

**RIBBON OF GREEN AND NORTH SASKATCHEWAN  
RIVER VALLEY AREA REDEVELOPMENT PLAN  
INTEGRATION PROJECT  
OUTLYING AREAS  
PRELIMINARY GEOTECHNICAL  
DESKTOP ASSESSMENT**



**THURBER ENGINEERING LTD.**



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PRELIMINARY GEOTECHNICAL  
DESKTOP ASSESSMENT**

**Report**

**to**

**O2 Planning + Design Inc.**

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Date: May 27, 2021  
File: 29863

Robin Tweedie, P.Eng.  
Review Principal



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## **1. INTRODUCTION**

This report presents the results of a preliminary geotechnical desktop assessment carried out by Thurber Engineering Ltd. (Thurber) in support of the Ribbon of Green Project for the North Saskatchewan River Valley and Ravine System in outlying areas not already included in the Southwest, Northeast, and Central Reach study areas that were previously assessed in 2017 and 2021.

The scope and requirements of this study were outlined in a proposal letter from Thurber to O2 Planning + Design Inc. (O2) dated August 27, 2020. Authorization to complete the project was provided by O2 in a correspondence dated November 27, 2020.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

## **2. PROJECT BACKGROUND**

It is understood that the City of Edmonton (City) is planning to undertake the consolidation of previously completed master and concept plans for the North Saskatchewan River Valley and Ravine system in the Central Reach portion of Edmonton.

Thurber has previously completed desktop assessments for the Southwest, Northeast, and Central Reach study areas, as presented in the following reports:

- Ribbon of Green Project, Landscape Feasibility Study, Preliminary Geotechnical Desktop Assessment – Revision 1, April 3, 2017.
- Ribbon of Green and North Saskatchewan River Valley Area Redevelopment Plan Integration Project, Central Reach, Preliminary Geotechnical Desktop Assessment, April 20, 2021.

It should be noted that the above mentioned 2017 report included assessment of both the Southwest and Northeast study areas, while the 2021 report focuses on the Central Reach study area. The approximate limits of each previous study area are illustrated on all drawings provided in Appendix A (Drawing Nos. 29863-1A through 29683-3B).

This report provides a desktop assessment of outlying areas not covered in the previous study areas, as delineated by the City and O2. These outlying areas consist of:



- An additional upstream segment of the North Saskatchewan River Valley situated southwest of the Southwest study area.
- Additional upstream areas of tributary ravines of the Southwest, Northeast, and Central Reach study areas.
- The southeast shoreline area of the Big Lake region, situated northwest of the Central Reach Area.
- Creeks and natural areas that surround the areas west and north of the Town of Beaumont.

These outlying areas are shown as the clouded zones on the attached drawings.

Topography maps for the study areas are provided for these outlying areas in Appendix A and have been separated into two regions for the entire Ribbon of Green study area: Drawing No. 29863-1A for the North Region and Drawing 29863-1B for the South Region.

The overall goals of the project include developing integrated conceptual level plans for these areas; the creation and implementation of engagement plans for internal, external, and regional stakeholders; and to support and sustain a River Valley system that meets the needs of all identified users and stakeholders.

As part of this work a geotechnical desktop study was required to identify and evaluate feasible access routes and infrastructure. The desktop study followed the same general methodology as previously completed for the 2017 and 2021 reports. No site reconnaissance for field truthing nor test hole drilling were part of the current scope of work.

This report provides a preliminary desktop review of available information to aid in the high-level assessment of possible areas of future development. Once key areas are identified during the ongoing screening process, Thurber can undertake more focused ground truthing of specific areas.

### **3. METHODOLOGY**

The desktop study comprised of the following tasks:

- Review of published geological maps within the study area.
- Review of available general geotechnical information from Thurber's in-house files.



- Review of current LiDAR maps provided to Thurber by O2 to provide information on topographic features and slope instabilities.

The overall project limits are extensive and cover large portions of the North Saskatchewan River Valley. More focused studies on selected areas, including limited site reconnaissance, will be undertaken as the overall project moves forward and prospective sites for future development are identified.

#### **4. SITE DESCRIPTION**

##### **4.1 Geological Setting**

The geological assessment of the project area is based on the review of available existing maps, lexicons, and water well records, including:

- L.A. Bayrock. Surficial Geology Edmonton. NTS 83H. Alberta Research Council. 1972.
- R. Bibby. Report 74-10. Hydrogeology of the Edmonton Area (Northwest Segment), Alberta. Alberta Research, Alberta. 1974.
- C.P. Kathol and R.A. McPherson. Urban Geology of Edmonton. Bulletin 32. Alberta Research Council. 1975.
- W.J. Ceroici. Report 78-5. Hydrogeological Map Edmonton Area (Southwest Segment), Alberta. Alberta Research Council. 1978.
- L.D. Andriashek. Bedrock Topography and Valley Thalwegs of the Edmonton Map Area. NTS 83H. Alberta Research Council. 1987.
- D.J. Glass. Lexicon of Canadian Stratigraphy. Volume 4. Western Canada. Canadian Society of Petroleum Geologists. Calgary, Alberta. 1990 and 1997.
- Atkinson, N. and Lyster S. Thickness and Distribution of Quaternary and Neogene Sediments in Alberta, (Canada). Alberta Geological Survey. 2012.
- Alberta Energy Regulator/ Alberta Geological Survey. Bedrock Geology of Alberta. Map 600. 2013.
- Alberta Government. Alberta Environment and Parks. Alberta Water Well Information Database. [www.groundwater.alberta.ca/WaterWells/d/](http://www.groundwater.alberta.ca/WaterWells/d/). 2021.



#### **4.1.1 Bedrock Geology**

The North Saskatchewan River has downcut rapidly through the surficial geological deposits in post glacial times and is incised into the underlying Upper Cretaceous bedrock of the Horseshoe Canyon Formation throughout the project area.

The Horseshoe Canyon formation which underlies the study area consists of deltaic and fluvial deposits of interbedded fresh and brackish water sandstone, siltstone, and shale with coal and bentonite beds.

Typical sediments consist of soft grey, greenish and white weathered bentonitic feldspathic sandstone, brown bentonitic shales, coal seams and beds of carbonaceous shale. Less common within the formation are concretions and beds of hard calcareous sandstone, thin nodular beds of red-brown ironstone and thin beds of bentonite. At its southern portion in the Edmonton area, the Bearpaw formation underlies the Horseshoe Canyon. The Bearpaw formation is composed of marine shale, open sea dark grey clays, claystones, shales, silt, and siltstone with subordinate sands and sandstones, concretionary beds, and thin beds of bentonite.

