DRAFT REPORT

PREPARED FOR THE CITY OF GRAND FORKS

Sewer Phasing Plan Study

April 2018

URBAN systems

304 - 1353 Ellis Street,
Kelowna, BC V1Y 1Z9 | T: 250.762.2517

APRIL 2018 | File: 0788.0052.01

April 27, 2018

City of Grand Forks
PO Box 220
Grand Forks, BC   V0H 1H0

Attention: Dolores Sheets

Re: Sewer Phasing Plan

Attached please find a “Draft” report on the Sewer Phasing Plan as requested. We have included an “Executive Summary” of the findings and are reserving final recommendations pending City review of this draft.

We look forward to the City’s comments and completion of the assignment with your approval.

Sincerely,

Scott Shepherd, AScT

Peter Gigliotti, P. Eng

CONTENTS

APPENDICES

EXECUTIVE SUMMARY

This report was commissioned by the City of Grand Forks in April 2017 and was approved for funding assistance under the Clean Water and Wastewater Fund.

The first section of the report deals with the expansion of the City's sewer collection. It is the City's long-term goal to eliminate on-site ground disposal systems by connecting to the community sewer system. Since this will happen gradually, it is the intent of this report to assess which areas represent the highest priority with respect to safeguarding the environment, the quality of the City groundwater supply, and public health.

The second part of the report deals with biosolids and the available opportunities for reclamation of biosolids. These include biosolids that have accumulated over many years in the City's lagoon system, as well as the forecast quantities of biosolids produced by the wastewater treatment plant. The treatment plant is currently undergoing an upgrade to provide equipment for sludge dewatering.

Extension of Sewer Collection System

The scope of the work is limited to those parts of the City (7 neighborhood areas) that currently do not have community sewer service (see figure 2.1). These areas utilize on-site septic tank and ground dispersal systems. It is not intended to address the functionality of the existing sewer network, which was previously examined as part of a multi-utility risk assessment exercise.

The assessment of risk factors was undertaken by Golder Associates and provides a desktop overview of 5 parameters that relate to contamination risks:

- Soil types and permeability
- Slope
- Depth to groundwater
- Parcel size
- Distance to surface water and/or wells

A copy of the Golder Associates report is located in **Appendix A.** The overall risk factor for each area represents a blend of the Final Risk Rating Overview. The risk ratings are developed as numerical ratings 1 to 4. For the purpose of the assessment, a Risk Factor of 1 is interpreted to have the lowest risk; while a Risk Factor of 4 is interpreted to have the highest risk.

The resulting classifications are as follows:

Risk 3: Hwy 3 East

Risk 2 South Ruckles, Johnson Flats, SW Grand Forks, Donaldson

Risk 1: PW/Richmond, Airport Industrial

All of the "Various" areas are classified as Risk 2. It is assumed that these areas will be Pay-as-You-Go, since they are close to existing sewer and driven by new growth. The exception is the north end Industrial parcel, which requires a long extension of sewer along Granby Road.

The rankings, areas and number of parcels in each neighbourhood are summarized in **Table 4.2.** The study also includes a resident questionnaire to provide a sense of how many property owners are experiencing any issues with wastewater surfacing or problems with their septic systems. Capital cost estimates are developed for retrofit sewer installation for each area and priority rankings are suggested for a retrofit sewer program.

Table 4.2 also includes these estimated capital costs for retrofit community sewer in each of the seven neighborhoods. A copy of the proposed expansion is located in **Figure 4.1.**

Table 4.2 – Areas, Risk Factors and $ / Hectare

	Area	Overall Risk Factor	Area (ha)	Parcels (Dev and Undev)	Capital Cost Estimate ($M)	Average $ per ha
1	Hwy 3 East end	3	6	8	1.9	317,000
2	Public works & Richmond Ave Industrial	1	13	19	1.9	146,000
3	Airport / Industrial	1	40	33	1.7	42,500
4	South Ruckles	2	20	124	3.8	190,000
5	Johnson Flats	2	60	170	3.3	55,000
6	SW GF	2	53	101	2.4	45,000
7	Donaldson / NW	2	31	66	1.1	35,500

Some of the neighbourhoods have already been extensively subdivided (e.g. South Ruckles). Others consist of large parcels. The retrofit sewer quantities are based on provision of community sewer on existing roads. Collection system networks for future subdivision of large parcels are not included and are assumed to be "Pay-as-You-Go" (PYG) This means that future expansion of the sewer network would become the developer's responsibility and would be turned over to the City when completed.

The capital cost to service each area is divided by the number of existing parcels to arrive at a value per parcel, and by the number of hectares to arrive at the cost per hectare.

Two neighbourhoods are identified for further study in the context of risk level and potential cost of servicing per hectare: Johnson Flats and Donaldson.

The city wastewater treatment plant is currently being upgraded and provision is made for increased flows from potential infill and additional service areas.

1.0 INTRODUCTION

1.1 Subject and Purpose

This report was commissioned by the City of Grand Forks in April 2017. The report is to deal with the areas of the City that do not have a community sewer and are not connected to the existing network. It is the City's long-term goal to eliminate on-site ground disposal systems by connecting to the community sewer system. Since this will happen gradually, it is the intent of this report to assess which areas represent the highest priority with respect to safeguarding the environment, the quality of the City groundwater supply, and public health. The project was approved for funding assistance under the Clean Water and Wastewater Fund.

The study also includes an assessment of how the City can deal with the biosolids produced at their wastewater treatment plant, both from past accumulation and from ongoing production.

1.2 Scope

The scope of the work is limited to those parts of the City that currently do not have community sewer service. These areas utilize on-site septic tank and ground dispersal systems. It is not intended to address the functionality of the existing sewer network, which was previously examined as part of a multi-utility risk assessment exercise.

The assessment of risk factors is undertaken by Golder Associates (see **Appendix A** for a copy) and provides a desktop overview of 5 parameters that relate to contamination risks:

- Soil types and permeability
- Slope
- Depth to groundwater
- Parcel size
- Distance to surface water and/or wells

The study also includes a resident questionnaire to provide a sense of how many property owners are witnessing any is4sues with wastewater surfacing or problems with their septic systems. Capital cost estimates are developed for retrofit sewer installation for each area and priority rankings are suggested for a retrofit sewer program.

The second part of the report deals with biosolids and the available opportunities for reclamation of biosolids. These include biosolids that have accumulated over many years in the City's lagoon system, as well as the forecast quantities of biosolids produced by the wastewater treatment plant. The treatment plant is currently undergoing an upgrade to provide equipment for sludge dewatering.

2.0 BACKGROUND

The sanitary sewer system in Grand Forks is comprised of a combination of individual on-site septic disposal systems and a community sanitary sewer collection system. Since the mid-1990's, Grand Forks has been committed to pursuing sanitary sewer service for all residents on a phased basis and has made some progress in providing sewer service for the community since then.

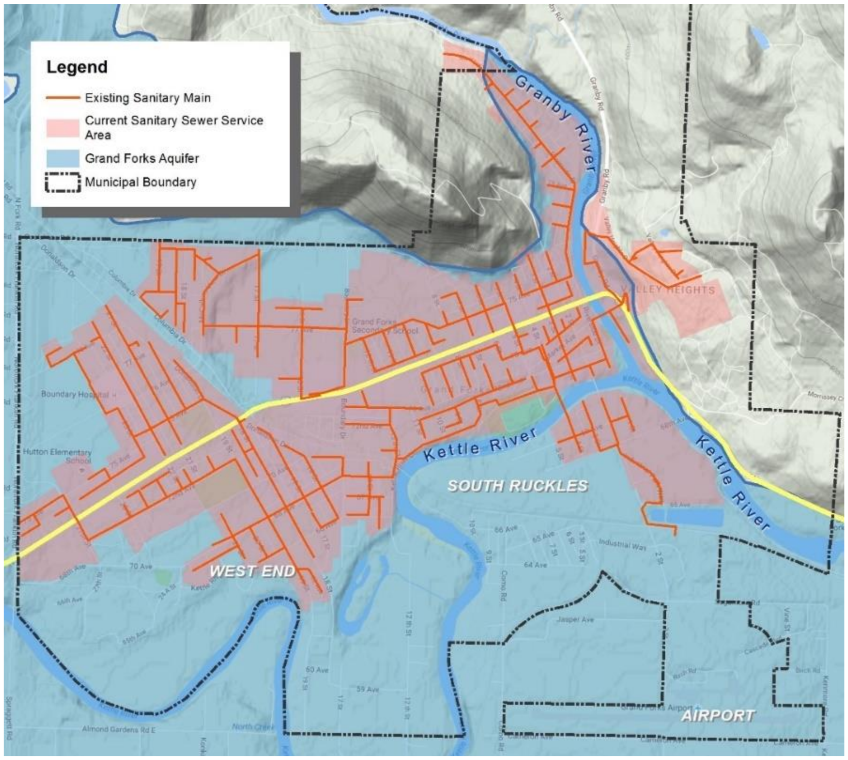
The process has recently gained community interest with the preparation of the Kettle River Watershed Management Plan (KRWMP) and the City's Well and Aquifer Protection Plan. The KRWMP identified the impacts to the water quality and quantity for both the Kettle River as well as the Grand Forks Aquifer. The unsewered areas of Grand Forks are considered to be a major source of nitrate and phosphorous loading to both the aquifer and to the Kettle River, particularly near the east end of the community where the aquifer is shallowest and the unsewered areas are located in the floodplain of the Kettle River. A key recommendation from these studies is to reduce the number of on-site septic disposal systems since they continue to age and the number of failures is expected to increase and potentially further impact the health of the public and that of the aquifer and the Kettle River.

The Grand Forks aquifer provides potable and agricultural water supply to several water utilities including the City of Grand Forks, Sion Improvement District, Grand Forks Irrigation District, Covert Irrigation District and several smaller community water systems. **Figure 2.1** below illustrates the location of the Grand Forks Aquifer in relation to the City's community sewer system.

The Kettle River is a significant tributary to the Columbia River which flows from the Monashee Mountains through the City of Grand Forks and south into the Washington State. The Kettle River is a significant community natural asset for the City and the region. In the Grand Forks region, the Kettle River provides a habitat for fish and aquatic ecosystems while enhancing several community water systems through recharging the Grand Forks aquifer. However, there are a number of cumulative impacts affecting the water quality of the Kettle River including on-septic disposal systems.

The City of Grand Forks wastewater system currently services the majority of parcels on the north side of the Kettle River and the North Ruckles area. The Airport, South Ruckles and portions of the West end directly adjacent to the Kettle River are currently not serviced with a community sewer system. **Figure 2.1** below illustrates the extents of the City's existing sewer system.

Figure 2.1 Existing Community Sewer System and Location of the Grand Forks Aquifer



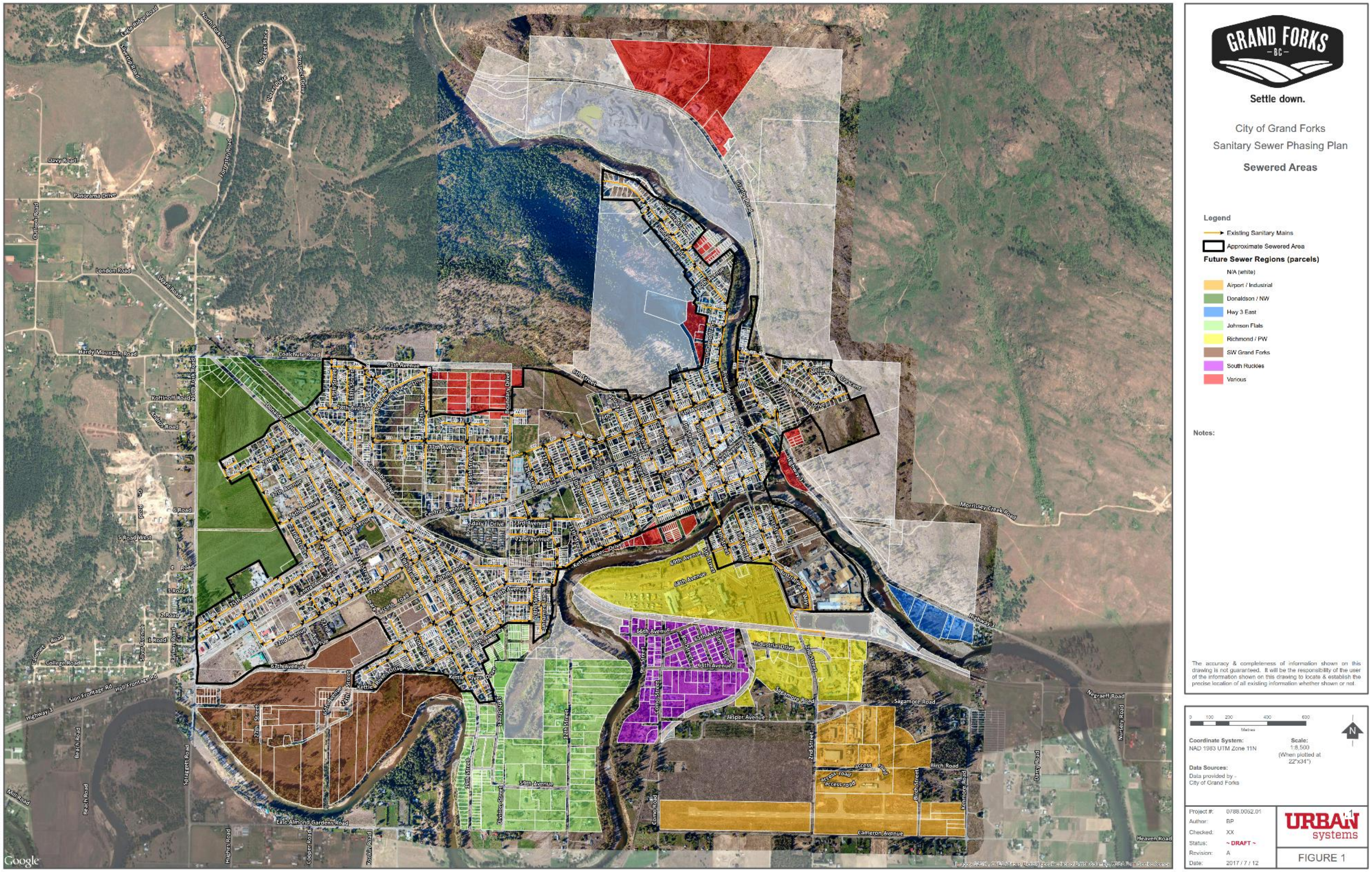
The areas and number of parcels outside of the community sewer system are as follows:

#	Location	ha	# parcels	*undeveloped	zoning
1	Hwy 3 East end	6	6	2	Highway / tourist commercial
2	Public works & Richmond Ave Industrial	13	14	5	Gravel / Mineral processing & Light Industrial
2	Airport / Industrial	40	22	11	Airport & light industrial 1
4	South Ruckles	20	118	6	Residential 1 & Rural Residential 4
5	Johnson Flats	60	131	39	Rural residential, residential 1 and small lot residential
6	SW GF	53	67	34	Rural residential, residential 1 and small lot residential
7	Donaldson / NW	31	57	9	R1, Light industrial
8	Under observation	24	34	11	R1 (but large lot, some acreage)

* For unserviced lots, only selecting ones outside wetland / core Environmental DPA area

The total parcels are 449, of which 332 are constructed with on-site septic systems. **Figure 2.2** on the following page illustrates the location of these parcels.

Figure 2.2 – Sewer Service Areas



2.1 Existing and Future Densities

The existing densities in areas without community sewer are governed by the Official Community Plan (OCP) for the various land use zones. The OCP requires a minimum parcel size of 1 hectare in areas without community sewer service. The minimum parcel size changes to 0.14 hectare when community sewer service is present. This would mean that a 1-hectare parcel could be subdivided into seven 1,400 m^2 parcels in residential zones R1, R2, R4, and R4A. Other zoning designations such as I1, AP, TH and TC may result in smaller parcels depending on market demand.

Table 2.1 provides an approximation of the potential additional parcels that might evolve as a result of community sewer service. These approximations are purely arithmetical extensions of area and allowable density. The subdivision of parcels will depend on a host of other factors such as flood plain, market demand, etc.

Table 2.1 - Existing and Projected Densities

	Area	Predominant Zone	Area (ha)	Min Parcel Size (w/o sewer ha)	Min Parcel Size (w/ sewer ha)	Exst Parcels	Pot. Parcels w/sewer #
1	Hwy 3 East end	TC / HC	6	1	0.14	8	-
2	Public works & Richmond Ave Industrial	I1	13	N/A	N/A	19	-
3	Airport / Industrial	AP	40	N/A	N/A	33	-
4	South Ruckles	R1 / R4	20	1	0.14	124	140
5	Johnson Flats	R4 / R2	60	1	0.14	170	430
6	SW GF	R4	53	1	0.14	101	380
7	Donaldson / NW	R4A	31	1	0.14	66	220

3.0 RISK ASSESSMENT

3.1 Approach to Risk Assessment

The approach to formulating a risk assessment matrix for each area with on-site sewer systems is to provide an overview of the risk factors that relate to a range of key parameters. The key parameters are under the headings of:

- Soil Types;
- Parcel area;
- Slope;
- Depth to groundwater;
- Distance to surface water or wells.

The risk ratings are developed as numerical ratings 1 to 4. For the purpose of the assessment, a Risk of 1 is interpreted to have the lowest risk; while a Risk of 4 is interpreted to have the highest risk. Risk ratings of 2 and 3 are low medium and high medium respectively. The representation of the risk is provided on a series of mapsets prepared by Golder Associates; the maps and report are included in **Appendix A**. A brief summary of the interpretations is provided below.

	Risk Details
Soils Mapset	Fluvial/glaciofluvial (Risk 1). Most soils in study area were described as fluvial/glaciofluvial. Fluvial/glaciofluvial soils within the floodplain were assigned a Risk of 2; these soils are closer to major creeks and inferred to consist of higher fines content. Colluvium (Risk 3) Till over Bedrock and Colluvium within the floodplain (Risk 4)
Parcel Area Mapset	Parcels larger than 1 ha are a Risk 1. As per Grand Forks Bylaw No. 1606, 1999, the minimum parcel size (for subdivision purposes and most zoning) is 1 ha where there is no community sewage or water system. 0.5 – 1 ha (Risk 2) 0.14 – 0.5 ha (Risk 3) <0.14 ha (Risk 4). As per bylaw, minimum parcel size (for subdivision purpose; for most zoning) of 0.14 ha when the parcel is connected to either a community sewage or water system, but not both; or 0.07 ha when the parcel or parcels are connected to a community sewage and water system.
Slope Mapset	2 - 5% (Risk 1); 5 – 10% (Risk 2); 10 -30% (Risk 3); and <2% and >30% (Risk 4). Risk 4 accounts for potential mounding affects (<2% slope).
Depth to Groundwater Mapset	Depths greater than 10 m are a Risk; 3 – 10m are Risk 2; 1 – 3 m are Risk 3; less than 1 m are Risk 4.
Setbacks and Capture Zones	To account for surface water bodies, private water wells and larger municipal wells, a Risk of 4 was assigned to those parcels where the majority of the lot was located

	Risk Details
	within a 30 m setback to surface water bodies, within a 30 m setback to private water wells and/or within the 10-year time of travel capture zone of a municipal well. The risks are assigned on the basis of available information on lot sizes, surficial geology, available well logs from the Ministry of Environment database, and available mapping of topography and surface water features. Figures #A through #E depict the risk ratings for each neighbourhood. The averages of the risk ratings for each neighbourhood are then weighted for importance as follows: • Depth to groundwater and slope are given a weighting multiplier of 1 • Parcel size, setbacks and capture zones are given a weighting multiplier of 2. The weighted risk ratings are then overlain, and a final feasibility risk rating calculated for each polygon.

3.2 Resident Questionnaire

A questionnaire was sent out to residents of the various neighbourhoods in an effort to determine the age of the on-site systems and if they are having problems with their systems. A total of 53 responses were recorded. The questions were:

1. What is your survey number?
2. How long has there been a septic system at your house?
3. Do you know the location of your septic tank and drainfield?
4. Is your drainfield located at the front of your property or in the backyard?
5. Do you have your system inspected and maintained by a qualified technician according to a maintenance schedule?
6. Have you ever experienced any problems with blockages or overflows?
7. Have you ever seen any spongy ground or smelt odours in the field area?
8. If so, which season is worst? [Spring] [Summer] [Fall] [Winter]
9. Do you also have a well that you use for: [Drinking water]
10. Do you also have a well that you use for: [Other]

Age: 21 respondents did not know the age of their system. The other responses ranged from 2 to 30 years, with two at 8 months. The overall average age was 20 years. Most respondents said they have regular inspections (10 said no regular inspections). Four respondents said they have had problems with their systems in terms of back-ups and spongy ground in their dispersal field area. Six respondents reported having a domestic well on the same property.

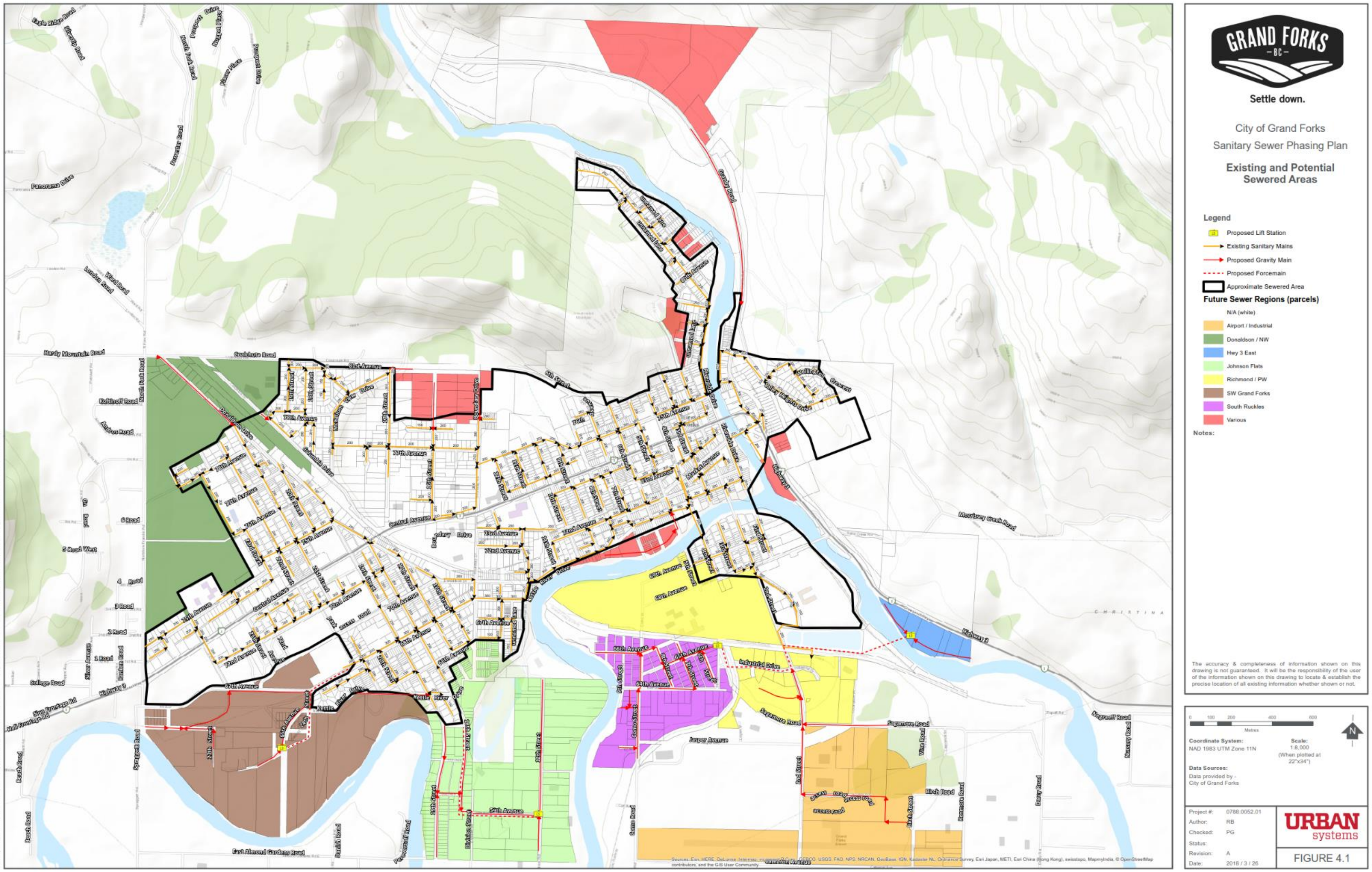
4.0 RETROFIT COMMUNITY SEWER SERVICE

Each of the seven neighbourhoods were assessed for the installation of a community collection system with a connection to the periphery of the existing sewer network. A copy of the proposed expansion of the collection system is located in **Figure 4.1** on the following page.

The topography in Grand Forks results in a requirement for a lift station in each of the seven neighbourhoods and a forcemain to deliver sewage to the existing collection system. The additional flows will, in some cases, require upgrading the existing pump stations. The impacts on existing lift stations are listed below:

- Marlex Station: impacted by flows from SW Grand Forks
- Val-Mar Station: not impacted
- Boundary Station: not impacted
- Granby Station: impacted by flows from the North area
- City Park Station; impacted by flows from Johnson Flats
- Industrial Station: impacted by flows from all neighbourhoods

Figure 4.1 – Existing and Potential Sewer Areas



The Marlex Station will require larger pumps. The Granby Station will require larger pumps, will need slope stabilization because it is in a precarious location, and will require a new forcemain river crossing as the existing aerial crossing is at risk of collapse. City Park Station will be impacted by higher flows arising from several neighbourhoods and may nee an increased pump size. There has been concern over the safety and reliability of the “under-river” crossing of the Kettle River as the pipe is old and in potential danger of collapse from corrosion. The Industrial Station pumps the entire City flow and it is in need of renovations and refurbishing. All of the additional neighbourhood flows will arrive at the Industrial Station, so larger pumps will be required.

The timing of lift station upsizing will depend on how quickly community sewer is extended into the candidate neighbourhoods. For some lift stations (such as Industrial Ave.) it is the cumulative effect of connecting additional neighbourhoods that will trigger and upsizing program. The cost of upsizing existing lift stations has therefore not been included in this stage of the report.

There are two forcemains that will require replacement to reduce risk of failure. These are:

a) The forcemain from City Park Station under the Kettle River. This could be replaced as a bored crossing under the river bed, or as a pipe bridge crossing. A detailed cost comparison should be undertaken before a method is selected.
b) The forcemain crossing of the Granby River from the Granby Station should be replaced with a more robust pipe bridge.

