified ESAs is available from the provincial inventory.

In addition to the four ESA selection criteria used provincially, additional criteria with local significance are often determined by municipalities. Because the provincial ESA inventory is coarse in scale, Red Deer County has produced a fine scale municipal ESA inventory containing greater detail on additional ESAs located within the County. Golder Associates (2010) developed three additional ESA criteria for the Red Deer County ESA Management Plan:

- **Additional Criterion 1:** Areas that contain important wildlife habitat which provide resources essential to meeting the life requisites of certain species at specific times of the year;
- **Additional Criterion 2:** Riparian areas; and
- **Additional Criterion 3:** Sites of recognized significance identified at the international, national, and provincial levels by various national and international organizations.

Golder Associates (2010) identified 26 ESAs within Red Deer County. Of these, two are located within the study area (when the Red Deer County ESA Management Plan was compiled, part of the study area was located in Red Deer County): the Blindman River ESA and the Red Deer Canyon ESA (**Figure 3-1**). The Blindman River ESA (1,841 acres in size) includes 632 acres of the north portion of the study area which is a known habitat of deer (*Odocoileus spp.*). A search of the FWMIS database revealed that there once was a great blue heron (*Ardea herodias*) nesting colony within the study area (GoA 2014b). Great blue herons return to their nesting colonies each spring; thus nests sites are often used by the species year after year. The species is therefore susceptible to habitat loss. The presence of the great blue heron colony is to be field-confirmed in later planning stages.



- Legend:**
- Red Deer County ESA
 - Golder Associates
 - Red Deer Canyon ESA
 - Blindman River ESA
 - Red Deer County ESA
 - Sweetgrass Consultants Ltd. Hazlett Lake ESA
 - Provincial ESA
 - Fiera Consulting Ltd. Alberta ESA
 - Study Area
 - City of Red Deer
 - Hydrology



FIGURE No. 3-1
 NORTH OF HIGHWAY 11A
 MASTER DRAINAGE PLAN

ENVIRONMENTAL
 ALBERTA AND RED DEER COUNTY
 ENVIRONMENTALLY SIGNIFICANT AREAS (ESA)

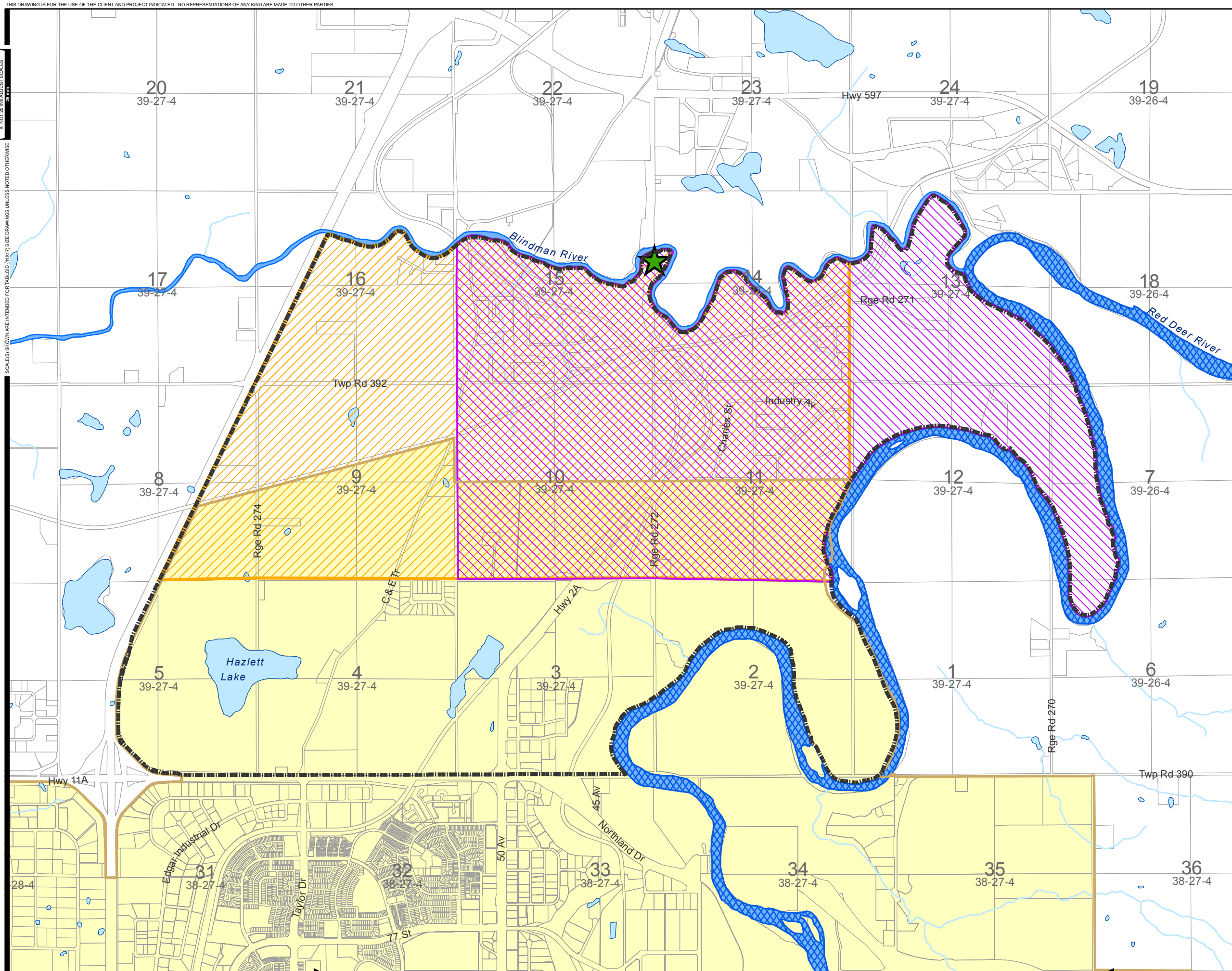
AE PROJECT No.	20153382
SCALE	1:30,000
APPROVED	
DATE	JUNE 2016
REV	
DESCRIPTION	ISSUED FOR FINAL REPORT

Known plant occurrences of marsh muhly (*Muhlenbergia racemosa*) and crowfoot violet (*Viola pedatifida*) are documented in this ESA (Golder Associates 2010). Both plant species are considered “May Be At Risk” as only one occurrence of marsh muhly is known to exist provincially and small populations of crowfoot violet are known to exist in few locations provincially (GoA 2014f; Golder Associates 2010). The documented presence of both plant species in the study area was confirmed through a search of the ACIMS database (Figure 3-2; GoA 2014c). Crowfoot violet is listed as an “S2 Imperiled” (rare due to very restricted range, very few populations (often 20 or fewer)), steep declines, or other factors making it very vulnerable to extirpation from a province or state) species in Alberta by the NatureServe scientific global database (NatureServe 2015). Filed confirmation is required prior to development to confirm the presence of marsh muhly and crowfoot violet.

The Red Deer Canyon ESA (11,542 acres in size) includes 2,058 acres of the east portion of the study area (Figure 3-1). There are a variety of factors contributing to the significance of the Red Deer Canyon. Sweetgrass Consultants Ltd. (1990) noted that the depth and morphological diversity of the Red Deer Canyon was significant in the parkland natural region, and the Federation of Alberta Naturalists (2007) noted the Red Deer Canyon contained diverse habitat for migratory birds. This portion of the study area also contains known nesting areas for American white pelican (*Pelecanus erythrorhynchos*) and osprey (*Pandion haliaetus*). Peregrine falcon (*Falco peregrinus*) is also documented within the ESA portion of the study area and is considered “At Risk” provincially and listed as an endangered species under Schedule 6 of the *Wildlife Regulation*. Federally, peregrine falcon is also considered a species of “Special Concern” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and listed as a threatened species under Schedule 1 of the *Species At Risk Act* (COSEWIC 2011; Government of Canada 2015). Canadian toad (*Anaxyrus hemiophrys*) has also been identified in this area. Although these species have been identified in the study area, the FWMIS database does not report the species observation date or number of observations; in-field investigation targeting each of the above species would assist in determining the present status of each in the study area, and the associated regulatory implications. It is reasonable to assume that areas of sufficient size, in their natural state will continue in the future to provide habitat for the above noted species.

In a 1990 inventory of Red Deer County ESAs, Sweetgrass Consultants Ltd. identified Hazlett Lake and its surrounding area as an ESA (Figure 3-1). This ESA surrounds the lake and contains most of E-5-39-27-W4M and areas west of Range Road 273A in W-4-39-27-W4M. The ESA is considered environmentally significant because the wetland contains excellent habitat for nesting waterfowl and shorebirds. A significant area of emergent vegetation provides excellent habitat for these species and the area’s vast topographic relief contributes to the variety of habitat available (Sweetgrass Consultants Ltd. 1990). The ESA was dropped from the 2010 Golder Associates inventory because Hazlett Lake had by that time been annexed by the City of Red Deer and was no longer part of Red Deer County’s ESAs. An assessment (2014 and ongoing) by Westhoff Engineering Resources, Inc. (2015a) has documented the presence of 53 birds and one mammal, which are provincially and/or federally listed species of concern (Table A-1), using habitat within the Hazlett Lake ESA. The species were identified based on available databases and were not physically observed at the site.

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



Legend:

- Protective Notation 960079 Ungulate Habitat Protection Area
- Blindman River Water Act Code of Practice Class C
- Red Deer River Water Act Code of Practice Class B
- Marsh Muhly (*Muhlenbergia Racemosa*)
- Crowfoot Viola (*Viola Pedatifida*)
- StudyArea
- City of Red Deer
- Hydrology

Note:
 Best possible data resolution for rare plants is ATS 1/4 section.
 Hatched 1/4 sections indicate that a plant has been identified within a 1/4 section and does not indicate that a plant is everywhere in a 1/4 section.



FIGURE No. 3-2
 NORTH OF HIGHWAY 11A
 MASTER DRAINAGE PLAN

ENVIRONMENTAL
 RARE PLANTS, PROTECTED AREAS,
 & WATERBODY CLASSES

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

3.3.1.1 Features Within the Study Area to Consider for Environmental Value:

The following locations within the study area are being considered environmentally valuable:

- Provincial ESAs located at: NW / SW / SE-2-39-27-W4M, and NW-1-39-27-W4M; and
- Red Deer County ESAs including the Blindman River ESA, Red Deer River ESA, and the former Hazlett Lake ESA.

Additional features which are considered for environmental value (such as wetlands and forested areas) are discussed in the remaining sections.

3.3.2 Environmentally Sensitive Areas

There is considerable overlap when considering the ESA definitions described above and those of environmentally sensitive areas. Generally, ESAs are provincially recognized areas of environmental importance and are subject to municipal development policies, while environmentally sensitive areas are considered specific to a given project and defined during a project's environmental assessment process. For the purpose of this review, environmentally sensitive areas within the study area consist of areas fitting the ESA definitions above but not covered in 1) the provincial ESA inventory, or 2) the Red Deer County ESA Management Plan. Environmentally sensitive areas within the study area have the potential to provide habitat for the ecologically sensitive species discussed in the following Section 3.3.3, ecological goods and services, recreational spaces, and a number of other benefits.

A search of the FWMIS database revealed that the study area is located within the sharp-tailed grouse (*Tympanuchus phasianellus*) and bald eagle (*Haliaeetus leucocephalus*) ranges. Sharp-tailed grouse is considered "Sensitive" provincially because this species appears to be in decline, likely due to farming intensification that has resulted in reduced habitat. Habitat typically used by sharp-tailed grouse includes dry, open, vegetated areas, grassy areas, brushy areas, and forested areas (Alberta Conservation Association 2010). Because this species' habitat description is fitting of most of the agricultural land in the study area, all forested areas and the surrounding open spaces between forested areas are considered environmentally sensitive (Figure 3-3). Bald eagle is considered "Sensitive" provincially because it is a species in recovery (GoA 2010). Habitat typically used by this species includes areas near to streams, rivers, lakes, and wetlands where large stands of tall trees are present (Cornell Lab of Ornithology, n.d.). The Blindman and Red Deer River valleys have high potential to contain such habitat, especially in areas where mature tree stands are present. The forested areas north and south of Hazlett Lake also have high potential to support bald eagle. As such, these valleys and lands surrounding Hazlett Lake are considered environmentally sensitive (Figure 3-1).

Both marsh muhly and crowfoot violet were documented independently in the study area. Marsh muhly was only surveyed in 1943, and crowfoot violet was only surveyed in 1951. Areas with potential to contain these species identified by Golder (2010) and by the GoA (2014c) ACIMS database are also considered environmentally sensitive areas, and environmental values in the study area. Specifically, wetlands and wet forested areas are considered environmentally sensitive because both species are found in these areas (Lahring 2003). Both plants are listed as "S2 Imperiled" species and are considered "May Be At Risk." Any habitat potentially containing these species, wetlands and forested areas (Figure 3-3), should be

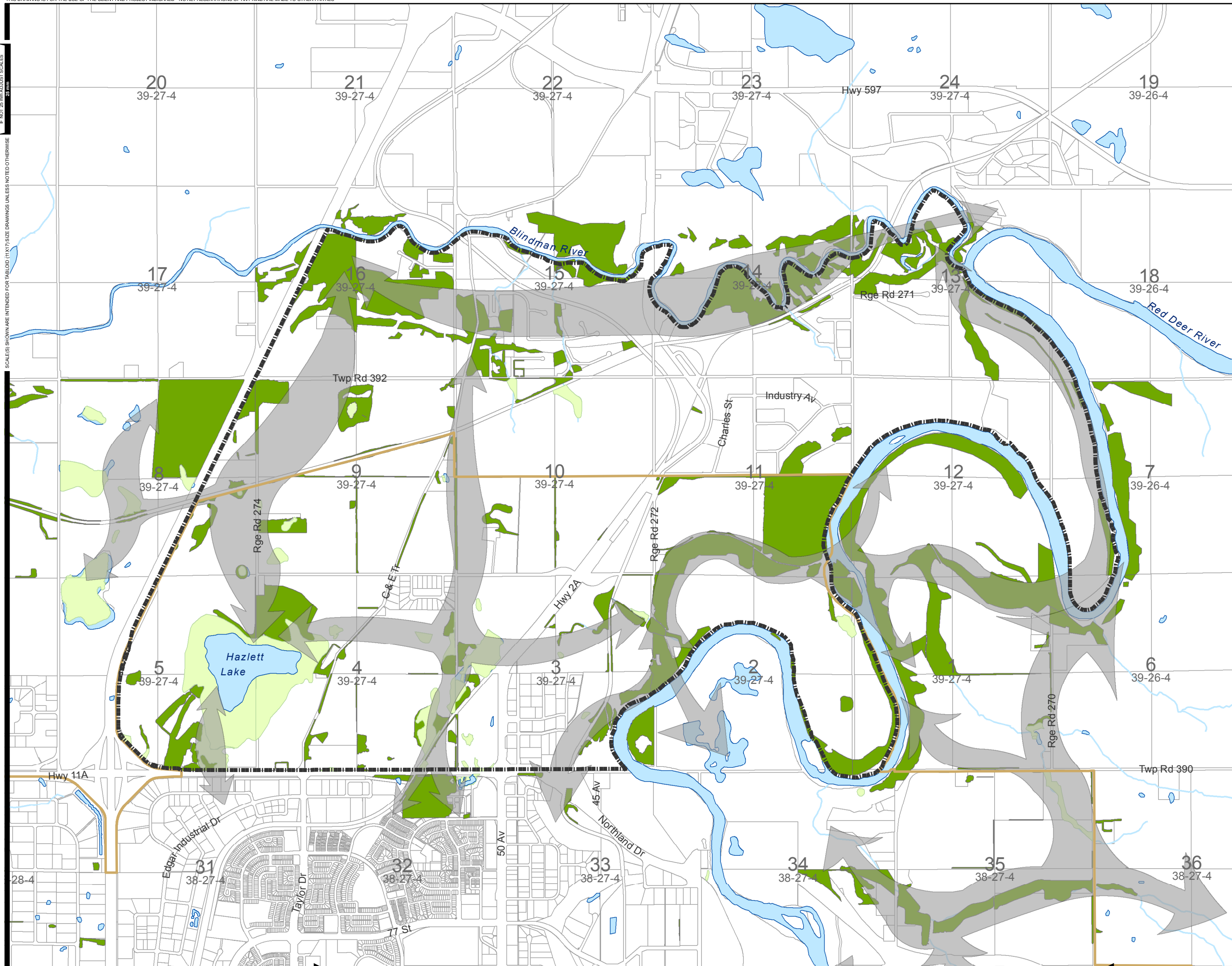
considered an Environmentally Sensitive Area. The presence of marsh muhly and crowfoot violet at the site is to be field-confirmed in later planning stages.

3.3.2.1 Features within the Study Area to consider for Environmental Value:

The following landscape features are being considered environmentally valuable:

- Forested areas surrounding Hazlett Lake and in the Blindman and Red Deer River canyons – these may serve as habitat for bald eagle;
- Forested areas in dense patches – these may serve as habitat for sharp-tailed grouse; and
- Wetlands – these may serve as habitat for marsh muhly and crowfoot violet.