The Bearpaw Formation is traced from present-day Montana to north of Edmonton. In the Edmonton Area, the formation becomes wedge-like in shape and then terminates. At the termination point, the Belly River Group underlies the Horseshoe Canyon formation.

Bedrock is frequently exposed on the North Saskatchewan valley slopes and tributary valley slopes, particularly on the exposed slopes of outside meander bends in the river and is generally present at shallow depth below the river channel.

#### **4.1.2 Bedrock Topography**

The North Saskatchewan River Valley, and Edmonton in general, features many large, buried valleys. The largest buried valley in the area is the Beverly Valley which is located beneath the central portion of the City of Edmonton and extends into the Northeast study area generally following the present-day North Saskatchewan River Valley.

In the Southwest study area, the Stony Valley follows the North Saskatchewan River Valley and the New Sarepta Valley is located within the vicinity of Whitemud and Blackmud Creeks.



These buried valleys represent the broad pre-glacial valleys that existed prior to glaciation and the lower parts of these valleys are infilled with alluvial sand and gravel deposits of the Empress Formation. These valleys were infilled with glacial deposits during glacial and post times.

Today's North Saskatchewan River Valley and tributary creeks are incised through these glacial deposits into the buried valleys deposits and into the bedrock formation.

Due to this, bedrock escarpments as well as surficial deposits dating from preglacial to more recent time can be observed on the river valley slopes.

### **4.1.3 Surficial Geology**

#### **4.1.3.1 River Valley and Tributary Ravines**

In the majority of the study area covered by the North Saskatchewan River valley and tributary ravines, the bedrock is covered by surficial deposits composed of late Tertiary and Quaternary period deposits.

These deposits consist of six major surficial deposit units, as follows: Empress formation, glacial till deposits, glaciolacustrine deposits, alluvium, colluvium with landslides, and organic deposits as shown on Drawing Nos. 29863-3A and 29863-3B, in Appendix A.

The alluvium is located on the low-level terraces and river channel at the bottom of the North Saskatchewan River Valley and tributary creeks, while all the other units are exposed at the river and creeks banks. Alluvium is composed of gravel, sand, silt, and clay deposits, generally fining upwards. The alluvium in the North Saskatchewan River is composed mostly of gravel and sand while alluvium in the tributary creeks is composed of silt and clay with some sand and gravel.

Glacial till is composed of mixture of clay, silt, and sand with pebbles, cobbles, boulders, and bedrock blocks. These deposits were laid down directly over the bedrock surface (or buried Empress formation channel deposits where present) during the glacial advance and retreat and can be relatively thick (tens of metres) through the study area.

Glaciolacustrine deposits are composed of bedded silt and clay with sand and were laid down in a large post glacial lake (Lake Edmonton) that formed at the ice front over the Edmonton area, during the ice retreat (i.e., some ten thousand years ago).

Colluvium is a gravitationally moved material due to landslides and mass movements and is comprised of bedrock or other surficial geology units. It is located on the valley slopes and it



is composed of gravitationally moved mixture of clay, silt, and sand. Widespread landslides are present in these colluvial soils along the river valley and creek valley slopes.

Towards the northeast portion of the study area, Tertiary and early Quaternary deposits include the Empress formation. In the Edmonton Area, preglacial sands and gravels are part of the Empress formation and they are also known locally as “Saskatchewan gravels and sands”.

The Empress formation sands and gravels are primarily quartzite with minor chert, ironstone, and coal fragments. This gravel and sand material originates from the Canadian Rockies to the west. The Empress formation is exposed in the northeast portion of the Central Reach and the Northeast study area along the bottom of North Saskatchewan River Valley banks or is covered by recent alluvium deposits. The sand and gravel of Empress formation are commonly extracted as building materials in large sand and gravel pit spread throughout the alluvial plain. Glacial till formations are also found overlying the Empress formation or the bedrock in area where the Empress formation is not present.

Organic deposits are formed at the top of the glaciolacustrine deposits in the shallow valleys in the ground surface, in stagnant water or wet areas. The organic deposits are located in the upper portion of the Horsehills Creek Ravine.

#### **4.1.3.2 Big Lake Area**

The Big Lake portion of the study area is located northwest of the Central Reach study area, on the western side of the City of Edmonton near Big Lake and the Sturgeon River, as shown on Drawing No. 29863-3A in Appendix A.

Surficial deposits of the Big Lake area consist of three major surficial deposit units as follows: glaciolacustrine deposits, colluvium with landslides, and lacustrine deposits.

Descriptions of glaciolacustrine deposits and colluvium are generally consistent with the respective descriptions provided in Section 4.1.3.1 for the river valley. Colluvium is found along the south shore of Big Lake where historical slope instability has been encountered.

Lacustrine deposits are sedimentary soils which have formed from deposition at the bottom of a historical or ancient lake. These deposits are common along the shorelines of Big Lake and the Sturgeon River and can consist of a mixture of loosely compacted silt, clay, and inorganic material.



#### **4.1.3.3 Beaumont Area**

The Beaumont portion of the study area is located southeast of the Southwest study area, as shown on Drawing No. 29863-3B in Appendix A.

Surficial deposits of the Beaumont area including along the other tributary valleys in the southern and southeastern portions of Edmonton consist of primarily glacial till at the surface. The description of glacial till in these areas are consistent with the general descriptions provided in Section 4.1.3.1 for the river valley.

### **4.2 Topography and Surface Features**

The project area is relatively large and consists of the most northeasterly and southwesterly portions of the North Saskatchewan River Valley outside the previously assessed areas, as well as tributary valleys that drain into the North Saskatchewan River on both banks. In addition, delineated areas around Big Lake and Beaumont are also included in the study area of outlying areas.

The general layout and topography of the additional project areas are shown on Drawing Nos. 29863-1A and 29863-1B in Appendix A. As previously mentioned, this study covers all highlighted areas outside of the boxed zones indicating the areas of previous study in 2017 and 2021.

The North Saskatchewan River flows in a southwest to northeasterly direction with numerous large meander bends and travels through the previous study areas, consisting of diverse urban and suburban terrain, encompassing adjacent river valley parks, golf courses, residential areas, and Edmonton's developed downtown core. Numerous highways, arterial road, and pedestrian bridges also cross the river through the study area.

At its northeastern and southwestern extents, the surrounding landscape is significantly more rural with the uplands consisting of agricultural areas and developing residential subdivisions. The tributary ravines are typically vegetated parkland that penetrate developed portions of the city along their banks and upland areas.