4.1 Basis of Capital Cost Estimates

The capital cost estimates for retrofit sewer construction use a set of assumptions with respect to excavation and backfill, restoration, dewatering and pipe grades. Some of these key assumptions include:

- Soils will be largely suitable for trench backfill, but sand will be used for pipe bedding
- PVC sewer pipe (200 mm diameter) will be used for collection system gravity sewer and for service connection
- Manholes will be 1050 mm diameter pre-cast concrete barrels
- Service connection will be 100 mm diameter PVC pipe (average length – 10 m to property line)
- Forcemains will be 150 mm diameter PVC pressure pipe.
- Asphalt surfaces will be reinstated with 50 mm thick asphalt pavement, 3.5 m wide

Unit prices used for estimates are listed in **Appendix B.**

A summary of the estimated quantities for each of the neighbourhoods is provided in **Table 4.1** below. The areas designated as “Various” are sub-split into areas (a) through (g).

Table 4.1 - Collection System Quantities for Designated Retrofit Areas

	Area	Gravity Sewer (m)	Manholes	Force main	Services	Pump Stations	Specials
1	Hwy 3 East end	500	4	1,200	10	1	River/Rail Crossing
2	Public works & Richmond Ave Industrial	600	8	200	180	1	Hwy Crossing
3	Airport / Industrial	1,400	8	600	10	1	-
4	South Ruckles	2,300	30	540	200	1	Rail/Hwy Crossing
5	Johnson Flats	3,000	26	1,200	20	1	-
6	SW GF	2,400	20	800	10	1	-
7	Donaldson / NW	500	8	500	15	1	-

4.2 Risk Factor and Capital Cost Estimates

The Golder Associates report included in **Appendix A** provides a summary of the risk factors and the ranking of each of the neighbourhoods under consideration. The rankings, areas and number of parcels in each neighbourhood are summarized in **Table 4.2**. This table also includes the estimated capital cost for retrofit community sewer in each of the seven neighbourhoods.

Some of the neighbourhoods have already been extensively subdivided (e.g. South Ruckles). Others consist of large parcels. The retrofit sewer quantities are based on provision of community sewer on existing roads. Collection system networks for future subdivision of large parcels are not included and are assumed to be “Pay -as-You-Go” (PYG) This means that future expansion of the sewer network would become the developer’s responsibility and would simply be turned over to the City when completed.

The capital cost to service each area is divided by the number of existing parcels to arrive at a value per parcel, and by the number of hectares to arrived at the cost per hectare.

It is evident that the cost per hectare is highest when the neighbourhood is remote from the existing network and there are obstacles such as river, railway or highway crossings. The lowest per parcel and per hectare costs are in Johnson Flats and Donaldson areas. The highest are in Hwy 3 East and PW/Richmond areas.

The overall risk factors represent a blend of the Final Risk Rating Overview as determined by Golder Associates. For example, if a neighbourhood has mostly Risk 2 with some Risk 1, it is classified as Risk 2. If the neighbourhood is rated as mostly Risk 3, with some Risk 2, it is classified overall as Risk 3.

The resulting classifications are as follows:

Risk 3: Hwy 3 East

Risk 2 South Ruckles, Johnson Flats, SW Grand Forks, Donaldson

Risk 1: PW/Richmond, Airport Industrial

All of the "Various" areas are classified Risk 2. It is assumed that these areas will be PYG, since they are close to existing sewer. The exception is the north end Industrial parcel, which requires a long extension of sewer along Granby Road.

Table 4.2 – Areas, Risk Factors and $ / Hectare

	Area	Overall Risk Factor	Area (ha)	Parcels (Dev and Undev)	Capital Cost Estimate ($M)	Average $ per ha
1	Hwy 3 East end	3	6	8	1.9	317,000
2	Public works & Richmond Ave Industrial	1	13	19	1.9	146,000
3	Airport / Industrial	1	40	33	1.7	42,500
4	South Ruckles	2	20	124	3.8	190,000
5	Johnson Flats	2	60	170	3.3	55,000
6	SW GF	2	53	101	2.4	45,000
7	Donaldson / NW	2	31	66	1.1	35,500

APPENDIX A

Golder Report

16 March 2018 Reference No. 1895271-001-L-Rev0

Mr. Peter Gigliotti, PEng
Urban Systems Ltd.
304 – 1353 Ellis Street
Kelowna, BC
V1Y 1Z9

SUMMARY OF THE HYDROGEOLOGICAL COMPONENT OF GROUND EFFLUENT DISPOSAL ASSESSMENT, CITY OF GRAND FORKS, BRITISH COLUMBIA

Dear Mr. Gigliotti,

Golder Associates Ltd. (Golder) is pleased to provide the results of a hydrogeological desktop study for evaluating in-ground effluent disposal systems within the City of Grand Forks (City) on behalf of Urban Systems Ltd. (USL; Client). It is our understanding that the City wishes to connect existing on-site septic systems to the municipal sanitary sewer system; and that the results of this desktop study will aid in prioritizing the existing systems for connection to the municipal sanitary sewer system.

The hydrogeological desktop study involved the classification of site-specific controlling factors (i.e., soil type, depth to groundwater, topographical slope, parcel size and horizontal setbacks) within select septic disposal regions (identified as sewer regions herein: refer to the Index Map attached) of the City (collectively referred to as the Study Area) and a subsequent qualitative risk overlay analysis using the controlling factors to categorize each sewer region in terms of its effectiveness for in-ground effluent disposal and to prioritize areas for connection to the municipal sanitary sewer system. Details of the scope of the work for this study were presented to USL in our proposal entitled "*Proposal and Cost Estimate for Hydrogeological Component of Effluent Disposal Assessment, City of Grand Forks*", dated 26 January 26 2018.

We note that this report, including all attached figures and tables, should not be used to determine the potential risk of in-ground effluent disposal on a local (lot-by-lot) basis; rather, it is only intended to assist the City and USL in the prioritization of the select sewer regions for connection to the municipal sanitary sewer system. Additional limitations are discussed in Section 2.0 and Section 5.0.

1.0 STUDY AREA

The study was completed for the following sewer regions specified by USL:

Table 1: Sewer Regions Assessed for Hydrogeological Desk-top Study

Sewer Region	Figure Numbers (for use with Section 3.0 below)
Donaldson / NW	1A through 1F
Various*	2A through 2F and 3A through 3F
Johnson Flats	4A through 4F
SW Grand Forks	4A through 4F
South Ruckles	5A through 5F
Airport / Industrial	5A through 5F
Hwy 3 East	5A through 5F
Richmond / PW	5A through 5F

Note:
* The “Various” sewer region is comprised of clusters of parcels that are spread across the Study Area; thus, to assist Golder with prioritization of sewer regions as part of this hydrogeological desktop study, the “Various” sewer region was subdivided into five separate sub-regions: North (2A through 2F), Central, South, East and West (3A through 3F).

2.0 METHODS

A Geographic Information System (GIS) qualitative risk overlay analysis was identified as the most efficient method of meeting the study objective of categorizing the sewer regions in terms of their effectiveness for in-ground effluent disposal. The risk overlay analysis involved the following:

- Selecting a total of 559 polygons within the specified City of Grand Forks sewer regions for analysis in the qualitative risk overlay model, where each polygon was represented by a single parcel.
- Classifying suitable controlling factors (refer to Section 2.1);
- Assigning risk ratings to each controlling factor on a polygon basis (refer to Section 2.3); and
- Combining (“overlaying”) the risk ratings and assigning a final risk rating to each sewer region (refer to Section 3.0).

Supplemental information obtained from on-line government maps, water well logs from the BC Ministry of Environment (MOE) Water Resources Atlas, a small number of reports accessed from Agriculture and Agri-Food Canada, BC MOE websites and Golder’s in-house library, were used to confirm and/or modify the risk ratings for the soil type, depth to groundwater and horizontal setback factors. Based on the results of the risk analysis, sewer regions were prioritized for connection to the municipal sanitary sewer system.

2.1 Controlling Factors

Controlling factors influencing the effectiveness of in-ground effluent disposal were based on selected parameters outlined in Oosting and Joy (2011), which represent standard hydrogeological parameters generally assessed as part of site-specific effluent disposal studies; and were limited by the size of the Study Area, as follows (in no specific order):

- The capability of a soil to infiltrate effluent; for the purposes of the risk analysis, this capability was identified by surficial geology, or soil type, evaluated to an approximate depth of five meters below surface. Soil type directly relates to the permeability of the soil, and hence, its capability of infiltrating effluent. Given the presence of the Kettle River and Granby River within the Study Area, it has been assumed that some interrelationship exists between soil type and the location of the floodplain adjacent to the Kettle and Granby Rivers (i.e., that soils within the floodplain are comprised to some degree of finer-grained materials that reduce soil permeability and infiltrating capability).

- Depth to a limiting condition (identified as a subsurface condition that limits the downward infiltration of groundwater/effluent; generally identified as fine-grained silty, clayey soils, till, bedrock or groundwater). For the purposes of the risk analysis, only depth to groundwater was considered as the limiting condition, as available soil data were not extensive and did not contain the level of detail necessary to identify soils or bedrock as limiting conditions. The depth to groundwater relates to the thickness of the unsaturated zone; effluent that infiltrates through a thicker unsaturated zone (*i.e.*, deeper groundwater level) is less likely to result in excessive groundwater mounding or to daylight as effluent seepage down-gradient of the effluent disposal area. Higher groundwater levels, that are expected be present in areas adjacent to surface water bodies, are accounted for in the Soil Type (floodplain) controlling factor (see bullet above).

- Slope of the ground surface. A relatively steep slope may impede the ability of the effluent to infiltrate into the ground surface, resulting in more surface run-off. Where steep slopes consist of soils with a high clay or silt content, infiltration of effluent may result in erosion or slide conditions. A relatively shallow slope may increase the potential for mounding of effluent due to the inability to naturally dissipate down slope.

Other regulatory factors that influence the feasibility of effluent disposal include the availability of sufficient area to accommodate in-ground disposal fields; that effluent does not surface or daylight within a certain distance from the disposal area; and that minimum setback distances are met, as follows:

- The area available for disposal (in terms of individual parcel size) was considered to be a controlling factor influencing the effectiveness of in-ground effluent disposal. A small parcel (<0.14 hectare) may not have the area available to accommodate a septic field, particularly when other setback requirements (for example, setback from buildings, roadways, groundwater wells, etc.) must be met. Additionally, parcel size also correlates with population density, where an abundance of smaller parcels is inferred to represent a relatively more populated community, or populated area within a community.

- A horizontal setback distance from surface water bodies, private water wells and larger municipal wells was considered a controlling factor. In order to account for minimum regulatory horizontal setback distances from surface water bodies and the potential increased risks associated with effluent disposal near a surface water body (including, but not limited to: an increase in the typically shallow groundwater levels observed near surface water bodies, reduced renovation time of effluent prior to seepage into surface water body, deterioration of surface water quality, eutrophication of surface water body, etc.), a 30 m horizontal setback distance was applied from all surface water bodies present in the Study Area. To account for minimum regulatory horizontal setback distances from groundwater wells, a 30 m horizontal setback distance was applied from all known private water wells (specifically, those registered with BC MOE). For larger high-production municipal wells, the published 10-year time of travel capture zone for each municipal well was considered a controlling factor. The time of travel capture zone indicates the time frame for contaminants (including effluent) to travel to the municipal well from a given point within the capture zone during pumping.

2.2 Sources of Information

The following data sources were used in this study:

2.2.1 Soil Type

Soil data was acquired from the Soil Information Tool map application (Ministry of Agriculture and MOE, 2018). The Soil Information Tool captures data from multiple sources, which for the Study Area included the 1:50,000 scale dataset "*Soil Survey of the Kettle River Valley in the Boundary District of British Columbia*" (SSKRV) maintained by Agriculture and Agri-Food Canada (1964 - 1976) and the coarser 1:1,000,000 scale dataset "*Soil Landscapes of Canada*" produced by Canadian Soil Information Service (CanSIS).

Soils information available on individual water well logs accessed through the BC MOE Water Resources Atlas, government reports and/or Golder's in‐house investigation reports was used to augment the datasets. For each parcel the dominant soil types were selected; if two soil types fell into one parcel, the soil type that occupied a higher percentage of the parcel was used for classification.

Floodplain maps for the Kettle and Granby Rivers were sourced from BC MOE Floodplain Maps by Region (Acres International Limited, 1992). This source included a finer 1:5,000,000 scale dataset with drawing Number 90-34 Sheets 5 through 8 defining the floodplain in the Study Area.

2.2.2 Slope of Ground Surface

A 20 m resolution Digital Elevation Model (DEM) was acquired from the Ministry of Forests, Lands, Natural Resource Operations and Rural Development, through DataBC (2018). The DEM was used to generate approximate slope, described as percentage rise over run. The average slope was then calculated for each parcel.

2.2.3 Parcel Size (available area for effluent disposal)

Parcel size was sourced directly from spatial data (shapefiles) provided to Golder by USL on 15 February 2018. Parcel area in hectares (ha) was calculated directly from the spatial information.

2.2.4 Depth to Groundwater

Depth to groundwater was derived from the BC MOE Water Resources Atlas, sourced from GeoBC; however, its original derivation was from the BC MOE – Water Protection and Sustainability Branch. For this study, water level information available from 485 water wells registered with BC MOE was used to derive a groundwater surface layer. Wells with a depth of zero were removed from the dataset. Due to the sparseness of water level data in some areas, and overall variations in depth to groundwater, an inverse distance weighting (IDW) interpolation scheme was used to create the desired surface across each sewer region. IDW interpolation scheme minimizes errors such as those described above, but in turn, reduces the overall precision of the analysis.

In some cases, specifically, where groundwater information was not available for entire sewer regions via the sources above (i.e., Richmond/PW, Airport/Industrial, Various – Central, Various – West, and Various – South), individual water wells logs adjacent or near the Study Area were used to augment the datasets.

2.2.5 Horizontal Setback Distance and 10 Year Capture Zone

The setback distance of 30 m from a freshwater body and a domestic water supply well was derived from the *Sewerage System Regulation* (SSR, 2010) and associated Version 3 of the Sewerage System Standard Practice Manual (2014). Effluent discharges to ground at flows <22.7 m^3/day are authorized under the SSR. It is noted that a horizontal setback distance of 60 to 300 m from a water supply (depending on maximum daily effluent flows) is required for effluent discharge authorized under the Municipal Wastewater Regulation (MWR, 2016) (i.e., at flows >22.7 m^3/day). Based on a review of the MOE’s online discharge database, where water wells are present in a sewer region, there are no authorizations of >22.7 m^3/day inside that sewer region; thus, a 30 m setback was applied in this study, in accordance with the SSR.

The 10-year capture zone was acquired from the BC Government application iMapBC. The extents of the 10-year capture zones were cross-referenced for validation with Golder’s report “Contaminant Inventory for the Grand Forks Aquifer” (Golder, 2003).

2.3 Assignment of Risk Rating for Controlling Factors

Risk ratings for each of the five controlling factors were assigned to each polygon in the model, as described in Table 2 below, and shown on the attached figures. Risk ratings were based on applicable regulatory requirements and on professional experience.

There are five figures for each sewer region (Figures #A through #F; refer to Table 1), where the first four figures in each mapset (Figures #A through #E) correspond to the risk rating of the five controlling factors, and the last figure in each mapset (Figure #F) corresponds to the final risk rating. An map showing the final risk rating of the whole Study Area is also provided and labelled as Figure 6.

Table 2: Assignment of Risk Ratings for Controlling Factors

Risk Factor	Risk Unit	Risk 1	Risk 2	Risk 3	Risk 4	Assumptions/Comments
Soil Type (Figure #A)	Soil Type	Fluvial[a], Glaciofluvial[a]	Fluvial, Glaciofluvial Within Floodplain	Colluvial	Till over Bedrock and Colluvial Within Floodplain	Soil types ranged from (inferred low to non-permeable) till over bedrock, (inferred moderately permeable) colluvial deposits, and (inferred permeable) fluvial/glaciofluvial sands and gravels. Soil type was assigned a risk rating based on its inferred permeability (infiltration capability), with the most permeable (highest infiltration capacity) as Risk 1, and least permeable (lowest infiltration capacity) as Risk 4. A similar soil type within the floodplain was assigned a higher risk rating due to the higher probability of underlying silts and clay deposits and general low permeability characteristics of soil within the floodplain.
Depth to Groundwater (Figure #B)	Metres Below Ground	>10	3 to 10	1 to 3	0 to <1	A lower risk rating was assigned to deeper groundwater, while a higher risk rating was assigned to shallower groundwater.
Average Slope (Figure #C)	Percent	0[b] to 5	5 to 10	10 to 30	>30	A lower risk rating was assigned to a shallower slope, while a higher risk rating was assigned to steeper slope.
Parcel Size (Figure #D)	Hectares	>1	0.5 to 1	0.14 to 0.5	<0.14	A lower risk rating was assigned to larger parcel sizes, while a higher risk rating was assigned to smaller parcel sizes. As per the City of Grand Forks Bylaw No. 1606, 1999 (for subdivision purposes; for most zoning), a minimum parcel size of 0.14 hectares is required when the parcel is connected to either a community sewage or water system, but not both; and a minimum parcel size of 0.07 ha is required when the parcel is connected to a community sewage and water system.
Horizontal Setback[c] and Capture Zones (Figure #E)	n/a	Outside of Setback and Capture Zone	n/a	n/a	Inside of Setback and Capture Zone	The lowest risk rating (Risk 1) was assigned to parcels outside of the setback requirements and capture zones, while the highest risk rating (Risk 4) was assigned to parcels within the setback requirements and capture zones. Where setbacks/capture zones intersected parcels, the risk rating was assigned based on the location of the majority of the parcel.

Notes:

[a] While all fluvial and glaciofluvial deposits have been assigned a ranking of Risk 1, in some cases, these deposits may be too permeable for sufficient renovation of effluent, which may potentially have a negative impact on the water quality of receiving water bodies. For the purposes of this large-scale study, differentiation has not been made between permeable deposits with sufficient renovation and those with insufficient renovation.

[b] A very flat topographical slope (i.e., <2%) may, in some cases, correlate with a “flat” groundwater surface, potentially resulting in excessive groundwater mounding due to a low hydraulic gradient. For the purposes of this study, higher risk ratings for “flat” groundwater surfaces have not been made, and all slopes less than 5% were assigned a ranking value of Risk 1.

[c] For the purposes of this study, setback requirements have only been applied to groundwater wells registered with the BC MOE. It was beyond the scope of this study to confirm whether registered wells within the Study Area are operational or abandoned/decommissioned, and/or if other wells not registered with the Province exist within the Study Area.

2.4 Assignment of Final Feasibility Risk Rating

2.4.1 Polygons (within Sewer Regions)

For each polygon, risk ratings for soil type, depth to groundwater and average slope were given a weighting of 1; while the risk rating for parcel size, setback requirements and capture zones was given a weighting of 2. Weightings were determined during the model calibration process and were based on available information for the Study Area, and on professional knowledge, resulting in a higher weighting being assigned to parcel size, setback requirements and capture zones. The weighted risk ratings were overlain, and a final feasibility risk rating was then calculated for each polygon.

2.4.2 Sewer Regions

For the purposes of assigning a final risk rating to each sewer region, the average weighted risk rating for each sewer region was calculated, and a final feasibility risk rating was then determined, as summarized in Table 3. Final feasibility risk ratings were assigned a Risk 1 through Risk 4, corresponding to an increase in risk associated with the effectiveness of in-ground effluent disposal, based on the five controlling factors listed above. Risk 1 corresponds to an area inferred to pose the lowest risk associated with the effectiveness of in-ground effluent disposal, while Risk 4 corresponds to an area inferred to pose the highest risk associated with the effectiveness of in-ground effluent disposal.

Table 3: Final Risk Ratings for Sewer Regions

Average Weighted Risk Rating	Final Feasibility Risk Rating
1.0 - <2.0	Risk 1
2.0 - <3.0	Risk 2
3.0 – 3.4	Risk 3
3.5 – 4.0	Risk 4

3.0 RESULTS OF QUALITATIVE RISK ANALYSIS

The final feasibility risk ratings for each polygon are shown on all attached figures with the suffix “E”.

The final feasibility risk ratings for each sewer region are summarized in Table 4. The sewer regions have been arranged such that the “*Average Weighted Risk Rating*” is shown from lowest (at the top of the table) to highest (at the bottom of the table). General comments regarding the final risk ratings are also provided.

Note again that each sewer region has been assigned a single value for final feasibility risk rating, where the single value is the average of the polygons within the sewer region. Therefore, each sewer region will be graphically shown as comprising polygons of more than one final feasibility risk rating.

Table 4: Results of Qualitative Overlay Risk Analysis

Sewer Region and Corresponding Figure		Average Risk Rating for each Controlling Factors					Average Weighted Risk Rating	Final Feasibility Risk Rating	Comments
		Soil Type	Depth to Groundwater	Slope	Parcel Size	Setback and Capture Zone			
Airport/ Industrial	5F	1.0	1.4	1.1	1.7	1.0	1.3	Risk 1	Minimal well data. Mostly Risk 1 with minor Risk 2 areas.
Various - West	3F	1.0	1.9	1.0	3.0	1.0	1.7	Risk 1	No well data within sewer region. Mostly Risk 1 with some intermediate risk (Risk 2-3) areas relating to small parcels and shallow groundwater recorded from surrounding wells.
Richmond/ PW	5F	1.9	1.5	1.5	2.8	2.3	1.9	Risk 1	Minimal well data. No well data in Northern section of this region. Mostly Risk 1 with some Risk 2 areas and minor Risk 3 areas due to small parcel sizes.
Various – North	2F	4.0	2.3	3.0	1.0	1.0	1.9	Risk 1	Minimal well data. Mostly Risk 1 with high risk till over bedrock (Risk 4), steep sloping topography (Risk 3) and intermediate depth to groundwater/ wells drilled into bedrock (Risk 2-3). Spring noted in centre of parcel by USL.

Sewer Region and Corresponding Figure		Average Risk Rating for each Controlling Factors					Average Weighted Risk Rating	Final Feasibility Risk Rating	Comments
		Soil Type	Depth to Groundwater	Slope	Parcel Size	Setback and Capture Zone			
South Ruckles	5F	1.9	1.0	1.2	3.6	1.1	1.9	Risk 1	Minimal depth to groundwater data. Mostly Risk 2 with some Risk 1 and minimal Risk 3 areas (small parcel size). Some areas near river within setback zone are higher risk and have steeper slope.
Hwy 3 East	5F	2.0	2.0	1.8	2.0	2.5	2.1	Risk 2	Mostly Risk 2 with some Risk 1 and Risk 3 areas. High risk areas (Risk 4) within river and well setback distance.
Donaldson/ NW	1F	1.0	1.0	1.7	2.7	2.9	2.1	Risk 2	Mostly Risk 2 with some Risk 1 and minimal high Risk 3-4 areas. Central portion of this region is within the 10-year well capture zone.
Various - Central	3F	2.1	2.0	1.5	3.8	1.0	2.2	Risk 2	No well data within sewer region. Mostly low to intermediate (Risk 1-2) areas. Minimal high risk soil type (Risk 3-4) of colluvium within floodplain and some high risk (Risk 4) small parcels.

Sewer Region and Corresponding Figure		Average Risk Rating for each Controlling Factors					Average Weighted Risk Rating	Final Feasibility Risk Rating	Comments
		Soil Type	Depth to Groundwater	Slope	Parcel Size	Setback and Capture Zone			
Johnson Flats	4F	1.5	2.0	1.3	3.4	1.9	2.2	Risk 2	Mostly Risk 2 with some low Risk 1 and high Risk 3 areas. This region has a broad range of parcel sizes and a large portion of this region is within the floodplain. Some areas are high Risk 4 within the 10-year well capture zone and well setback distance.
Various – East	3F	1.1	1.1	3.4	3.5	1.4	2.2	Risk 2	Minimal well data within sewer region. High (Risk 4) area within setback distance from the Kettle/Granby Rivers. High risk (Risk 3-4) steep slope and high risk small parcel sizes.
Various - South	3F	1.7	2.0	1.7	3.8	1.5	2.3	Risk 2	No well data within sewer region. High (Risk 4) risk for small parcel sizes and some portions of this region within the setback distance from the Kettle River.
SW Grand Forks	4F	1.2	1.8	1.1	3.2	4.0	2.6	Risk 2	Mostly Risk 2, with some Risk 3 areas including majority of region within floodplain. High Risk 4 as region is entirely within 10-year well capture zone.

4.0 DISCUSSION OF QUALITATIVE RISK ANALYSIS

4.1 Sewer Regions

4.1.1 Risk 4

There are no sewer regions that are considered a Risk 4. However, note that some smaller areas within individual sewer regions have individual parcel risk rankings of 4.

4.1.2 High Risk Areas

Based on the qualitative risk analysis, the sewer regions of SW Grand Forks (Figure 4F), Various – South (Figure 3F), Various – East (Figure 3F), Johnson Flats (Figure 4F) and Various – Central (Figure 3F) appear to pose the highest risk with respect to the effectiveness of in-ground effluent disposal. This is mainly due to the higher risk ratings associated with a small parcel size, location within the setback distance requirements and/or capture zones, as well as flooding and high groundwater table as a result of proximity to the Kettle and/or Granby Rivers.

4.1.3 Lower Risk Areas

Based on the qualitative risk analysis, the sewer regions of Airport/Industrial (Figure 5F), Various – West (Figure3F), Richmond/PW (Figure 5F), Various – North (Figure 2F), South Ruckles (Figure 5F), Hwy 3 East (Figure 5F), Donaldson/NW (Figure 1F) and Various – Central (Figure 3F), appear to pose a low (Risk 1) to intermediate (Risk 2) risk with respect to the effectiveness of in-ground effluent disposal.

Where numerous groundwater wells are concentrated within one area of the sewer region (i.e., Donaldson/NW, South Ruckles and Richmond/ PW), the risk of impacting groundwater supply sources from the in-ground disposal of effluent is likely to increase, particularly in established communities where disposal systems may be older and/or in developed communities where parcel sizing may be smaller.

4.2 Corroboration of Desktop Study

Should the City wish to corroborate the results of this qualitative risk analysis, additional assessment may be conducted, including subsurface investigations to confirm local soil and groundwater conditions; and long-term groundwater and surface water monitoring programs within select sewer regions, particularly those in proximity to clustered water wells or aquatic receiving environments.

Additionally, the City may wish to identify existing and operational/abandoned/decommissioned private water wells within each sewer region. This study only accounted for water wells registered with the Province. Additional (non-registered) water wells may exist, and their presence may result in an increase to the risk ratings in that sewer region.

We understand that the City has completed a preliminary survey to identify individual septic disposal system issues within the City boundary as well as to assess which properties utilize both a septic field and water well. The results of the survey may be superimposed onto the final risk rating figures to assist in prioritizing sewer regions.

The maps and risk ratings generated as part of this study should not be relied upon for prioritizing individual parcels for connection to municipal sanitary system, but should rather be used to assist in the prioritizing of the larger sewer regions.

5.0 STANDARD LIMITATIONS

This report, which includes all associated figures, was prepared by Golder Associates Ltd. (Golder) for the exclusive use of Urban Systems Ltd. (USL; Client) and the City of Grand Forks.