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



- Legend:**
- Potential Wildlife Corridor
 - Natural Ecological Space**
 - Waterbody
 - Forested Area
 - Wetland
 - Study Area
 - City of Red Deer



FIGURE No. 3-3
 NORTH OF HIGHWAY 11A
 MASTER DRAINAGE PLAN

ENVIRONMENTAL
 FORESTED AREAS, WETLANDS, AND POTENTIAL
 WILDLIFE CORRIDORS

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

3.3.3 Sensitive Species, Habitats, and Potential Movement Corridors

Sensitive species are those at risk of extirpation, extinction, and/or population decline. These species could be at risk of being impacted by changes in land use in the study area which could result in loss of unique habitat required for the various life stages of a sensitive species. These sensitive species are typically determined provincially and federally; for the purpose of this review, environmentally sensitive species will consist of the following:

- Species provincially listed as Endangered or Threatened under Schedule 6 of the *Wildlife Act Regulation*;
- Species provincially assessed as Sensitive, May Be At Risk, At Risk, or Extirpated by AEP;
- Species federally listed as Special Concern, Threatened, Endangered, or Extirpated under Schedule 1; of the Species At Risk Act; and
- Species federally assessed as Special Concern, Threatened, Endangered, or Extirpated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Aside from the provincially and federally listed sensitive species, migratory and breeding birds are also being considered environmental values on a temporal basis. Migratory and breeding birds select specific habitats during nesting and breeding season. Generally, these birds can flee if disturbed; however, nestlings that have not fledged are unable to do so. Their nests are protected by the federal *Migratory Birds Convention Act* and therefore, habitat capable of supporting these species is considered an environmental value at certain times of the year (Government of Canada 2014). Forested area and wetlands (**Figure 3-3**) provide excellent habitat for a variety of migratory birds and waterfowl; **Table A-1** contains a list of all environmentally sensitive species with potential to use this habitat.

A large number of environmentally sensitive species that are of provincial or federal concern including fish, amphibians, insects, mammals, and birds were identified in the study area. These species were identified using the FWMIS and ACIMS databases, and the findings of the Hazlett Lake 2014 Baseline Assessment (GoA 2014b; GoA 2014c; Westhoff Engineering Resources, Inc. 2015a). In total, four species of fish, one amphibian, one insect, one mammal, and 53 species of birds were identified as environmentally sensitive species. **Table A-1** displays all environmentally sensitive species identified in the study area. If these environmentally sensitive species are confirmed to be present, it may indicate a high habitat value in the study area.

Changes in land use have the potential to impact water bodies by changing the interaction between aquatic and terrestrial ecosystems (Dodds and Whiles 2010). Pertaining to the study area, changes in surface water infiltration, sheet flow, soil compaction, storm water release, and water retention are among the factors which have potential to impact aquatic ecosystems and therefore environmentally sensitive species of fish must also be considered in this review. Rivers and streams are provincially classified by the significance of habitat they contain; the province also designates Restricted Activity Periods (RAP) for these waters where certain activities are regulated. The Blindman River is a Class C waterbody with minimal sensitive habitat and a RAP of April 16 to June 30, and the Red Deer River is a Class B waterbody which contains some critical habitat and a RAP of September 16 to June 30 (**Figure 3-2**). Although these rivers

are not contained within the study area, they will be considered in this review because development on surrounding lands may change the terrestrial/aquatic interactions in these areas. Fish in these waters have the potential to be impacted by factors such as storm water discharge and sediment release.

A search of the FWMIS database revealed that 17 species of fish are documented in the rivers (**Table A-1**). All are considered “Secure” provincially, with the exception of brown trout (*Salmo trutta*), lake sturgeon (*Acipenser fulvescens*), sauger (*Sander canadensis*), and spoonhead sculpin (*Cottus ricei*). Brown trout are a non-native species in these waters and are therefore not considered environmentally sensitive (GoA 2010). However, increased pressures due to recreational fishing and declining habitat suitability have caused a population decline in recent years and the species is of special concern to AEP for its importance as a sport fishery. Currently, AEP is developing a management strategy for brown trout which reside in the Red Deer River (J. Reilly, personal communication, 2015). Lake sturgeon, although “status undetermined” provincially, is listed under Schedule 6 of the *Wildlife Regulation* as an “Endangered” species and therefore, should be considered of extreme importance when planning developments which could impact this species’ habitat (GoA 2014f; GoA 2014g). Sauger is considered “Sensitive” provincially because there are few known occurrences of this species in Alberta. Spoonhead sculpin is considered “May Be At Risk” provincially because this species occurs in small populations. This sculpin is of special significance to the City of Red Deer because its population has declined in the Red Deer River downstream of the Dickson Dam (GoA 2010, **Table A-1**).

A patchwork of forested areas exists in the Blindman and Red Deer River Canyons, surrounding wetlands, along property breaks, and within natural areas. These forested features, rolling terrain, and steep canyons provide heterogeneous mosaic habitats which are potentially conducive to wildlife movement throughout the study area (**Figure 3-3**; MacDonald 2003). Wildlife groups which typically use such habitat include birds (migratory, raptors, and waterfowl), ungulates (moose and deer), and carnivorous species (coyote and fox). **Figure 3-3** displays the movement corridors which may currently be used by animals within the study area. Red Deer County’s ESA Management Plan also identified that both river canyons provide ungulate habitat (Golder 2010). Additionally, a protective notation (PNT) held by AEP exists on land within the Blindman River Canyon at NW-14-39-27-W4M and NE-15-39-27-W4M (**Figure 3-2**); this PNT960079 protects habitat significant to ungulates and significant stream bank habitat (GoA 2014b).

3.3.3.1 Features Within the Study Area to Consider for Environmental Value:

The following landscape features are being considered environmentally valuable:

- Forested areas – these may serve as habitat for environmentally sensitive species, amphibians, and migratory birds;
- Wetlands – these may serve as habitat for environmentally sensitive species, amphibians and migratory birds;
- Blindman and Red Deer River canyons – these areas provide significant wildlife habitat;
- Streams, rivers, and ephemeral draws – these serve as, or connect to habitat for sensitive fish species;
- Potential wildlife movement corridors; and

- PNT960079 – this protective notation protects habitat significant to ungulates and significant stream bank habitat.

3.3.4 Water Courses, Wetlands, Ephemeral Draws and Flood Prone Areas

Waterbodies, including rivers, streams, ephemeral draws, wetlands, and their associated riparian zones provide ecological goods and services, wildlife habitat; and frequently function as wildlife movement corridors (MacDonald 2003). Wetlands frequently function as recharge areas for aquifers (Dodds and Whiles 2010). The study area contains numerous small and large wetlands and waterbodies, several small streams and ephemeral draws, and is bordered on two sides by rivers (**Figure 3-3**). There are 4 provincially mapped (*Water Act* applies) waterbodies draining north into the Blindman River, and one mapped waterbody draining east into the Red Deer River; these waterbodies may contain water year-round or serve as ephemeral draws, but are subject to the provincial *Water Act* regardless (GoA 2014b). The major wetlands and lakes consist of Hazlett Lake and a wetland located in W-3-39-27-W4M. Hazlett Lake is located in the southwest portion of the study area in E-5-39-27-W4M and W-4-39-27-W4M.

The Alberta Flood Hazard Identification Program was used to determine the floodway and flood fringe areas within the study area. Floodway and flood fringe mapping in the program is limited to Sections 2 and 3 of 39-27-W4M and therefore much of the study area bounded by the Red Deer River is unassessed, as is the entire area bounded by the Blindman River. Of the area assessed, a large part of SE-3-39-27-W4M is considered a flood fringe zone. The outside bend of the Red Deer River in SE-3-39-27-W4M, and 2-39-27-W4M is considered floodway. The City of Red Deer Land Use Bylaw considers flood risk areas as those areas lying within the 1:100 year flood zone (City of Red Deer 2006).

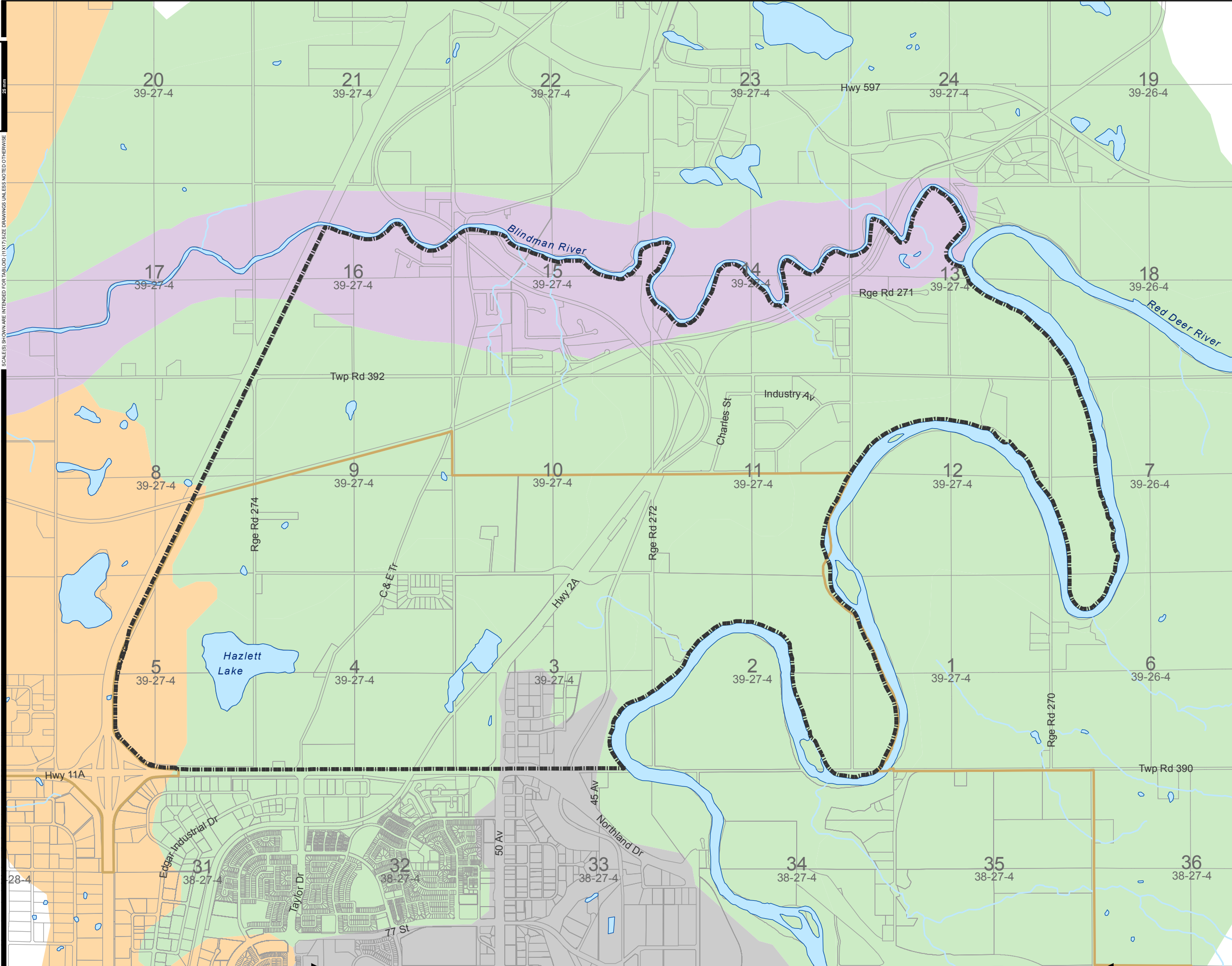
3.3.4.1 Features Within the Study Area to Consider for Environmental Value

The following landscape features are being considered environmentally valuable:

- Rivers, streams, ephemeral draws, wetlands, and their associated riparian zones and setbacks;
- Floodway and flood fringe areas assessed by the Alberta Flood Hazard Identification Program; and
- Areas lying within the 1:100 year flood zone.

3.3.5 Soils, Slopes, and Vegetation

The Agricultural Region of Alberta Soil Inventory Database (AGRASID) was used to determine soil type and classification within the study area, considering only the topsoil. Discounting areas of unknown soil type (most often urban areas), the most prevalent soils are orthic black chernozem soils. These soils occupy most of the study area, including the Red Deer River Canyon. Orthic regosol soils are found throughout the Blindman River Canyon and occupy the northern portion of the study area. A small west portion of study area is comprised of eluviated black chernozem soils (GoA 2014e). **Figure 3-4** displays the distribution of surface soil types in the study area.



Legend:

- Soil Order, Soil Subgroup
- Chernozemic, Eluviated Black Chernozem
 - Chernozemic, Orthic Black Chernozem
 - Regosolic, Orthic Regosol
 - Data Not Available
- StudyArea
 City of Red Deer
 Hydrology



FIGURE No. 3-4
NORTH OF HIGHWAY 11A SERVICING STUDY

ENVIRONMENTAL SURFACE SOILS

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Furthermore, the AGRASID database identified two classes of soil in the study area (Class 3 and Class 5) and a number of subclasses (GoA 2014e). Class 3 soils are predominant (present in 90% of the study area) and described as having “moderate limitations that restrict growth of the specified crops.” Class 5 soils comprise the remaining 10% and are described as having “severe limitations for sustained production of the specified crops” (Government of Canada 1995; GoA 2014e). The limitations (subclasses) noted in the database are temperature, slope, water holding capacity, salinity, rock content, and drainage; no further details were available (Government of Canada 1995).

Steep slopes and escarpments are considered environmental values because they provide habitat in the form of topographic relief for wildlife and if disturbed can be the source of erosion and sediment control issues. Waterbodies are often located at the base of steep slopes, compounding their importance as environmental values. In this review, steep slopes are defined as any slope with a 15% or steeper grade. This grade is often considered the maximum grade allowable for development and is locally referenced by Red Deer County and the City of Red Deer (O2 Planning + Design Inc. 2010; Red Deer County 2010; Trenhaile 2012). **Figure 3-5** shows all slopes in the study area with grades of 15% to 20%, and 20% or higher. Generally, the slopes of the Red Deer River Canyon and the eastern-most slopes of the Blindman River Canyon contain grades of 15% or more and are therefore not environmentally feasible for some forms of development when considering the O2 Planning + Design Inc. (2010) recommendations.

3.3.5.1 Features Within the Study Area to Consider for Environmental Value

The following landscape features are being considered environmentally valuable:

- Class 3 (chernozem) soils conducive to agricultural production;
- All slopes with a 15% grade or steeper; and
- Forested areas where native vegetation characteristic of this Subregion may still exist.

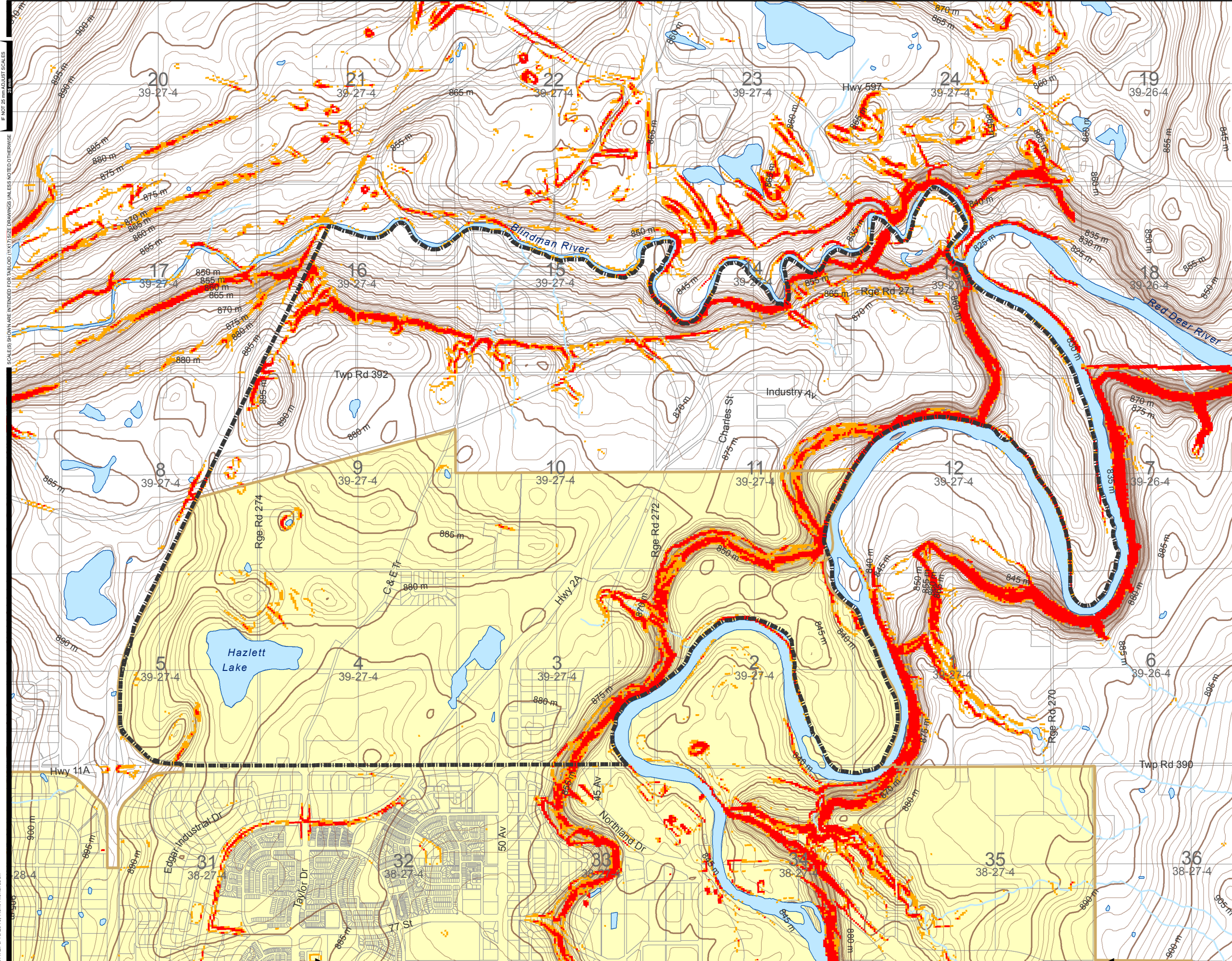
3.3.6 Historical Resources, Existing Land Use, and Potential Sources of Contamination

In an effort to preserve features with cultural significance, historical resources identified by Alberta Culture and Tourism are considered environmental values for in this review. A search of the historical resources database revealed that historical resources are present throughout the study area (**Figure 3-6**). The most common historical resources value (HVR) was 5p, followed by 4p and by 5a (GoA 2015). A HVR of 5p indicates that the land parcel is believed to contain a historical resource of palaeontological significance. A HVR of 4p indicates that the land parcel contains a historical resource of palaeontological significance which may require avoidance. A HVR of 5a indicates that the land parcel is believed to contain a historical resource of archaeological significance (GoA n.d.[a]).