The Big Lake areas is a historical wetland area mixed with surrounding agricultural zones that are developing into residential areas. The Beaumont area is a rapidly developing town south of Edmonton that was formerly an agricultural area mixed with some natural creek areas.

The slope profiles for the study area, as shown in Drawing Nos. 29863-2A and 29863-B in Appendix A, are indicative of past major slope instabilities which occurred as a result of the rapid



downcutting of the river valley through the weak surficial and bedrock deposits. These are further discussed in Section 4.3.

The slope angle of the river valley in the study area ranges from approximately 10 to 20 degrees in the upper portions of the river valley, while the lower portions of the valley slopes are greater than 30 degrees and may approach more than 40 to 50 degrees in some areas. Lower portions of steep slopes are typically bare of vegetation. The steeper slopes tend to be situated on the outside of bends where active erosion has taken place. An area of significantly steep slopes can be noted in the southwestern stretches of the North Saskatchewan River valley and its tributary ravines and creeks.

Slope angles in the Big Lake area can approach greater than 20 degrees in delineated areas where previous instability has been noted along the southern shoreline, but slopes in this area are typically less than 10 degrees.

The Beaumont area features relatively gentle slopes less than 10 degrees, with some very local creek valley slopes approaching 20 degrees. It is expected that these slopes are relatively low in height compared to either Big Lake or the North Saskatchewan River valley.

### **4.3 Results of LiDAR Interpretation**

An interpretation of bare earth LiDAR imagery provided to Thurber by O2 was carried out to provide information on the slope morphology and the presence of landslides along the slopes in the delineated outlying areas.

The study indicated the presence of some landslides along the valley slopes of the North Saskatchewan River valley and its tributary valleys, as well as along the southern shoreline of Big Lake. Approximate locations of these landslide features are shown on Drawing Nos. 29863-3A and 29683-B in Appendix A.

The observed landslide features based on the results of the LiDAR interpretation are described below and further description of these features are presented in Section 5. These landslide features include (a) active or recent landslides, (b) old or inactive landslides, or (c) debris slides, as follows:

#### **a) Active or Recent Landslides**

Generally, these landslide areas are located at the outside bends of the North Saskatchewan River valley between the valley crest and the riverbed. At these locations, the river has actively



eroded the toe of the slope, undermining of the upper slope occurs, triggering slumping of the upper portions of the slope. Active or recent landslides can also be developed as small, isolated soil slumping or as thin colluvium creeping and sliding down the slope.

b) Old Landslides - Inactive or Minor Landslides

Large scale ancient or apparently inactive landslides exist along slopes at various locations where active scarps and cracks are visible. It is believed that the intensive sliding processes in the areas of inactive landslides occurred a long time ago (thousands of years) during the valley incision after the drainage of glacial Lake Edmonton. These large ancient sliding areas are apparently dormant, but the steep slide surface is prone to surficial creep movement and local shallow slumping.

c) Debris Sliding

Most of the slope colluvium material present in the river valley and Big Lake is thin and it is moving slowly downhill (slope creep). These areas can feature large slope areas of debris that can be connected to each other and are slowly creeping downhill.

It is difficult to differentiate the age and relative activity (i.e., active, or dormant) of a slide from the LiDAR imagery. In order to delineate and assess this further, temporal air photo interpretation (API) will need to be undertaken, where stereo air photo pairs are examined from different time periods. A full API of the overall project sites is beyond the scope of this current report. However, it should be undertaken when the study becomes more focused on selected development areas.

## **5. PRELIMINARY GEOTECHNICAL EVALUATION**

No information is currently available on the proposed future developments within the North Saskatchewan River valley and its tributaries or the Big Lake or Beaumont areas. It is anticipated, however, that most recreational opportunities for the public would involve developments in the flatter low level terraces near the bases of slopes (valley, lakeshore, or sides of ravines and creeks), similar to many of the existing parks and public facilities. However, these will require access from the uplands by way of the slopes. In addition, future trails are being planned that traverse sections through these slopes.

A detailed slope stability assessment for the entire project area is beyond the scope of this current work. Following are some preliminary evaluations and recommendations based on the results of the desktop study to this point.



- a) Various existing access roads and trails exist within the project study areas. It is expected that trail development along these routes should not negatively impact the existing valley slopes, assuming that these trails are performing to a satisfactory level at the current time, and any future trail developments are properly planned to consider the slope morphology and current slope stability conditions. These areas should be inspected and evaluated on a case-by-case basis.
- b) Major landslide areas have been identified along the banks of the river valley and Big Lake as part of this study. Such areas are sensitive to slope movement and can be destabilized by slope construction activities that are not properly planned. As options for development are considered, it would be prudent to avoid these landslide areas, to the extent possible.
- c) Steep slope areas of the river valley and Big Lake have also been identified as part of this study. Similar to identified landslide zones, areas identified for future development should avoid these areas of steep slopes, for this study generally considered to slopes steeper than are greater than about 25 degrees. However, this is a generalization, and should be assessed on a site-specific basis.
- d) All potential future trails and access routes traversing valley, ravine, and lakeshore slopes should be investigated on a site-specific basis. This would entail an evaluation of the current slope stability, the potential impact of the project on the current slope stability, and preferred routing of these trails and routes. At that time, any suggested modifications to the development locations, and possible mitigation measures, can be evaluated.
- e) Adequate setbacks from the crest and toes of slopes should be established for recreational development on a site-specific basis to avoid potential impacts from future slope instabilities.
- f) It should be recognized that, even with appropriate setbacks from landslide areas along the top of the North Saskatchewan River Valley and Big Lake, there is still considerable risk that future landslides could impact access points and paths, which would require future maintenance or the possibility of facility relocation.
- g) Future access construction may involve minor cuts and fills for maintaining widths and grades as well as clearing of vegetation. Regardless of whether upgrading an existing access or building a new one, construction along the top of the river valley, ravine, and lakeshore slopes will require care to avoid destabilizing the existing slopes. These should be evaluated on a site-specific basis and appropriate measures should be implemented to mitigate the potential effects of construction on or near slopes. Cuts and fills will generally require properly designed retaining structures to maintain the existing slope stability.



- h) No disturbance to existing slopes or bank by construction activities should be allowed during future development. Vegetation removal or construction activities should be limited to the facility footprint. Stockpiling should not be permitted on the top of slope and dumping and discharging water over slope should also be avoided. It is imperative that surface water runoffs be properly diverted away from the ravine slopes and top of bank, and no channelized flow should be allowed over the top of bank, to reduce the potential of future slope erosion and slope instability.
- i) The Big Lake area is known to be comprised of relatively thick and unconsolidated lacustrine deposits, especially in the vicinity of the lake and the connecting Sturgeon River. These deposits can contain significant organic content which can present challenging geotechnical conditions for design and construction. Site specific geotechnical investigations will be required to delineate the presence of these deposits on any proposed development area.