Golder Associates Ltd. (Golder) has prepared this document in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this document. No warranty, express or implied, is made.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, has been prepared by Golder for the sole benefit of the Client. It represents Golder's professional judgment based on the knowledge and information available at the time of completion. Golder is not responsible for any unauthorized use or modification of this document. All third parties relying on this document do so at their own risk.

The factual data, interpretations, suggestions, recommendations and opinions expressed in this document pertain to the specific project, Site conditions, design objective, development and purpose described to the Client, and are not applicable to any other project or location. In order to properly understand the factual data, interpretations, suggestions, recommendations and opinions expressed in this document, reference must be made to the entire document.

This document, including all text, data, tables, plans, figures, drawings and other documents contained herein, as well as all electronic media prepared by Golder, are considered its professional work product and shall remain the copyright property of Golder. The Client may make copies of the document in such quantities as are reasonably necessary for those parties conducting business specifically related to the subject of this document or in support of or in response to regulatory inquiries and proceedings. Electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore no party can rely solely on the electronic media versions of this document.

6.0 CLOSURE

We trust this report provides you with the information you require at this time. Should you have any questions or require additional information or clarification, please do not hesitate to contact the undersigned.

Yours very truly,

GOLDER ASSOCIATES LTD.

DWiesner

Danielle Wiesner, EIT
Junior Environmental Engineer

Mar 16/18

PROFESSIONAL
PROVINCE OF
P. ATHANASOPOULOS
35943
BRITISH COLUMBIA
GEOSCIENTIST

Pana Athanasopoulos, MSc, PGeo
Senior Hydrogeologist

March 19, 2018
Association of Professional Engineers and Geoscientists of the Province of British Columbia
J. D. FOLEY
GEOSCIENTIST LICENSEE
Limited Licence
130262

Jacqueline Foley, MSc, GeoL
Associate, Senior Hydrogeologist

DW/PA/JF/asd

Attachments: Figures Index Map
1A through 1F Donaldson / NW
2A through 2F Various*
3A through 3F Various*
4A through 4F Johnson Flats
4A through 4F SW Grand Forks
5A through 5F South Ruckles
5A through 5F Airport / Industrial
5A through 5F Hwy 3 East
5A through 5F Richmond / PW
6 Final Risk Rating Overview

https://golderassociates.sharepoint.com/sites/23749g/deliverables/issued to client/1895271-001-l-rev0/1895271-001-l-rev0-summary of the hydrogeological component 16mar_18.docx

7.0 REFERENCES

Acres International Limited. 1992. "*Floodplain Mapping Kettle and Granby Rivers, Grand Forks Area - 200 Year Frequency.*" British Columbia Ministry of Environment and Climate Change Strategy. Drawing No. 90-34, Sheets 5-8. September 30, 1992.

Agriculture and Agri-Food Canada. 2013a. "*Canadian Soil Information Service – Soils of British Columbia, ILTCOOLA*"

Agriculture and Agri-Food Canada. 2013b. "*Canadian Soil Information Service – Soils of British Columbia, RUTLAND".*

Agriculture and Agri-Food Canada. 2013c. "*Canadian Soil Information Service – Soils of British Columbia, KRUGER".*

Agriculture and Agri-Food Canada. 1963. "*Soil Map of the Kettle River Valley British Columbia Sheet 2*"

British Columbia Ministry of Environment and Climate Change Strategy. 2018. "*Environmental Management Act, BC Municipal Wastewater Regulation*"

British Columbia Ministry of Environment and Climate Change Strategy. "*BC Water Resources Atlas". Accessed in February 2018.*

The Corporation of the City of Grand Forks. 1999. "*Zoning Bylaw No. 1606*".

DataBC. 2018. Website: https://catalogue.data.gov.bc.ca/dataset/digital-elevation-model-for-british-columbia-cded-1-250-000; accessed February 2018.

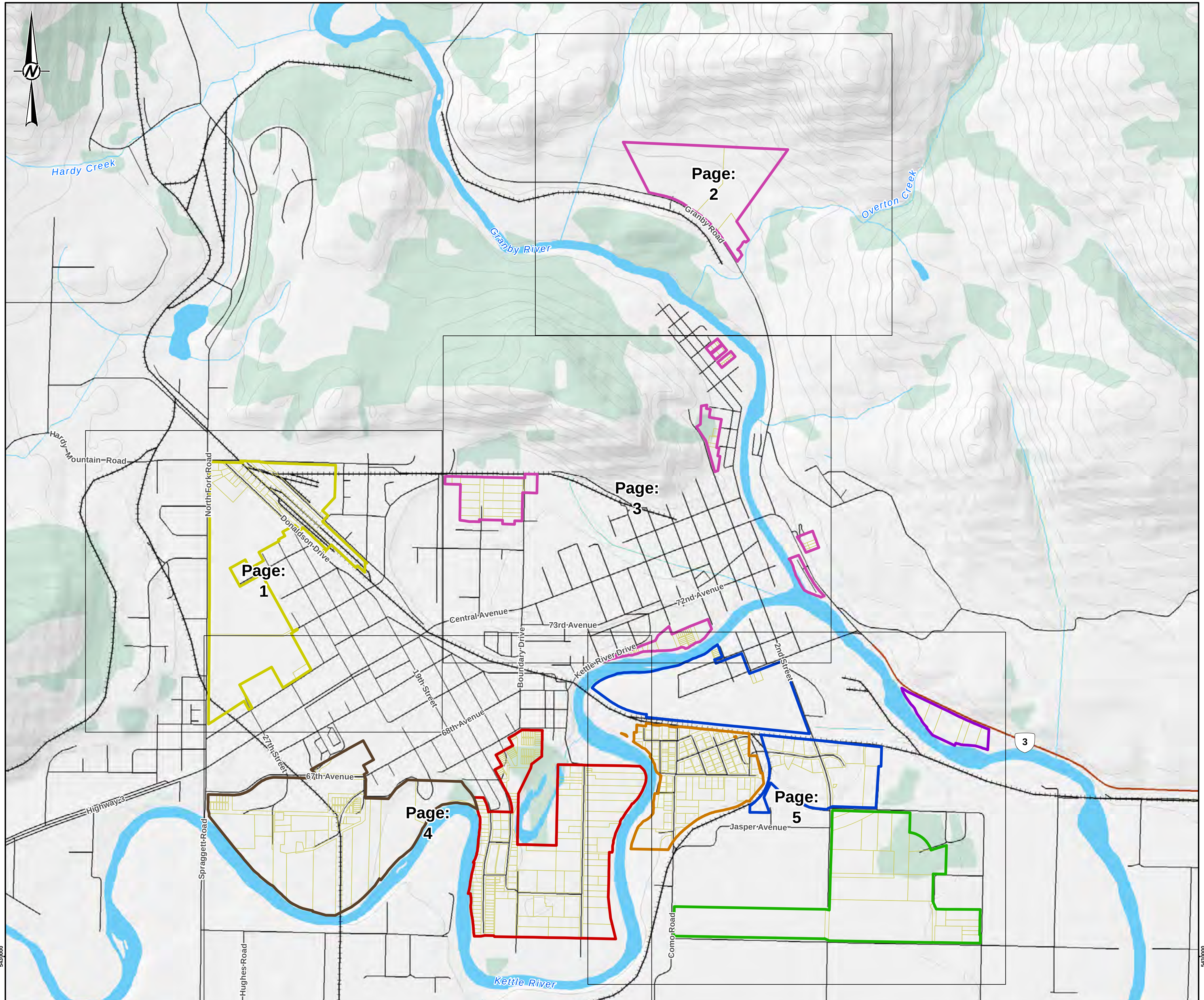
Golder Associates Ltd. 2003. "*Contaminant Inventory for the Grand Forks Aquifer*" Issued on behalf of the Grand Forks Aquifer Protection Committee.

Ministry of Health. 2014. Sewerage System Standard Practice Manual, Version 3. 367pp.

Municipal Wastewater Regulation under the *Environmental Management Act*. B.C. Reg. 87/2012, O.C. 230/2012 (includes amendments up to B.C. Reg. 41/2016, February 20, 2016).

Oosting, Andrew and Joy, Doug. 2011. "*A GIS-Based Model to Access the Risk of On-Site Wastewater Systems Impacting Groundwater and Surface Water Resources.*" Canadian Water Resources Journal, 36:3, 229-246.

Sewerage System Regulation under the *Public Health Act*. B.C. Reg. 326/2004, O.C. 701/2004 (includes amendments up to B.C. Reg. 209/2010, June 28, 2010).



LEGEND

PARCEL

SEWER REGION

AIRPORT / INDUSTRIAL

DONALDSON / NW

HWY 3 EAST

JOHNSON FLATS

RICHMOND / PW

SW GRAND FORKS

SOUTH RUCKLES

VARIOUS

BASE DATA

HIGHWAY

ROAD

RAILWAY

CONTOUR (20m)

WATERCOURSE

WATERBODY

VEGETATION

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE
INDEX MAP

CONSULTANT

GOLDER

YYYY-MM-DD	2018-03-16
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	INDEX

LEGEND

PARCEL

SEWER REGION

DONALDSON / NW

RISK RATING FOR SOIL

RISK 1: FLUVIAL / GLACIOFLUVIAL

RISK 2: FLUVIAL / GLACIOFLUVIAL WITHIN FLOODPLAIN

RISK 3: COLLUVIUM

RISK 4: TILL / COLLUVIUM OVER BEDROCK AND COLLUVIUM WITHIN FLOODPLAIN

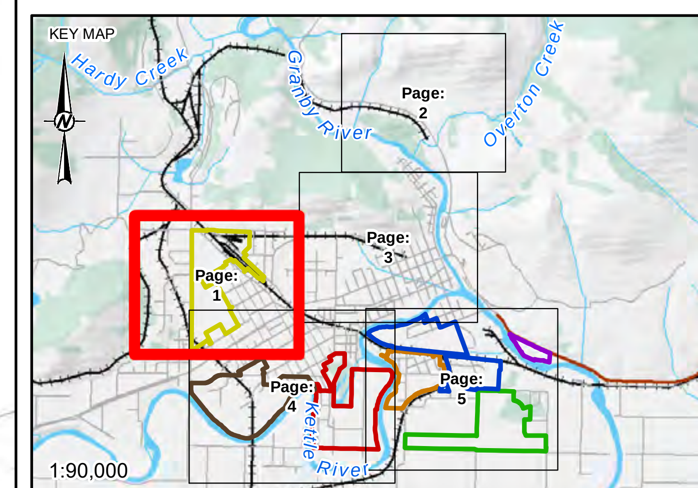
BASE DATA

ROAD

RAILWAY

CONTOUR (20m)

VEGETATION



0 90 180

1:6,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

RISK RATING FOR SOIL
DONALDSON / NW

CONSULTANT

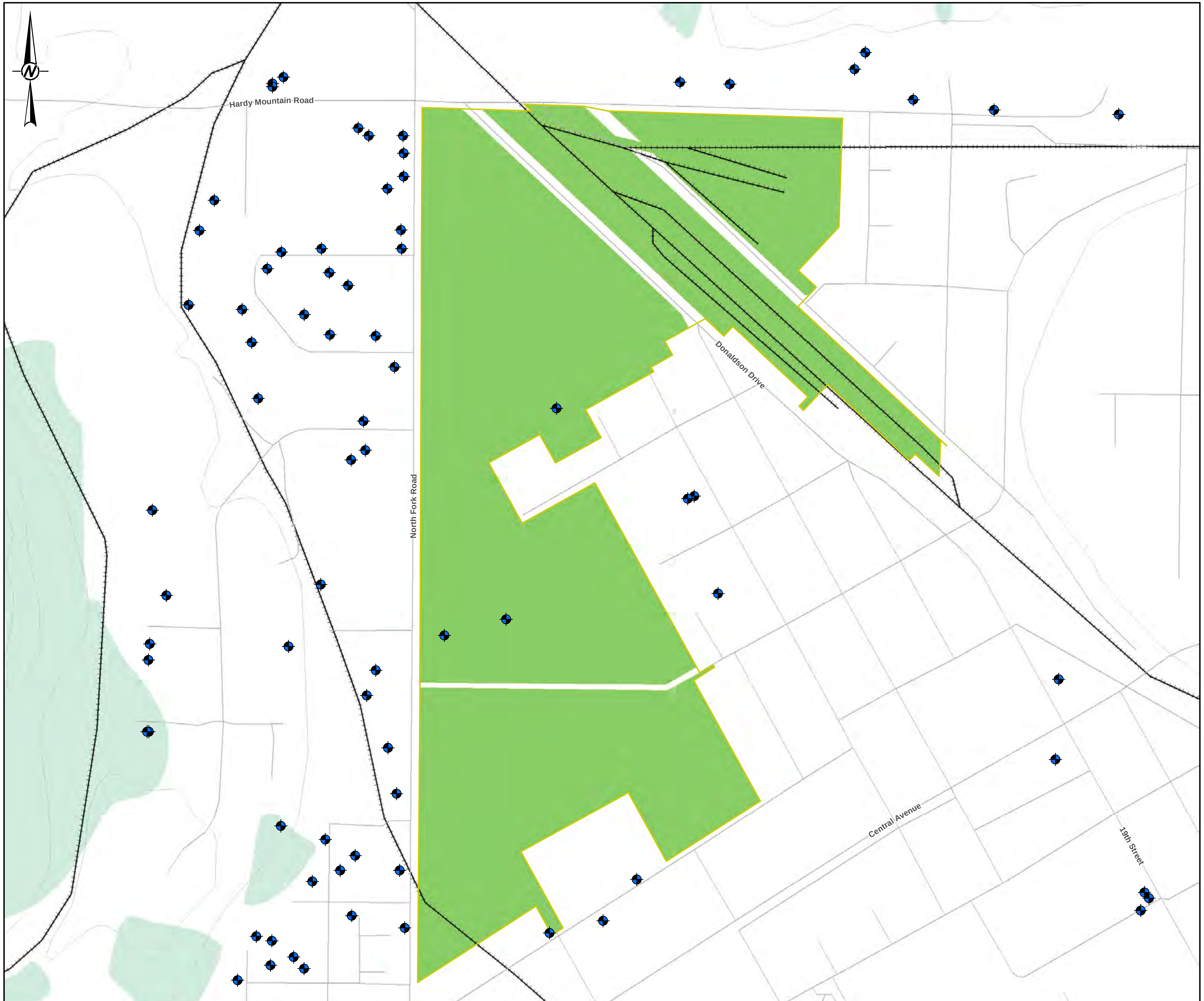
GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	1A

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm



LEGEND

GROUNDWATER WELL

PARCEL

SEWER REGION

DONALDSON / NW

RISK RATING FOR DEPTH TO GROUNDWATER

RISK 1: > 10 m

RISK 2: 3 - 10 m

RISK 3: 1 - 3 m

RISK 4: < 1 m

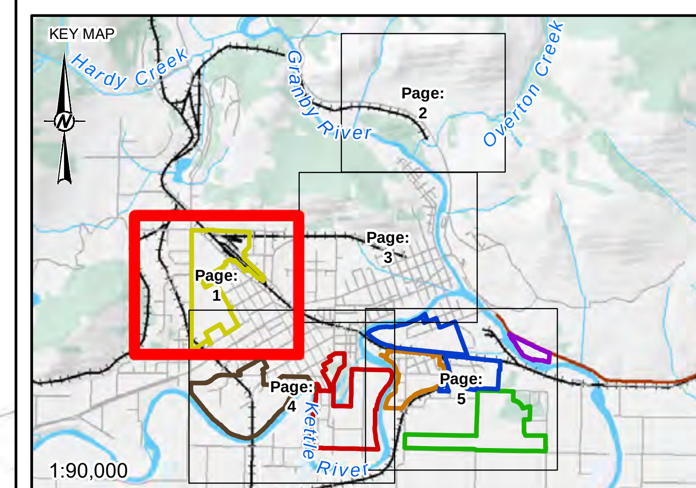
BASE DATA

ROAD

RAILWAY

CONTOUR (20m)

VEGETATION



0 75 150

1:6,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

RISK RATING FOR DEPTH TO GROUNDWATER
DONALDSON / NW

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	1B

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

LEGEND

PARCEL

SEWER REGION

DONALDSON / NW

RISK RATING FOR SLOPE

RISK 1: < 5 %

RISK 2: 5 - 10 %

RISK 3: 10 - 30 %

RISK 4: > 30 %

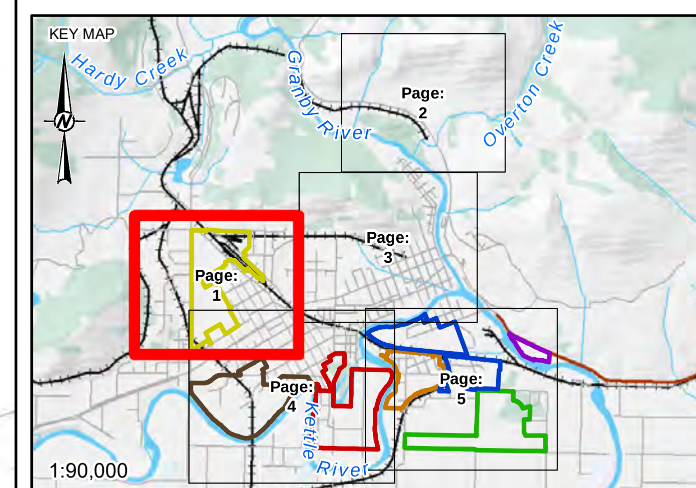
BASE DATA

ROAD

RAILWAY

CONTOUR (20m)

VEGETATION



0 75 150

1:6,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

RISK RATING FOR SLOPE
DONALDSON / NW

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	1C

PATH: \\golder.gds\gal\Burnaby\CAD-GIS\Client\Urban Systems Ltd\Grand_Forks\99_PROJECTS\1895271\02_PRODUCTION\1000\MXD\Report\1895271_1000_Figure_C_Risk_Rating_for_Slope_mapbook_Scenario_3.mxd PRINTED ON: 2018-03-16 AT 4:34:09 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

0

LEGEND

PARCEL

SEWER REGION

DONALDSON / NW

RISK RATING FOR PARCEL SIZE

RISK 1: > 1 ha

RISK 2: 0.5 - 1 ha

RISK 3: 0.14 - 0.5 ha

RISK 4: < 0.14 ha

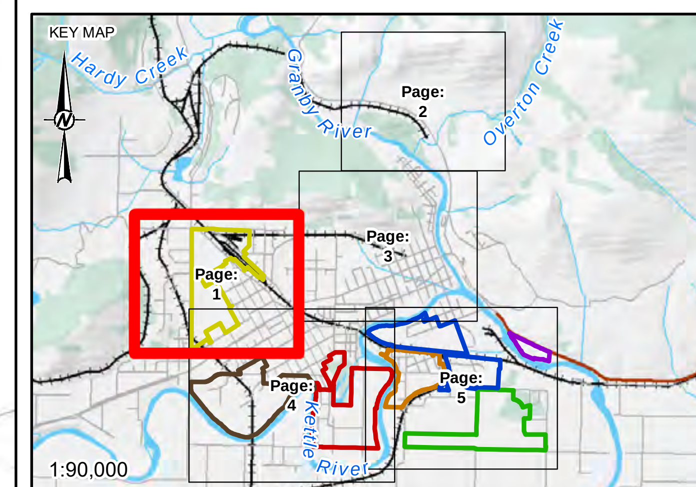
BASE DATA

ROAD

RAILWAY

CONTOUR (20m)

VEGETATION



0 75 150

1:6,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

RISK RATING FOR PARCEL SIZE
DONALDSON / NW

CONSULTANT

GOLDER

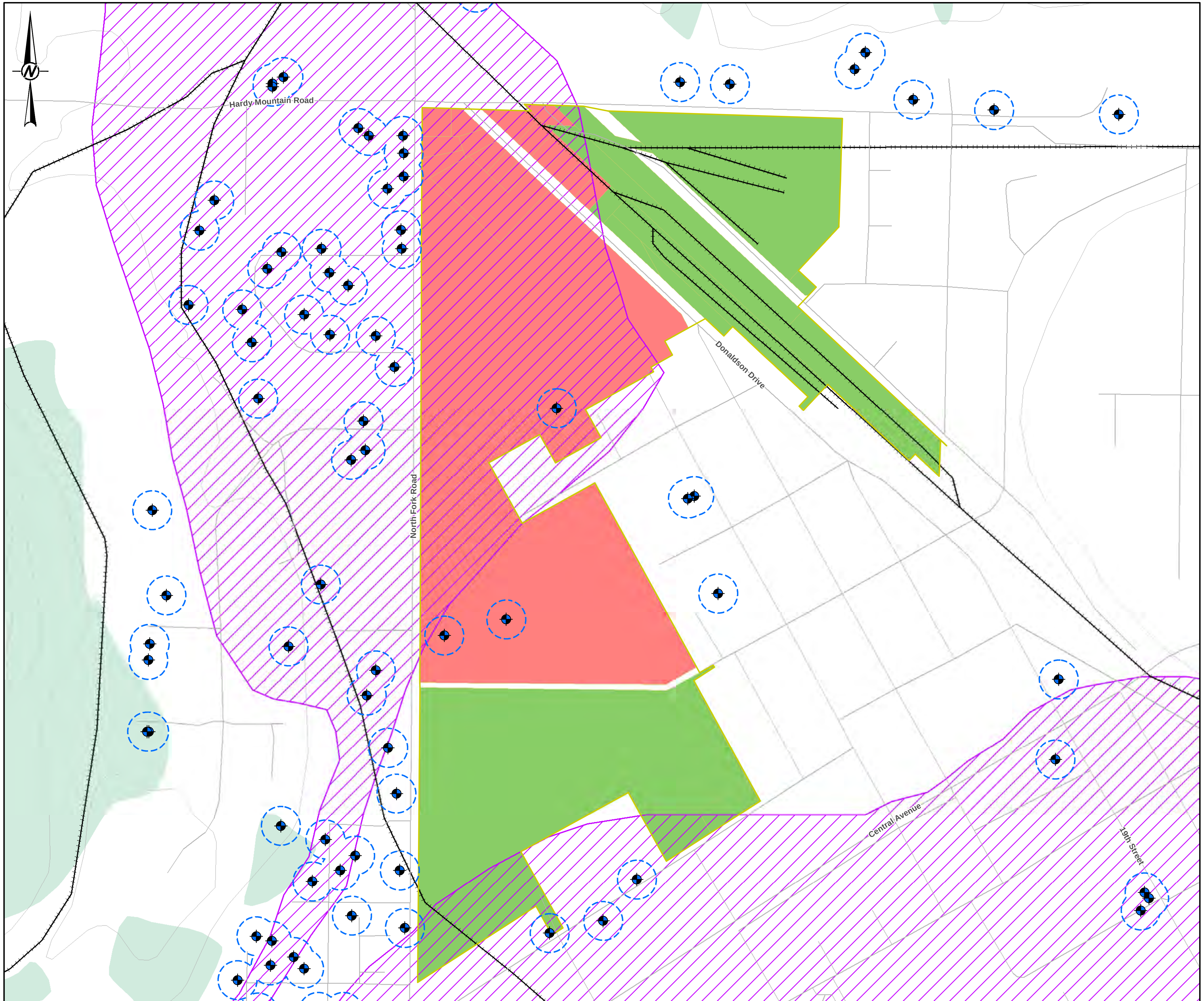
YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	1D

PATH: \\golder.gds\gal\Burnaby\CAD-GIS\Client\Urban Systems Ltd\Grand_Forks\99_PROJECTS\1895271\02_PRODUCTION\1000\MXD\Report\1895271_1000_Figure_D_Risk_Rating_for_Parcel_Size_mapbook.mxd PRINTED ON: 2018-03-16 AT: 5:07:24 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm



LEGEND

- GROUNDWATER WELL
- PARCEL

SEWER REGION

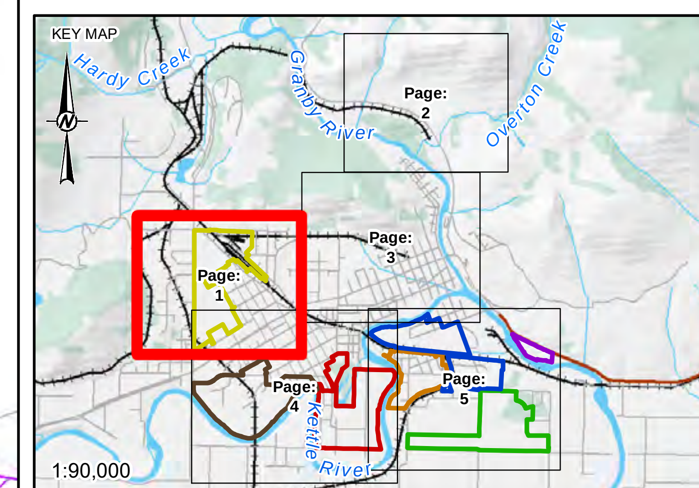
- DONALDSON / NW

RISK RATING FOR SURFACE WATER SETBACKS AND WELL CAPTURE ZONES

- RISK 1
- RISK 4

BASE DATA

- ROAD
- RAILWAY
- CONTOUR (20m)
- VEGETATION
- HORIZONTAL SETBACK FOR SURFACE WATER BODIES/WATER SUPPLY WELLS
- WELL CAPTURE ZONE (10 YEAR)



0 80 160

1:6,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE
RISK RATING FOR SURFACE WATER/WATER WELL SETBACKS AND WELL CAPTURE ZONES DONALDSON / NW