There are several prominent land use types in the study area. The primary land use type is crop farming followed by commercial/industrial use, rural residential, transportation infrastructure, and no land use (forested). Oil and gas activity is also prevalent in the study area. A search of the AbaData 2.0 database revealed a network of pipelines which service numerous wells in the study area (AbaData 2.0; **Figure 3-7**). A search of the Petroleum Tank Management Association of Alberta (PTMAA) database determined that

there are known chemical storage tanks located in Sections 3, 10, 11, and 14 of 39-27-W4M (PTMAA 2015). PTMAA can provide (for a fee) the specific location, status, contents, and registration of all known tanks in the study area if requested. Undocumented tanks may be present at homesteads, equipment yards, and on private land. Tanks may (historically and presently) contain chemicals which could be sources of pollution and contamination.

THIS DRAWING IS FOR THE USE OF THE CLIENT AND PROJECT INDICATED - NO REPRESENTATIONS OF ANY KIND ARE MADE TO OTHER PARTIES



- Legend:
- Slope
 - 15-20%
 - >20%
 - Contour 5m
 - Contour 1m
 - StudyArea
 - City of Red Deer
 - Hydrology

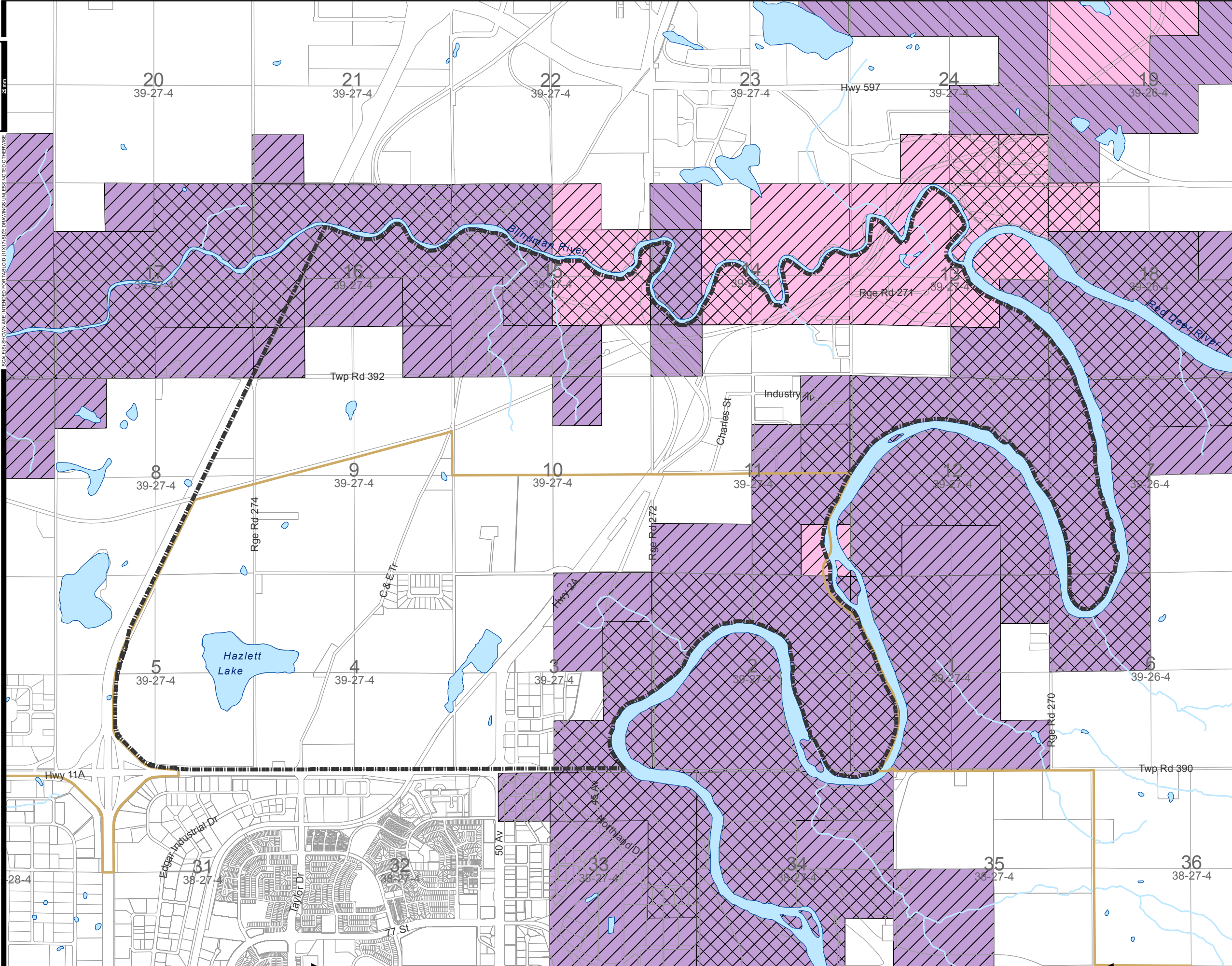


FIGURE No. 3-5
NORTH OF HIGHWAY 11A
MASTER DRAINAGE PLAN

ENVIRONMENTAL
STEEP SLOPES

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 DATE: 6/13/2016, Kent Richardson



Legend:
Historic Resource Value (HRV)

- March 2015
- Archaeological
 - Palaeontological
 - HRV5
 - HRV4
 - Study Area
 - City of Red Deer
 - Hydrology

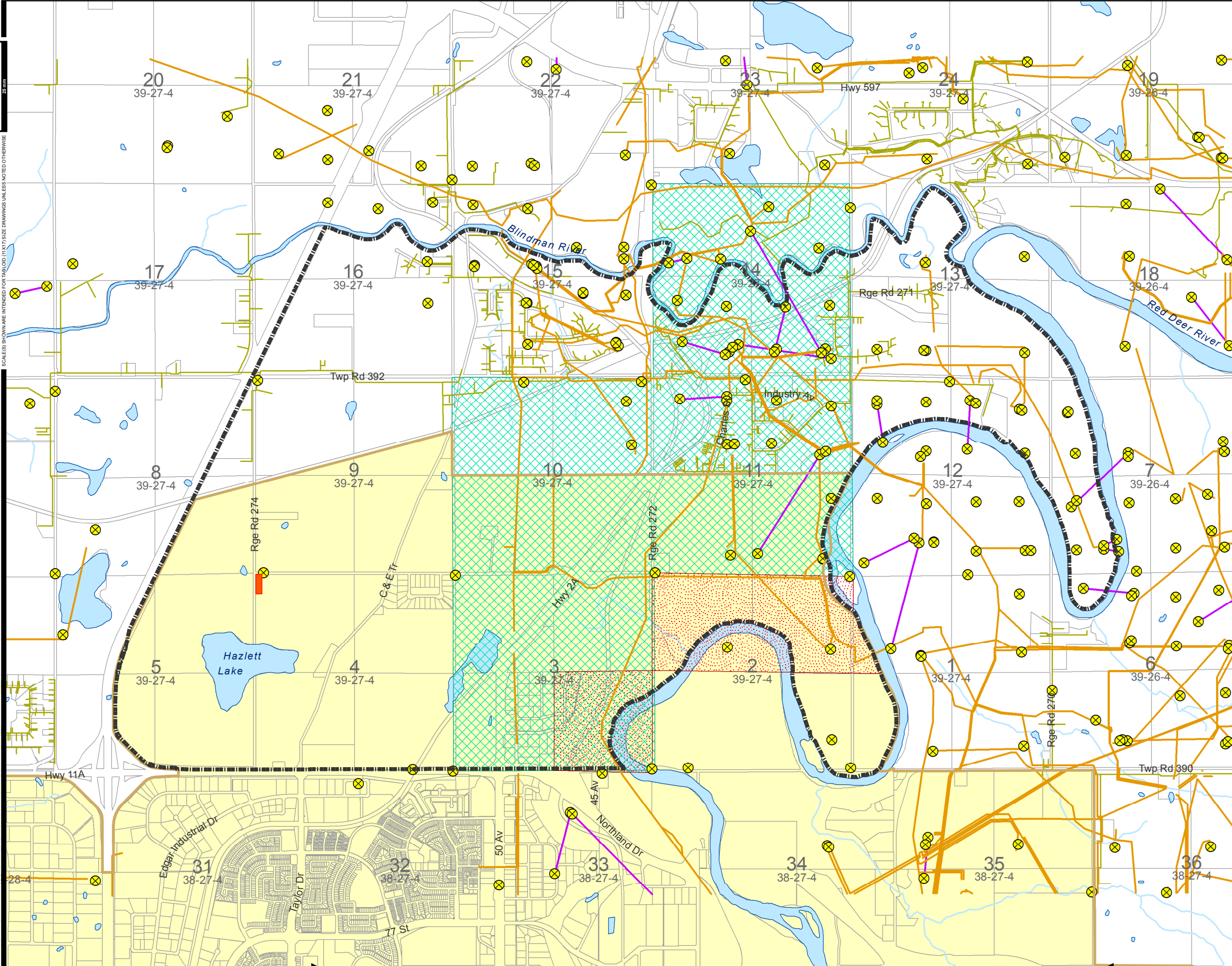
Note:
* HRV4 - Contains a historic resource that may require avoidance
* HRV5 - Believed to contain a historic resource



FIGURE No. 3-6
NORTH OF HIGHWAY 11A SERVICING STUDY

ENVIRONMENTAL
HISTORIC RESOURCES

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DATE	JUNE 2016
REV	
DESCRIPTION	ISSUED FOR FINAL REPORT



- Legend:**
- Well
 - Pipeline
 - Low Pressure Pipeline
 - Oil/Gas Well Line
 - Area Containing Chemical Tanks
 - Area with Former Landfills
 - Former Landfill
 - StudyArea
 - City of Red Deer
 - Hydrology



FIGURE No. 3-7
NORTH OF HIGHWAY 11A SERVICING STUDY

ENVIRONMENTAL
KNOWN PIPELINES, WELLS, LANDFILLS AND
AREAS CONTAINING CHEMICAL STORAGE TANKS

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DESCRIPTION	ISSUED FOR FINAL REPORT

3.3.6.1 Features Within the Study Area to Consider for Environmental Value

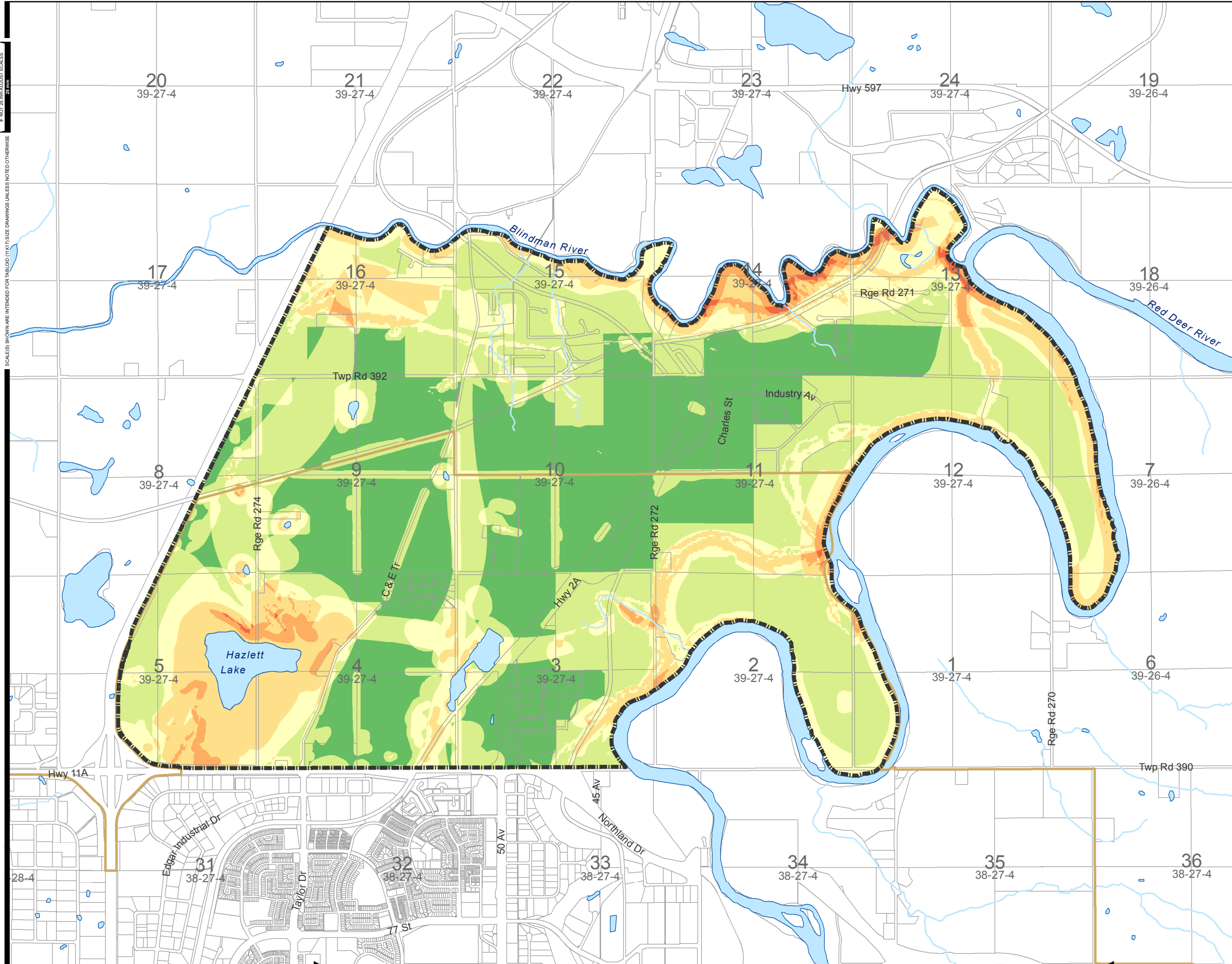
The following landscape features are being considered environmentally valuable:

- All legal subdivisions listed in the Alberta historical resources database; and
- All sections identified to contain chemical storage tanks – tanks are potential sources of contamination.

3.4 POTENTIAL IMPACTS TO ENVIRONMENTAL VALUES AND MANAGEMENT RECOMMENDATIONS

To illustrate areas that are environmentally sensitive to development, ESAs, sensitive areas, valuable wildlife habitats, movement corridors, water features, steep slopes, historical resources, and the associated spatial data attributed to each were analyzed spatially to determine areas where environmental values were concentrated. This analysis is represented by a map (**Figure 3-8**) where red shading indicates high concentrations of environmental values. Similarly, areas shaded in green contain relatively fewer known environmental values. It should be noted that the environmentally sensitivities used in this assessment were identified through a desktop review of available information. **Figure 3-8** was used to identify areas where the expansion of service areas could have the greatest environmental impact.

At this time the impacts to environmental values associated with the expansion of service areas can only be discussed at a broad scale. There are environmental regulatory constraints which apply to certain development proposals which could be associated with the expansion of service areas (**Table A-2**). To understand the potential environmental impacts of a proposed development, detailed biophysical assessments could supplement existing information and should emphasize the cumulative environmental impacts and long-term changes in the biophysical conditions to the larger study area. The following sections will overview the potential impacts to environmental values identified above, and should serve as discussion points for assessment during the detailed biophysical assessment process.



- Legend:**
- Environmental Sensitivity**
- High
 - Moderate
 - Low
 - No Variables Identified
- Study Area**
- City of Red Deer**
- Hydrology** ■



FIGURE No. 3-8
 NORTH OF HIGHWAY 11A SERVICING STUDY
 ENVIRONMENTAL
 CONCENTRATION OF ENVIRONMENTAL VALUES

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SCALE	1:30,000
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3.4.1 Loss of Wildlife Habitat and Connectivity Corridors

Certain features in the study area provide significant habitat for a variety of wildlife. As discussed earlier, areas such as the Blindman and Red Deer River Canyons, Hazlett Lake, and forested areas provide excellent habitat for a number of birds, amphibians, and mammals. Not only do wildlife species require these natural spaces, certain species also require a distance away from human disturbance.

Also important is the amount of potential habitat connectivity for wildlife in the study area. Potential wildlife movement corridors exist in both river valleys, on contour with steep inclines, and along Highway 2 between Hazlett Lake and the Blindman River Canyon. These movement corridors contain forested areas, featuring both island and continuous biogeographic characteristics necessary for wildlife forage, cover, and critical life stages (Macdonald 2003). Forested areas within movement corridors also provide nesting and rearing habitat for some migratory bird species, and excellent foraging opportunities for birds of prey.

Recommendation:

It is recommended that only minimal development be permitted in the Blindman and Red Deer River Canyons, and surrounding Hazlett Lake in order to preserve wildlife habitat. Minimal development in potential wildlife movement corridors is also recommended, especially for the north/south corridor along Highway 2 between Hazlett Lake and the Blindman River Canyon, within each river valley, and the east/west corridor connecting Hazlett Lake to the Red Deer River Canyon. The suggested minimal development in these areas may include natural, open space, or park land uses. A focus on providing nature appreciation and low-impact recreation opportunities for the public may also be incorporated into these spaces.

The maintenance of corridors for wildlife movement and habitat purposes requires that corridors be designed to a minimum width and incorporate land and vegetation features conducive to supporting habitat for the target wildlife species. Some potential wildlife movement corridors are comprised of continuous natural space while others simply encompass a patchwork of features in a natural state. If prioritizing areas for designation as wildlife movement corridors is desired, areas with continuous connectivity including waterbodies should take priority over patchier areas with less connectivity. Where the maintenance of functional wildlife habitat and movement corridors is desired, a minimum corridor width of 100 m is recommended (Fischer and Fischenich 2000). Where this wildlife movement corridor includes a river or stream, this width should be measured from the top of the bank.