## **6. FUTURE WORK**

Due to the extensive area currently under consideration, the scope of this desktop study involved a relatively high-level evaluation of the project area to identify areas of potential geotechnical constraints. As noted above, the major geotechnical constraint is the relatively widespread slope instabilities (both active and dormant) along the North Saskatchewan River and tributary valleys and Big Lake slopes. It is anticipated that the identification of these problematic landslide and steep slope areas in this report will inform the site selection process going forward.

Once key areas for access and infrastructure development are identified through the evaluation of geotechnical, as well as other important criteria, more focused review of these specific areas should be undertaken.

This will involve site specific desktop investigation, including review of any available geotechnical reports pertinent to these areas, possible API, site reconnaissance, and preliminary slope stability assessments. The results of this review should serve as a basis to further inform long term development plans, as well as highlight the geotechnical limitations, if any, for the proposed development concepts.

## **7. LIMITATION AND USE OF THIS REPORT**

There is a possibility that this report may form part of the design and construction documents for information purposes. This report was issued before any final design or construction details have been prepared or issued. Therefore, differences may exist between the report recommendations



and the final design, in the contract documents, or during construction. In such instances, Thurber Engineering Ltd. should be contacted immediately to address these differences.

Designers and contractors undertaking or bidding the work should examine the factual results of the investigation, satisfy themselves on the adequacy of the information for design and construction, and make their own interpretation of the data as it may affect their proposed scope of work, cost, schedule, safety, and equipment capabilities.



## STATEMENT OF LIMITATIONS AND CONDITIONS

### 1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

### 2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

### 3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

### 4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

### 5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

### 6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

### 7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.



## **APPENDIX A**

Drawing No. 29863-1A – Topography Map - North Region

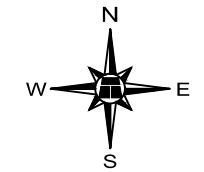
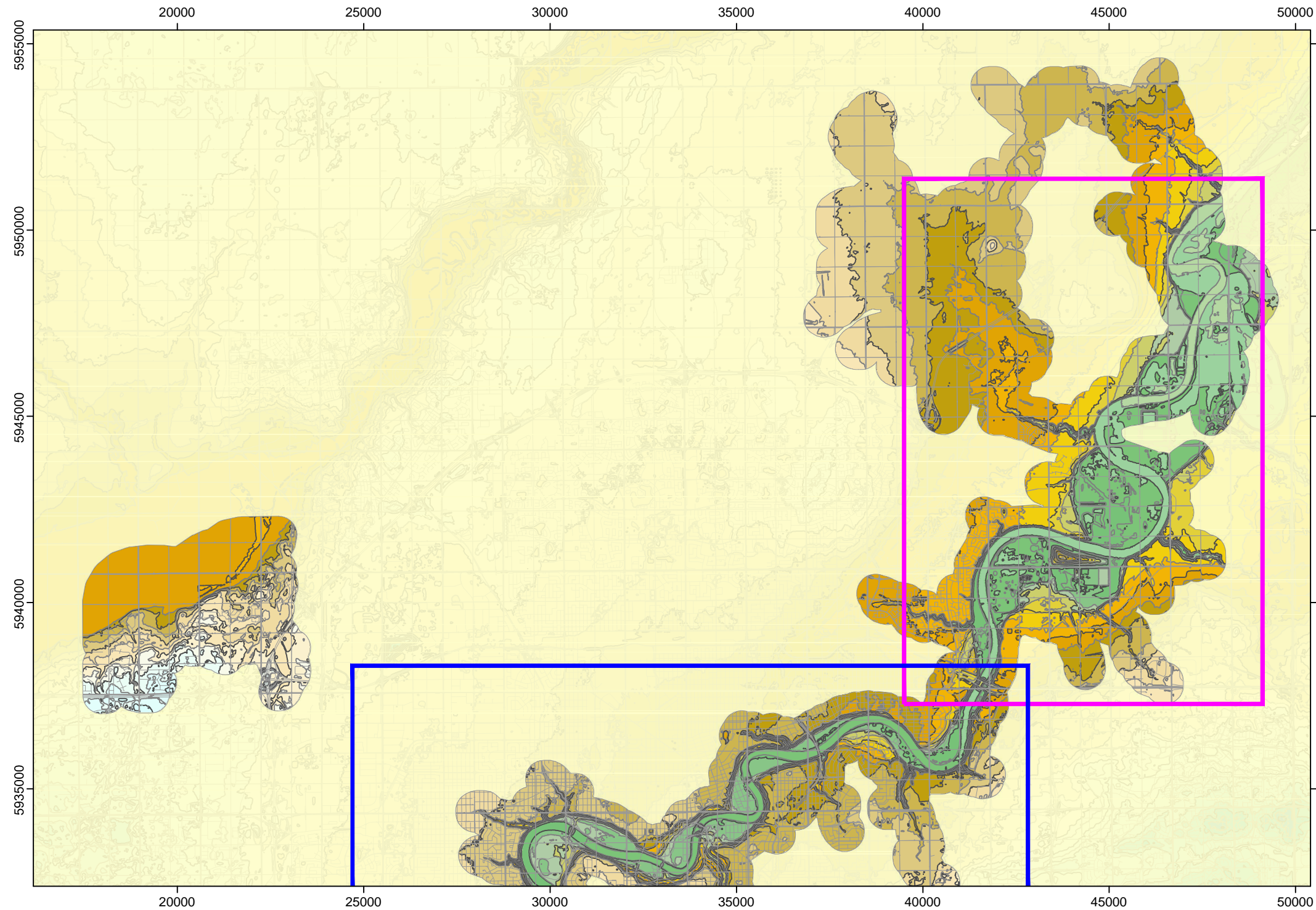
Drawing No. 29863-1B – Topography Map - South Region

Drawing No. 29863-2A – Topography Slope Map - North Region

Drawing No. 29863-2B – Topography Slope Map - North Region

Drawing No. 29863-3A – Geology Map - North Region

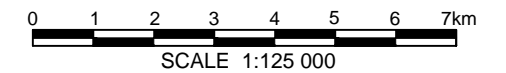
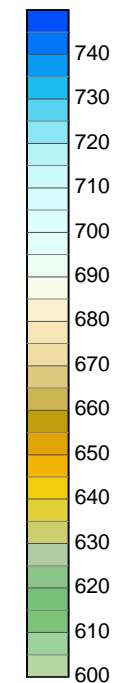
Drawing No. 29863-3B – Geology Map – South Region