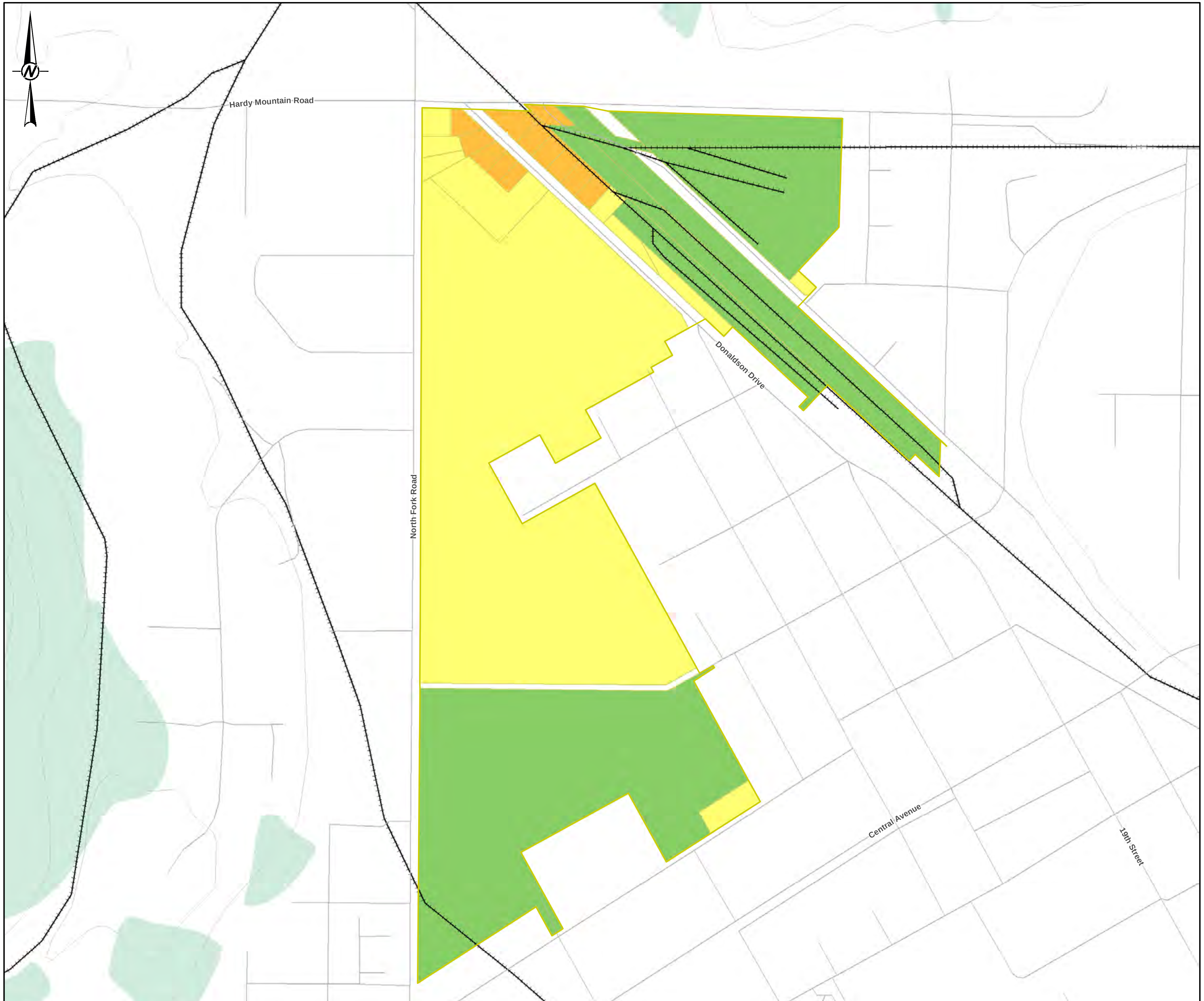
CONSULTANT
GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	1E

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm



LEGEND

PARCEL

SEWER REGION

DONALDSON / NW

FINAL RISK RATING

RISK 1

RISK 2

RISK 3

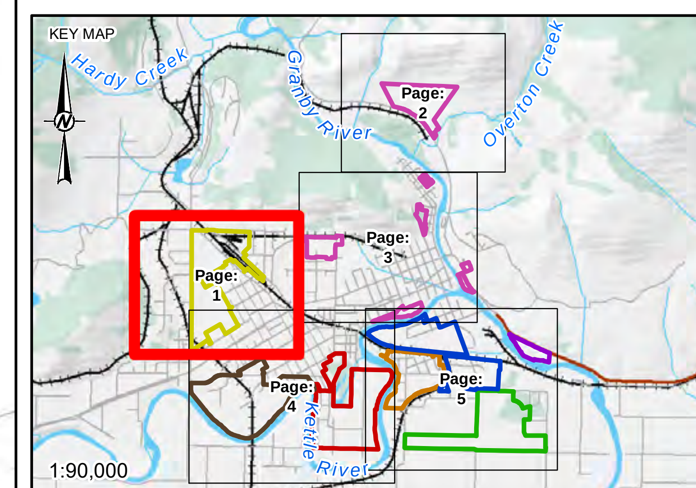
BASE DATA

ROAD

RAILWAY

CONTOUR (20m)

VEGETATION



0 75 150

1:6,000 METRES

REFERENCE(S)
1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE
FINAL RISK RATING
DONALDSON / NW

CONSULTANT

GOLDER

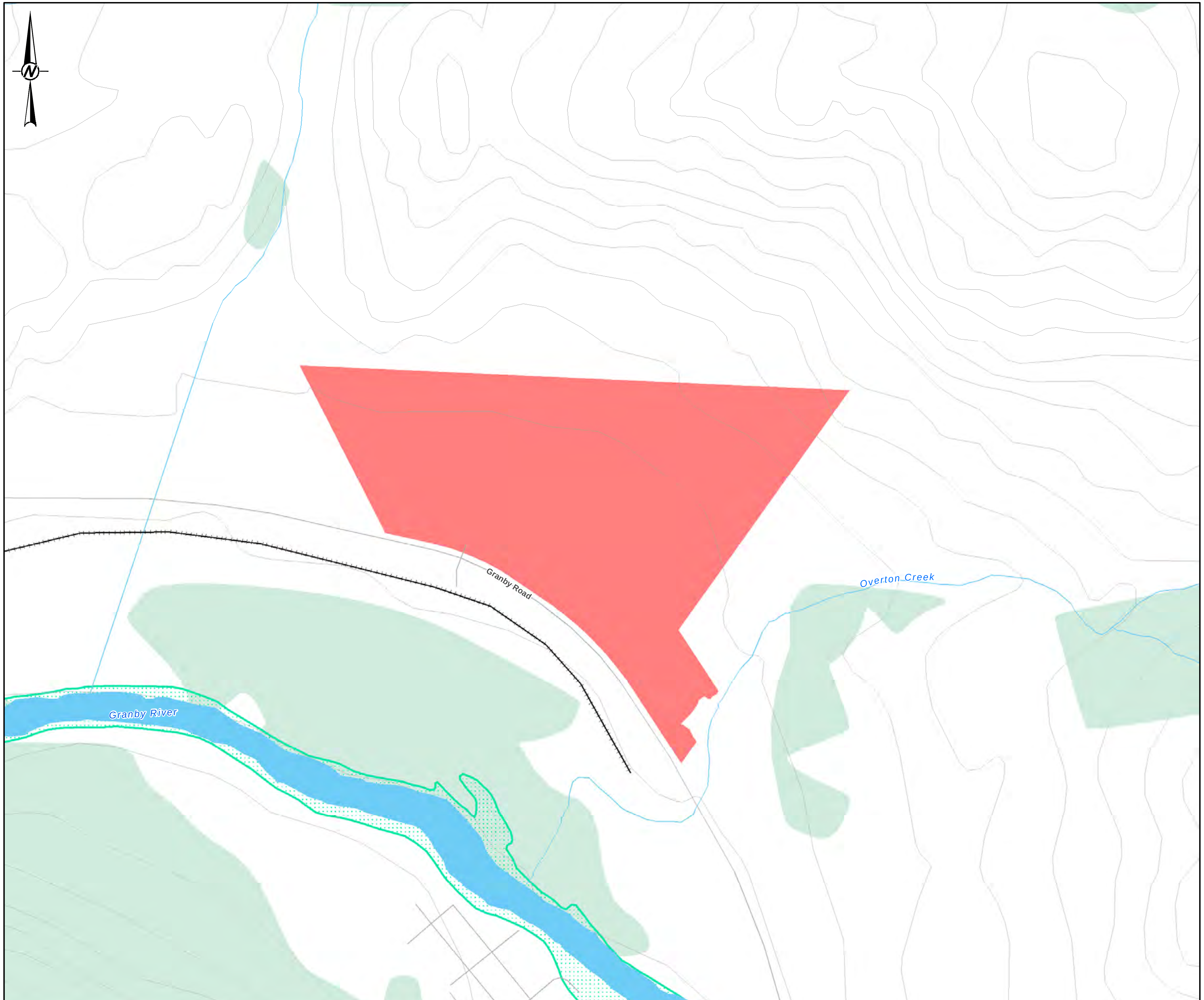
YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	1F

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm 0

PATH: \\golder.gds\gal\Burnaby\CAD-GIS\Client\Urban Systems Ltd\Grand_Forks\99_PROJECTS\1895271\02_PRODUCTION\1000\MXD\Report\1895271_1000_Figure_F_Final_Risk_Rating_Scenario_3_Parcel_Weight_2_Setback_Weight_2_mapbook.mxd PRINTED ON: 2018-03-16 AT: 4:38:03 PM



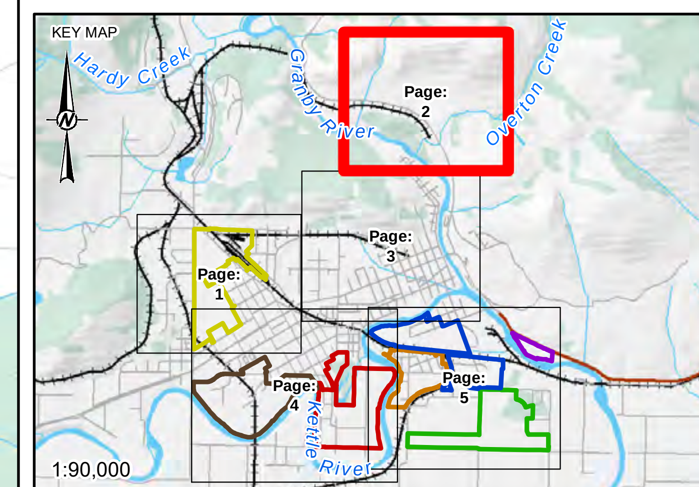
LEGEND

RISK RATING FOR SOIL

- RISK 1: FLUVIAL / GLACIOFLUVIAL
- RISK 2: FLUVIAL / GLACIOFLUVIAL WITHIN FLOODPLAIN
- RISK 3: COLLUVIUM
- RISK 4: TILL / COLLUVIUM OVER BEDROCK AND COLLUVIUM WITHIN FLOODPLAIN

BASE DATA

- ROAD
- RAILWAY
- CONTOUR (20m)
- WATERCOURSE
- VEGETATION
- FLOODPLAIN



0 90 180

1:6,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

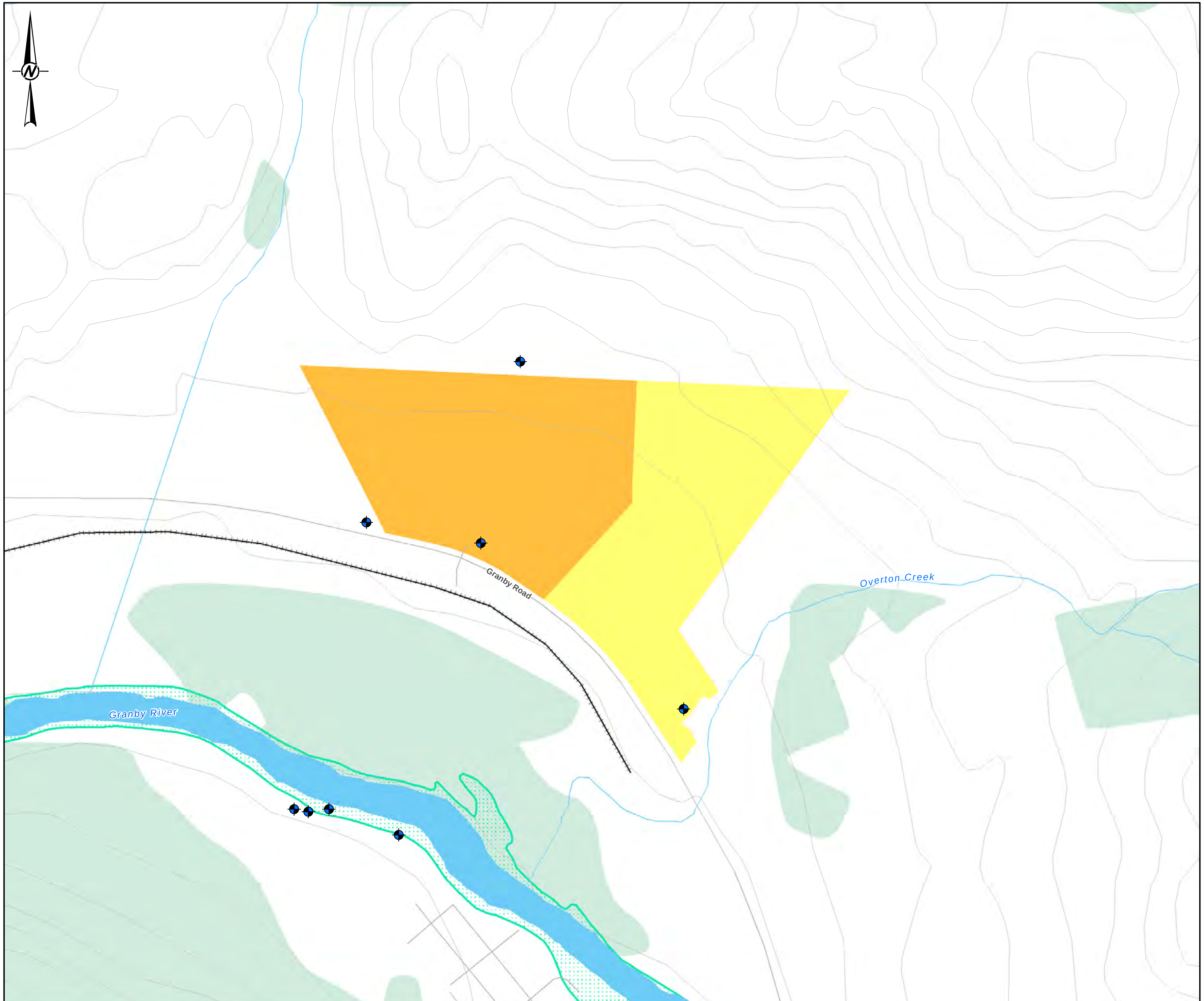
TITLE
RISK RATING FOR SOIL
VARIOUS - NORTH

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	2A



LEGEND

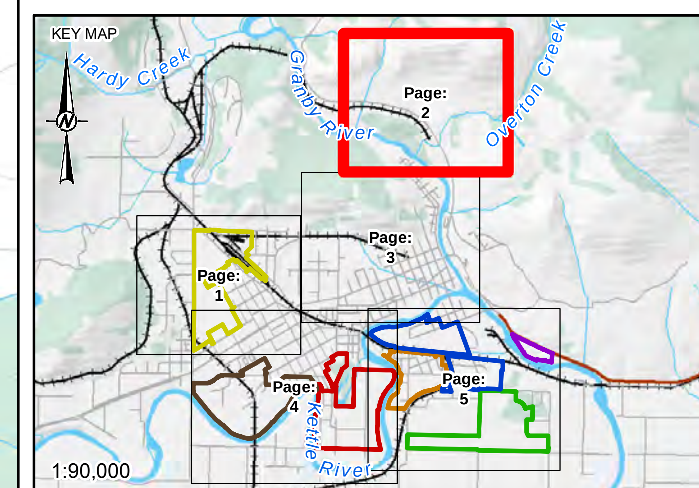
- GROUNDWATER WELL

RISK RATING FOR DEPTH TO GROUNDWATER

- RISK 1: > 10 m
- RISK 2: 3 - 10 m
- RISK 3: 1 - 3 m
- RISK 4: < 1 m

BASE DATA

- ROAD
- RAILWAY
- CONTOUR (20m)
- WATERCOURSE
- VEGETATION
- FLOODPLAIN



0 75 150

1:6,000 METRES

REFERENCE(S)
1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE
RISK RATING FOR DEPTH TO GROUNDWATER
VARIOUS - NORTH

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

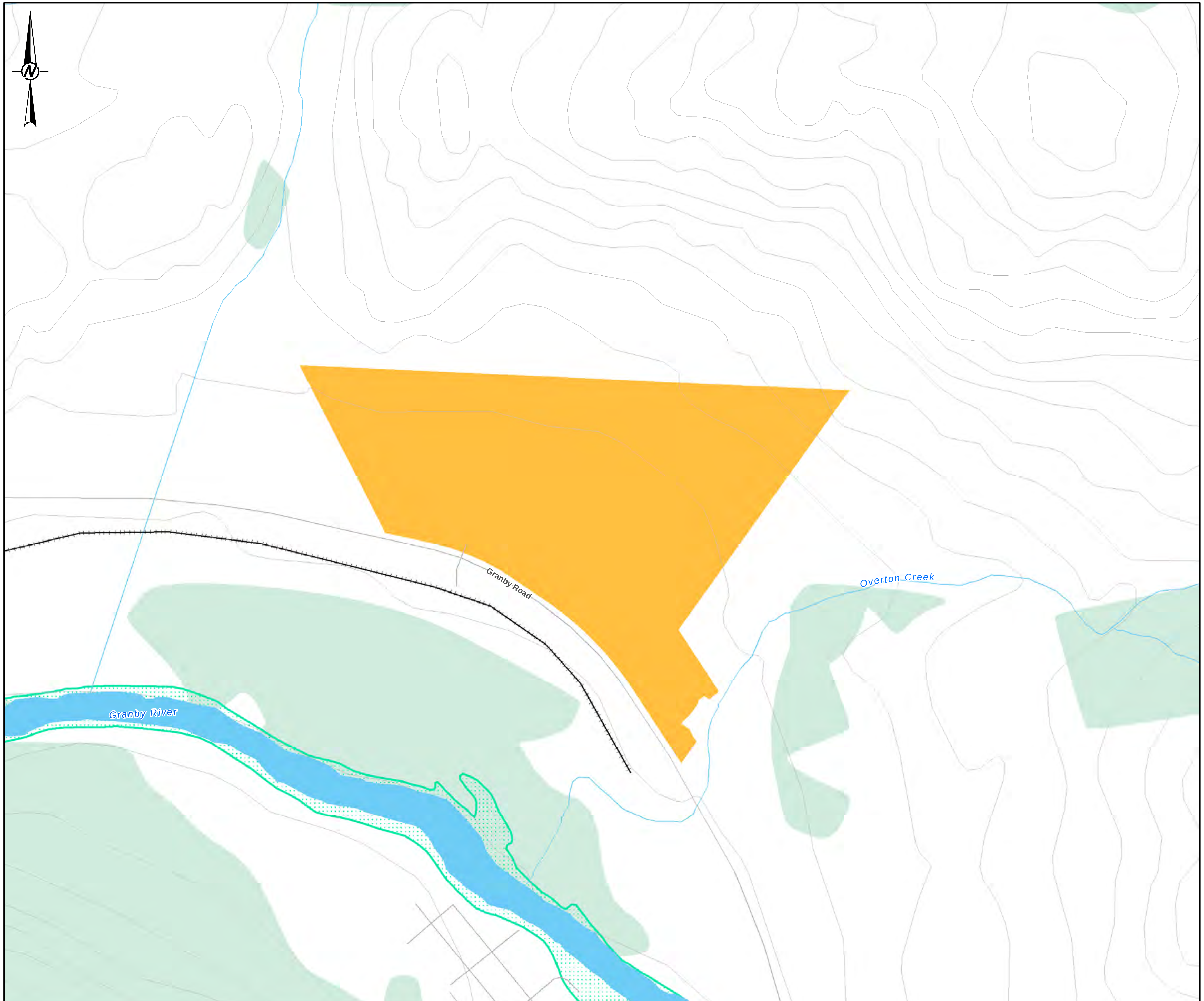
PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	2B

PATH: \\golder.gds\gal\Burnaby\CAD-GIS\Client\Urban Systems Ltd\Grand_Forks\99_PROJECTS\1895271\02_PRODUCTION\1000\MXD\Report\1895271_1000_Figure_B_Risk_Rating_for_Groundwater_mapbook.mxd PRINTED ON: 2018-03-16 AT: 4:39:26 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

0



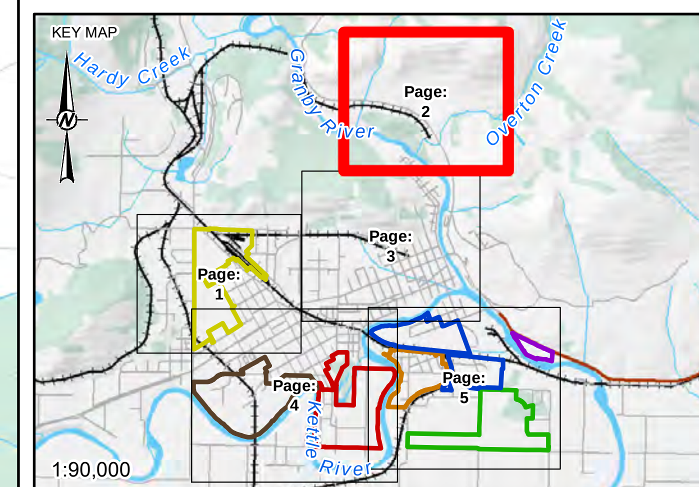
LEGEND

RISK RATING FOR SLOPE

- RISK 1: < 5 %
- RISK 2: 5 - 10 %
- RISK 3: 10 - 30 %
- RISK 4: > 30 %

BASE DATA

- ROAD
- RAILWAY
- CONTOUR (20m)
- WATERCOURSE
- VEGETATION
- FLOODPLAIN



0 75 150

1:6,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

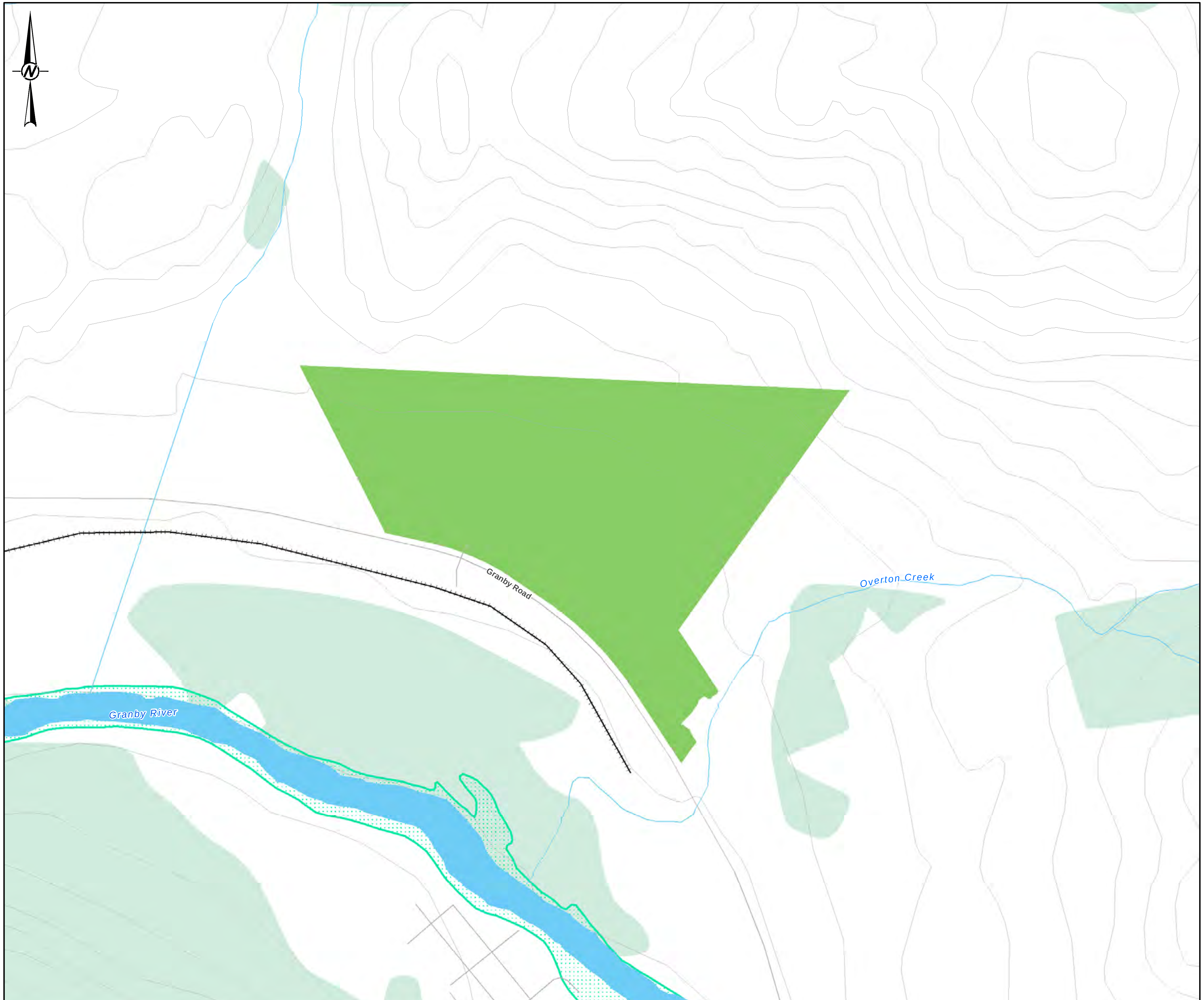
RISK RATING FOR SLOPE
VARIOUS - NORTH

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

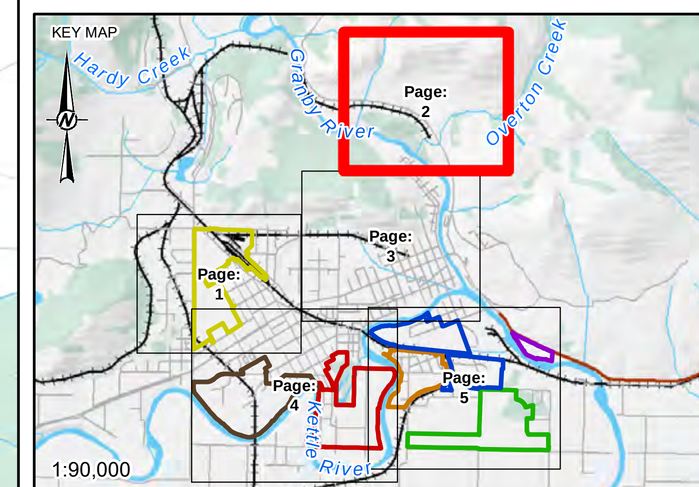
PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	2C