3.4.2 Loss of Rare Plant Species

Marsh muhly and crowfoot violet habitat may be present in wet natural forested areas and wetlands. Habitat for these species may be lost should development of these areas occur. The species may also be impacted by the modifications of wetlands (reduced wetland footprint or conversion to storm water retention areas). Long-term agriculture has resulted in the removal of some suitable habitat for these rare plant species in the study area (GoA 2014c). There may remain sub-populations of either species in areas not impacted by historic land development.

Recommendation:

Because natural wetlands and forested areas are likely the only remaining areas that could contain these plant species, it is recommended that such areas remain intact in future development plans. Barring these conservation measures, it is suggested that rare plant surveys be completed in these areas prior to development at the multi-neighborhood structure plan stage. If found, rare plants can be transplanted to a suitable area, or the area could be designated ecologically significant and conservation measures employed. The NatureServe organization should be consulted prior to moving a rare plant.

3.4.3 Accelerated Eutrophication and Loss of Wetland Productivity

Hazlett Lake, and likely the remaining wetlands in the study area are considered trophically productive (between mesotrophic and eutrophic). These wetlands serve to provide significant foraging, cover, and nesting habitat for waterfowl and shorebirds; they also provide nutrient exchange for local ecosystems and carbon sequestration (Westhoff Engineering Resources, Inc. 2015a). Disturbance and development of surrounding lands can increase nutrient input to these waterbodies, causing accelerated eutrophication, algal blooms, temporary spike in productivity, production of toxic cyanobacteria, followed by the loss of the area to provide wildlife habitat and carbon sequestration benefits.

Wetlands are provincially protected under the *Public Lands Act*, and *Water Act*. Any development within a permanent waterbody, including wetlands, requires a disposition; although the GoA does not excerpt their rights on all wetlands, generally only significant connected wetland systems. Under the *Water Act*, any construction in a waterbody, including filling, requires approval. As a part of the approval process the GoA requires compensation for disturbance under the Wetland Policy (2013).

Recommendation:

It is recommended that wetlands are maintained as sensitive landscape features during the land use planning process. Wetlands will require delineation to determine their precise boundaries, and a no development buffer should be applied to each wetland. Buffer distance may vary depending on the productivity and class of each wetland, but are necessary to intercept and sequester pollution and nutrients flowing towards each wetland. A literature review by Hawes and Smith (2005) indicates a minimum buffer distance of 30 m is required in most cases to remove 90% of common pollutants and sediment entering waterbodies during normal precipitation conditions¹. Depending on the conservation goal(s), a larger no development buffer could be designated around certain wetlands where the maintenance of functional wildlife habitat is considered important (such as wetlands located within or near to a potential wildlife movement corridor). In such case, the minimum recommended buffer width is 100 m or more (Chase et al. 1997).

3.4.4 Pollution and Nutrient Input to Waterbodies

Pollution which may impact waterbodies can take many forms and any of a number of vectors when introduced to a waterbody. Common pollutants include benzene and similar chemicals, fertilizers and

¹ Normal precipitation conditions refer to the precipitation volume, surficial spread, soil infiltration, and vegetation in a catchment basin under natural conditions (no human infrastructure within a catchment basin).

pesticides, excess nutrient loading, sediment loading, and excess solar exposure. These pollutants have a range of consequences including: toxification of the aquatic environment, eutrophication of water, algal blooms, loss of spawning and rearing habitats, warming of surface waters, production of cyanobacteria, and depletion of dissolved oxygen necessary for the survival of fish and aquatic insects. A decrease in aesthetic value is also often associated with pollution input to waterbodies. Existing conditions in the study area include farming which likely means that fertilizers have been used on soils in the past. These impacts are typically compounded when residential, commercial, and industrial development takes place near waterbodies as the risk for a pollutant to enter the waterbody is increased, and surface runoff flows are altered and can transport pollutants.

Recommendation:

It is recommended that storm water management infrastructure be designed such that runoff from developed areas does not enter natural waterbodies untreated. At minimum, storm water should pass through oil and grit separators where sediments and petroleum products can be removed from water. Storm water must not enter a waterbody at high velocity but should rather be diverted to detention ponds for primary treatment and slowly discharged to waterbodies. In all cases, consider diverting runoff to storm water treatment facilities.

Pollution may also enter waterbodies by overland runoff flow. This vector of introduction can be mitigated by maintaining the existing riparian buffer strips around waterbodies, and planting vegetation where none presently exists. The minimum recommended buffer width, measured from the top of the bank, required to intercept pollution is 30 m when vegetation consists of forest (shrubs, trees, grasses). Where only grasses are present, the recommended buffer width should be doubled (Chase et al. 1997; Hawes and Smith 2005).

When considering the location of riparian buffer strips, it is recommended that all natural water conveyance features are protected from the introduction of pollution. All ephemeral draws, and first, second, and third order tributaries should be considered with equal importance to the Blindman and Red Deer Rivers, and protected using riparian buffer strips with minimum width of 30 m (Hawes and Smith 2005). Similarly, it is important that riparian buffer strips extend along the entire length of each waterbody. In certain cases, privately owned lands have maintained lawns to the waterbody's edge. In such cases, the benefits of the surrounding riparian buffer strips are negated; landowners with un-buffered properties leading to waterbodies should be encouraged to re-vegetate those areas to maintain a contiguous buffer along the waterbody (Hawes and Smith 2005).

To inhibit solar pollution to waterbodies (which raises water temperatures and reduces concentration of available oxygen), vegetation should be left intact on banks. The height of the vegetation is more important than the width of the buffer strip, provided that the buffer is at minimum 30 m wide to mitigate pollutant laden overland runoff. In the Red Deer region, vegetation along rivers should consist of natural forest with mature trees and adequate regeneration to maintain the forest (Chase et al. 1997).

3.4.5 Flood Risks

Certain parts within the study area are susceptible to flooding as they are located near rivers or in low lying flood fringe areas. As mentioned, little flood risk information is available in the study area with the exception of the southeast portion bounded by the Red Deer River. A preliminary review of data available from AEP shows that areas within 12 and 15 of 39-27-W4M and 6, 7, and 18 of 39-26-W4M of the Red Deer River Canyon may be susceptible to flooding. Section 4.3 of this report contains additional information regarding flood risks in the study area.

Recommendation:

Complete a flood risk analysis of the study area considering the 1:100 flood elevation currently referenced in the City of Red Deer Land Use Bylaw. Given the increased frequency of flood events in recent years, flood analysis could be completed to include flood events of greater proportion. Development within the flood risk area should be limited to recreational trails, open space, natural park, or environmental reserve, and the required infrastructure should be designed to accommodate and withstand flood inundation. To reduce the risk of mass wasting during flood conditions, it is recommended that the flood-risk area remain entirely vegetated.

3.5 HAZLETT LAKE

Hazlett Lake is considered a wetland of regional environmental significance by the City of Red Deer (2005) which provides important waterfowl and marsh bird habitat (Westhoff Engineering Resources, Inc. 2015a). Prior to the area's annexation by the City of Red Deer, Hazlett Lake and the surrounding area was identified as an ESA of Red Deer County (**Figure 3-1**; Sweetgrass Consultants Ltd. 1990). The Hazlett Lake ESA (**Figure 3-1**) surrounds the lake and contains most of E-5-39-27-W4M and west of Range Road 273A in W-4-39-27-W4M. There is considerable information available regarding Hazlett Lake in the Hazlett Lake 2014 Baseline Assessment prepared by Westhoff Engineering Resources, Inc. The Lake is considered "fair" in health, is highly biologically productive, and considered mesotrophic to eutrophic. Limnological assessment indicates that pollution is present in the lake and is likely caused by precipitation runoff from Highway 2, Highway 11A, and the Queen's Industrial Park south of the lake (Westhoff Engineering Resources, Inc. 2015a).

The baseline assessment completed by Westhoff Engineering Resources, Inc. identified three amphibians, 276 birds, and 10 mammals using habitat on and around Hazlett Lake. Of these species of wildlife, 53 birds and one mammal are provincially and/or federally listed species of concern (**Table A-1**). There have been no documented fish or fish inventory studies in Hazlett Lake. The lake is not hydraulically connected by surface waters to any fish bearing waterbody and is unlikely to contain fish of importance to an aboriginal, commercial, or recreational fishery (GoA 2014b). A study of fish habitat and inventory of species present would determine if the lake is fish bearing.

Hazlett Lake is surrounded by a mix of land uses including rural residential, crop farming, and native forest. The area immediately surrounding the lake is undisturbed wetland and contains environmentally significant habitat for waterfowl and nesting shorebirds (Westhoff Engineering Resources, Inc. 2015a). The native

forest north and south of the lake likely provides habitat for birds of prey including federally “endangered” ferruginous hawk, peregrine falcon, and short-eared owl. Additionally, the forested area south of the lake likely provides suitable habitat for federally “endangered” olive-sided flycatcher, and the surrounding wetland likely provides suitable habitat for federally “endangered” rusty blackbird. All federally “endangered” species mentioned above are known to have been present in the Hazlett Lake area, and have been documented previously but have not been visually confirmed for the purpose of this study.

The precipitation catchment basin surrounding Hazlett Lake is 268 hectares in area and extends east from Highway 2, north from Highway 11A, west from Range Road 273A, and south from Township Road 391. In emergency precipitation situations, Hazlett Lake can be used as a discharge waterbody to divert water from Queen’s Business Park (Westhoff Engineering Resources, Inc. 2015a).

Recommendations for Potential Management Options:

The habitat features surrounding Hazlett Lake are unique to the Red Deer area and provide significant habitat for 53 documented migratory birds, birds of prey, shore birds, waterfowl, and one mammal; all are species of environmental concern. Of these, 7 are designated species at risk and protected federally under the Species at Risk Act. Because of the environmental significance associated with Hazlett Lake, it is recommended that development surrounding Hazlett Lake be restricted and that the area surrounding the lake be designated as environmental reserve, urban park, or protected area. A provincial recreation lease may be required for the protection of Hazlett Lake, as the province has jurisdiction over the lake itself. It is also recommended that at minimum, one wildlife movement corridor be maintained between the area surrounding Hazlett Lake and the Blindman or Red Deer River canyons.

Two options are available to create wildlife movement corridors. The simplest option would be to connect all forested areas along Highway 2 between the lake and the Blindman River canyon with a wide wildlife movement corridor. The width of such a corridor should be a minimum of 100 m; however, if recreational land use is also planned for the area, then the buffer should be widened to accommodate human use, parking lots, shelters, and other park infrastructure. A suitable distance from Highway 2 should also be considered to minimize the noise impacts associated with Highway 2. Another wildlife movement corridor could be created by connecting the green spaces planned in the south portion of the study area. Low lying wet areas are present in this portion of the study area and green spaces planned here could be widened to a minimum of 100 m (excluding the wet areas) to accommodate wildlife passage. This option is limited by two road crossings: Highway 2A and Range Road 273A.

There are a variety of viable management options for Hazlett Lake and the surrounding area if the City of Red Deer were to designate low/no development in this area. Hazlett Lake could be designated an urban park much like Calgary’s Nose Hill Park. Nose Hill Park was created to preserve the unique natural environment found in the park and is used by Calgary’s residents for recreation and nature appreciation (City of Calgary n.d.). Should long term protection of Hazlett Lake and the area surrounding it be desired, the City could administer the protection of the area, or pursue discussions with AEP for protection as a provincial park or other protected area under joint jurisdiction of the City of Red Deer and the GoA. Involving AEP in the management and maintenance of the area affords access to AEP’s resources and expertise. Like Lois Hole Centennial Provincial Park within and west of, the City of St. Albert, Hazlett

provides many of the same bird habitats and could be protected for its environmental significance and future public use (GoA n.d.[b]).

Finally, it is recommended that the City of Red Deer continue the environmental monitoring currently being conducted at Hazlett Lake by Westhoff Engineering Resources, Ltd.(2016) lists 74 management recommendations for Hazlett Lake. These recommendations should be applied to the short, medium, and long term management plan for the Hazlett Lake area and its catchment basin. Due to the environmentally significant nature of Hazlett Lake, it is also recommended that detailed biophysical assessment of the area be conducted specific to the desired development.

3.6 GENERAL PRACTICES FOR IDENTIFYING CROWN CLAIMABLE WETLANDS

This subsection provides a summary of the GoA (2014h) document “Guide for Assessing Permanence of Wetland Basins” and is intended to serve as a preliminary planning tool for the City of Red Deer to be used when creating drainage plans where wetlands are present and must be modified or removed for infrastructure development and drainage purposes. This information should be used to assist in the identification of wetlands within the study area, which could be considered Crown claimable or of significant environmental importance requiring significant compensation if modified or removed. With this knowledge, the City of Red Deer can design elements of drainage plans and selectively preserve, modify, or remove wetlands in a resource effective way.

Prior to disturbance of a wetland, permissions must be obtained under both the Water Act and Public Lands Act. An Approval under the Water Act for wetland disturbance triggers the Alberta Wetland Policy (2013), and a Wetland Impact Assessment is required to be completed on the wetland(s) to be disturbed. A Water Act Approval must be accompanied by an outcome of Crown-claimability under the Public Lands Act, in other words, a determination whether the Crown plans to claim any portion of the wetlands to be disturbed. This Crown-claimability result is provided, upon request, by a lands officer with Alberta Environment and Parks (AEP; this process may take between 4 and 8 months). To expedite the lands officer’s review of wetlands, an “assessment of permanency”, or “primary assessment” may be completed by a qualified professional, and submitted to AEP. The remainder of this subsection discusses the process for determining wetland permanency for a Crown-claimability outcome under the Public Lands Act.

The Province of Alberta has jurisdiction over the bed and banks of all waterbodies in the province. Waterbodies determined to be permanent are likely to have their ownership claimed by the Province of Alberta under Section 3 of the Public Lands Act. It is important to note that Crown claimable status may exist for wetlands that were historically drained or filled without authorization from the Province of Alberta and must be included in the assessment process. The three criteria for the Province to assert ownership are as follows: the wetland must be:

- A body of water;
- Naturally occurring; and
- Permanent (or reasonably so).

A “primary assessment” of wetland permanence may begin with a desktop review of available data. The assessor should possess a range of knowledge and skills including:

- Strong skills in aerial photography interpretation;
- Basic understanding of geomorphology and landscape formation;
- Basic understanding of obtaining and interpreting precipitation trends;
- Moderate skills in wetland botany; and
- Moderate skills in wetland ecology.

The general procedure for delineating wetland requires the historical comparison of aerial photographs of a wetland cross-referenced with historical and seasonal precipitation data. The general procedure is as follows:

1. Obtain historical precipitation data for the area containing the wetland(s) of interest and determine periods of lower and greater than normal precipitation.
2. Obtain two sets of aerial photographs representing the earliest and latest photographs of the areas containing wetland(s) of interest and obtain interim photographs corresponding with periods of lower than and greater than normal precipitation. Duplicates of each aerial photograph are required for analysis with a stereoscope.
3. Compare aerial photographs using a stereoscope to reveal topography and identify wetlands, low areas and depressions which have potential to collect water. Note how these water prone areas respond to inundation by water during periods of lower and greater than normal precipitation. If possible, determine seasonal extent of surface cover by water during varying periods of precipitation. These data will begin to show the permanence of each wetland.
4. Note any features which may alter the way water inundates water prone areas; features to look for include:
 - Ditching;
 - Dugouts;
 - Roads and impoundments;
 - Constructed and treatment wetlands;
 - Wetlands created by leaky irrigation;
 - Abrupt changes in wetland class; and
 - Any other features which may alter the natural dispersal of water on the land scape.
5. Based on the information available in the aerial photography, identify the number of weeks each wetland is flooded annually with consideration to periods of lower and greater than normal precipitation, and periods of normal precipitation. If sufficient data has been gathered, fit each wetland into the appropriate wetland class to determine the preliminary classification of each wetland.

Approximate wetland boundaries and permanence results may be obtained from the desktop review and confirmed during a field visit. The field professional should have the additional skills of:

- Wetland vegetation identification; and
- Field techniques and procedures.

Prior to 2015, two major classification systems have been used in Alberta for wetland impact assessments: Stewart and Kantrud (1971) for wetlands within the white zone of Alberta and Cowardin Classification System for wetlands within the green zone of Alberta (GoA 2011). The new wetland policy references a new GoA-produced classification system, heavily based upon the above two systems (GoA 2015). If a full Wetland Impact Assessment is completed on a wetland to be disturbed, the new GoA classification should be used. If only a “primary assessment” is completed for permanency determination, the Stewart and Kantrud system may be used, as it is potentially a simpler process, and the GoA has provided permanency guidance based on this classification system. In other words, the GoA has identified those classes of Stewart and Kantrud wetlands that are most Crown claimable.

Using the Stewart and Kantrud system, wetlands can be classified into seven classes (**Table 3-1**) which correspond to permanence and can be used as a proxy to evaluate potential Crown claimability. Wetland class can be broadly estimated during the desktop portion of the assessment; however, in some cases completing only the desktop portion of the assessment may not provide the breadth of detail required by the Province of Alberta to determine permanence.

**Table 3-1
Stewart and Kantrud Wetland Classes and Their Potential Crown Claimability (GoA 2014h)**

Major Wetland Class and Dominant Vegetation Zone		Permanency	Weeks Flooded (/year)	Potential Crown Claimability
Class I	Local vegetation	Ephemeral	N/A	No
Class II	Wet meadow	Temporary	1 – 4	No
Class III	Shallow marsh	Seasonal	5 – 7	Possibly
Class IV	Deep marsh	Semi-permanent	18 – 51	Yes
Class V	Open water	Permanent	52	Yes
Class VI	Open water and bare ground	Saline	N/A	Case-by-case
Class VII	Fen	Fen	N/A	No

The complete assessment of Crown claimability of all wetlands that may be disturbed can be resource intensive. With these general practices for determining potential Crown claimability, drainage plans can be developed in a way that reduces the number of complete wetland assessments required to complete drainage plan designs. Note: if the crown claims ownership of a wetland, a disposition may still be obtained to disturb a portion of that wetland, similar to a disposition for disturbing the bed and shore of any other water body, however, in extreme cases, a disposition may also be refused by AEP, resulting in no further development of a Crown-claimed wetland.