**LEGEND**

- NORTHEAST STUDY AREA (2017)
- CENTRAL REACH STUDY AREA (2021)

**GROUND SURFACE ELEVATIONS (CONTOURS 5m)**






**GEOTECHNICAL DESKTOP STUDY  
RIBBON OF GREEN AND NORTH SASKATCHEWAN  
RIVER VALLEY AREA**

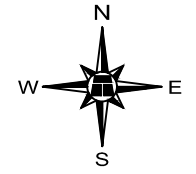
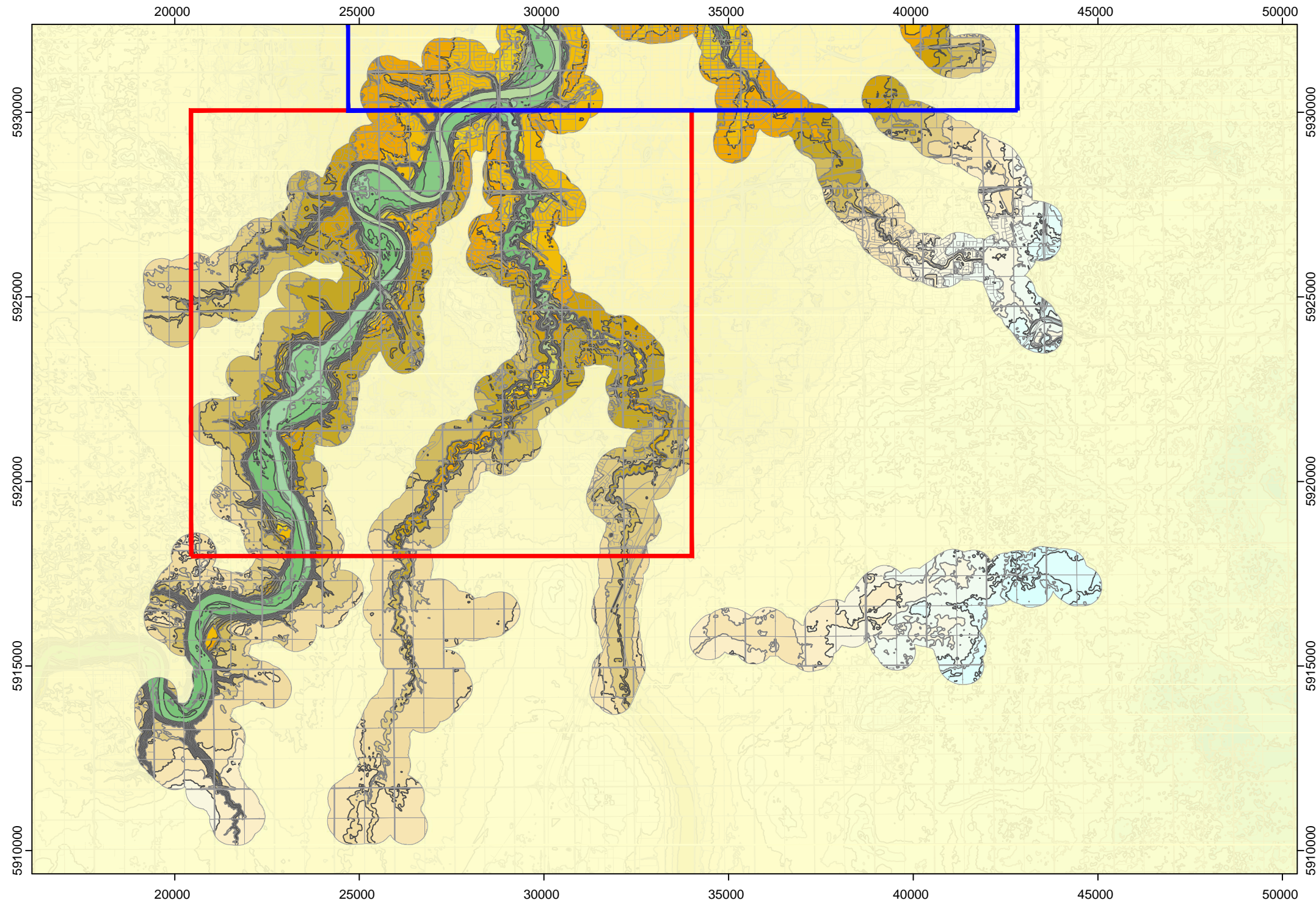
**TOPOGRAPHY MAP  
NORTH REGION**

**DWG No. 29863-1A**

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APPROVED BY	RWT
SCALE	1:125 000
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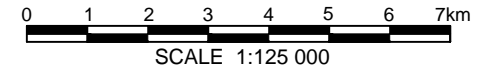
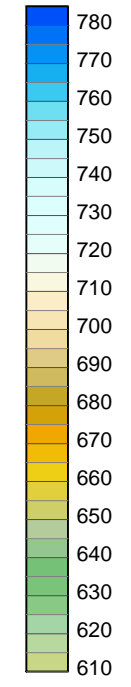
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**LEGEND**

- CENTRAL REACH STUDY AREA (2021)
- SOUTHWEST STUDY AREA (2017)