LEGEND

RISK RATING FOR PARCEL SIZE
- RISK 1: > 1 ha
- RISK 2: 0.5 - 1 ha
- RISK 3: 0.14 - 0.5 ha
- RISK 4: < 0.14 ha

BASE DATA
- ROAD
- RAILWAY
- CONTOUR (20m)
- WATERCOURSE
- VEGETATION
- FLOODPLAIN



0 75 150
1:6,000 METRES

REFERENCE(S)
1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

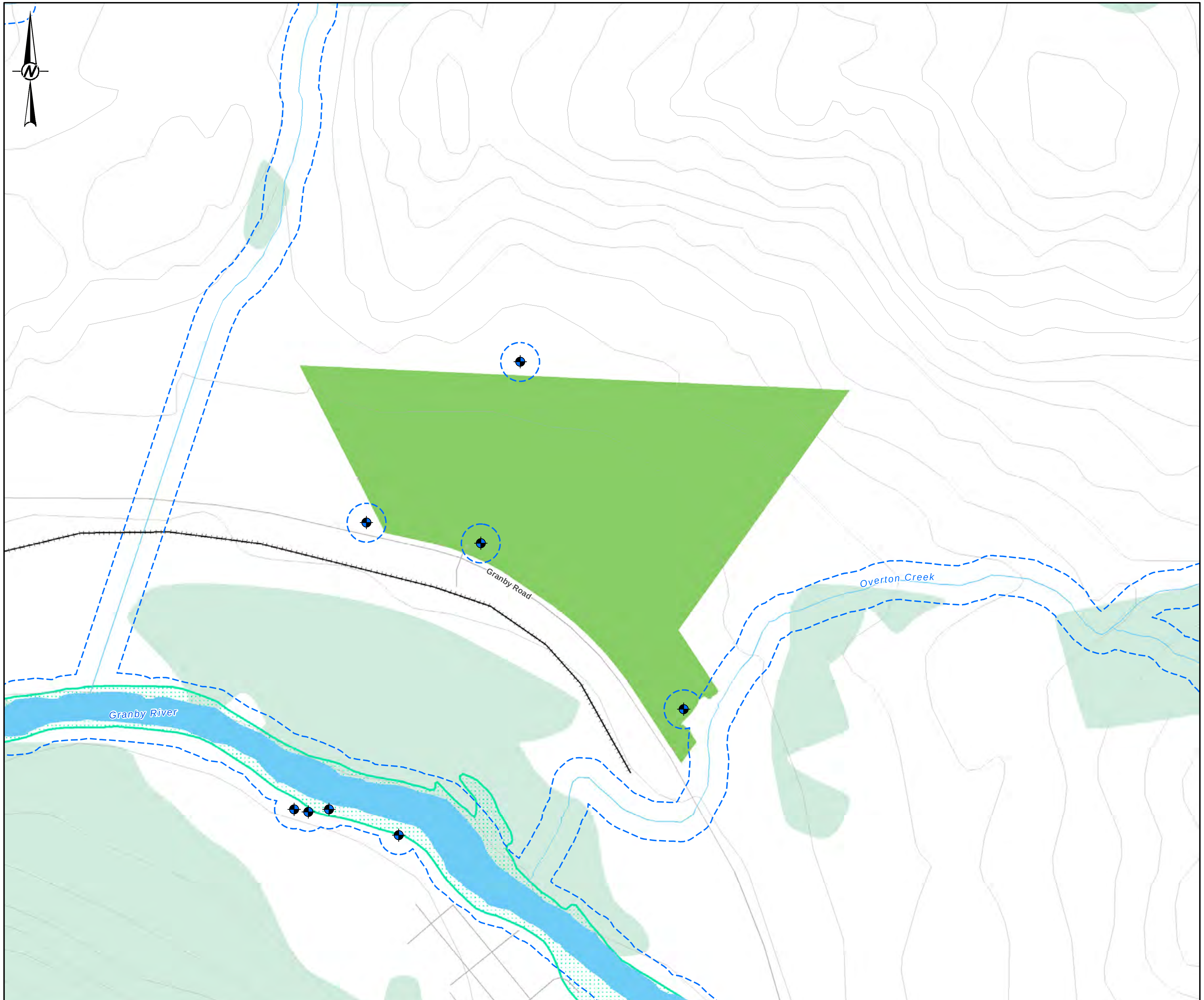
TITLE
RISK RATING FOR PARCEL SIZE
VARIOUS - NORTH

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	2D



LEGEND

GROUNDWATER WELL

RISK RATING FOR SURFACE WATER SETBACKS AND WELL CAPTURE ZONES

RISK 1

RISK 4

BASE DATA

ROAD

RAILWAY

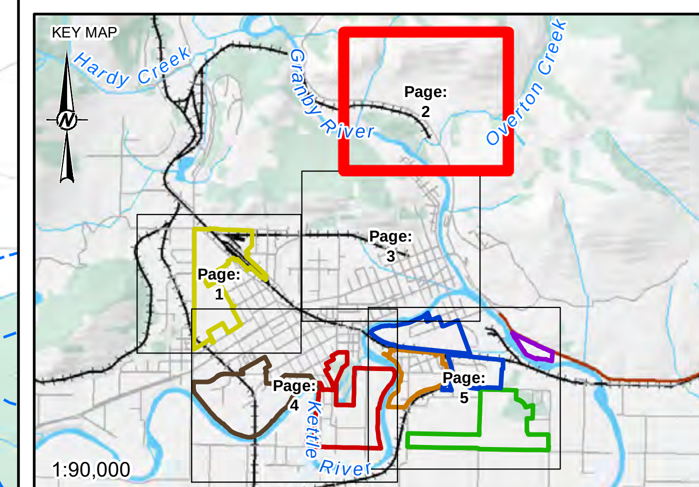
CONTOUR (20m)

WATERCOURSE

VEGETATION

HORIZONTAL SETBACK FOR SURFACE WATER BODIES/WATER SUPPLY WELLS

FLOODPLAIN



0 80 160

1:6,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

RISK RATING FOR SURFACE WATER/WATER WELL SETBACKS AND WELL CAPTURE ZONES VARIOUS - NORTH

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

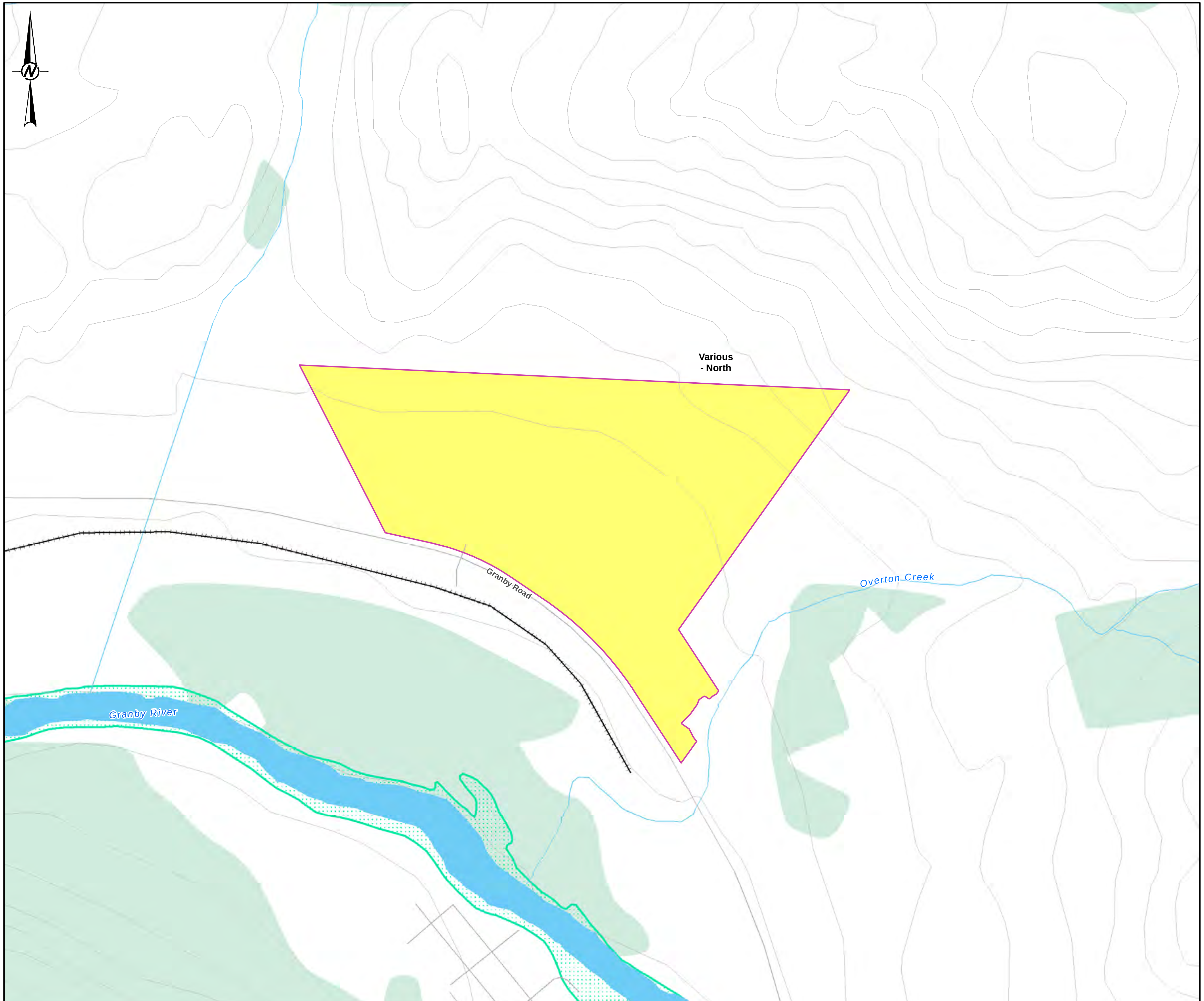
PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	2E

PATH: \\golder.gds\gal\Burnaby\CAD-GIS\Client\Urban Systems Ltd\Grand_Forks\99_PROJECTS\1895271\02_PRODUCTION\1000\MXD\Report\1895271_1000_Figure_E_Risk_Rating_for_Setbacks_and_Capture_Zones.mxd PRINTED ON: 2018-03-16 AT: 4:59:49 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

0



LEGEND

SEWER REGION

VARIOUS

FINAL RISK RATING

RISK 2

BASE DATA

ROAD

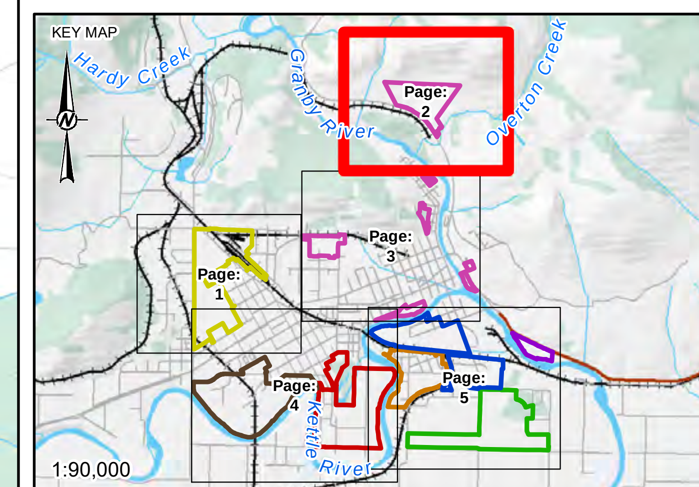
RAILWAY

CONTOUR (20m)

WATERCOURSE

VEGETATION

FLOODPLAIN



0 75 150

1:6,000 METRES

REFERENCE(S)
1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE
FINAL RISK RATING
VARIOUS - NORTH

CONSULTANT

GOLDER

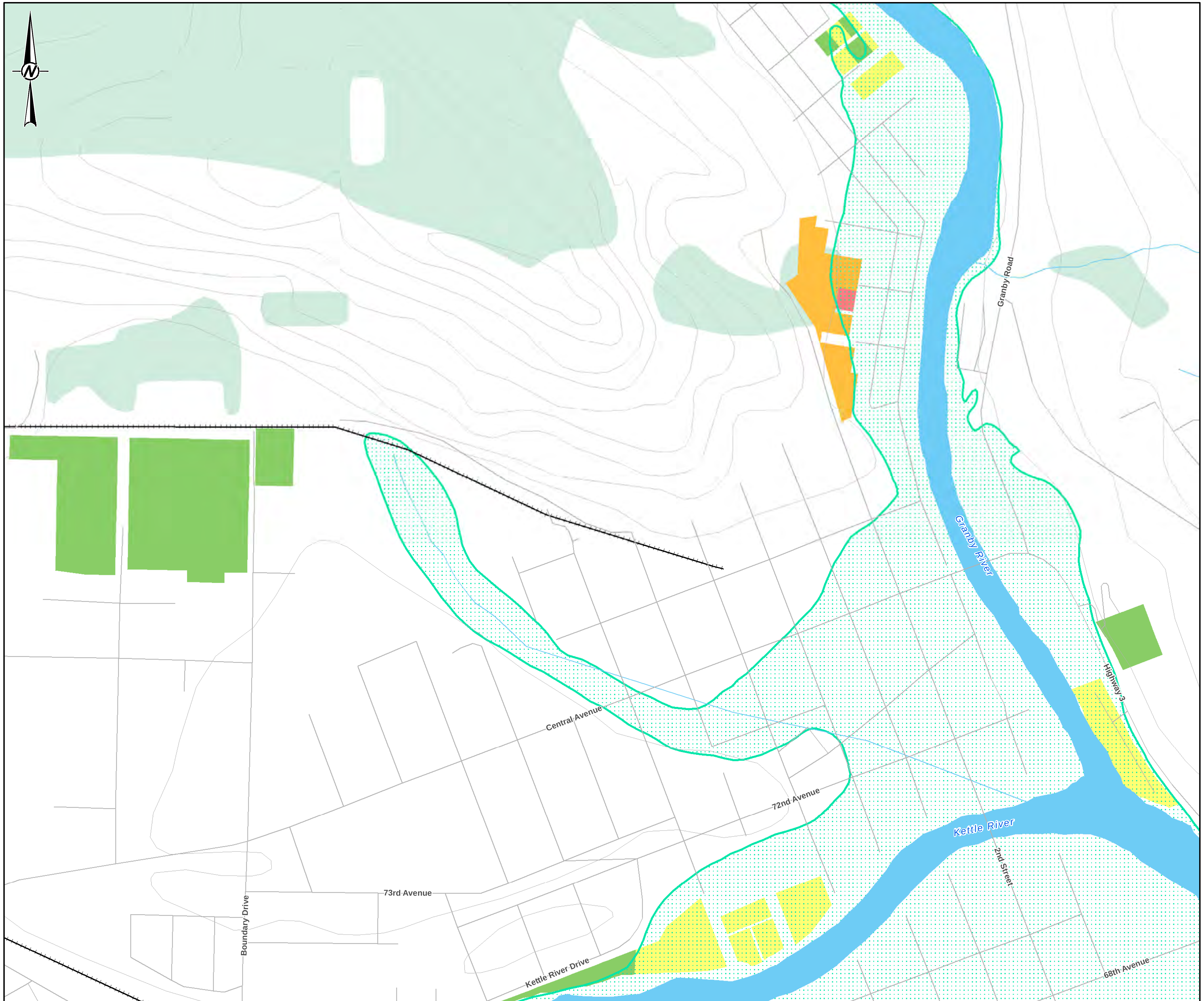
YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	2F

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

0



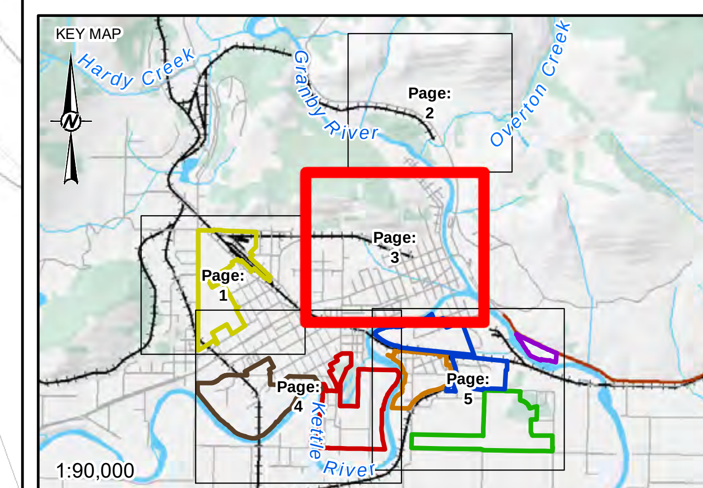
LEGEND

RISK RATING FOR SOIL

- RISK 1: FLUVIAL / GLACIOFLUVIAL
- RISK 2: FLUVIAL / GLACIOFLUVIAL WITHIN FLOODPLAIN
- RISK 3: COLLUVIUM
- RISK 4: TILL / COLLUVIUM OVER BEDROCK AND COLLUVIUM WITHIN FLOODPLAIN

BASE DATA

- ROAD
- RAILWAY
- CONTOUR (20m)
- WATERCOURSE
- VEGETATION
- FLOODPLAIN



0 90 180

1:6,500 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE
RISK RATING FOR SOIL
VARIOUS - CENTRAL, EAST, SOUTH, WEST

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	3A

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

LEGEND

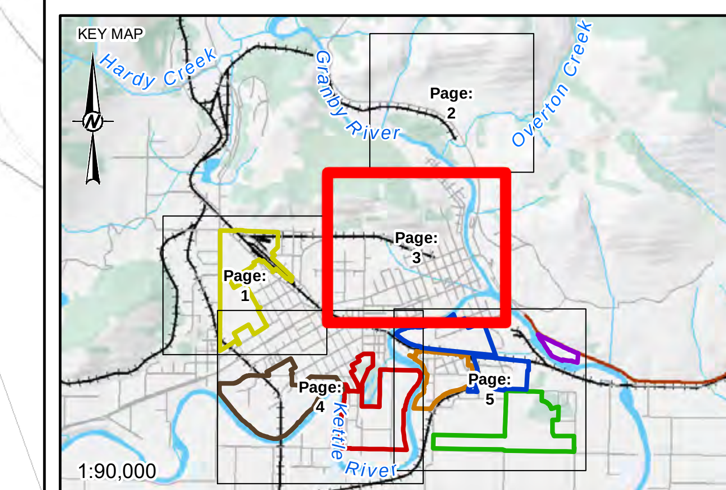
- GROUNDWATER WELL

RISK RATING FOR DEPTH TO GROUNDWATER

- RISK 1: > 10 m
- RISK 2: 3 - 10 m
- RISK 3: 1 - 3 m
- RISK 4: < 1 m

BASE DATA

- ROAD
- RAILWAY
- CONTOUR (20m)
- WATERCOURSE
- VEGETATION
- FLOODPLAIN



0 80 160

1:6,500 METRES

REFERENCE(S)
1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE
RISK RATING FOR DEPTH TO GROUNDWATER
VARIOUS - CENTRAL, EAST, SOUTH, WEST

CONSULTANT

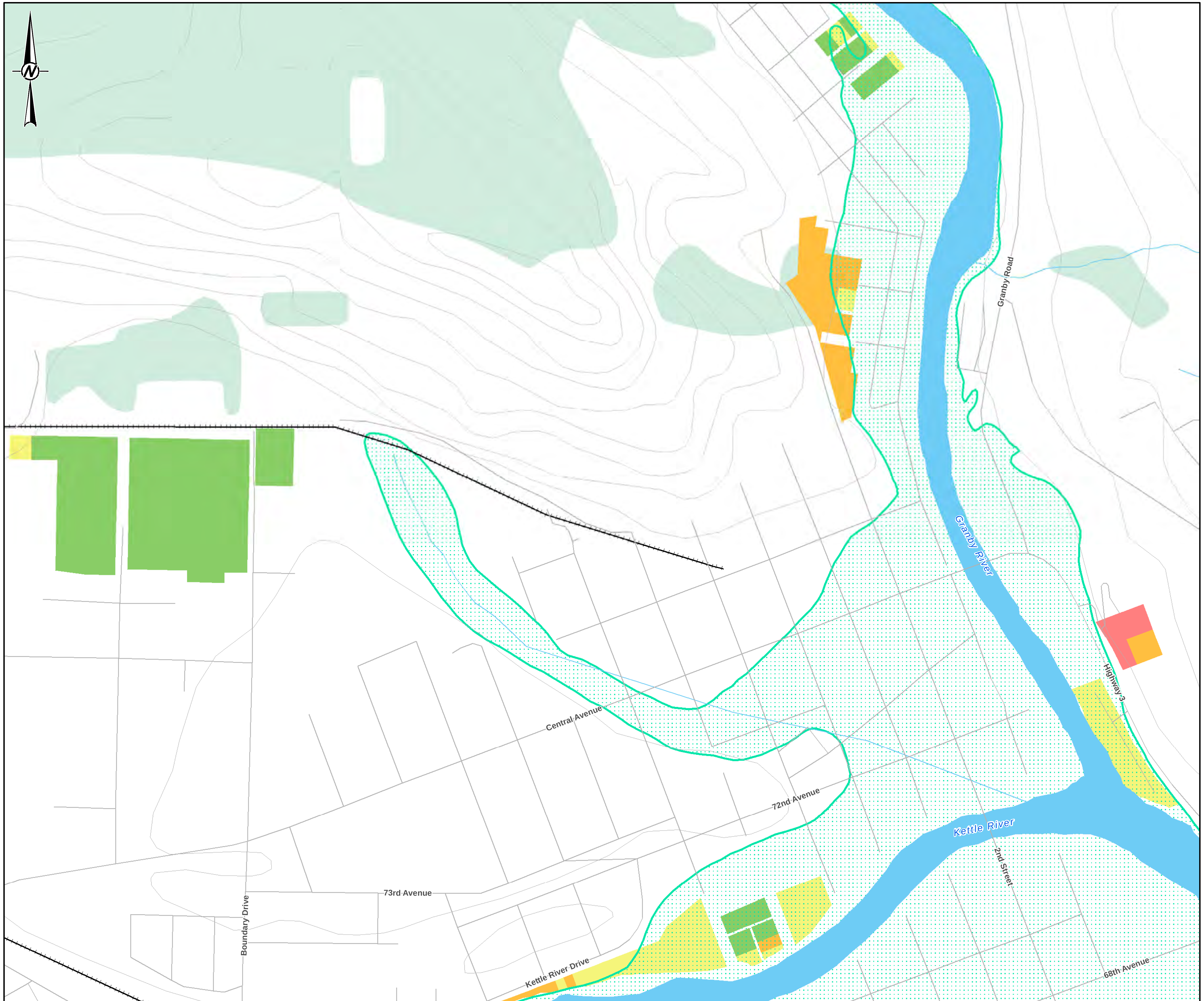
GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	3B

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm



LEGEND

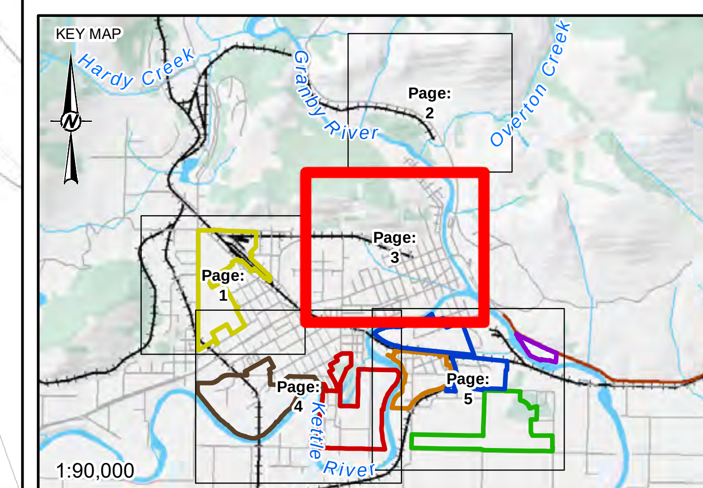
RISK RATING FOR SLOPE

- RISK 1: < 5 %
- RISK 2: 5 - 10 %
- RISK 3: 10 - 30 %
- RISK 4: > 30 %

BASE DATA

- ROAD
- RAILWAY
- CONTOUR (20m)
- WATERCOURSE
- VEGETATION
- FLOODPLAIN

KEY MAP



0 80 160

1:6,500 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

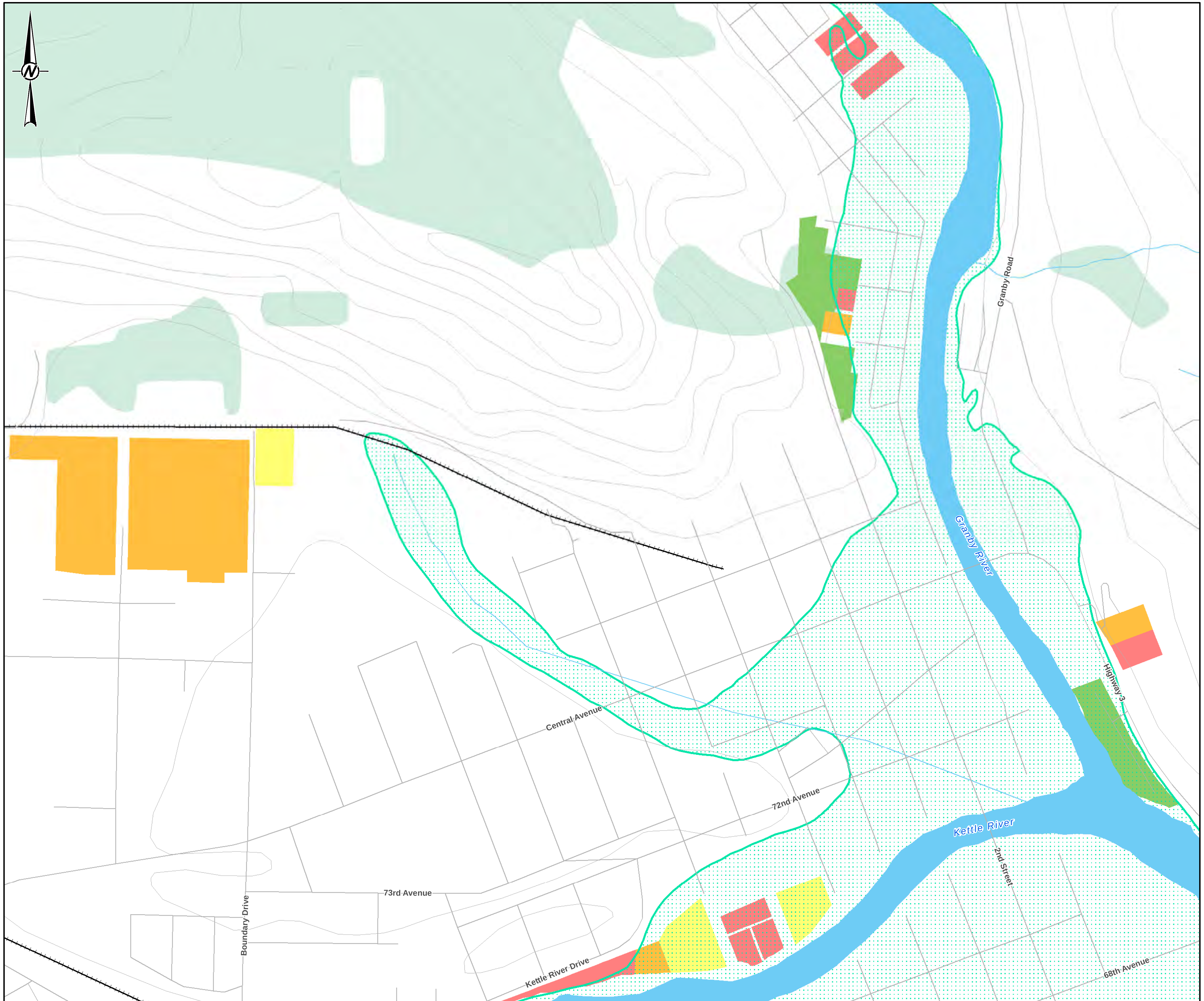
TITLE
RISK RATING FOR SLOPE
VARIOUS - CENTRAL, EAST, SOUTH, WEST

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	3C



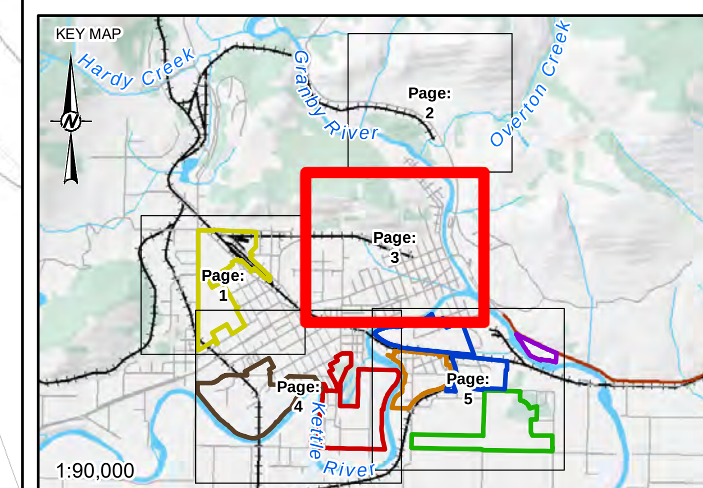
LEGEND

RISK RATING FOR PARCEL SIZE

- RISK 1: > 1 ha
- RISK 2: 0.5 - 1 ha
- RISK 3: 0.14 - 0.5 ha
- RISK 4: < 0.14 ha