3.7 CONCLUSION

The study area bounded by Highways 2 and 11A, and the Blindman and Red Deer Rivers, contains many environmental values which should be considered when designating land use in the study area. Of

significant value are the Blindman River and Red Deer River canyons, Hazlett Lake and its surrounding lands, and potential wildlife movement corridors that link these features. Their significance is illustrated by a number of factors including valuable habitat for a diverse number of documented species including 276 bird species (53 are species of environmental concern and 7 are federally protected), 10 mammal species (one is of environmental concern), and 3 amphibian species (one of environmental concern).

The greatest potential environmental impacts of expanding service areas are loss of habitat for species of environmental concern, loss of wildlife connectivity corridors, loss of rare plant species, eutrophication of wetlands and loss of wetland productivity, pollution of waterbodies, and heightened flood risks. A number of mitigation strategies are recommended to address. The importance of riparian buffer strips, forested habitat corridors, and the value of designating protected environmentally significant areas or environmental reserves may be the strongest actions to avoid or mitigate impacts to environmental values. Implementing one mitigation recommendation will typically serve to mitigate multiple potential impacts.

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4 Ultimate Servicing

4.1 WATER DISTRIBUTION SYSTEM

4.1.1 Ultimate Servicing

Ultimate water servicing for the study area has been analyzed in detail and considers system operation, reservoir location, zone delineation and regional demands among others items. The concepts which have developed from the analysis have been based on the design demands outlined within Section 2 – Design Criteria. Some of the criteria appear to be conservative in nature, which may result in oversizing of water system infrastructure. This has been communicated to the City of Red Deer, and City staff has chosen to continue on the basis of developing a conservative servicing concept.

4.1.2 Water Distribution System

The WaterCAD models developed in the City of Red Deer 2013 Water Distribution System Study (2013 Water Study, Stantec), were used as the basis for this analysis. The supply and distribution system beyond the study boundary were not reviewed or validated. It is assumed that the City will install the necessary supply system (including watermains and distribution pumping) in order to meet a minimum HGL of 912 m at the junction of Highway 11A and Highway 2A. An HGL of 912 m is currently required in agreement with the North Red Deer Regional Water Services Commission (NRDRWSC).

As well, the future system demands were not reviewed outside of the study boundary, including those established for the NRDRWSC in the 2013 Water Study.

4.1.3 Water Servicing Philosophy

A number of high level servicing concept variations were assessed prior to developing a full servicing plan for the Study Area. These include:

- North Reservoir location;
- North Reservoir and Pumphouse service area;
- Pressure zone delineation; and
- Utilization of the NRDRWSC supply line.

The concepts identified above and the resulting implications are fully described in the following sections.

4.1.3.1 North Reservoir Location

Potential reservoir locations were assessed on a high level basis. The study area was reviewed in terms of topography and other site constraints. Ideally reservoirs are located in higher elevations in order to reduce distribution pumping requirements. It is also advantageous to be located in reasonable proximity to the initial service area in order to limit up-front watermain installation. Locating reservoirs in central areas can also reduce the maximum outgoing pipe sizes as piping can be installed in multiple directions.

Based on the above considerations, the site identified in the 2013 Water Study is a suitable location for the reservoir. It is currently shown at the junction of Highway 11A and Highway 2A, at the north end of a future 900 mm diameter main (proposed to be installed during the infill development stage, by 2022 as per the 2013 Water Study). This future supply main (and future additional twin main) will also support the NRDRWSC demands, and supply growth at the Queens Business Park as well as to future developments further to the west of the current study area. The reservoir site is located adjacent to existing development within the study area, and is in good proximity to support growth adjacent to Highway 11A as well as interim growth which is anticipated to occur in close proximity to the Queens Reservoir (discussed further in Section 5.1).

A second potential reservoir location was identified approximately 1,600 m north of the current proposed site, located immediately east of Highway 2A. This site provides a central location within the study area, has a similar elevation to the original proposed site, is located nearby existing developments to be serviced and is easily accessible. However, locating the reservoir farther to the north will require an extension of the supply main. This scenario was modelled to determine the associated distribution and supply main sizes. As anticipated, the overall length of large diameter mains was reduced due to the central location; however, costs were approximately 6% higher for this reservoir site due to the increased supply main installation costs.

Although the NRDRWSC supply main could be utilized to provide interim supply, an additional 900 mm supply main would eventually be required to supply to the North Reservoir. This would increase to 1050 mm if the projected future growth along the NRDRWSC was to be included.

On this basis, it is recommended that the future North Reservoir and Pumphouse be installed in the general area of Highway 11A and Highway 2A.

4.1.3.2 North Reservoir and Pumphouse Service Area

Two alternatives have been investigated in terms of the future North Reservoir and Pumphouse service area. In the first option, the facility could operate in a traditional manner, whereby the future supply main will fill the reservoir, and distribution pumps will provide system pressure to the study area. As such, distribution pressure within the study area will be unaffected by conditions upstream. In the second option, the portion of the study area which is located east of Highway 2A can be serviced directly off of the WTP zone pressure, and the North Reservoir service area can be restricted to lands located west of Highway 2A.

A clear advantage to supplying a portion of the study area from the current WTP zone is that additional pumping from the North Reservoir will not be required for this area. Distribution pressure in the area will be fully dependent on the upstream supply pressure, and will fluctuate based on upstream conditions, as well as filling requirements for downstream reservoirs. It will be imperative that upstream supply mains be sufficiently sized in order to minimize headloss such that design filling rates do not result in less than minimum pressures in the study area.

If this concept were to be adopted, it is recommended that the associated storage volume be located at the North Reservoir due to risk of supply interruption along the future supply mains. In the event that stored water is required in order to maintain system pressure, a connection to the North Reservoir via a PRV will be required. However, this will not contain water supplied from the North Reservoir to the study area alone, as this zone would be interconnected to the WTP zone, and therefore the NRDRWSC supply main as well. Any contribution from the North Reservoir to a lower, eastern zone will result in providing pumped water to the NRDRWSC. It is conceivable that the reservoir could deplete sooner than anticipated due to downstream demands, if not controlled.

Following discussions with the City of Red Deer, it was determined that two servicing concepts would be put forward for review and consideration by the City. The first would be based on a traditional reservoir/pumphouse which will service the entire area as shown on **Figure 4-1**. The second will be based on utilizing existing pressure within the WTP zone for those areas within the study area which are located east of Highway 2A, as shown on **Figure 4-2**.

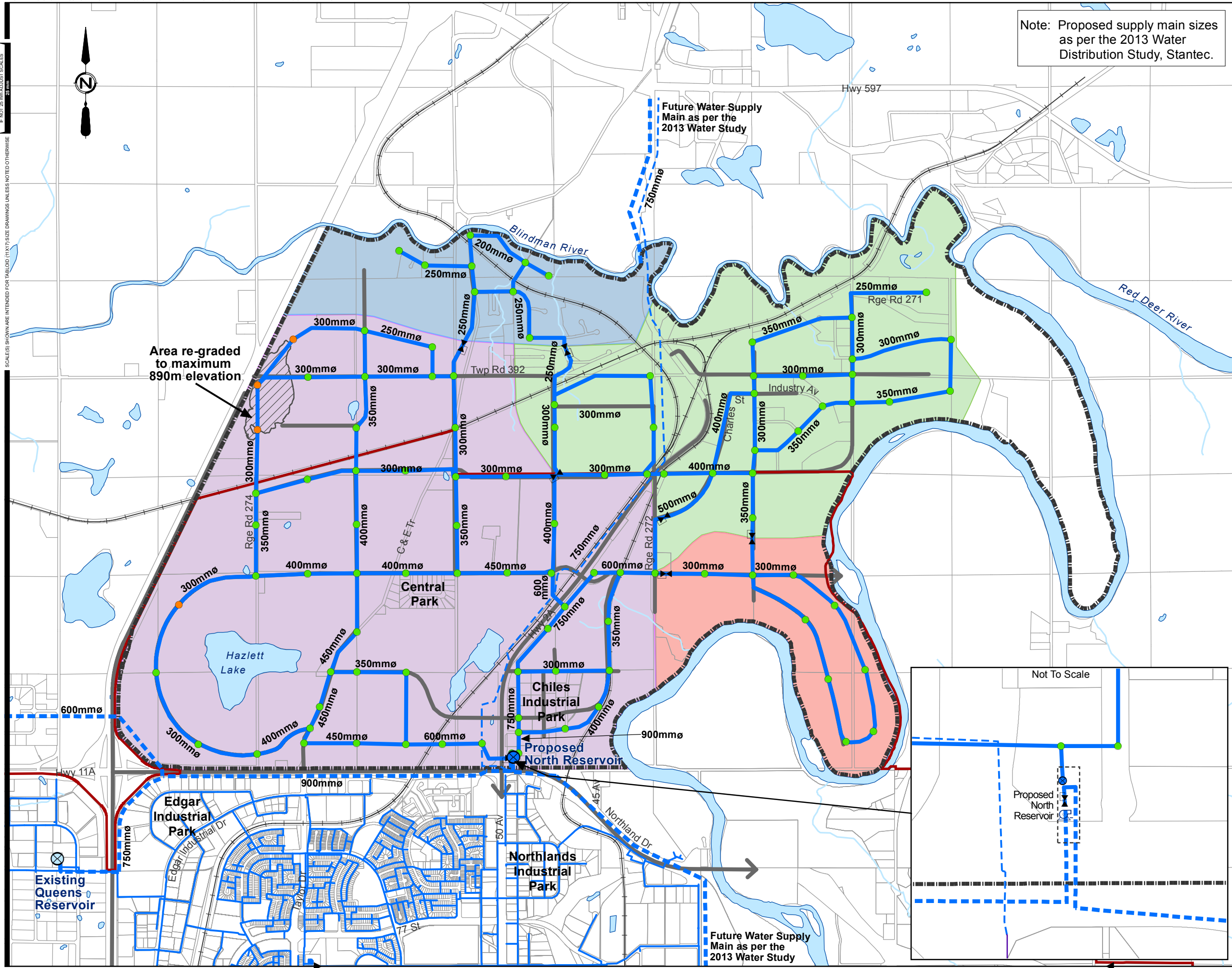
SCALE(S) SHOWN ARE INTENDED FOR TABLORD (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

IF NOT 20 mm AS SHOWN SCALES

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DATE: 6/13/2016, Kent Richardson



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



Legend:

- Existing Reservoir
- Proposed Reservoir
- Proposed PRV
- Proposed Pump

- Peak Hour Pressure
- < 300 kPa (43.5 psi)
 - 300 kPa (43.5 psi) - 345 kPa (50 psi)
 - 345 kPa (50 psi) - 551 kPa (80 psi)
 - 551 kPa (80 psi) - 586 kPa (85 psi)
 - > 586 kPa (85 psi)

- Existing Supply Main
- Proposed Supply Main
- Proposed Distribution Main
- Existing Distribution Main

- Pressure Zones
- HGL = 885m
 - HGL = 900m
 - HGL = 915m
 - HGL = 930m

- Proposed Transportation
- Study Area
- City of Red Deer



FIGURE No. 4-1
NORTH OF HIGHWAY 11A SERVICING STUDY

WATER
ULTIMATE WATER CONCEPT - OPTION 1

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

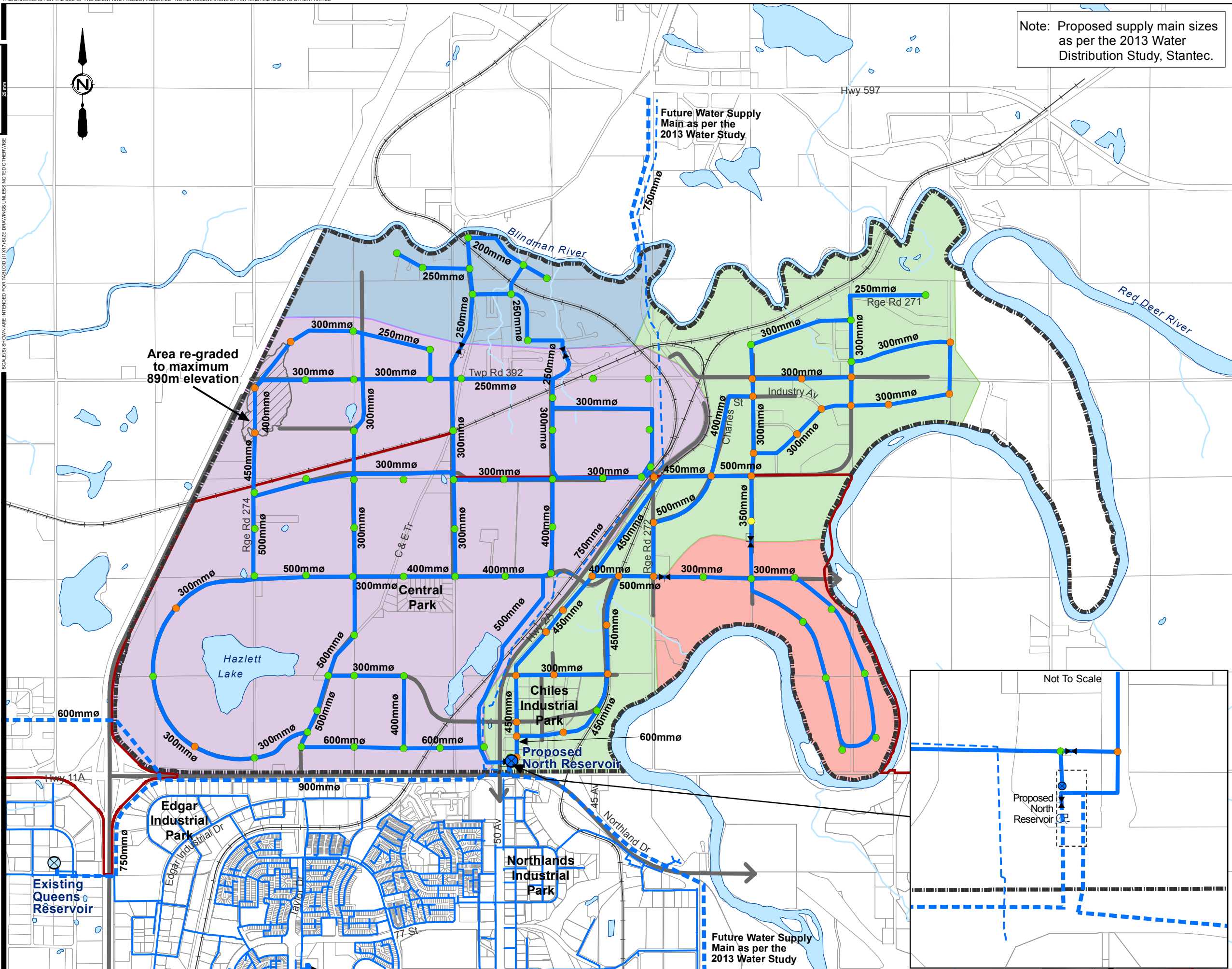


IF NOT 20 mm AS SHOWN SCALES

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



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



- Legend:**
- ⊗ Existing Reservoir
 - ⊕ Proposed Reservoir
 - ⊠ Proposed PRV
 - ⊡ Proposed Pump
- Peak Hour Pressure**
- < 300 kPa (43.5 psi)
 - 300 kPa (43.5 psi) - 345 kPa (50 psi)
 - 345 kPa (50 psi) - 551 kPa (80 psi)
 - 551 kPa (80 psi) - 586 kPa (85 psi)
 - > 586 kPa (85 psi)
- Supply Mains**
- Existing Supply Main
 - Proposed Supply Main
- Distribution Mains**
- Proposed Distribution Main
 - Existing Distribution Main
- Pressure Zones**
- HGL = 885m
 - HGL = 900m
 - HGL = 919m
 - HGL = 930m
- Other Features**
- Proposed Transportation
 - ▭ Study Area
 - ▭ City of Red Deer

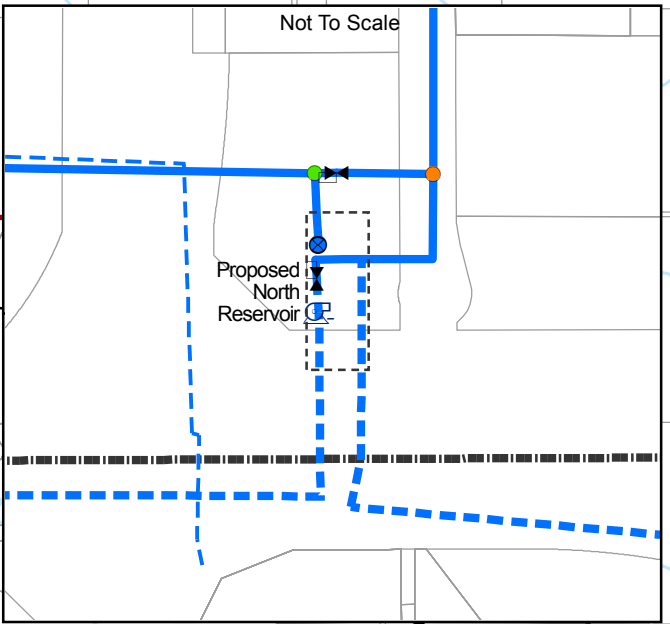


FIGURE No. 4-2
NORTH OF HIGHWAY 11A SERVICING STUDY
WATER
ULTIMATE WATER CONCEPT - OPTION 2

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

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DATE: 6/13/2016, Kent Richardson

4.1.3.3 Pressure Zone Delineation

It is proposed that the future pressure zone boundaries be revised from those presented in the 2013 Water Study, in the event that the North Reservoir and Pumphouse is to service the entire study area. Re-structuring the zone delineation based on topography rather than the highway, will allow for reduced large diameter main installation. It will be possible to install one shared main along Highway 2A, rather than two mains at two different zone pressures. It will also increase looped watermain connections creating a robust distribution system. It will require only one header pipe and set of pumps due to the single outgoing pressure zone, and may therefore result in a smaller pumphouse footprint and reduced pumphouse costs. It will also be possible to place PRV's in locations that will limit the maximum system pressure to 80 psi, rather than 85 psi.