**GROUND SURFACE ELEVATIONS (CONTOURS 5m)**

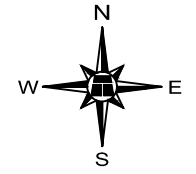
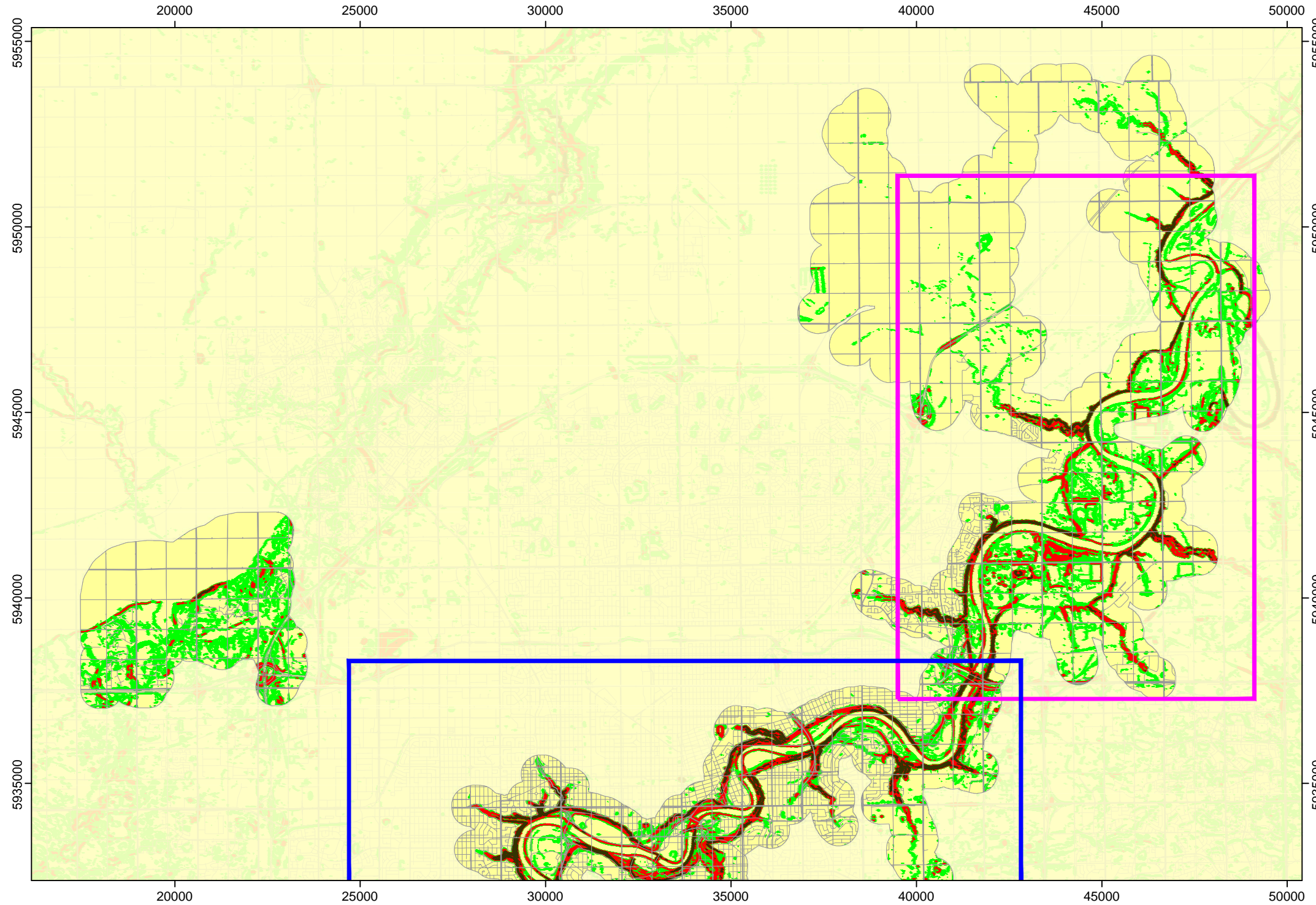


**GEOTECHNICAL DESKTOP STUDY  
RIBBON OF GREEN AND NORTH SASKATCHEWAN  
RIVER VALLEY AREA**

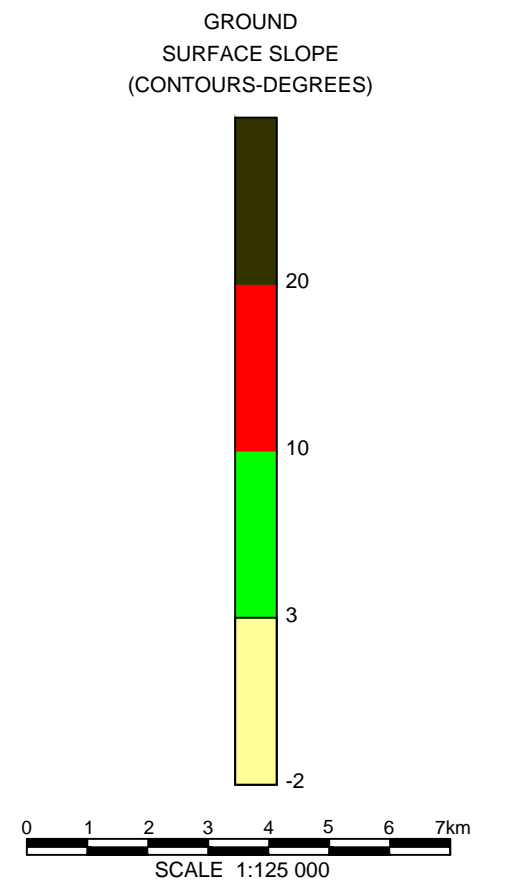
**TOPOGRAPHY MAP  
SOUTH REGION**


**DWG No. 29863-1B**



- LEGEND**
- NORTHEAST STUDY AREA (2017)
  - CENTRAL REACH STUDY AREA (2021)