BASE DATA

- ROAD
- RAILWAY
- CONTOUR (20m)
- WATERCOURSE
- VEGETATION
- FLOODPLAIN



0 80 160

1:6,500 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

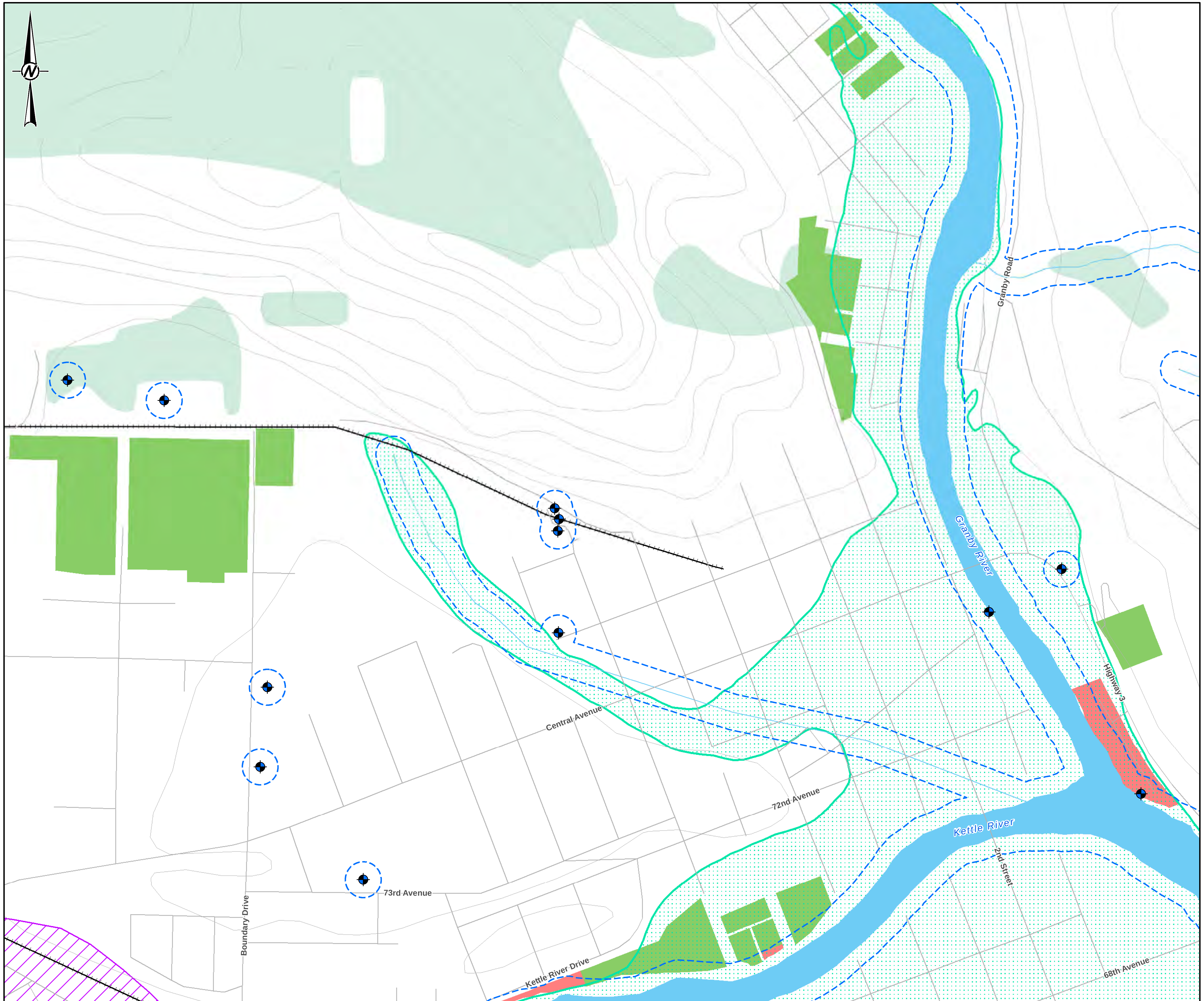
RISK RATING FOR PARCEL SIZE
VARIOUS - CENTRAL, EAST, SOUTH, WEST

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	3D



LEGEND

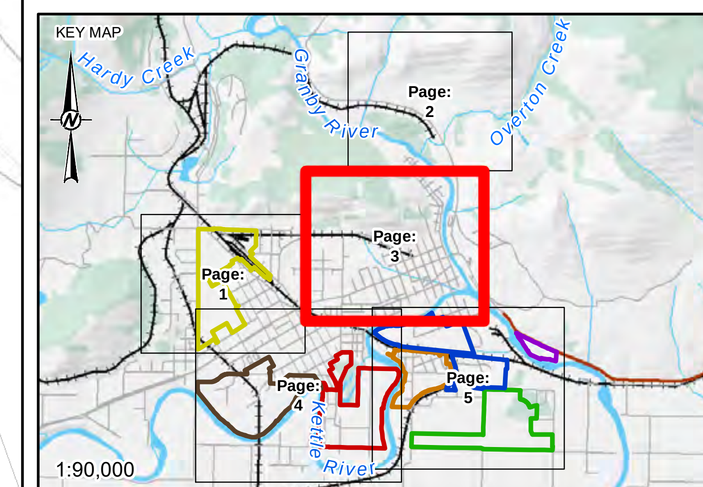
- GROUNDWATER WELL

RISK RATING FOR SURFACE WATER SETBACKS AND WELL CAPTURE ZONES

- RISK 1
- RISK 4

BASE DATA

- ROAD
- RAILWAY
- CONTOUR (20m)
- WATERCOURSE
- VEGETATION
- HORIZONTAL SETBACK FOR SURFACE WATER BODIES/WATER SUPPLY WELLS
- FLOODPLAIN
- WELL CAPTURE ZONE (10 YEAR)



0 90 180

1:6,500 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

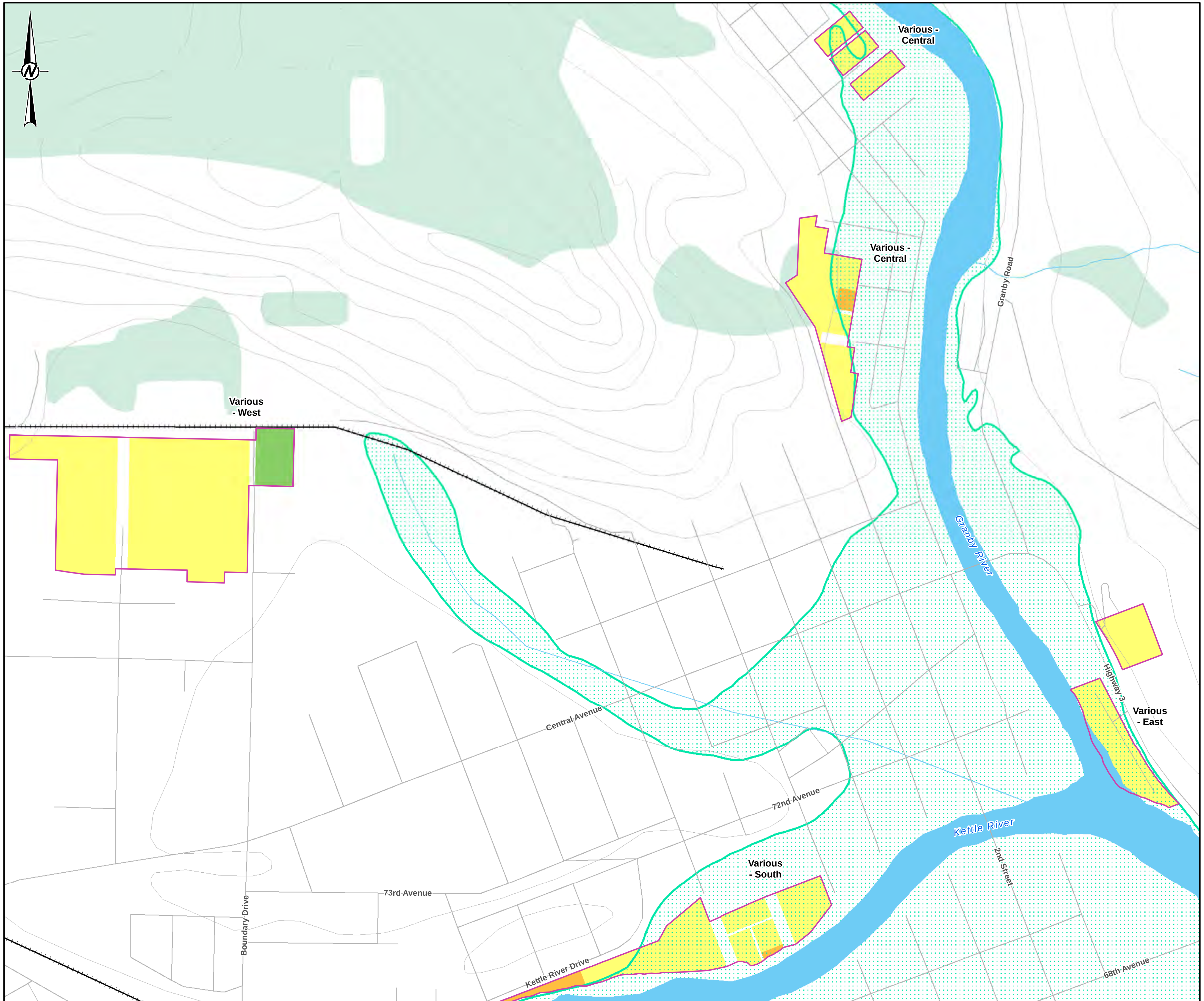
TITLE
RISK RATING FOR SURFACE WATER/WATER WELL SETBACKS AND WELL CAPTURE ZONES VARIOUS - CENTRAL, EAST, SOUTH, WEST

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	3E



LEGEND

SEWER REGION

VARIOUS

FINAL RISK RATING

RISK 1

RISK 2

RISK 3

BASE DATA

ROAD

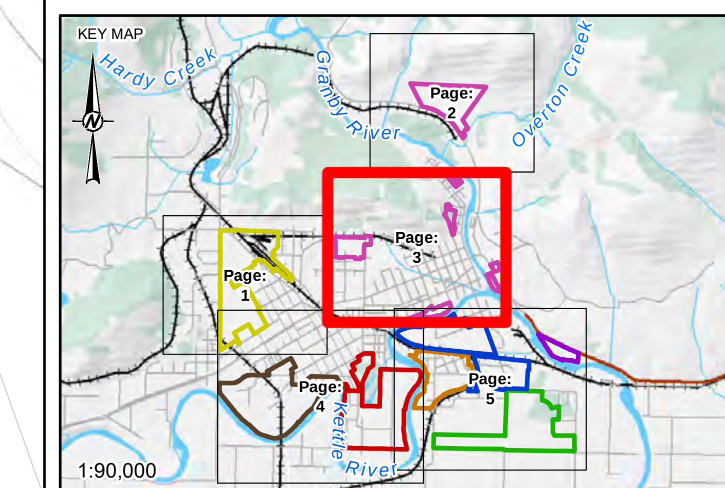
RAILWAY

CONTOUR (20m)

WATERCOURSE

VEGETATION

FLOODPLAIN



0 80 160

1:6,500 METRES

REFERENCE(S)
1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

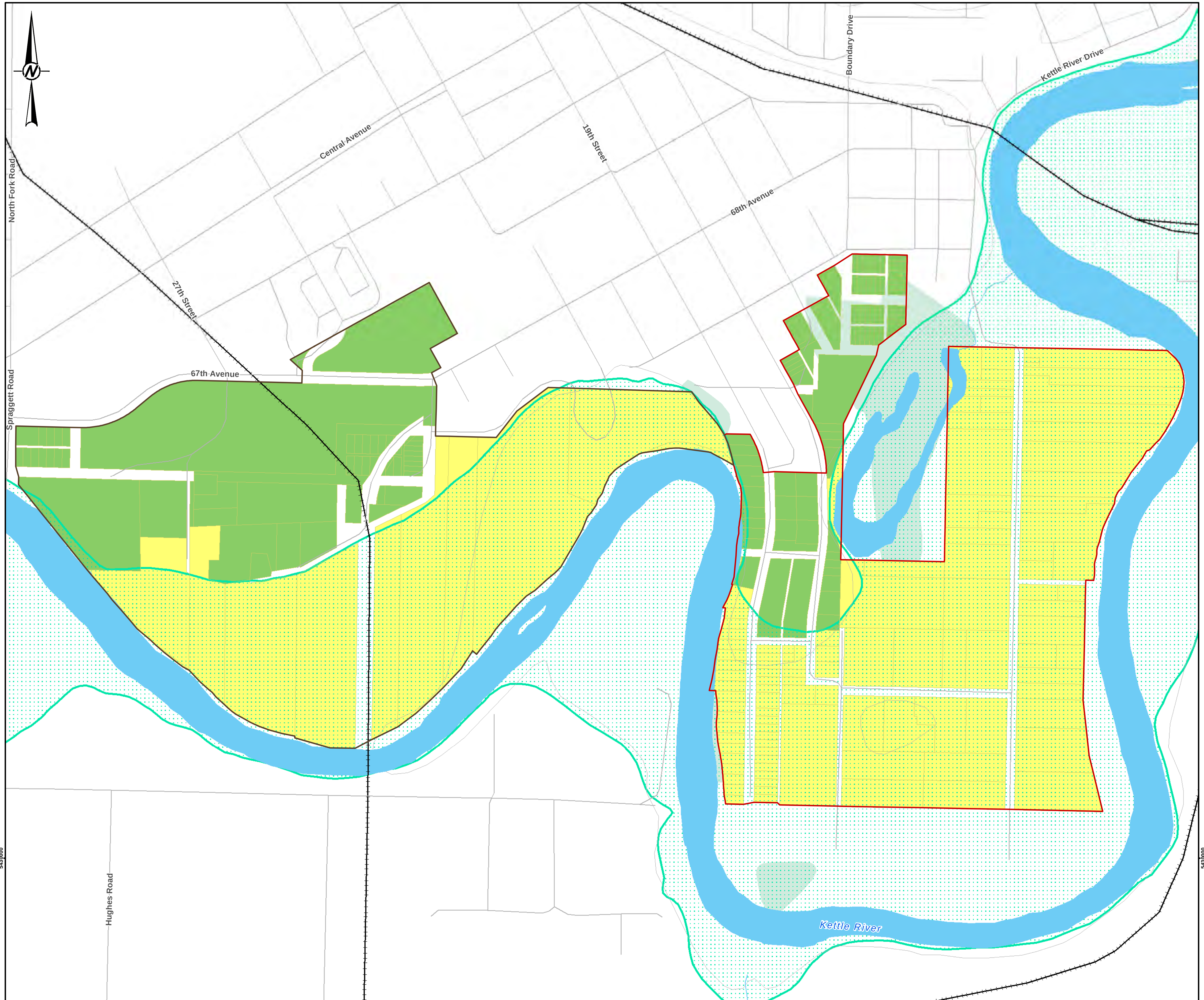
TITLE
FINAL RISK RATING
VARIOUS - CENTRAL, EAST, SOUTH, WEST

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	3F



LEGEND

PARCEL

SEWER REGION

JOHNSON FLATS

SW GRAND FORKS

RISK RATING FOR SOIL

RISK 1: FLUVIAL / GLACIOFLUVIAL

RISK 2: FLUVIAL / GLACIOFLUVIAL WITHIN FLOODPLAIN

RISK 3: COLLUVIUM

RISK 4: TILL / COLLUVIUM OVER BEDROCK AND COLLUVIUM WITHIN FLOODPLAIN

BASE DATA

ROAD

RAILWAY

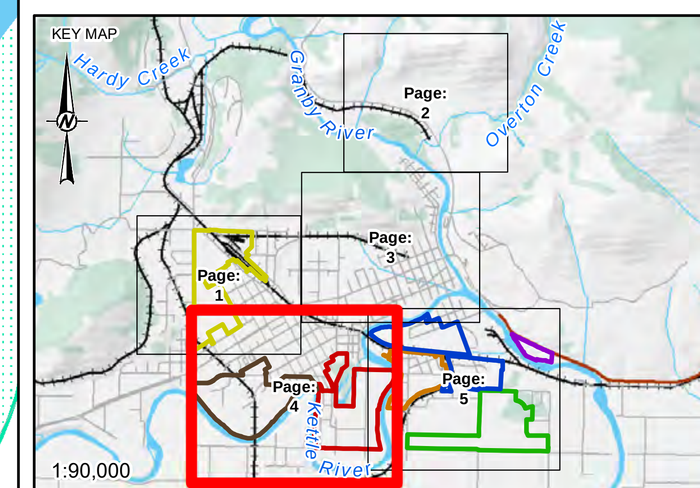
CONTOUR (20m)

WATERCOURSE

WATERBODY

VEGETATION

FLOODPLAIN



0 110 220

1:7,500 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.

2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

RISK RATING FOR SOIL

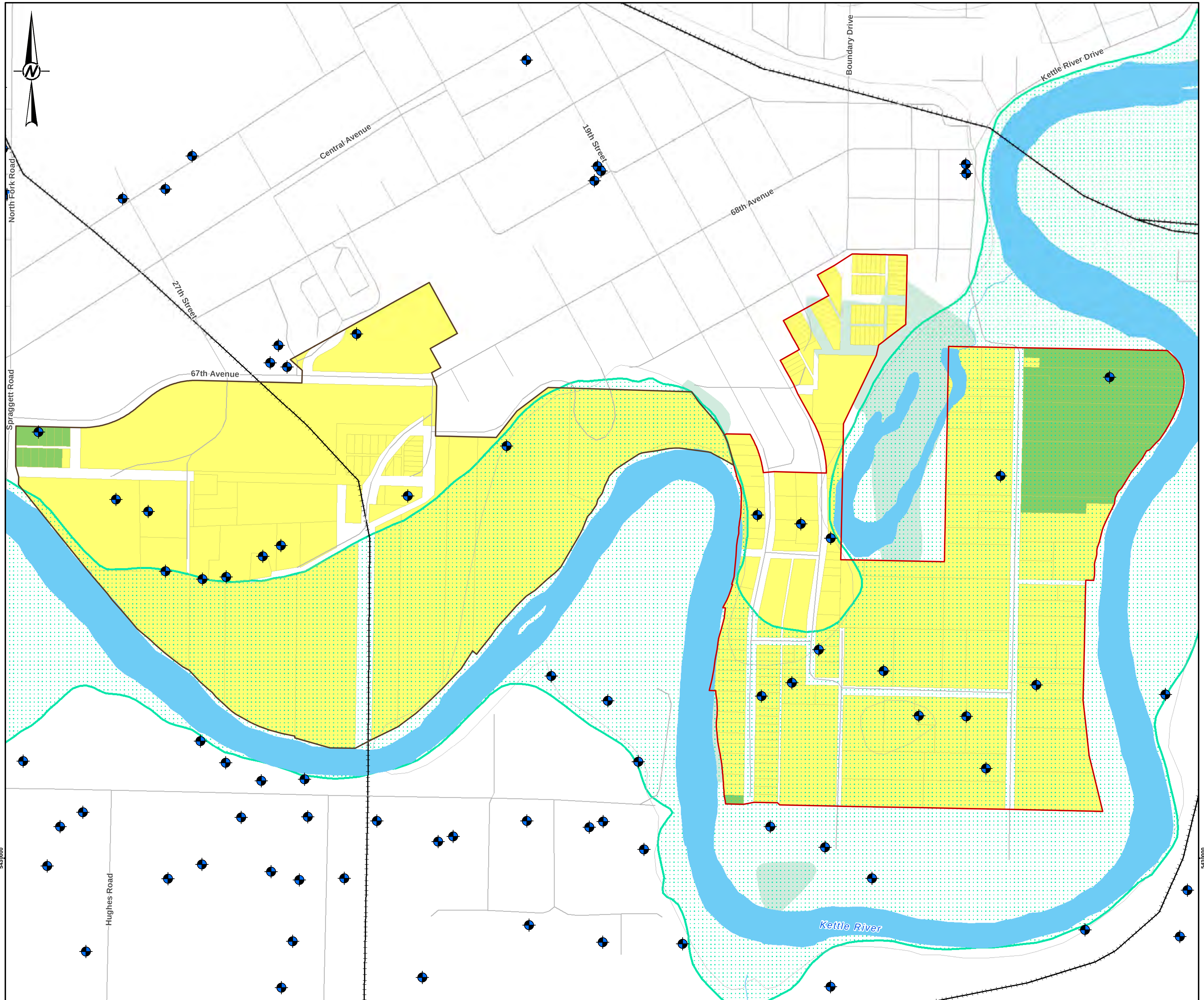
SW GRAND FORKS AND JOHNSON FLATS

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	4A



LEGEND

GROUNDWATER WELL

PARCEL

SEWER REGION

JOHNSON FLATS

SW GRAND FORKS

RISK RATING FOR DEPTH TO GROUNDWATER

RISK 1: > 10 m

RISK 2: 3 - 10 m

RISK 3: 1 - 3 m

RISK 4: < 1 m

BASE DATA

ROAD

RAILWAY

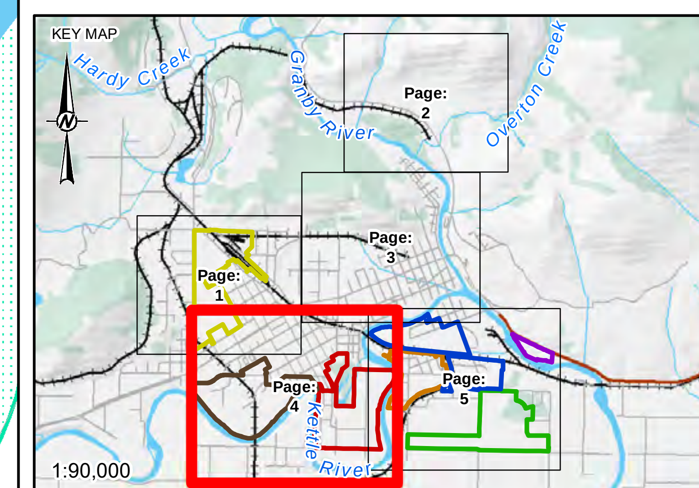
CONTOUR (20m)

WATERCOURSE

WATERBODY

VEGETATION

FLOODPLAIN



0 90 180

1:7,500 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

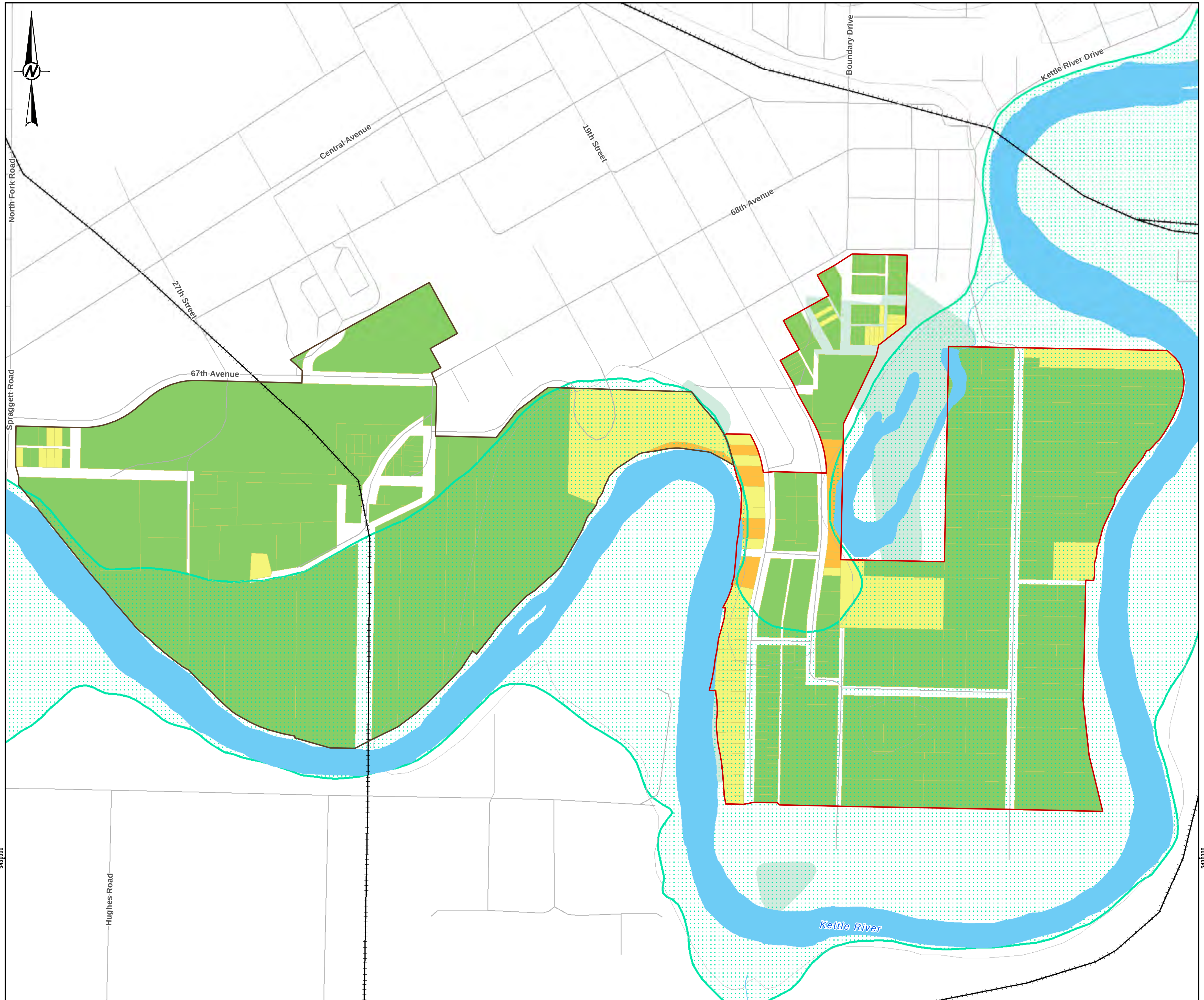
RISK RATING FOR DEPTH TO GROUNDWATER
SW GRAND FORKS AND JOHNSON FLATS

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	4B



LEGEND

PARCEL

SEWER REGION

JOHNSON FLATS

SW GRAND FORKS

RISK RATING FOR SLOPE

RISK 1: < 5 %

RISK 2: 5 - 10 %

RISK 3: 10 - 30 %

RISK 4: > 30 %

BASE DATA

ROAD

RAILWAY

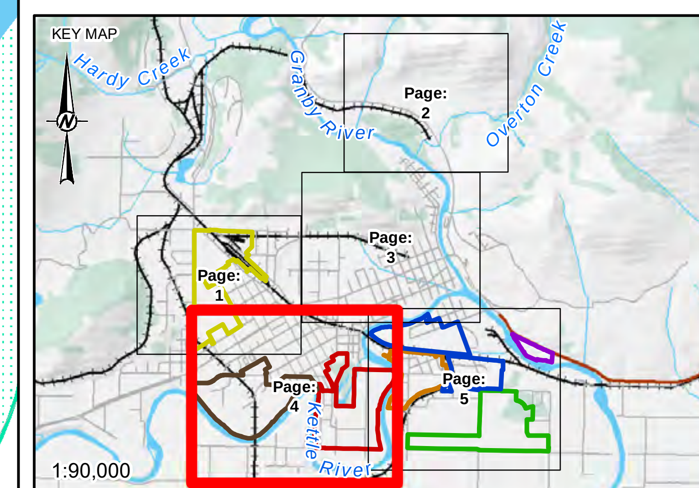
CONTOUR (20m)

