Saskatoon Freeway Functional Planning Study

Phase 1 Functional Design Report

Saskatchewan Ministry of Highways

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Executive Summary

The Government of Saskatchewan, through the Ministry of Highways (Ministry), is completing a functional planning study which will determine how the Saskatoon Freeway will look and operate. The study was originally planned to be completed in three phases. This report; Saskatoon Freeway - Phase 1 Functional Design Report, describes the activities and functional design recommendations for the Saskatoon Freeway in Phase 1. Phase 3 was removed from the scope of this study and will be completed in the future and is no longer part of the current Saskatoon Freeway Functional Planning Study scope. A final project report will be completed which will tie the Phase 1 and Phase 2 reports together as well as address functional design items that overlap these phases including intelligent transportation system concepts, over dimension routing, and project staging opportunities.

The Saskatoon Freeway will be a minimum four-lane divided uninterrupted flow freeway, which is approximately 55-kilometres in length. It begins at Highway 11 south of the City of Saskatoon (CoS) (south of Floral Road), passes around the east, north, and west sides of the city ending at Highway 7/Highway 60. The Saskatoon Freeway Functional Planning Study (SFFPS) will consider the placement of 16 interchanges, 5 railway overpasses, 4 flyovers, and a new bridge crossing the South Saskatchewan River. The study is scheduled to be completed in 2022. At the time of writing this report, Phase 2 has started and scheduled for completion in 2022. Currently, there is no timetable for a final decision regarding the freeway's construction.

The SFFPS has been divided into three phases. The first phase of the SFFPS is focused on the segment extending from the east side of the South Saskatchewan River to a point just south of Highway 16 on the northwest side of the CoS. This phase encompasses critical commercial development areas with lands restricted to protect the outcome of the SFFPS. Refining the property through the functional planning study process will enable development to proceed. Phase 1 is approximately 10 km in length and intersects Wanuskewin/Highway 11, Highway 12, and Highway 16.

This Phase 1 report elaborates on previous general location studies completed by the Ministry and provides functional plans that can be used either as a "Reference Concept" for alternate delivery models such as a Design/Build model or can be used as the basis for proceeding with a detailed design using a traditional Design/Bid/Build delivery model.

The following key technical functional planning study elements for Phase 1 are described in this report:

- An update of the regional Travel Demand Model (TDM) using a design and planning year of 2063 (CoS and Saskatoon Census Metropolitan Area (CMA) populations of 748,000 and 831,000, respectively);
- Functional design criteria and level-of-service targets for the freeway, interchange, and bridge structures components;
- Three-dimension conceptual alignment and laning designs for the freeway and interchanges;
- Environmental and Heritage Study used to guide functional designs;
- Stakeholder engagement processes and events;
- Multiple Account Evaluation (MAE) processes and out comes for interchange concepts and South Saskatchewan River Bridge Crossing Concepts;
- Drainage data and schemes to maintain existing drainage patterns; and

- Approximate right-of-way property requirements including proposed Transportation Utility Corridors.

The following are key highlights/recommendations/outcomes of this functional planning study phase:

- The June 2019 Design Workshop concluded that the Wanuskewin and Highway 11 interchanges identified in the preceding general location phase should be consolidated at the Wanuskewin interchange location;
- An interchange was added at Penner Road to better serve the Wanuskewin Heritage Park and commercial lands west of Highway 11;
- The 2063 TDM hourly volumes and level of service targets resulted in a need for at least four lanes in each direction across the South Saskatchewan River Bridge. An additional fifth lane is required across the river bridge in the southeast direction to ensure lane balancing and route continuity for Highway 11;
- Route continuity was an important requirement for Highway 11 and Highway 16 extending from south of the city to north of the city. This resulted in the use of major fork geometric designs retaining design speeds of 130 km/h not only along the freeway alignment but also to/from Highway 11 and Highway 16.
- The impact to Wanuskewin Heritage Park was minimized by shifting the Highway 11 interchange;
- Drainage patterns were retained; especially in the section between Highway 12 and Highway 16 by increasing the number of through-grade culverts;
- Existing water storage capacity was maintained in the drainage system by designating additional storage area adjacent to the Hudson Bay Swale; and
- The property requirements for the Highway 12 interchange were established in a manner to maximize flexibility of future interchange design solutions. Planning details and road service function decisions for Highway 12 south of the freeway were not finalized at the time of writing this report; therefore, two interchange concepts were used to identify property requirements.

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1 Introduction

The Government of Saskatchewan, through the Ministry of Highways and Infrastructure (Ministry), is engaging in a functional planning study which will determine how the Saskatoon Freeway will look and operate. This freeway is expected to be a minimum four-lanes, 55-kilometre stretch of divided highway that begins at Highway 11 south of the City of Saskatoon (CoS) and connects with Highway 7 west of the city. The Saskatoon Freeway Functional Planning Study (SFFPS) will consider the placement of 16 interchanges, 5 railway overpasses, 4 flyovers, and 1 major river crossing. The study is scheduled to be completed in 2022. Currently, there is no timetable for a final decision regarding the freeway's construction.

The Ministry identified significant traffic delays and safety issues with provincial highway traffic entering the CoS and destined for other provincial highway routes exiting the City. The CoS and the Saskatoon Census Metropolitan Area (CMA) are experiencing population growth, resulting in an increase to congestion and safety problems. The traffic problems will be most prevalent with large trucks, some hauling dangerous goods using intra-city travel routes. The Saskatoon Freeway will alleviate congestion on intra-city travel routes and will improve the safety for all road users. The Saskatoon Freeway will also provide a high mobility route for trucks to move goods across, to and from Saskatchewan.