**GEOTECHNICAL DESKTOP STUDY  
RIBBON OF GREEN AND NORTH SASKATCHEWAN  
RIVER VALLEY AREA**

**TOPOGRAPHY SLOPE MAP  
NORTH REGION**

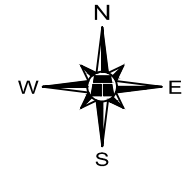
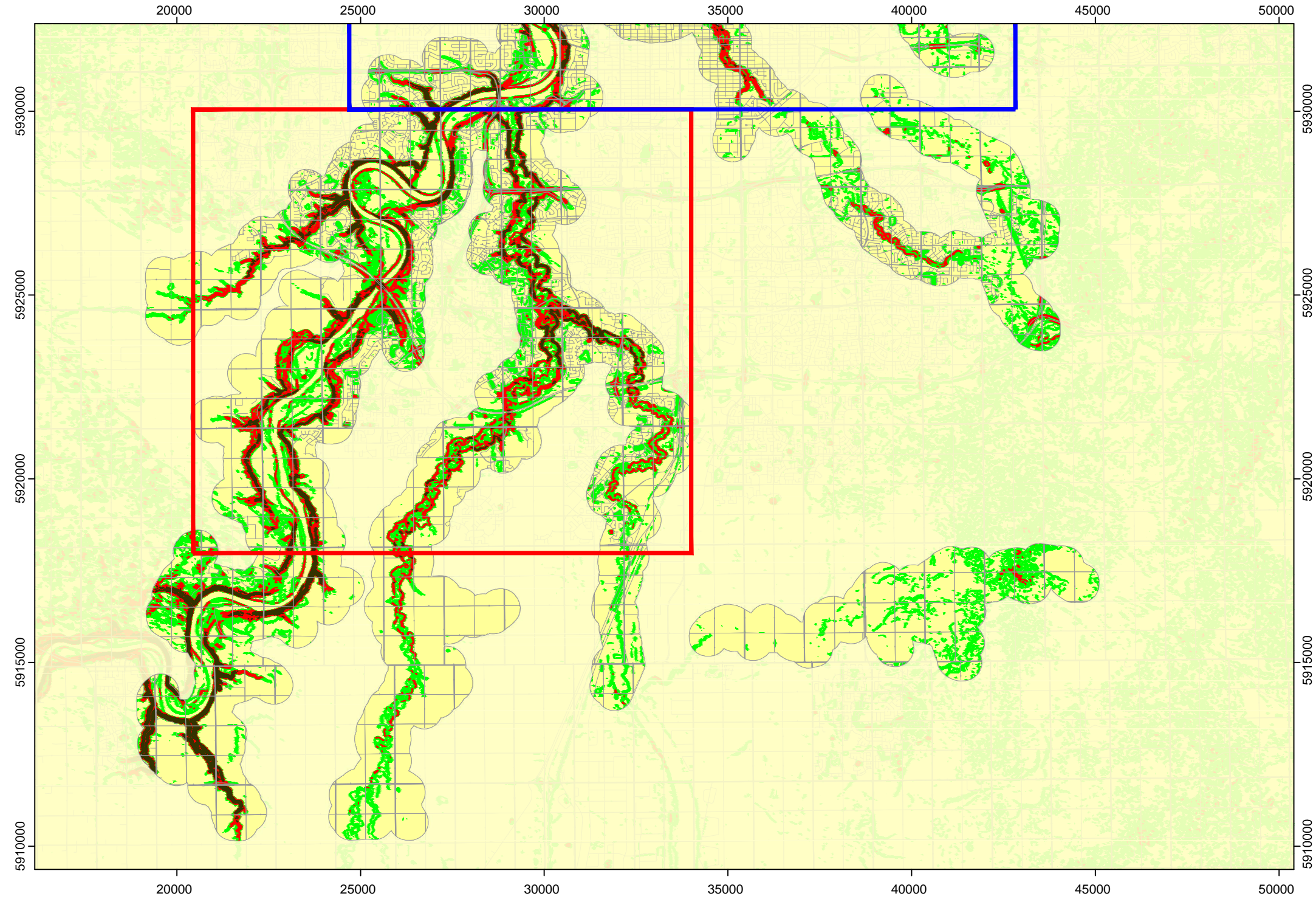
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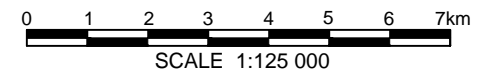
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**LEGEND**

- CENTRAL REACH STUDY AREA (2021)
- SOUTHWEST STUDY AREA (2017)

**GROUND SURFACE SLOPE (CONTOURS-DEGREES)**



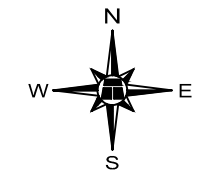
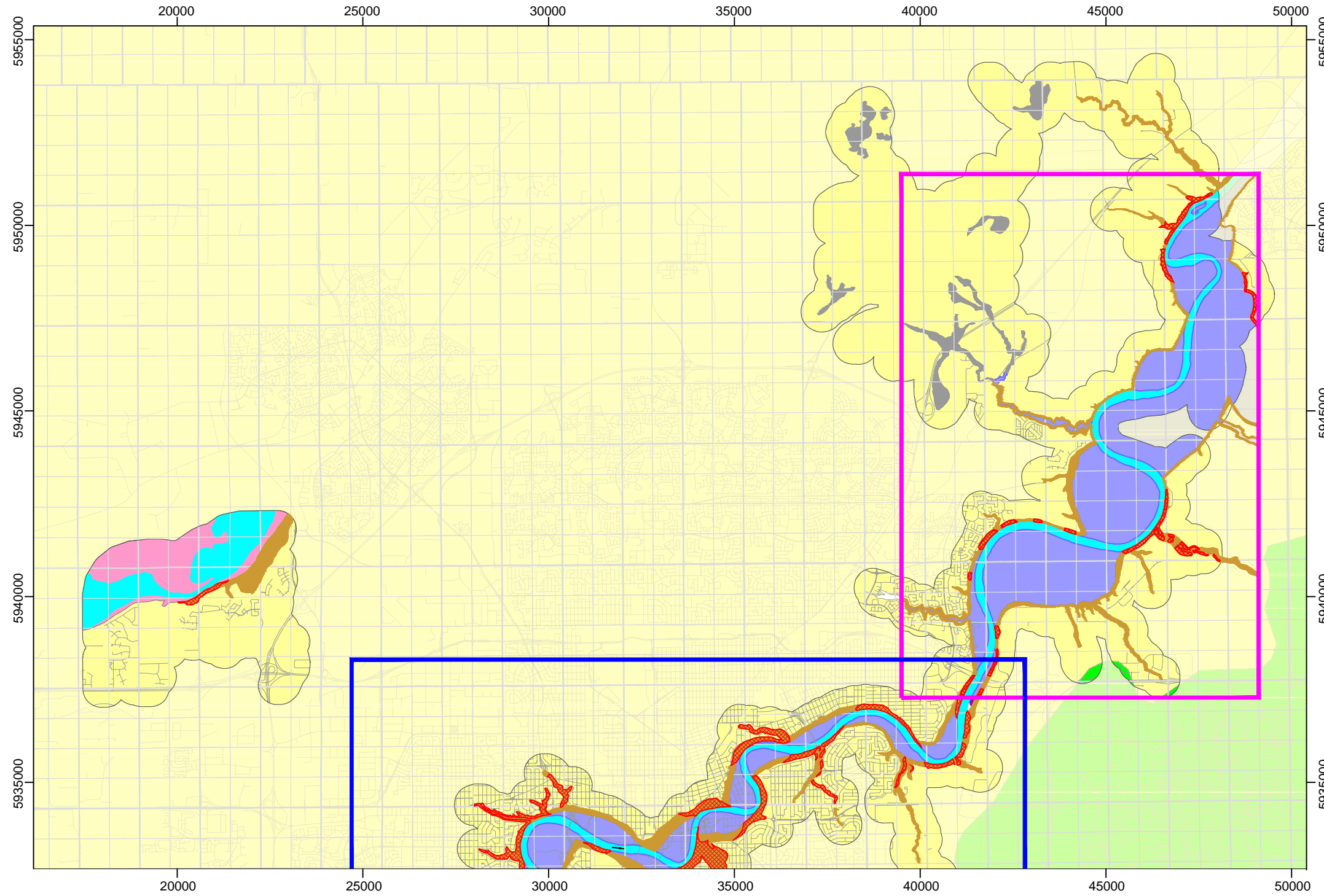
**GEOTECHNICAL DESKTOP STUDY  
 RIBBON OF GREEN AND NORTH SASKATCHEWAN  
 RIVER VALLEY AREA**