WATERCOURSE

WATERBODY

VEGETATION

FLOODPLAIN



0 90 180

1:7,500 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE
RISK RATING FOR SLOPE
SW GRAND FORKS AND JOHNSON FLATS

CONSULTANT

GOLDER

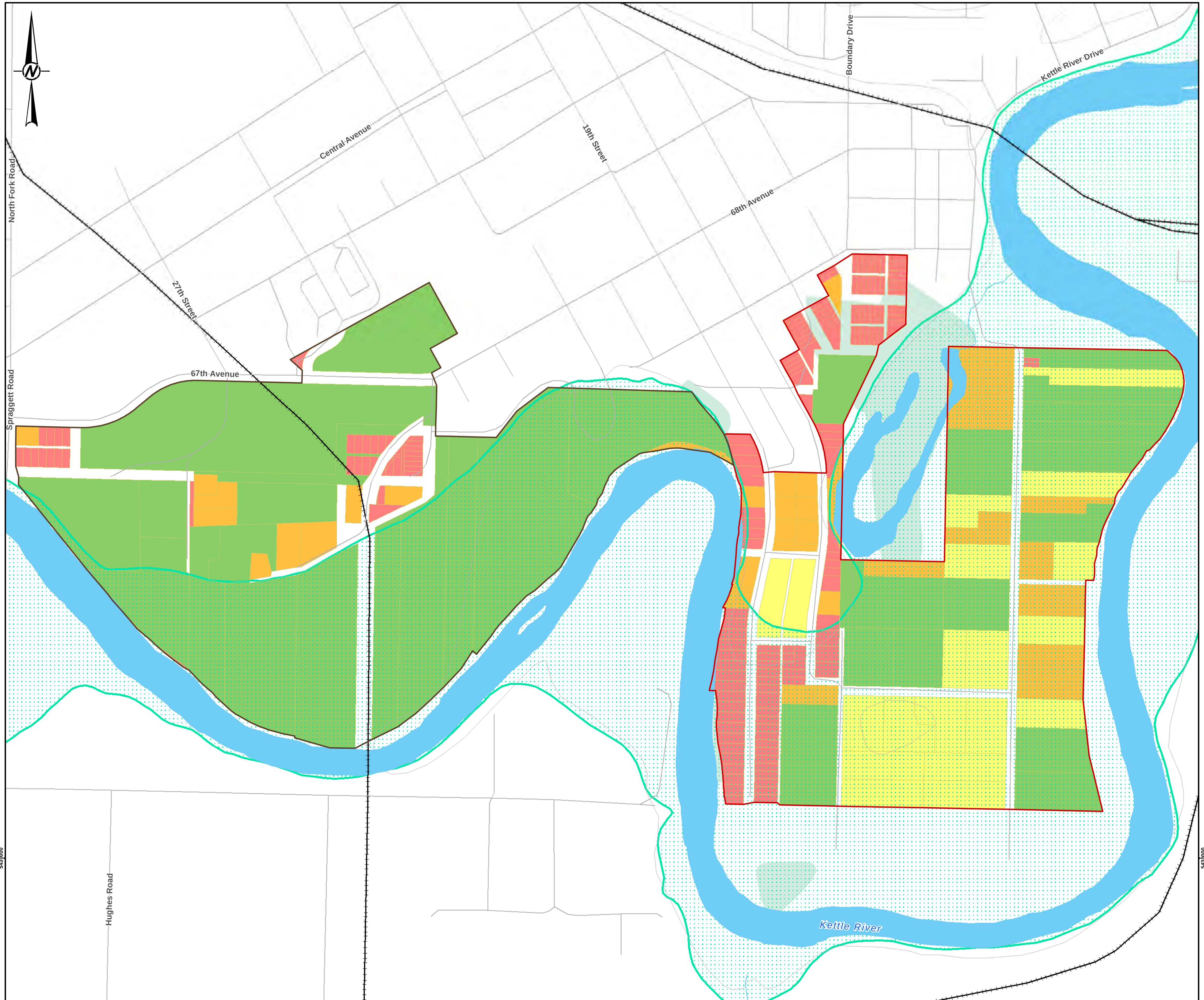
YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	4C

PRINTED ON: 2018-03-16 AT 4:35:29 PM

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm



LEGEND

PARCEL

SEWER REGION

JOHNSON FLATS

SW GRAND FORKS

RISK RATING FOR PARCEL SIZE

RISK 1: > 1 ha

RISK 2: 0.5 - 1 ha

RISK 3: 0.14 - 0.5 ha

RISK 4: < 0.14 ha

BASE DATA

ROAD

RAILWAY

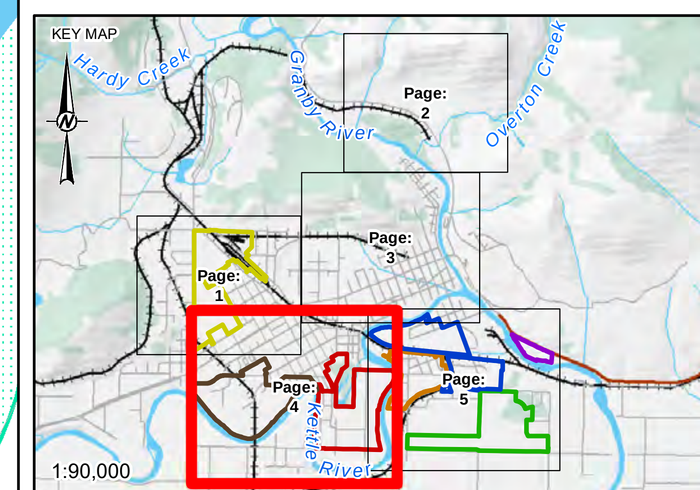
CONTOUR (20m)

WATERCOURSE

WATERBODY

VEGETATION

FLOODPLAIN



0 90 180

1:7,500 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

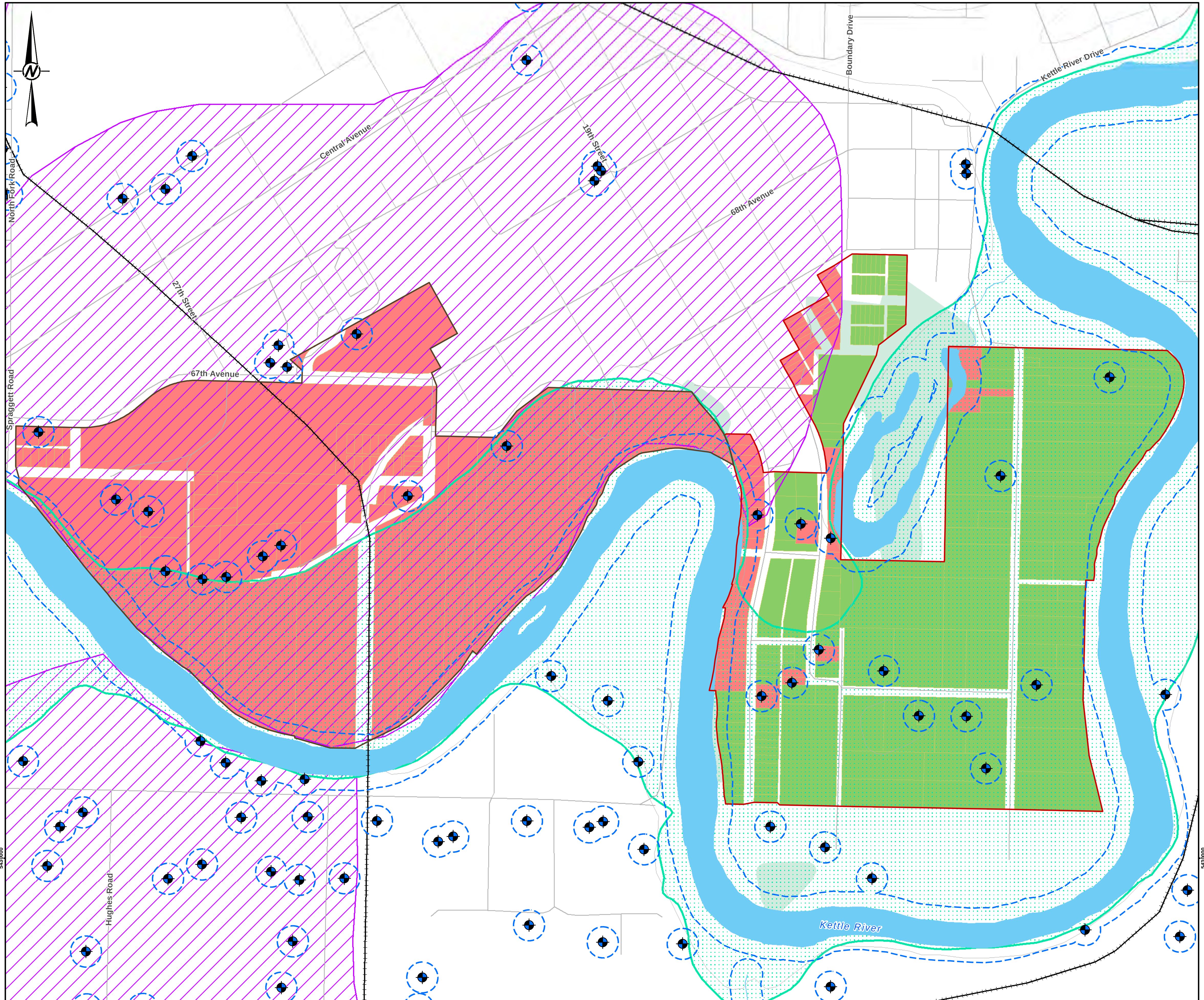
RISK RATING FOR PARCEL SIZE
SW GRAND FORKS AND JOHNSON FLATS

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	4D



LEGEND

GROUNDWATER WELL

PARCEL

SEWER REGION

JOHNSON FLATS

SW GRAND FORKS

RISK RATING FOR SURFACE WATER SETBACKS AND WELL CAPTURE ZONES

RISK 1

RISK 4

BASE DATA

ROAD

RAILWAY

CONTOUR (20m)

WATERCOURSE

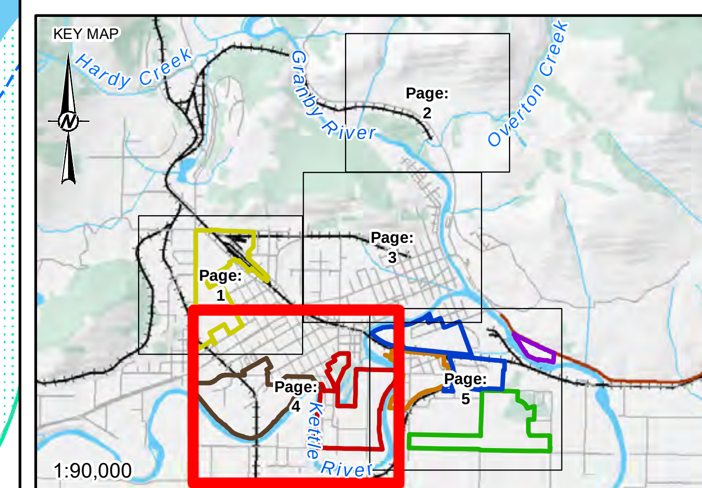
WATERBODY

VEGETATION

HORIZONTAL SETBACK FOR SURFACE WATER BODIES/WATER SUPPLY WELLS

FLOODPLAIN

WELL CAPTURE ZONE (10 YEAR)



0 100 200

1:7,500 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE
RISK RATING FOR SURFACE WATER/WATER WELL SETBACKS AND WELL CAPTURE ZONES SW GRAND FORKS AND JOHNSON FLATS

CONSULTANT

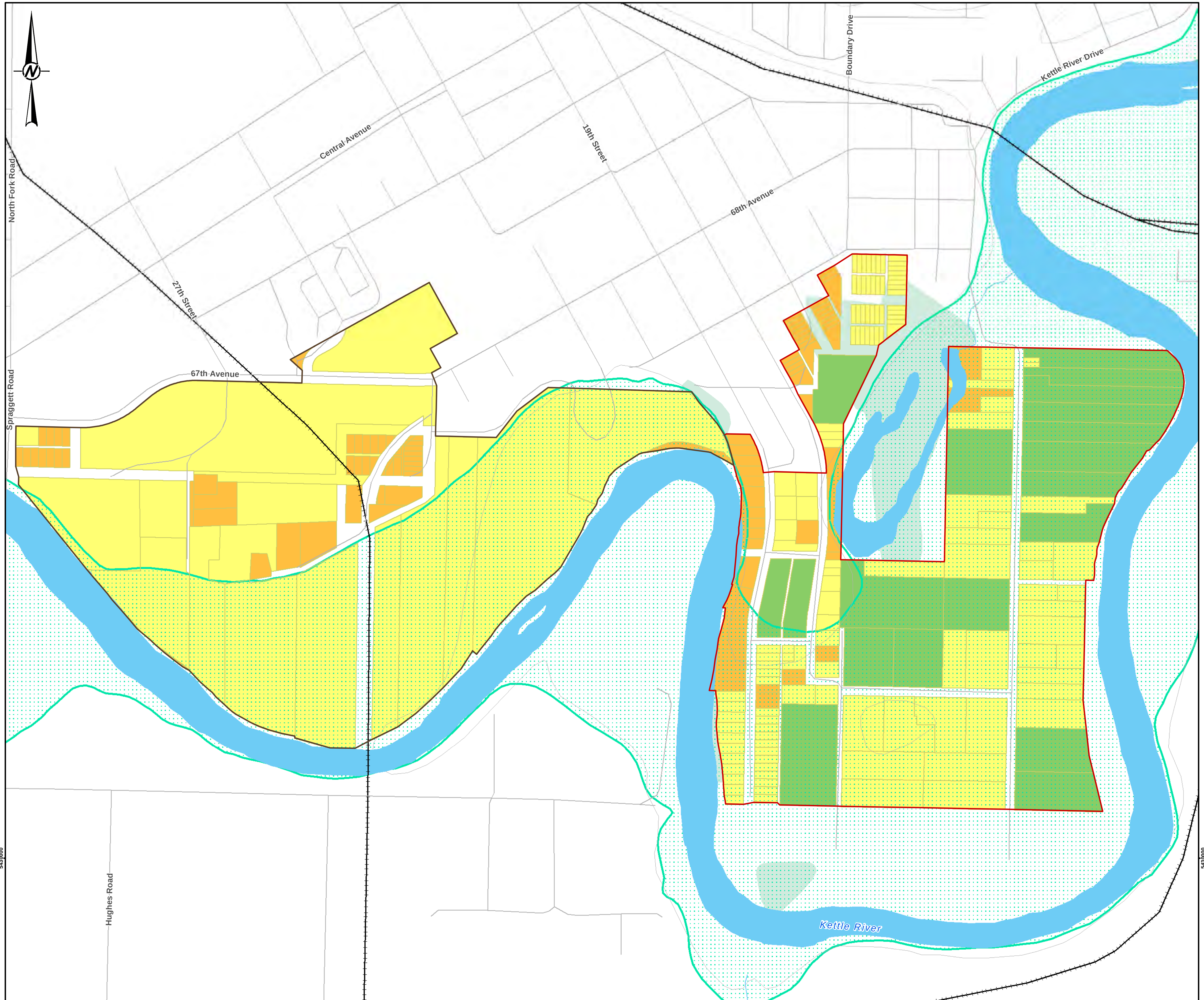
GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	4E

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm



LEGEND

PARCEL

SEWER REGION

JOHNSON FLATS

SW GRAND FORKS

FINAL RISK RATING

RISK 1

RISK 2

RISK 3

BASE DATA

ROAD

RAILWAY

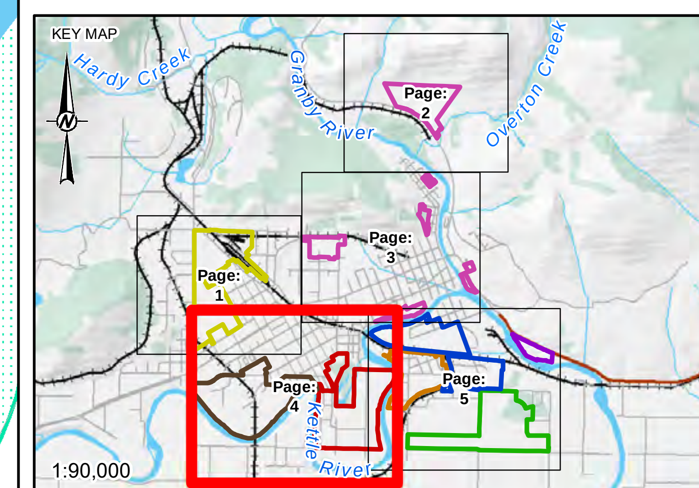
CONTOUR (20m)

WATERCOURSE

WATERBODY

VEGETATION

FLOODPLAIN



0 90 180

1:7,500 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

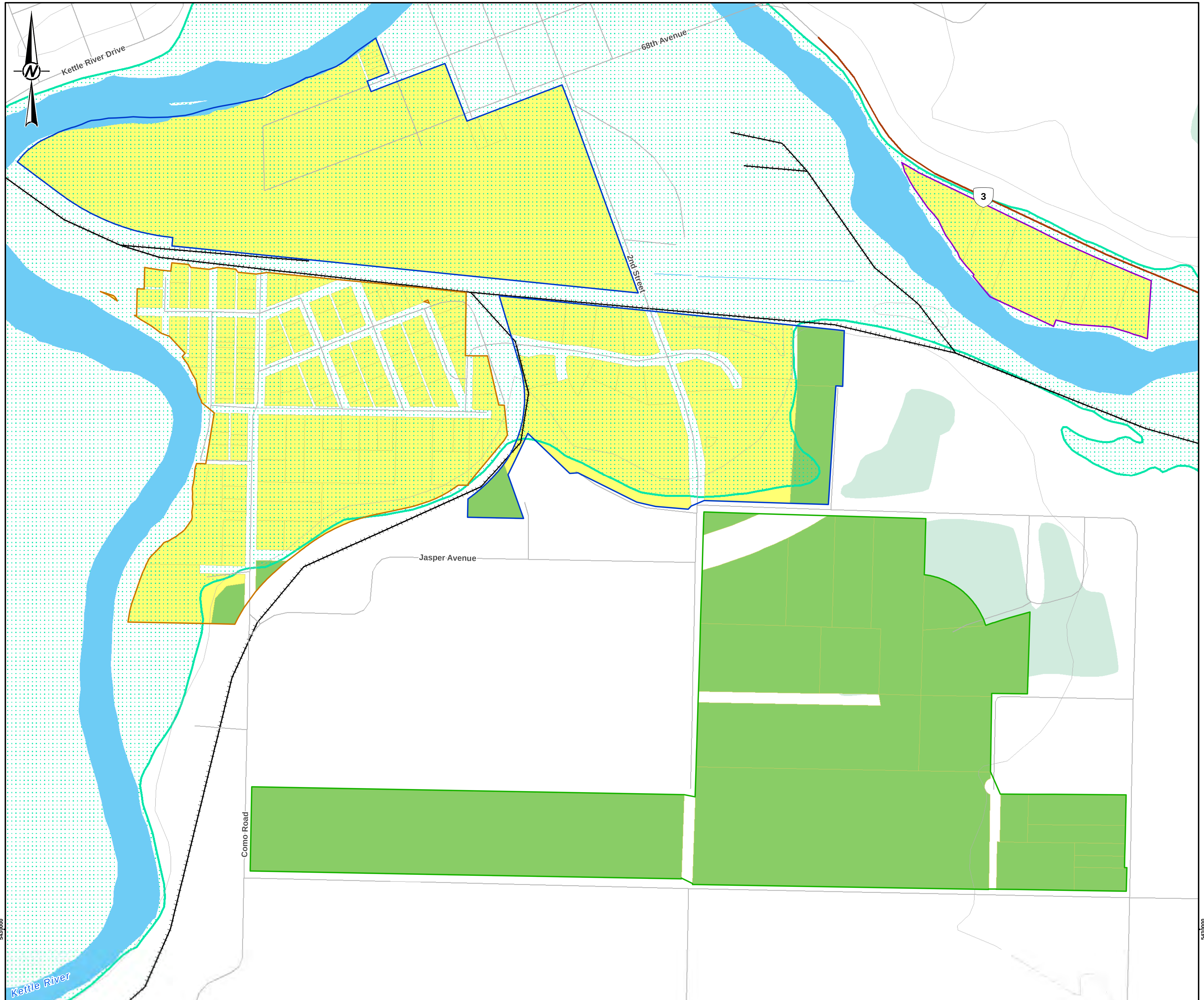
FINAL RISK RATING
SW GRAND FORKS AND JOHNSON FLATS

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	4F



LEGEND

PARCEL

SEWER REGION

AIRPORT / INDUSTRIAL

HWY 3 EAST

RICHMOND / PW

SOUTH RUCKLES

RISK RATING FOR SOIL

RISK 1: FLUVIAL / GLACIOFLUVIAL

RISK 2: FLUVIAL / GLACIOFLUVIAL WITHIN FLOODPLAIN

RISK 3: COLLUVIUM

RISK 4: TILL / COLLUVIUM OVER BEDROCK AND COLLUVIUM WITHIN FLOODPLAIN

BASE DATA

HIGHWAY

ROAD

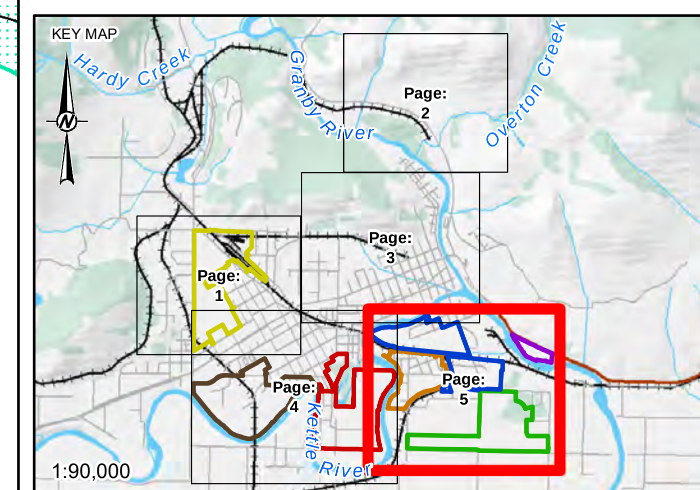
RAILWAY

CONTOUR (20m)