In the event that the service area is to be split along Highway 2A, the pressure zone extents are not proposed to be modified significantly from that shown in the 2013 Water Study.

4.1.3.4 Utilization of NRDRWSC Supply Line

It is understood that the City is entertaining the option to purchase the existing 750 mm NRDRWSC supply line located south of the City limits. The intent is to use this watermain to service existing development in the area. The potential to incorporate the watermain into future development in the area is also to be investigated.

It is understood that the City is required to provide water at an HGL of 912 m at the Meter Vault located along Highway 2A, north of Highway 11A. It is also understood that the regional waterline has been designed to accommodate a maximum HGL of 919 m, which is consistent with the WTP pressure zone. There is a window of pressure at the current supply point which therefore must be provided both now and in the future, consisting of a range of 7 m (10 psi). However if the City integrates the NRDRWC pipe into their system, the location and pressure requirements for the NRDRWSC supply will need to be re-evaluated. In order to fully incorporate the NRDRWSC line into the future distribution system of the entire study area, the future North Pumphouse would be required to pump the regional flows in addition to the study area flows. Outgoing pressure would also need to be controlled via a pressure reducing valve (PRV) in order to protect the downstream pipeline. The 2013 Water Study identifies the future NRDRWSC max day flows as 985 L/s, while the current study area max day flows are calculated at 631 L/s. Therefore, accommodating the future regional flows will require a considerable increase in pumping capacity, which would otherwise not be required.

If not pumped, the NRDRWSC waterline could only service the study area located east of Highway 2A based on a supply HGL of 919 m from the WTP. If this portion of the study area were to be supplied directly from the WTP rather than from the proposed North Reservoir, then there may be a potential to incorporate the existing regional waterline within the future distribution system. This would require that the areas located east of the regional waterline become an extension of the Water Treatment Plant pressure zone at 919 m HGL.

Modelling results indicate that it is possible to incorporate capacity for future NRDRWSC growth within the distribution system through the oversizing of mains. Although potentially cost effective in the long run, this alternative has a risk associated with it. Such extensive growth is not assured and watermains within the eastern study area could end up vastly oversized for the foreseeable future if development beyond the Blindman River stalls. As such, it may not be prudent to oversize watermains within the study area to accommodate future NRDRWSC growth. The NRDRWSC ROW should be maintained however, in order to provide sufficient space to install a future twinned main when required.

If incorporating the NRDRWSC future twinned supply main within the distribution system, watermain sizes will increase from 500 mm and 500/450 mm to 750 mm and 600/500 mm north from the Highway 11A in order to supply the additional future flow of the NRDRWSC. Otherwise, a future twinned 750 mm diameter main will be required, as was identified in the 2013 Water Study.

4.1.4 Proposed Servicing Concepts

A large hill located in the north area of the study area creates a physical constraint in maintaining minimum pressure during the peak hour condition. It has been assumed that the area shown on both **Figures 4-1** and **4-2** will be re-graded to reduce the ground elevation by up to 10 m (to a maximum elevation of 890 m) in order to make the area more developable as well as to provide minimum pressure. If it is not possible to re-grade the area to this degree, then other possible solutions may include:

- Booster station;
- Trickle fill system (without fire flow provision);
- Increasing the zone pressure (minimally and depending on the servicing option selected); and
- Modifying the land use.

As such, the servicing options presented in the enclosed figures and discussed below, have been based on a maximum ground elevation of 890 m.

Option1 (Figure 4-1)

In this option, the supply mains will fill the North Reservoir, which will then pump into the study area at an HGL of 930 m. A 900 mm main will travel north, reducing to 750 mm and 400 mm mains within the Chiles Subdivision. A 600 mm main will travel west crossing the highway and railway tracks. The mains will reduce in size as they branch out into the development areas.

The primary pressure zone will be serviced directly from the North Reservoir and Pumphouse. Three additional pressure zones will be required in the north, northeast and southeast areas. A minimum of two PRV stations are recommended to service each of the proposed future pressure zones. The proposed pressure zones are as follows:

- Primary Zone: 930 m HGL
- North Zone: 900 m HGL
- Northeast Zone: 915 m HGL
- Southeast Zone: 885 m HGL

The resulting pressures through the study area distribution system range from 371 kPa (54 psi) to 544 kPa (79 psi) during the average day scenario, and 291 kPa (42.2 psi) to 531 kPa (77 psi) during the peak hour scenario. The maximum static pressure will be in the order of 579 kPa (84 psi) during low demand periods.

This option is anticipated to be the most simple to operate, and will result in more consistent zone pressures. However, all demand will be re-pumped which will result in higher associated pumping costs.

Option 2 (Figure 4-2)

The second option takes advantage of existing pressure provided by the WTP, whereby lands east of Highway 2A will operate as an extension of the WTP zone. The supply mains will fill the North Reservoir, as well as bypass the reservoir to supply the eastern portions of the study area. The North Reservoir will pump into the western portion of the study area at an HGL of 930 m.

Oversizing of mains east of Highway 2A will be required in order to incorporate capacity for future NRDRWSC growth within the distribution system. However, it is not necessary to accommodate the NRDRWSC, and twinning of the regional line can occur when required in the future.

A 750 mm main will be required extending west from the Pumphouse, reducing to 600 mm and 500 mm watermains. A 600 mm watermain will extend north from the Pumphouse which will reduce to 450 mm mains through the Chiles subdivision. The mains will reduce in size as they branch out into the development areas.

The primary western pressure zone will be serviced directly from the North Reservoir and Pumphouse. The primary eastern pressure zone will be an extension of the 919 m HGL system. Two additional pressure zones will be required in the north and southeast areas. A minimum of two PRV stations are recommended to service each of the proposed future pressure zones. The proposed pressure zones are as follows:

- Primary West Zone: 930 m HGL
- Primary East Zone: 919 m HGL
- North Zone: 900 m HGL
- Southeast Zone: 885 m HGL

The resulting pressures through the study area distribution system range from 371 kPa (54 psi) to 564 kPa (82 psi) during the average day scenario and 291 kPa (42.2 psi) to 517 kPa (75 psi) during the peak hour scenario. The maximum static pressure will be in the order of 538 kPa (78 psi) during low demand periods.

Fire flows will fully meet the design criteria of 300 L/s for commercial/industrial development in some locations in Option 2. The City is aware and accepts the model results as the actual fire flows for the particular developments have not been determined at this time.

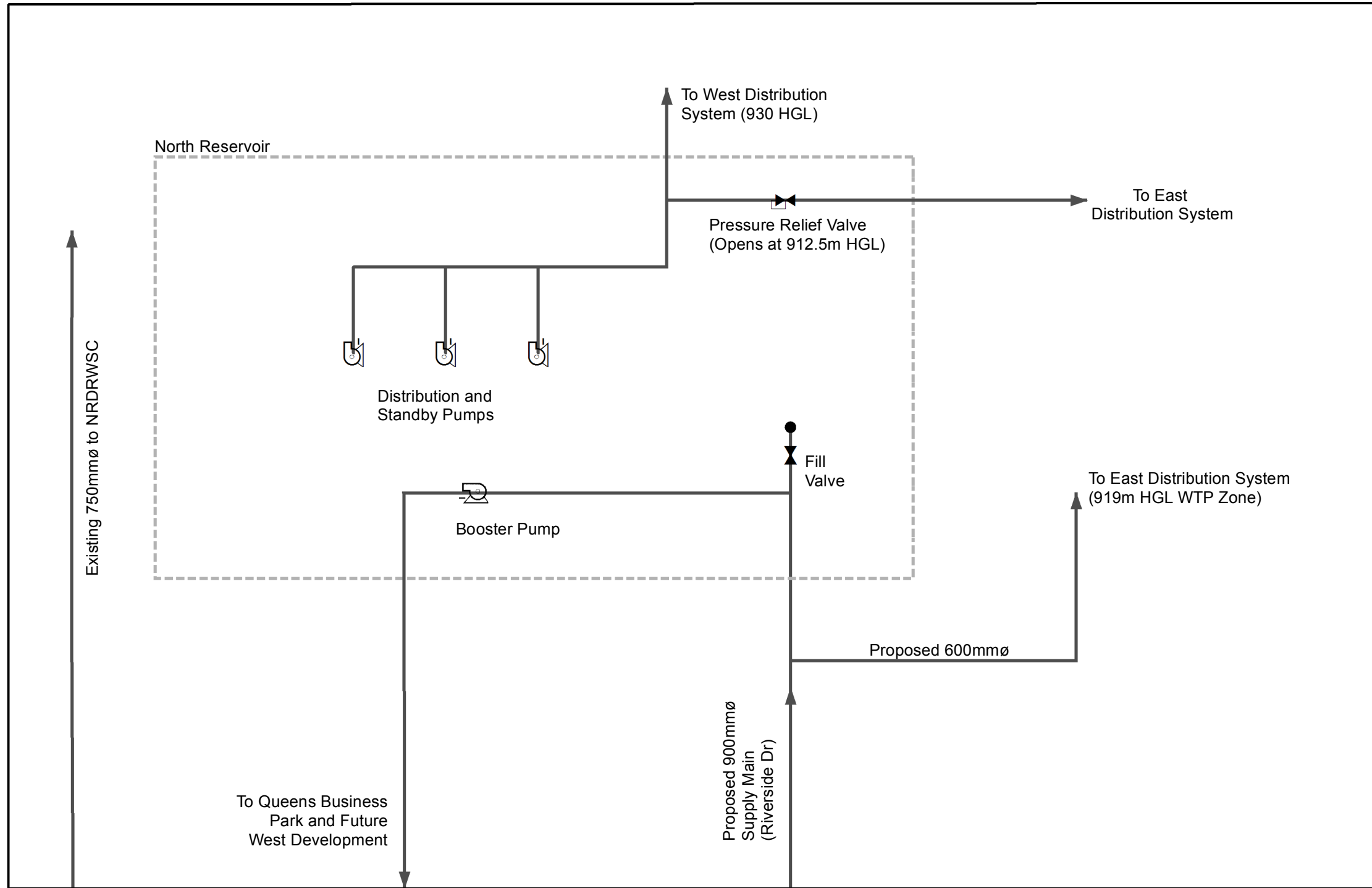
It will not be possible to operate the North Reservoir and Pumphouse like a typical floating style reservoir, which pumps into the adjacent area run daily to maintain pressure and turnover the reservoir. This is due to the minimum pressure requirement of the NRDRWSC, which will necessitate large diameter supply mains

in order to keep head losses relatively low. As well, regular pumping into the 919 m HGL zone by the North Reservoir will also supply the NRDRWSC, which would be wasteful in terms of unnecessarily pumping the regional flows.

Sufficient supply pressure will need to be ensured in order to meet distribution system pressure and fire flow requirements. However, it is assumed that sufficiently sized upstream mains will be installed in order to supply the commission as well as multiple future reservoirs downstream. As well, a PRV connection to the higher, western zone can be provided if required, although careful attention to the setpoint must be made in order to ensure that re-circulation of the water from the higher zone to the lower zone does not generally occur. The model results indicate that a PRV setpoint at an HGL of 912.5 m will be required to meet minimum peak hour pressures. Reservoir filling may need to be halted or reduced during peak demand periods while the PRV is active, to discourage re-circulation in the system.

Figure 4-3 provides a schematic drawing for the operation of the north reservoir for Option 2.

North Reservoir Schematic - Option 2



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DATE: 6/13/2016, Kent Richardson

SCALE(S) SHOWN ARE INTENDED FOR TABLOAD (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE
IF NOT 25 mm AS SHOWN SCALES



FIGURE No. 4-3
NORTH OF HIGHWAY 11A SERVICING STUDY
NORTH RESERVOIR SCHEMATIC

AE PROJECT No.	20153382
SCALE	1:31,785
APPROVED	
DATE	JUNE 2016
REV	
DESCRIPTION	ISSUED FOR FINAL REPORT

Comparative advantages and disadvantages for each servicing concept are outlined below:

Option 1

Advantages

- Simple to operate.
- Service area will be unaffected by potential upstream pressure fluctuations.
- Storage capacity is easy to access.
- Stored water will be accessed by the study area only.

Disadvantages

- Increased pumping costs.
- Does not take advantage of available pressure within the system.

Comments

- It will not be possible to integrate the NRDRWSC waterline within the proposed distribution system, if the NRDRWSC waterline is to remain supplied by the WTP Zone, and the Study Area is to be serviced by the North Reservoir. Significant additional pumping will be required if the NRDRWSC Waterline is to be served via the North Reservoir.

Option 2

Advantages

- Takes advantage of available pressure.
- Will require less pumping effort and therefore reduced pumping costs.

Disadvantages

- Potential pressure fluctuations due to upstream conditions and filling of reservoirs and commission
- Storage from the future North Reservoir will not be regularly accessible to lands east of Highway 2A within the study area, however, could be accessed in emergency or low pressure conditions.
- When storage is accessed by lands east of Highway 2A during low pressure scenarios, it will be possible for pumped water from the North Reservoir to travel beyond the study area, including to the NRDRWSC.

Comments

- Can easily integrate the NRDRWSC waterline within the proposed distribution system (919 m HGL zone), if desired.

Recommendation:

It is generally recommended that the City consider proceeding with Option 2 in order to make use of existing pressure in the system. It will be necessary to ensure that adequate pumping and supply main

capacity precede development in the area, to ensure that adequate pressure is available to meet the supply agreement with the NRDRWSC.

4.1.5 Future North Reservoir

A schematic of the future North Reservoir is shown on Figure 4.3 for Option 2. As show in the figure, Option 2 assumed that water supplying lands east of Highway 2A will bypass the North Reservoir altogether. Distribution and standby pumping for lands west of Highway 2A will be supplied via the North Reservoir. A fill valve will ensure that minimum upstream pressures will be sustained, such that low zone pressures are not experienced during filling of the North Reservoir. A Pressure Relief Valve will be located in the Pumphouse, which will open upon low upstream pressure to support the WTP Zone (lands east of Highway 2A).

An in-line booster pump which will supply the Queens Industrial Park and future west development directly is identified as house within the future North Pumphouse.

As identified in the Design Criteria – Section 2, storage requirements will be based on the following basis:

$S = A + B + \text{the greater of C or D}$:

- S = total storage requirement, m^3
- A = Fire protection storage, m^3
- B = Equalization storage= 25% Peak Day, m^3
- C = Emergency storage = 15% of Average Day, m^3
- D = Disinfection contact (CT) storage, m^3

Based on the fire flow criteria, the resultant storage volume required for fire protection is $4,320 m^3$. This volume is based on a fire flow of 300 L/s for duration of 4.0 hours. This volume of storage is to be in addition to the other operational storage needs. **Table 4-1** provides the required storage for the proposed North Reservoir.

Table 4-1
North Reservoir Storage Requirements

AD L/s	MDD L/s	Equalization m ³	Emergency m ³	Fire Storage m ³	Total Storage m ³
347	555	11,988	4,497	4,320	20,805

For Option 1, pumping requirements will need to accommodate the greater of the max day demand plus fire flow, and the peak hour demand, as shown in **Table 4-2**. Modelling results indicated that the peak hour pumping rate may reduce to approximately 750 L/s in Option 2 due to direct contribution from the WTP zone, however, a conservative approach would be to maintain full peak hour pumping at 1,000 L/s.

Table 4-2
North Reservoir Pumping Requirements

MDD + Fire L/s	Peak Hour L/s	Required Pumping Capacity L/s
855	1,000	1,000

4.1.6 Future Supply Mains

The size of future supply mains has not been assessed and it has been assumed that sufficient supply and pressure will be provided such that a minimum HGL of 912m, can be achieved at the NRDRWSC meter vault location. It is recommended that further study be undertaken in order to confirm the projected future design population and associated flow for all serviced areas including the current study area, Queens Business Park, the NRDRWSC and lands further to the west. Additional design criteria such as the pipe roughness coefficient C-Factor values should also be confirmed prior to pipe size selection.

However, based on the ultimate system model provided, it appears that an HGL of 912 at the NRDRWSC meter vault may not be fully met during reservoir filling scenarios. Based on the installation of two 1050 mm mains (a previous concept), the supply pressure during the max day filling scenario is anticipated to be approximately 911.5 m HGL, with velocities within the mains at 1.2 m/s. This is slightly below the agreed HGL requirement, however, has been based on potentially conservative design demands. The HGL would be expected to be somewhat lower if 900 mm and 1050 mm diameter supply mains are installed. These pipe sizes provide ample pressure to fill the future North Reservoir.

Supply details to the North Reservoir will require further thought which will include the pumping concept to the Queens Business Park and development further west. An in-line booster-station located at the North Reservoir has been considered for the purpose of this report.

4.1.7 WTP Pump Capacity

An assessment of the WTP pump capacity has been undertaken to establish the servicing capacity that can be used to service the North of Highway 11A study lands. The assessment considers only the existing system demands, and does not consider growth elsewhere in the system. **Tables 4-3** and **4-4** present the assessment based on servicing Options 1 and 2. In both options, additional pumping capacity will be required to accommodate the entire study area.