**TOPOGRAPHY SLOPE MAP  
 SOUTH REGION**













**DWG No. 29863-2B**

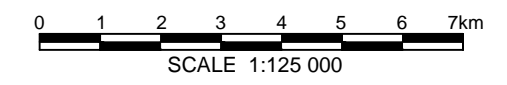
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FILE No.	29863






**LEGEND**

-  NORTHEAST STUDY AREA (2017)
-  CENTRAL REACH STUDY AREA (2021)
-  WATER
-  MAJOR LANDSLIDE AREA
-  MAJOR ORGANIC DEPOSITS
-  LACUSTRINE DEPOSITS
-  COLUVIUM
-  ALLUVIUM
-  EOLIAN DEPOSITS
-  GLACIOLACUSTRINE DEPOSITS
-  GLACIAL TILL DEPOSITS
-  BEDROCK






**GEOTECHNICAL DESKTOP STUDY  
RIBBON OF GREEN AND NORTH SASKATCHEWAN  
RIVER VALLEY AREA**

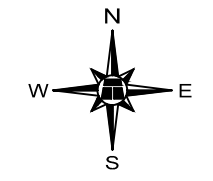
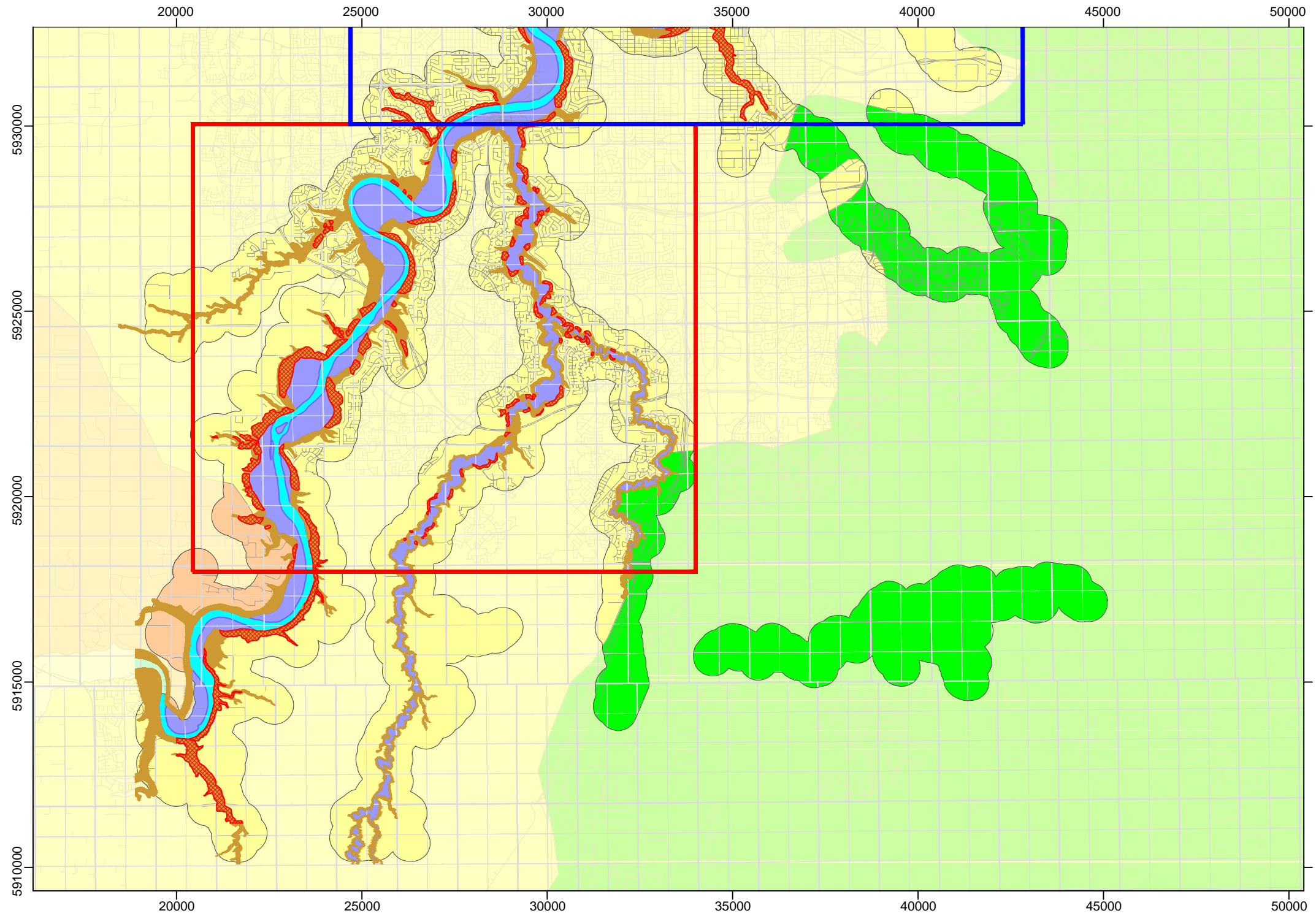
**SURFICIAL GEOLOGY MAP  
NORTH REGION**

**DWG No. 29863-3A**













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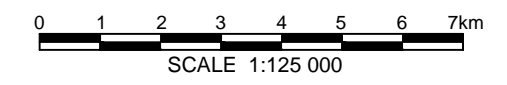



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**LEGEND**

-  CENTRAL REACH STUDY AREA (2021)
-  SOUTHWEST STUDY AREA (2017)
-  WATER
-  MAJOR LANDSLIDE AREA
-  MAJOR ORGANIC DEPOSITS
-  LACUSTRINE DEPOSITS
-  COLUVIUM
-  ALLUVIUM
-  EOLIAN DEPOSITS
-  GLACIOLACUSTRINE DEPOSITS
-  GLACIAL TILL DEPOSITS
-  BEDROCK






**GEOTECHNICAL DESKTOP STUDY  
RIBBON OF GREEN AND NORTH SASKATCHEWAN  
RIVER VALLEY AREA**

**SURFICIAL GEOLOGY MAP  
SOUTH REGION**

**DWG No. 29863-3B**

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