WATERCOURSE

VEGETATION

FLOODPLAIN



0 100 200

1:7,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

RISK RATING FOR SOIL
RICHMOND / PW, SOUTH RUCKLES, AIRPORT / INDUSTRIAL, AND HWY 3 EAST

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	5A

5430000

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

LEGEND

- GROUNDWATER WELL
- PARCEL

SEWER REGION

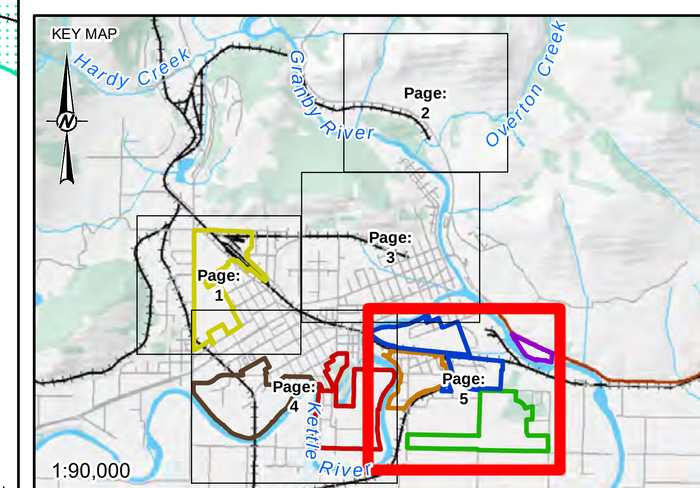
- AIRPORT / INDUSTRIAL
- HWY 3 EAST
- RICHMOND / PW
- SOUTH RUCKLES

RISK RATING FOR DEPTH TO GROUNDWATER

- RISK 1: > 10 m
- RISK 2: 3 - 10 m
- RISK 3: 1 - 3 m
- RISK 4: < 1 m

BASE DATA

- HIGHWAY
- ROAD
- RAILWAY
- CONTOUR (20m)
- WATERCOURSE
- VEGETATION
- FLOODPLAIN



0 90 180

1:7,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

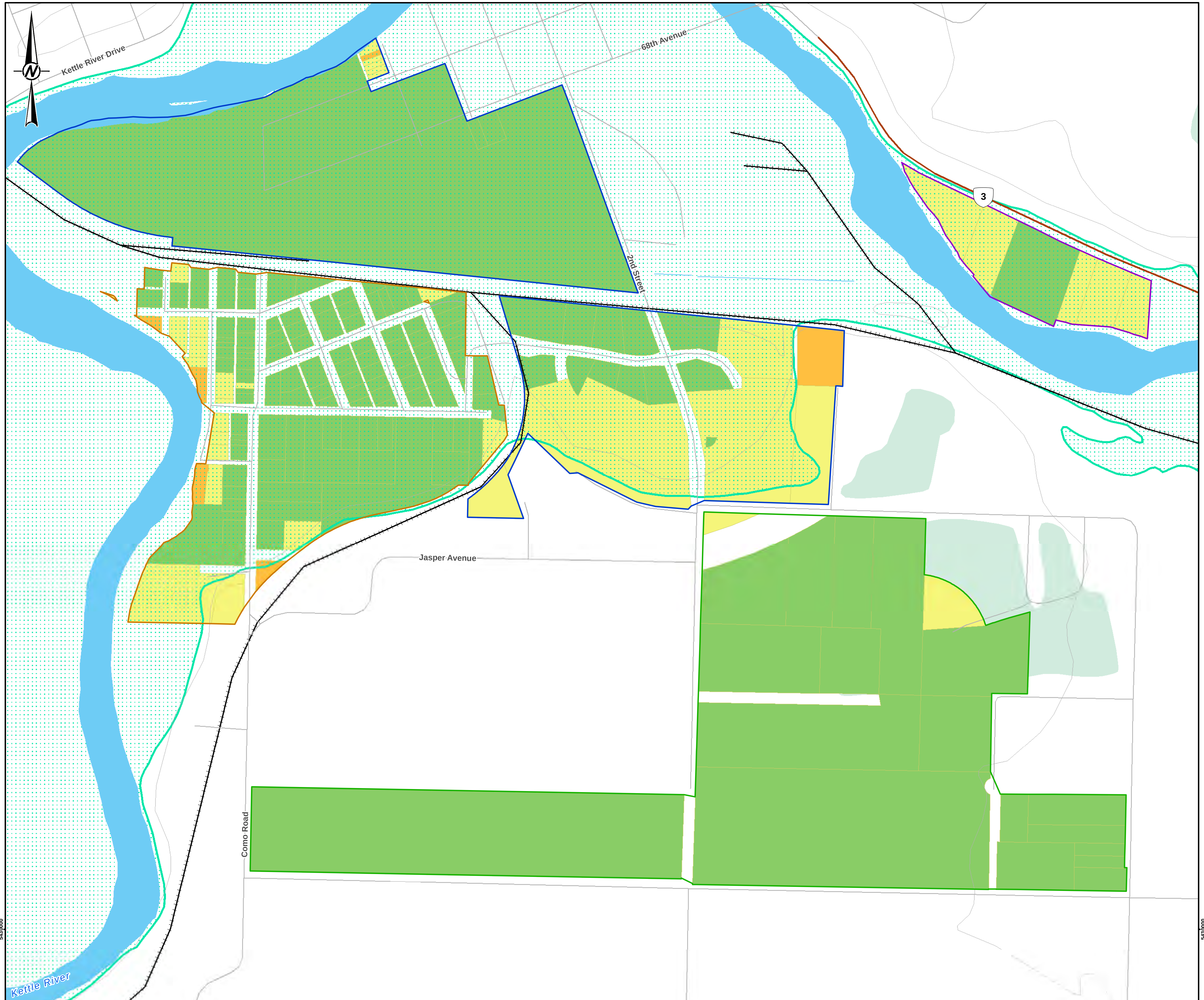
RISK RATING FOR DEPTH TO GROUNDWATER
RICHMOND / PW, SOUTH RUCKLES, AIRPORT / INDUSTRIAL, AND HWY 3 EAST

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	5B



LEGEND

PARCEL

SEWER REGION

AIRPORT / INDUSTRIAL

HWY 3 EAST

RICHMOND / PW

SOUTH RUCKLES

RISK RATING FOR SLOPE

RISK 1: < 5 %

RISK 2: 5 - 10 %

RISK 3: 10 - 30 %

RISK 4: > 30 %

BASE DATA

HIGHWAY

ROAD

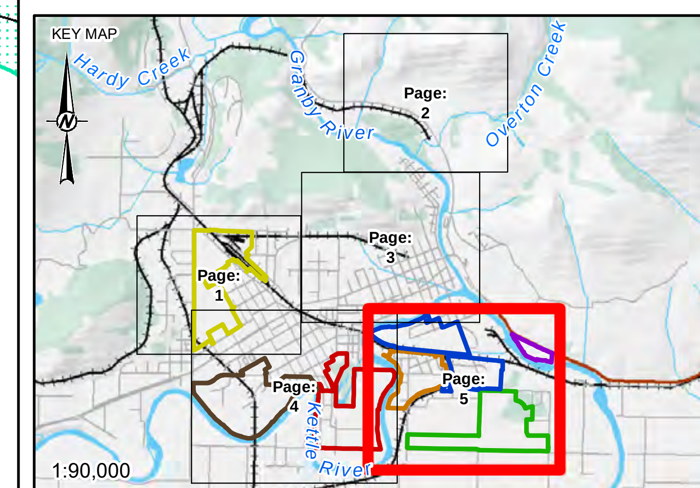
RAILWAY

CONTOUR (20m)

WATERCOURSE

VEGETATION

FLOODPLAIN



0 90 180

1:7,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

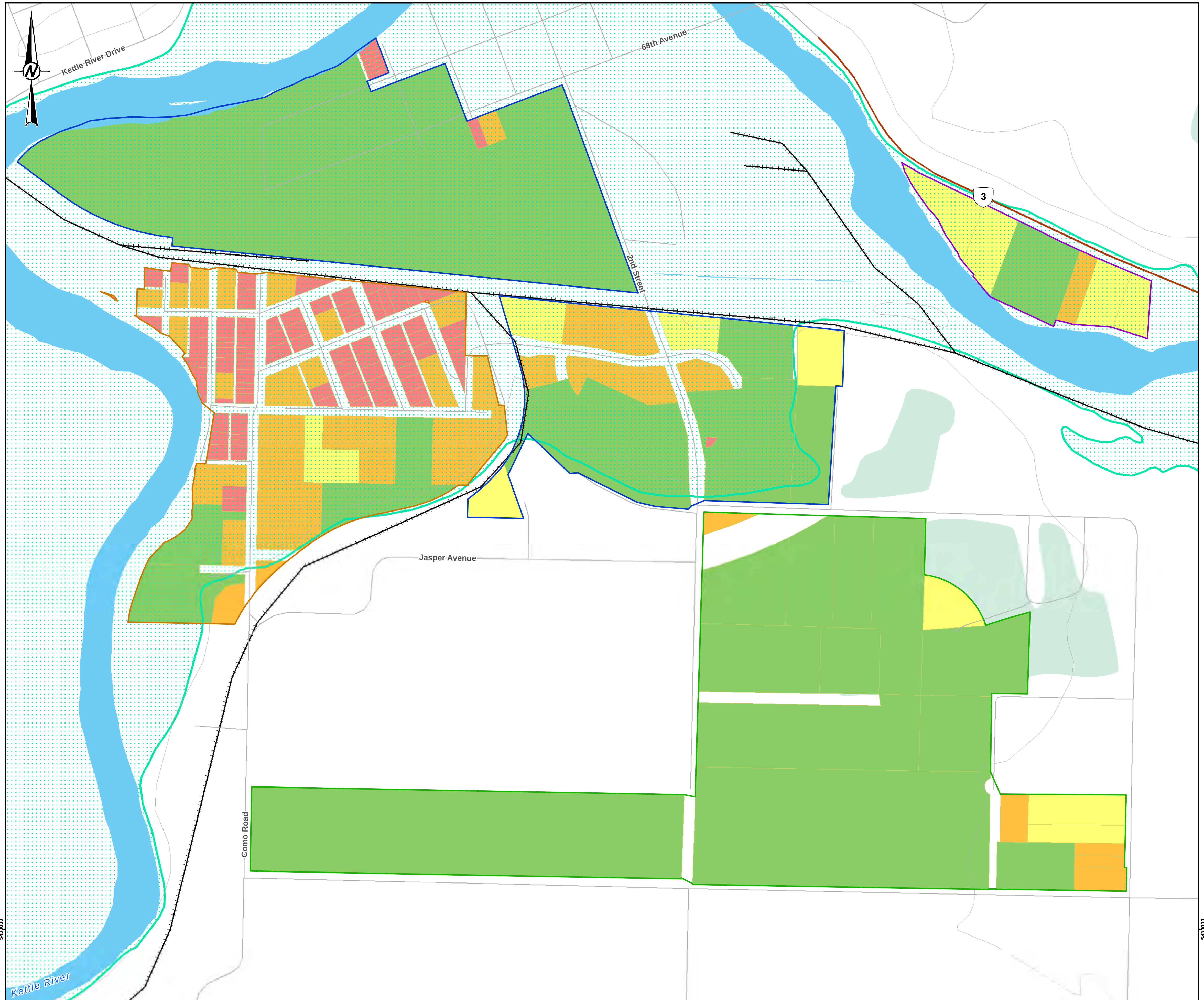
RISK RATING FOR SLOPE
RICHMOND / PW, SOUTH RUCKLES, AIRPORT / INDUSTRIAL, AND HWY 3 EAST

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	5C



LEGEND

- PARCEL

SEWER REGION

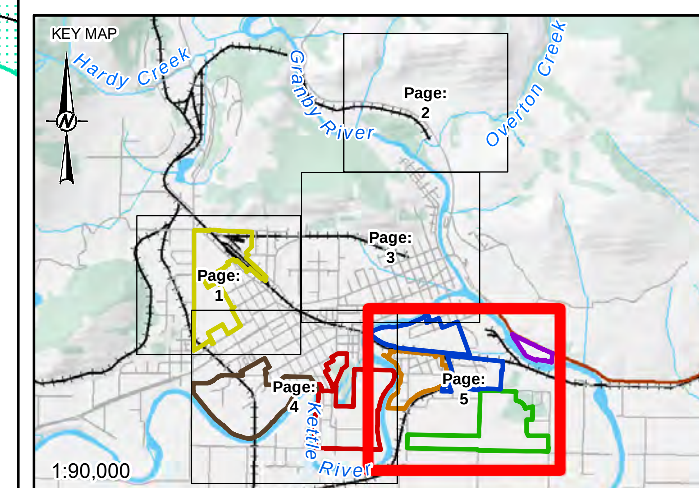
- AIRPORT / INDUSTRIAL
- HWY 3 EAST
- RICHMOND / PW
- SOUTH RUCKLES

RISK RATING FOR PARCEL SIZE

- RISK 1: > 1 ha
- RISK 2: 0.5 - 1 ha
- RISK 3: 0.14 - 0.5 ha
- RISK 4: < 0.14 ha

BASE DATA

- HIGHWAY
- ROAD
- RAILWAY
- CONTOUR (20m)
- WATERCOURSE
- VEGETATION
- FLOODPLAIN



0 90 180

1:7,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE
RISK RATING FOR PARCEL SIZE
RICHMOND / PW, SOUTH RUCKLES, AIRPORT / INDUSTRIAL, AND HWY 3 EAST

CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	5D

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

LEGEND

GROUNDWATER WELL

PARCEL

SEWER REGION

AIRPORT / INDUSTRIAL

HWY 3 EAST

RICHMOND / PW

SOUTH RUCKLES

RISK RATING FOR SURFACE WATER SETBACKS AND WELL CAPTURE ZONES

RISK 1

RISK 4

BASE DATA

HIGHWAY

ROAD

RAILWAY

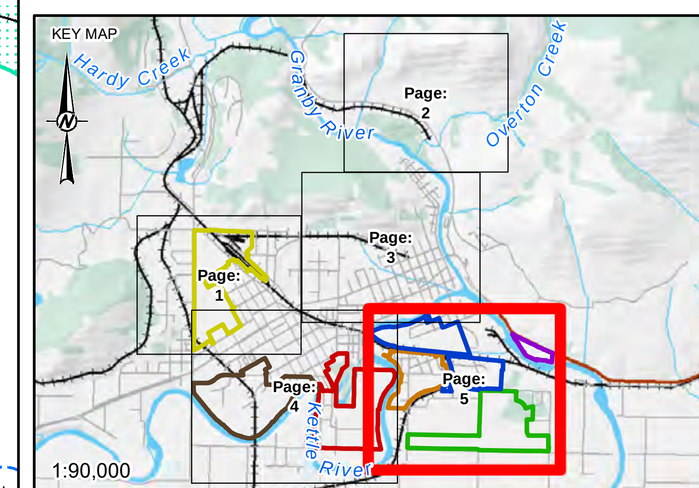
CONTOUR (20m)

WATERCOURSE

VEGETATION

HORIZONTAL SETBACK FOR SURFACE WATER BODIES/WATER SUPPLY WELLS

FLOODPLAIN



0 90 180

1:7,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

RISK RATING FOR SURFACE WATER/WATER WELL SETBACKS AND WELL CAPTURE ZONES RICHMOND / PW, SOUTH RUCKLES, AIRPORT / INDUSTRIAL, AND HWY 3 EAST

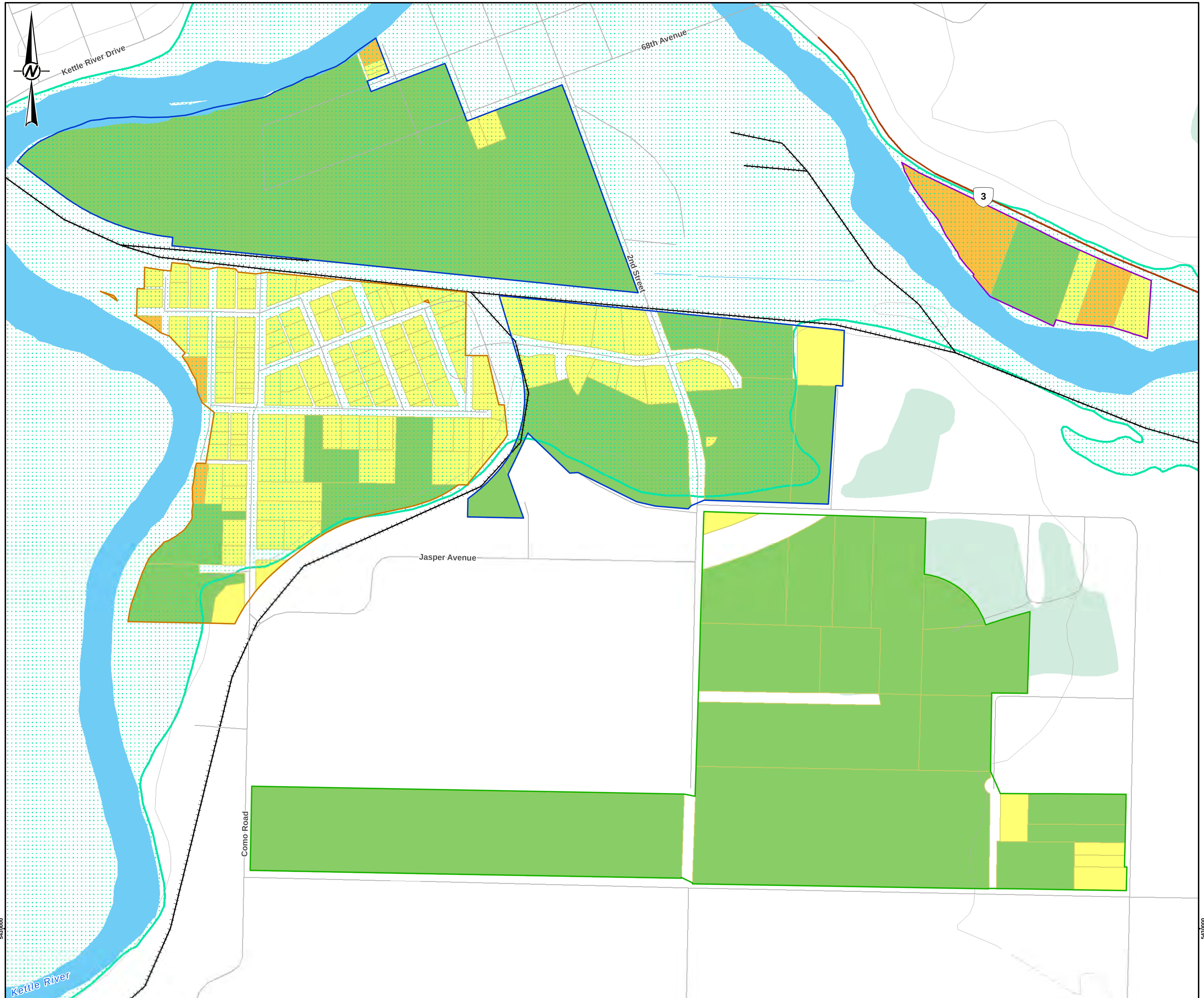
CONSULTANT

GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	5E

25mm



LEGEND

PARCEL

SEWER REGION

AIRPORT / INDUSTRIAL

HWY 3 EAST

RICHMOND / PW

SOUTH RUCKLES

FINAL RISK RATING

RISK 1

RISK 2

RISK 3

BASE DATA

HIGHWAY

ROAD

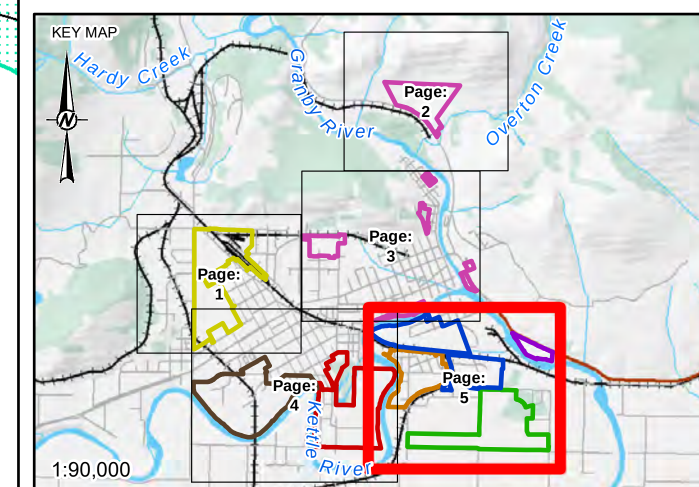
RAILWAY

CONTOUR (20m)

WATERCOURSE

VEGETATION

FLOODPLAIN



0 90 180

1:7,000 METRES

REFERENCE(S)

1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT

URBAN SYSTEM LTD.

PROJECT

URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE

FINAL RISK RATING
RICHMOND / PW, SOUTH RUCKLES, AIRPORT / INDUSTRIAL, AND HWY 3 EAST

CONSULTANT

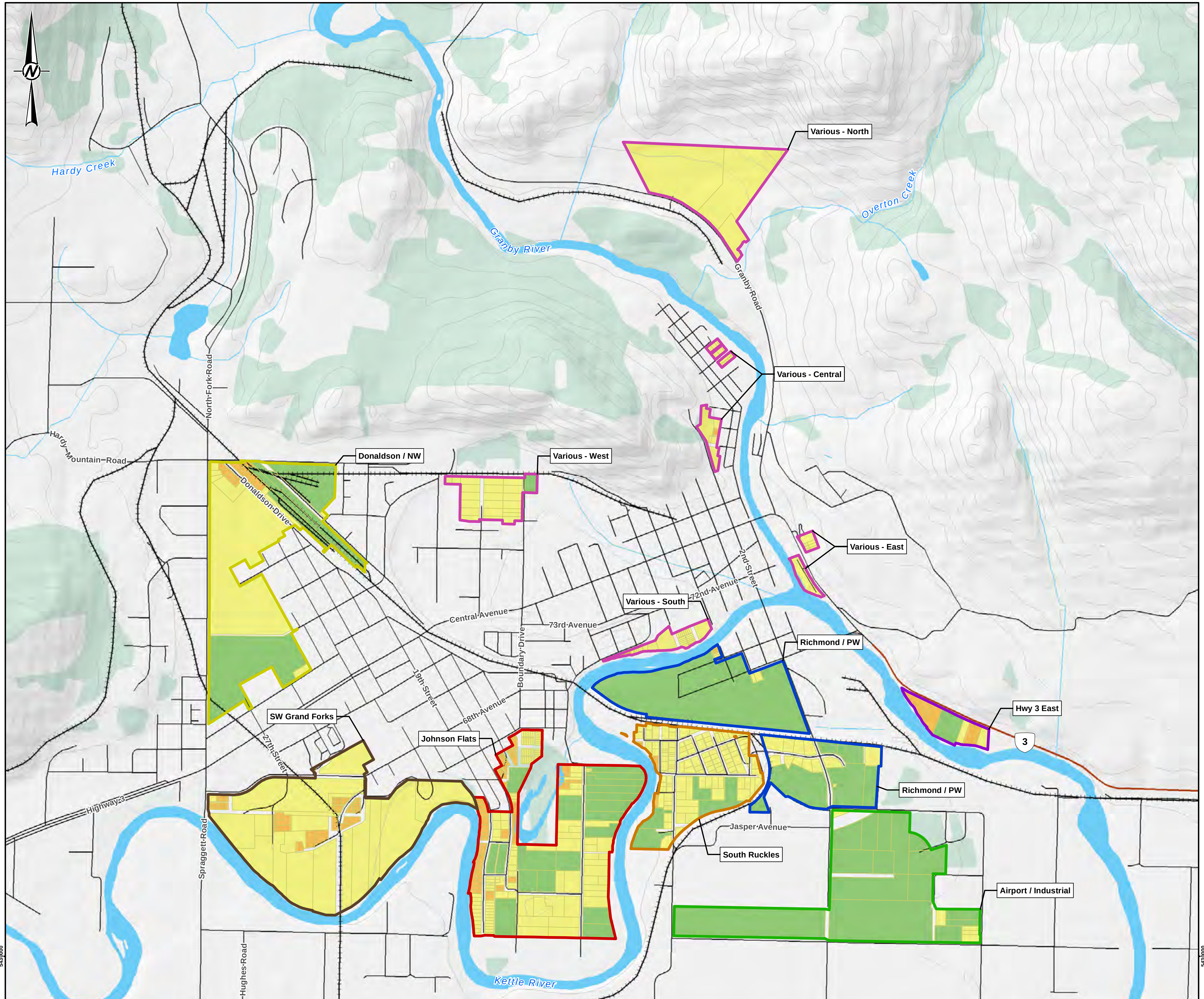
GOLDER

YYYY-MM-DD	3/16/2018
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	5F

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm



LEGEND

PARCEL

SEWER REGION

AIRPORT / INDUSTRIAL
DONALDSON / NW
HWY 3 EAST
JOHNSON FLATS
RICHMOND / PW
SW GRAND FORKS
SOUTH RUCKLES
VARIOUS

FINAL RISK RATING

RISK 1
RISK 2
RISK 3

BASE DATA

HIGHWAY
ROAD
RAILWAY
CONTOUR (20m)
WATERCOURSE
WATERBODY
VEGETATION

0 500 1,000

1:20,000 METRES

REFERENCE(S)
1. SEWER REGIONS PROVIDED BY THE CITY OF GRAND FORKS.
2. CONTOURS, ROADS, VEGETATION, WATERCOURSES, AND WATERBODIES OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

CLIENT
URBAN SYSTEM LTD.

PROJECT
URBAN SYSTEMS/SEWER/GRAND FORKS

TITLE
FINAL RISK RATING
OVERVIEW

CONSULTANT

GOLDER

YYYY-MM-DD	2018-03-16
DESIGNED	PA
PREPARED	RC
REVIEWED	PA
APPROVED	JF

PROJECT NO.	CONTROL	REV.	FIGURE
1895271	1000	0	6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

APPENDIX B

Unit Costs

Table of Unit Prices (2018)	Unit	Price
1. 200mm Diameter PVC Gravity Sewer	l.m.	$260
2. Manholes	Each	$8,000
3. Service Connections	Each	$2,800
4. Road Restoration (asphalt – 3.5m wide)	l.m.	$120
5. 100mm Diameter PVC Forcemain	l.m.	$180
6. Small Lift Station (under 5L/s)	Each	$250,000
7. Medium Lift Station (5-10 L/s)	Each	$300,000

Highway 3 East

500 @ $440	$220,000
Manholes: 4 @ $8,000	$32,000
Forcemains: 1,200 @ $300	$360,000
Service Connections: 1 @ $2,800	$28,000
Pump Station	$250,000
River Crossing	$250,000
Rail Crossing	$150,000
	$1,290,000
Contingency (30%)	$387,000
Engineering & Construction Services (15%)	$253,000
	$1,930,000
Rounded	**$2,000,000**

PW / Richmond

600 @ $440	$264,000
Manholes: 8 @ $8,000	$64,000
Forcemains: 200 @ $300	$60,000
Service Connections: 180 @ $2,800	$504,000
Pump Station	$250,000
Highway Crossing	$150,000
	$1,292,000
Contingency (30%)	$388,000
Engineering & Construction Services (15%)	$252,000
	$1,932,000
Rounded	**$2,000,000**

Airport / Ind	
1,400 @ $440	$616,000
Manholes: 8 @ $8,000	$64,000
Forcemains: 600 @ $300	$180,000
Service Connections: 10 @ $2,800	$284,000
Pump Station	$250,000
	$1,138,000
Contingency (30%)	$342,000
Engineering & Construction Services (15%)	$322,000
	$1,702,000

SW GF	
2,400 @ $440	$1,056,000
Manholes: 20 @ $8,000	$56,000
Forcemains: 800 @ $300	$240,000
Service Connections: 10 @ $2,800	$28,000
Pump Station	$250,000
	$1,630,000
Contingency (30%)	$489,000
Engineering & Construction Services (15%)	$318,000
Total	**$2,437,000**

South Ruckles	
2,300 @ $440	$1,012,000
Manholes: 30 @ $8,000	$240,000
Forcemains: 540 @ $300	$162,000
Service Connections: 200 @ $2,800	$560,000
Pump Station	$250,000
Rail / Highway Crossing	$300,000
	$2,524,000
Contingency (30%)	$757,000
Engineering & Construction Services (15%)	$492,000
	$3,773,000

Donaldson	
500 @ $440	$220,000
Manholes: 8 @ $8,000	$64,000
Forcemains: 500 @ $300	$150,000
Service Connections: 15 @ $2,800	$42,000
Pump Station	$250,000
	$726,000
Contingency (30%)	$218,000
Engineering & Construction Services (15%)	$142,00
Total	**$1,086,000**

Johnson Flats	
3,000 @ $440	$1,320,000
Manholes: 26 @ $8,000	$208,000
Forcemains: 1,200 @ $300	$360,000
Service Connections: 20 @ $2,800	$56,000
Pump Station	$250,000
	$2,194,000
Contingency (30%)	$658,000
Engineering & Construction Services (15%)	$428,000
	$3,280,00