Table 4-3
WTP Pumping Capacity: Servicing Option 1

Demand Scenario	Demands (L/s)			WTP Pumping Surplus/Deficit (L/s)
	WTP Existing	N. Hwy 11A Area	Total	
Average Day	503.5	347	850.5	511.5
Peak Day	730.1	555	1285.1	76.9
Peak Hour ¹	877.1	555	1432.1	-70.1
Night Filling ¹	888.2	555	1443.2	-81.2
Peak Day plus Fire Flow ²	614.9	555	1169.9	192.1

¹ It is assumed that the peak day demand of 555 L/s will be maintained during peak hour and night filling operations.

² The system will have the capacity to supply the peak day demand during fire flow conditions; however, it is assumed that filling can be interrupted during fire flow scenarios.

Table 4-4
WTP Pumping Capacity: Servicing Option 2

Demand Scenario	Demands (L/s)			WTP Pumping Surplus/Deficit (L/s)
	WTP Existing	N. Hwy 11A Area	Total	
Average Day	503.5	347	850.5	511.5
Peak Day	730.1	555	1285.1	76.9
Peak Hour ¹	877.1	702	1579.1	-217.1
Night Filling ²	888.2	407	1295.2	66.8
Peak Day plus Fire Flow ³	614.9	555	1169.9	192.1

¹ Demand is based on Peak Day west of Highway 2A and Peak Hour east of Highway 2A (is directly connected)

² Demand is based on Peak Day west of Highway 2A and night demand east of Highway 2A (1/3 of Peak Day)

³ Based on the peak day demand for the entire study area (is greater than the peak day plus fire flow demand east of Highway 2A).

4.1.8 Cost Estimate

Detailed cost estimates are provided in **Appendix B** based on individual watermain sections, along with unit costs for installations in developed and undeveloped lands. As well, watermain node reference plans are included in **Appendix B** for both servicing options. The costs include an allowance of 30% for contingency and engineering. The costs presented are in 2016 dollars and do not include GST. Costs are not included for supply mains or future trunking of the NRDRWSC watermain. **Table 4-5** presents a summary of the cost estimate for water servicing for options 1 and 2.

**Table 4-5
Preliminary Cost Estimate – Water Distribution**

Description	Quantity	Total Cost
Option 1		
Watermains	50.6	\$ 68,559,400
PRV Stations	6	\$ 1,200,000
North Reservoir and Pump House	1	\$ 22,860,000
Total Cost		\$ 92,619,400
Cost Per Developable Hectare (1,721 ha)		\$53,817
Option 2 – Recommended Option		
Watermains	53.8	\$ 72,282,000
PRV Stations	5	\$ 800,000
North Reservoir and Pump House	1	\$ 22,860,000
Total Cost		\$ 95,942,000
Cost Per Developable Hectare (1,721 ha)		\$ 55,715

4.2 SANITARY SEWER SYSTEM

4.2.1 Ultimate Servicing

Ultimate sanitary servicing for the study area has been analyzed in detail and considers sewershed delineation, sanitary system sizing, operation, alignment, lift station locations, among others items. The design assumptions used for this analysis have been outlined in Section 2 – Design Criteria.

4.2.2 Sanitary Sewer System

The sanitary sewer system alignment and sizes beyond the study boundary were not reviewed or validated. It is assumed that the City will install the necessary sanitary system outside the study area (including sanitary mains and lift station/force mains) to facilitate conveyance. It should be noted that the offsite areas serviced are substantial and represent significantly large development areas and design flows. **Table 4-6** summarizes the offsite flows that are considered as part of the wastewater servicing concept for the north of Highway 11A service area.

Table 4-6
Summary of Offsite Flows from Future Development Areas

Description	Developable Area (Approximate)	Peak Design Flow	Location for Addition of Flows
Future development to the west of Highway 2 and to the south of Highway 11A	4,700 ha	3,000 L/s	HWY 2 & HWY 11A
Future development to the west of Highway 2 and to the north of Highway 11A	1,370 ha	700 L/s	Intersection of HWY 2 and rail crossing to the North of HWY 11A
Future development to the west of Highway 2 and in close proximity to Twp Rd 392	250 ha	130 L/s	Intersection of Highway 2 and Twp Rd 392

It should be noted that the North Red Deer Regional Wastewater Commission (NRDRWWC) is in the design phase of a regional wastewater system that will convey raw wastewater to the City of Red Deer Wastewater Treatment Plant from the Town of Blackfalds, the City of Lacombe, and Lacombe County. At the time of writing this report, the location of the tie-in to the City's system has not been established but it is expected to tie-in between the north east corner of the Chiles Industrial Subdivision and the City of Red Deer Wastewater Treatment Plant. A tie-in to the City of Red Deer's wastewater collection system may provide opportunities for shared use infrastructure for the City and the NRDRWWC.

Odour management should be considered at the tie-in point where sewage from the regional system enters the City's wastewater collection system.

4.2.2.1 Sanitary Sewershed Delineation

The sanitary sewershed boundaries have been revised from those presented in the 2013 Wastewater Study based on topography. The study area is characterized by undulating terrain for the most part, which required a detailed analysis of the topography. The sags and crests along the future sanitary alignments were identified, to more precisely ascertain the serviceability and depth of future pipes and manholes. The sub catchments were delineated based on the location of the manholes and aggregated based on proposed trunks. The aggregated sub catchments are presented in **Figure 4-4**.

The undulating terrain required deeper manholes which were avoided where possible but not eliminated. The manhole depths should be revisited as a part of the preliminary/detailed design. Future sanitary sewers follow the road alignments for the most part, except where constrained by topography or physical features such as lakes/water bodies. The offsite areas were not evaluated in detail as this was beyond the scope of this study, and the sewershed boundaries and areas from the 2013 Wastewater Study were used for these areas.

4.2.3 Proposed Servicing Concept

The study area is proposed to be serviced by a combination of gravity mains and lift station/forcemains.

The topography within the Highway 11A corridor presents some challenges for gravity servicing. Therefore, two servicing options have been identified for wastewater trunks within the Highway 11A corridor based on gravity trunk systems and pumped systems respectively. The following provides a summary of the two servicing options that were evaluated for the Highway 11A corridor.

Option 1: Gravity trunks within the Highway 11A Corridor

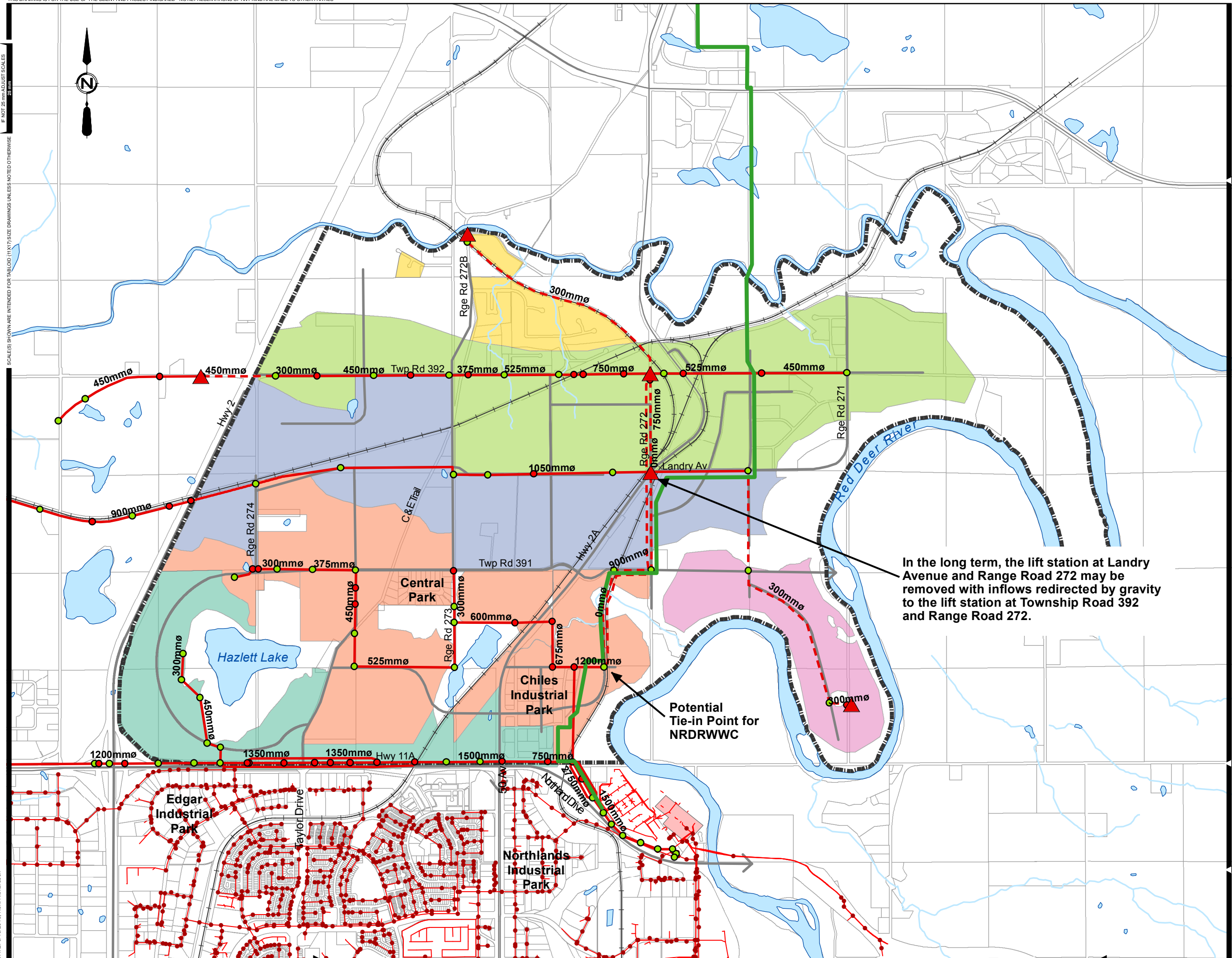
Option 1 provides gravity trunks for the full length of the wastewater collection system along Highway 11A and to the Wastewater Treatment Plant.

Option 2: Lift station and forcemains within the Highway 11A Corridor

Option 2 includes a wastewater lift station with forcemains within the Highway 11A corridor that are positioned to avoid the need for deep gravity trunks. The lift station is shown to the west of Range Road 274 with forcemains extending approximately 1 km to the east of the proposed lift station.

Figure 4-4 and **Figure 4-5** show the alignment of the trunks, force mains, and lift stations for Options 1 and 2 respectively.

SCALES(S) SHOWN ARE INTENDED FOR TABLORD (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE
 IF NOT 25 mm AS SHOWN SCALES



- 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

In the long term, the lift station at Landry Avenue and Range Road 272 may be removed with inflows redirected by gravity to the lift station at Township Road 392 and Range Road 272.

Potential Tie-in Point for NRDRWWC



FIGURE No. 4-4
 NORTH OF HIGHWAY 11A SERVICING STUDY
 ULTIMATE WASTEWATER CONCEPT OPTION 1 WITH CATCHMENT AREAS

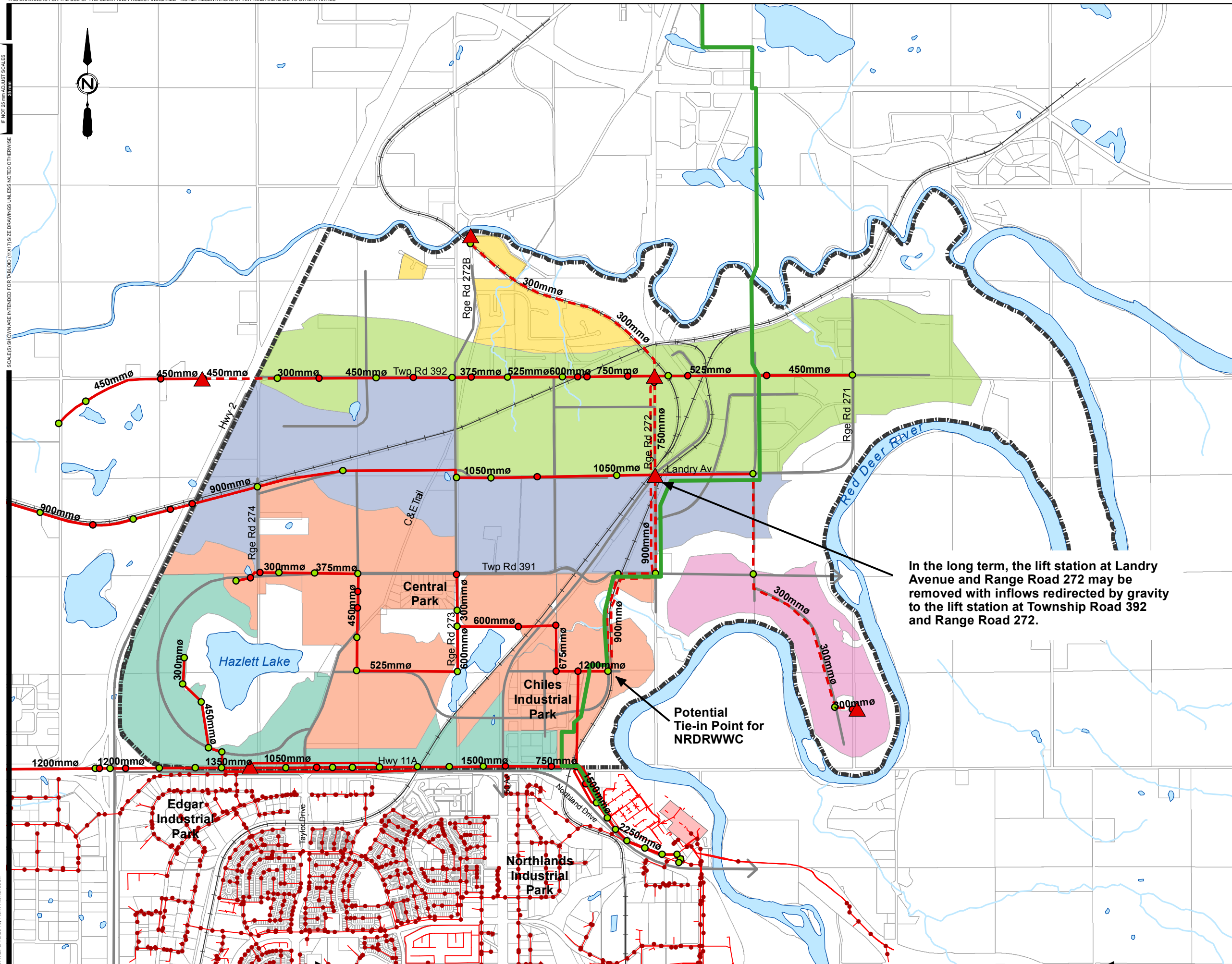
AE PROJECT No.	20153382
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DATE	JUNE 2016
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DESCRIPTION	ISSUED FOR FINAL REPORT

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 DATE: 6/13/2016, Kent Richardson

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

IF NOT 20 mm AS JUST SCALES

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DATE: 6/13/2016, 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



In the long term, the lift station at Landry Avenue and Range Road 272 may be removed with inflows redirected by gravity to the lift station at Township Road 392 and Range Road 272.

Potential Tie-in Point for NRDRWWC

FIGURE No. 4-5

NORTH OF HIGHWAY 11A SERVICING STUDY

ULTIMATE WASTEWATER CONCEPT OPTION 2 WITH CATCHMENT AREAS

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

The future growth model for scenario 2 of the 2013 Wastewater System Study provided by Stantec Consulting was used to analyze the study area. Additional manholes were added to the model to represent the variation in topography, and the catchment areas were re-delineated and reassigned to the manholes.

Offsite flows from future development areas were accommodated in the ultimate servicing concepts that were developed. Offsite flows represent significant contributions to the ultimate design flows and had significant impacts on the sizing of the system.

The study area can be subdivided into 5 catchments, based on the trunk it is serviced by. **Table 4-7** shows a summary of the developable/developed areas, and the corresponding land use for each catchment.

Table 4-7
Summary of Developable/Developed Area in Each Catchment by Land Use

Catchment	Developable Area (ha)	Residential	Industrial	Commercial	Mixed	Community Facility
A	205	112	19	67	7	
B	416	129	160	86		41
C	388	255	133			
D	120	120				
E	525	280	245			
F	67	67				
Total	1,721	963	557	153	7	41

Each of the catchments has been discussed further including the infrastructure required to service the catchment. The catchment areas are shown on **Figure 4-4** and **Figure 4-5**.

Catchment A: This catchment is located immediately north of Highway 11A, and is bounded by Highway 2 on the west and CNR on the east. The total service area in this catchment is 205 ha, and is comprised of residential, industrial, commercial and mixed land uses.

The trunks servicing Catchment A have been sized to carry offsite flows from the areas to the west of Highway 2 in addition to the flows generated within the North of 11A study area. The offsite areas have not been analyzed as a part of the study and the wastewater flows from the 2013 Wastewater Study have been used. The following Table notes the approximate peaks wastewater flows that are attributable to the North of Highway 11A area and the offsite areas (west of Highway 2).

Table 4-8
Catchment A – Wastewater Flow Sources

Wastewater Flow Source	Approximate Peak Flow
North of 11A – Catchment A	85 L/s
Offsite service areas (west of Highway 2)	3,000 L/s

The Table above shows that the flows required for Catchment A in the North of 11A Service area account for less than 3% of the peak flows that will be conveyed along the Highway 11A corridor.

Two options were evaluated for wastewater conveyance along the Highway 11A corridor to compare the configurations for gravity trunks in contrast to pumped system with a lift station and forcemain.

Option 1: Gravity trunks within the Highway 11A corridor

Option 1 provides gravity trunks for the full length of the wastewater collection system along Highway 11A and to the Wastewater Treatment Plant. The gravity system requires twin (two) 1350 mm gravity trunks to convey the peak flow of approximately 3,085 L/s. The deep gravity trunks would reach a maximum depth of 11 m along the Highway 11A corridor. For pipe deeper than 7 m, trenchless installation (pipe jacking) would likely be required. Based on the profile of the gravity trunks along the Highway 11A corridor, it is estimated that 1,150 m of pipe would require trenchless installation. The following figure shows the profile of the gravity trunk system for Option 1.

Option 2: Lift station and forcemains within the Highway 11A corridor

Option 2 provides a wastewater lift station to the west of Range Road 274. Wastewater would be pumped through twin (two) 1,050 mm forcemains for a distance of approximately 1,100 m before discharging into the gravity system that leads to the Wastewater Treatment Plant. Through implementing Option 2, the City can avoid the deep trunk gravity sewers that would be required for the gravity system in Option 1. The following profile illustration has been exported from the PCSWMM model to show the profile of the proposed system for Option 2.

There is a ridge across Highway 11A in the vicinity of Range Road 274, where an 11 m deep 1,500 mm trunk (Option 1) or a lift station and twin (two) 1,050 mm force mains (Option 2), are required to service this area and convey the sanitary flows to the WWTP. The deep trunk/lift station will discharge to a 1,500 mm trunk that is reduced in size to a 750 mm trunk at 12.5 % slope and will ultimately discharge to the WWTP through a 2400 X 2250 mm box culvert.

Figures illustrating the two wastewater conveyance options for the Highway 11A corridor are illustrated in the following profile figures.

Figure 4-6
Option 1 Wastewater Profile: Gravity Trunks Within the Highway 11A Corridor

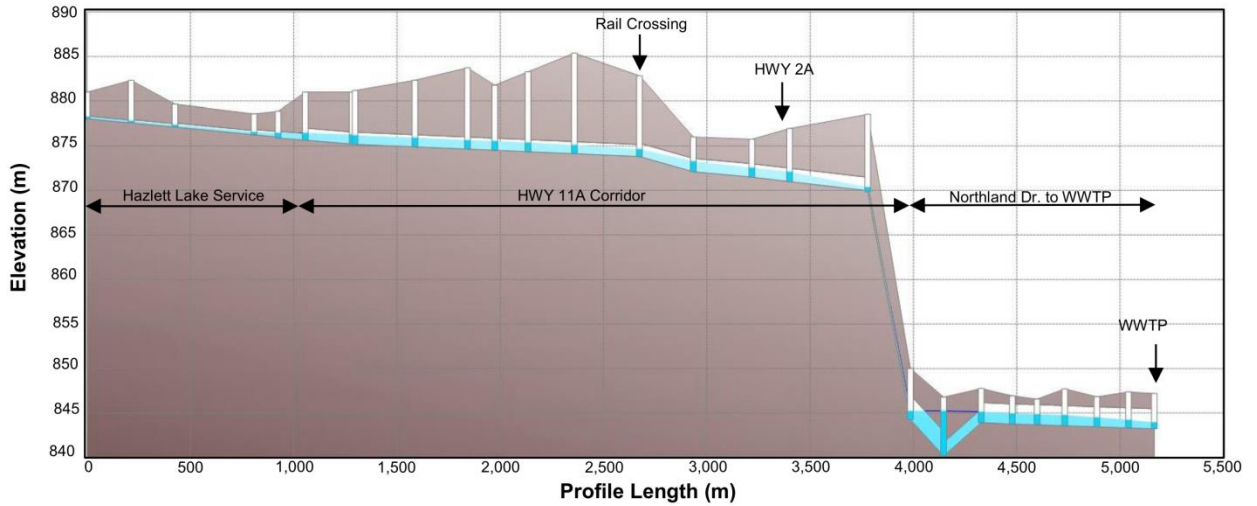
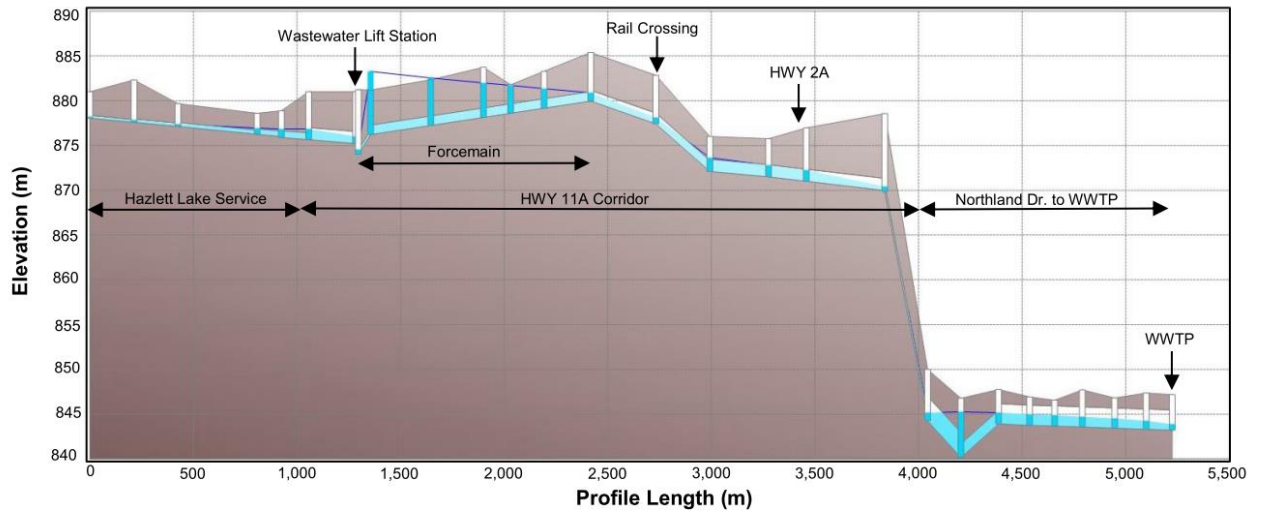


Figure 4-7
Option 2 Wastewater Profile: Lift Station and Forcemains Within the Highway 11A Corridor



The two options required to service this area have been analyzed and the detail cost estimates shown in **Appendix C**. The cost analysis shows that the capital cost for Option 1 (Gravity Trunks) is approximately \$1.8M higher than the capital cost for Option 2 (Lift Station & Forcemain).

Option 1 will avoid future operation costs involved with the lift station. The major disadvantage to Option 1 however, is the maintenance of the deep trunks which can be cumbersome.

Catchment B: This catchment is located between catchments A and C, and bounded by Highway 2 on the west and RR 272 on the east. The service area in this catchment is a mix of residential, commercial, industrial and community facilities. The general direction of flow in this basin is from north west to south east. The sanitary trunk in this catchment changes alignment instead of going straight along Township Road 391, to account for topography and to improve serviceability. The gravity main sizes in this catchment will range from 300 mm to 1200 mm discharging to a 900 mm trunk at 3.4 % slope which will discharge to the Wastewater Treatment Plant. This catchment does not have any offsite areas discharging to it.

Catchment C: This catchment is located between Catchments B and E, and bounded by Highway 2 on the west and Red Deer River on the east. The service area is a mix of residential and industrial land uses. Sizing of the trunks in this catchment has been made to accommodate the flows within the North of Highway 11A study area in addition to offsite future development areas to the west of Highway 2.

Flow allowances for future development to the west of Highway 2 are equivalent to 700 L/s in the trunk required for Catchment C. Wastewater flows from the offsite areas were taken from the City's 2013 Wastewater System Study and were not reassessed as part of this study.

The northern portions of the catchment are at a lower elevation than the southern portions of the catchment and will require a lift station and force main to service this catchment. (Catchments E and F are at lower elevation than this Catchment C and will also need to be serviced by lift stations) A 2 km forcemain with a diameter of 900 mm will pump wastewater from the intersection of Range Road 272 and Landry Avenue to the gravity main in the NE corner of the Chiles Industrial Park, from which wastewater can be conveyed by Gravity to the Wastewater Treatment Plant. The 900 mm wastewater forcemain in Catchment C is sized to accommodate flows from Catchment D and E which will be conveyed through the 900 mm forcemain in the long-term servicing plan. The gravity mains in this catchment range from 450 mm to 1,050 mm.

It should be noted that the lift station proposed at the intersection of Range Road 272 and Landry Avenue is considered to be an interim lift station that may be taken out of service following the construction of the lift station shown in Catchment E at the intersection of Range Road 272 and Township Road 392. Upon the removal of the lift station at the intersection of Range Road 272 and Landry Avenue, flows can be conveyed by a gravity to the Lift Station at Range Road 272 and Township Road 392.

Catchment D: Catchment D is located in the Red Deer River Valley. The land use plan for this area has not been finalized yet, and this area may be developed as a residential neighbourhood, or left as an open space. For the purpose of this study, it has been assumed that this area will be developed as residential land use. This catchment is approximately 30 m lower than the areas to the north and west, thus requiring a

lift station and force main to service this area. The force mains from this area tie into the gravity main along Landry Avenue, which drains to the lift station for Catchment C, and ultimately to the gravity main at the NE corner of the Chiles Industrial Park.

Catchment E: This catchment is located along Township Road 392 and generally drains towards it. The land use in this catchment is primarily residential and industrial to the west and east of Range Road 272 respectively. This catchment is located at an elevation lower than Catchment C, and will require a lift station and forcemain to service the proposed area. The gravity mains in this catchment range from 300 mm to 750 mm while the force mains in this catchment are 750 mm.

Flow allowances for future development to the west of Highway 2 are equivalent to 130 L/s in the trunk required for Catchment E.

The lift station on Range Road 272 and Landry Avenue can be decommissioned in the future with all flows directed to the lift station at Township Road 392 and Range Road 272. This would reduce the long-term operations and maintenance requirements for the wastewater collection system.

Catchment F: This catchment is located to the north of Catchment E, and bounded by Blindman River to the north, Highway 2 to the west, and CNR to the east. The catchment comprises of existing country residential lots, in the Blindman River valley and is approximately 30 m lower than Catchment E. The existing development will have to be serviced by a lift station and force main, tying into the lift station for Catchment E, which will ultimately discharge to the WWTP.

4.2.4 Cost Estimate

The preliminary costs associated with the future sanitary system for both options presented are summarized in **Table 4-9**.

**Table 4-9
Preliminary Costs – Sanitary Sewer**

Description	Quantity	Total Cost
Option 1 – Gravity trunks within the Highway 11A corridor		
Gravity Mains	23.6 km	\$ 82,707,300
Forcemains	7.5 km	\$ 8,641,100
Lift Stations	4	\$ 35,057,000
Total Cost		\$ 126,405,400
Cost Per Developable Hectare (1,721 ha)		\$ 73,449
Option 2 – Lift station and forcemains within the Highway 11A corridor		
Gravity Mains	20.9 km	\$ 62,153,000
Forcemains	9.6 km	\$ 13,614,900
Lift Stations	5	\$ 48,837,000
Total Cost		\$ 124,604,900
Cost Per Developable Hectare (1,721 ha)		\$ 72,403

Note: Pipes within Catchments A, C, and E include infrastructure sizing to service areas outside of the North of Highway 11A study boundary.

Detailed cost estimates for the gravity mains, forcemains, and lift stations for each phase of development are provided in **Appendix C** and are based on individual sanitary sewer sections along with unit costs for installation in undeveloped lands. The costs include an allowance of 30% for contingency and engineering. A lump sum cost of 2% has been added to each lift station cost to account for odour control systems. The costs presented are in 2016 dollars and do not include GST.

Two options were evaluated in Catchment A, as discussed previously for cost effectiveness. The costs associated with Option 1 (deep trunks) were found to be approximately \$1.8M higher than Option 2 (lift station and forcemain), and would avoid the future operation costs associated with the lift station.

4.3 STORMWATER DRAINAGE SYSTEM

4.3.1 Ultimate Servicing

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.

As shown in **Figure 2-1** (land use), approximately 1,721 ha of developable area is included in the study area which includes a mix of industrial, commercial and residential land uses. Approximately 762 ha of the study area is considered undevelopable area that includes natural zones, designated as parks and natural reserves, which provide attenuation of peak flows during a storm event.

The following sections provide a summary of the stormwater management requirements and the ultimate servicing drainage concept to assist with the planning of the future development areas within the servicing study area.

4.3.2 Existing Topography and Natural Features

Manifold GIS software and DEM data were used to generate detailed contours, overland drainage paths and sag locations to assess the major drainage system for the project area. The DEM data was also used to delineate general and detailed catchment boundaries for the existing and future conditions. The existing topography of the project area is shown in **Figure 4-8**.

Figure 4-8 shows the topography using 1 and 5 m contour intervals. Based on the contours, the future development area is divided into two drainage basins, the Blindman basin and the Red Deer River basin. Both basins seem to have a good natural drainage system which will facilitate the intersection of surface runoff through a series of ditches, culverts and storm sewer systems (where necessary) towards the proposed stormwater management facilities.

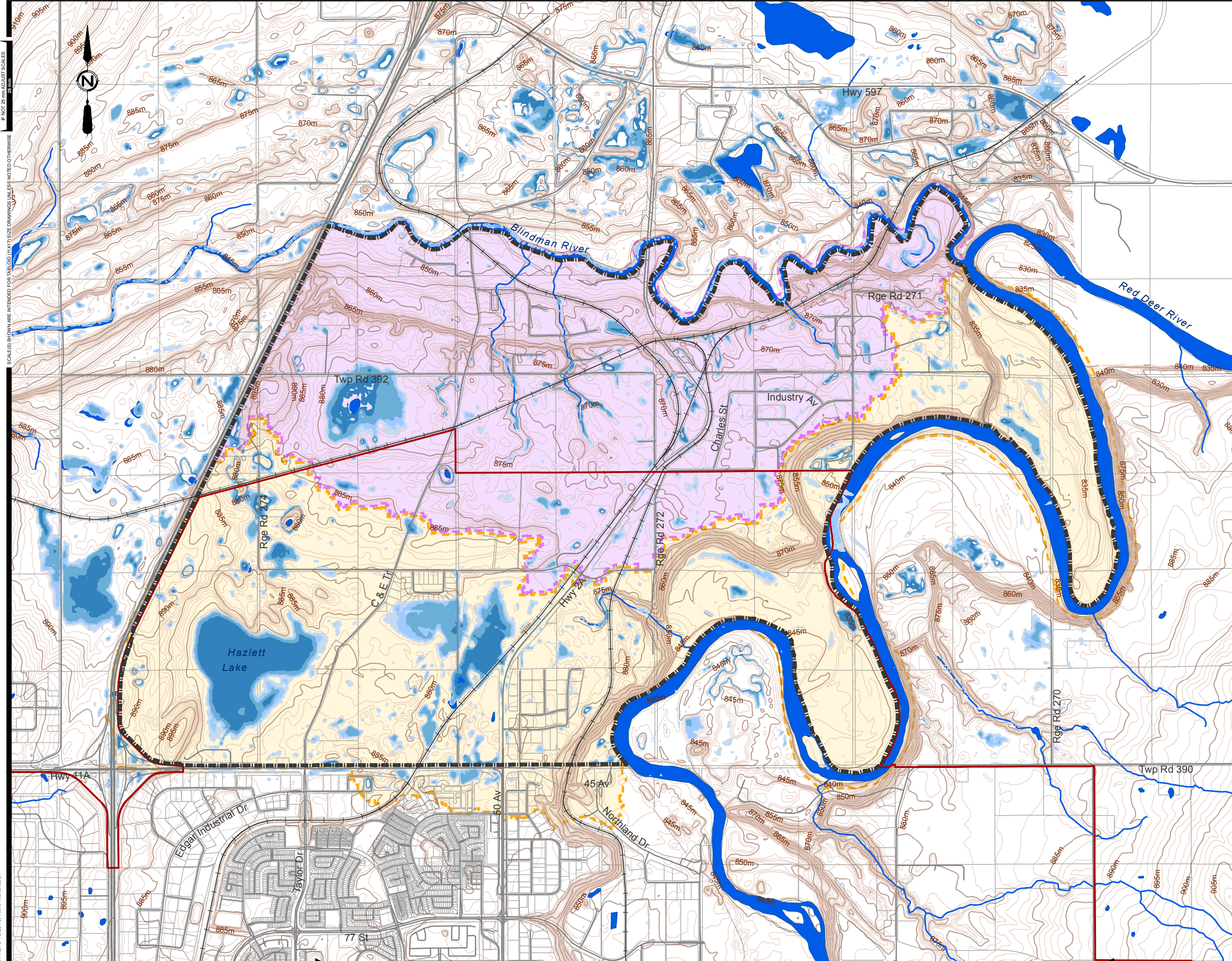
There are few sags areas within the project boundaries, as shown in **Figure 4-8**. The most significant sags (not including existing wetlands and lakes) has approximate ponding depths between 0.5 m – 1m, specifically south of Central Park subdivision which is consistent with observed ponding issues in previous years.

The Hazlett Lake and the lake on the IPSCO property are also part of the natural features present within the project area. The surface runoff of the Red Deer River basin drains through these two natural lakes, and eventually discharges east towards the Red Deer River.

The following are key notes based on the analysis of the existing topography and 1 m contours:





- Approximately 1169 ha of the total area drains towards the Blindman River;
- Approximately 1635 ha of the total area drains towards the Red Deer River;
- A major trapped area is observed south of the Central Park subdivision;
- Approximately 273 ha and 417 ha drains directly to the Hazlett Lake and lake on the IPSCO property respectively; and
- Existing wetlands should be preserved as stormwater management facilities to provide additional storage within the future development area. A more detailed environmental study will be required during the development phase to confirm wetland classification and to establish environmental values for preservation.



THIS DRAWING IS FOR THE USE OF THE CLIENT AND PROJECT INDICATED - NO REPRESENTATIONS OF ANY KIND ARE MADE TO OTHER PARTIES





Legend:

Trapped Areas

-  0.1m - 0.3 m
-  0.3m - 0.5m
-  0.5m - 1.0 m
-  1.0m - 1.5m

-  Blindman River Catchment
-  Red Deer River Catchment

-  Contour 1m
-  Contour 5m



-  Study Area
-  City of Red Deer



FIGURE No. 4-8
NORTH OF HIGHWAY 11A SERVICING STUDY

STORMWATER
GENERAL TOPOGRAPHY

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