General location studies (Saskatchewan Ministry of Highways and Infrastructure, November 2017; UMA, June 2005; and UMA, August 2007) were completed and established a 500 m corridor in which the freeway would be located. The purpose of the SFFPS is to determine the conceptual design for the North, East, and West segments within the general location corridor, to identify property requirements thereby reducing the extents of current property restrictions, and to provide a reference concept for future phases of detailed design and construction.

This Phase 1 Functional Design Report includes a description of previous studies completed to date, including details of the general location plan which is the base location reference for this study. Existing conditions are also discussed including identified environmental and geotechnical constraints, as well as constraints imposed by existing infrastructure (utilities, railway, roadways, etc.). Stakeholder Engagement and Communication activities are discussed including details on engagement activities, consulted stakeholder groups, and summaries of stakeholder input. Transportation planning was undertaken by updating the traffic demand model (TDM). Background traffic volumes and studies were reviewed, and stakeholders consulted on current CoS and surrounding community development plans. The Functional Plan portion of the report details design criteria, access plans, horizontal and vertical alignment, and bridge concepts. as well as the Multiple Account Evaluation (MAE) process used in the selection of the preferred Phase 1 interchange concepts. Multiphase supporting information is also discussed including utility plans and conflicts, geotechnical details, road safety audit, and intelligent transportation systems. Recommendations are also provided. Information on staging will be provided in the final summary report.

Key deliverables for SFFPS include:

1. **Functional Plan**, incorporating previous planning activities since 2001, setting the alignment of the freeway and developing interchange concepts (including bridges) which will be used as a reference concept for future procurement options;

2. **Public and Stakeholder Engagement Plan**, which will be followed to gain endorsement from major stakeholders and allow the Ministry to be open and transparent throughout the planning phases;

3. **Bridge Concept(s)** for crossing the South Saskatchewan River; and

4. Accurate **property line and boundaries** for the freeway alignment, interchanges, service roads, and realigned cross roads which are based on the functional design concepts.

Key functional planning activities that will elaborate on the general location and preceding reports are:

- Update and regionalize the regional travel demand model using a design and planning year of 2063;
- Develop functional design criteria and establish level-of-service targets for the freeway and interchange components;
- Develop a three-dimension conceptual alignment and laning for the freeway;
- Develop three-dimension concept plans for interchanges (including bridges) and fly-overs including laning;
- Incorporate environmental and heritage study data;
- Incorporate drainage data;
- Assess possible staging options;
- Develop approximate right-of-way property requirements; and
- Develop the South Saskatchewan River crossing bridge concept(s).

1.1 Study Area

The SFFPS is focused on the 500 m corridor developed in previous studies as illustrated in **Figure 1.1**. Freeway mainline alignment options were retained within the general location corridor; however, interchanges and intersecting roads extended beyond the corridor to facilitate acceptable geometric design and operational characteristics. In addition, access concepts were developed for municipal roads that were intersected by the freeway.

The SFFPS began with Phase 1 (north). Phase 2 (east) is currently in progress. Phase 3 (west) was removed from the original scope of work and will be completed in the future. Reporting will be completed for each phase as they are completed. A final report will be issued detailing the final functional plan of all phases, including revisions (if any).

Figure 1.1: Saskatoon Freeway Functional Planning Study Corridor

1.2 Phases of Work

The SFFPS has been divided into three phases as illustrated in **Figure 1.2**.

The first phase of the SFFPS is focused on the segment extending from the east side of the South Saskatchewan River to a point just south of Highway 16 on the northwest side of the CoS. This phase encompasses critical commercial development areas with lands restricted to protect the outcome of the SFFPS. Refining the property requirements through the functional planning study process will enable development to proceed. Phase 1 is approximately 10 km in length and intersects Wanuskewin/Highway 11, Highway 12, and Highway 16. Although Phase 1 includes the river crossing, details of a bridge option study **(Section 7.2)** initiated in Phase 1 will be finalized in the Phase 2 Functional Planning Study report.

The second phase of the SFFPS is focused on the east side of the CoS extending from Highway 11 south of Grasswoods to the beginning of Phase 1 at the South Saskatchewan River. This phase will complete important conceptual alignments for Highway 11 and Highway 16 around the east side of the city. This phase encompasses significant existing and future residential developments as well as some commercial development areas. Completion of the functional plan will also allow better definition of required property and thus allowing development to proceed with some certainty of the freeway location. Phase 2 is approximately 27 km in length and will intersect major roads, such as Central Avenue, Blackley Road, Highway 41, Highway 5, 8th Street, Patience Lake Road, Highway 16, Range Road 3045, Highway 11, and various other minor roadways.

The third phase of the SFFPS is focused on the west side of the CoS extending from a point just south of Highway 16 to Highway 7 at the junction with Highway 60. This phase generally encompasses agricultural lands, including a large land holding by Moosomin First Nation on the north. Range Road 684 is a rural paved road that connects at the junction with Highway 7/Highway 14 and the Dalmeny Access at Highway 16. This is a well traveled road that will be intersected by the Saskatoon Freeway near the Beam Road interchange. Phase 3 is approximately 18 km in length and will intersect Beam Road, Claypool Drive, Highway 14, and Highway 7/Highway 60.

The Functional Plan is progressing as three separate phases as described in the subsequent sections.

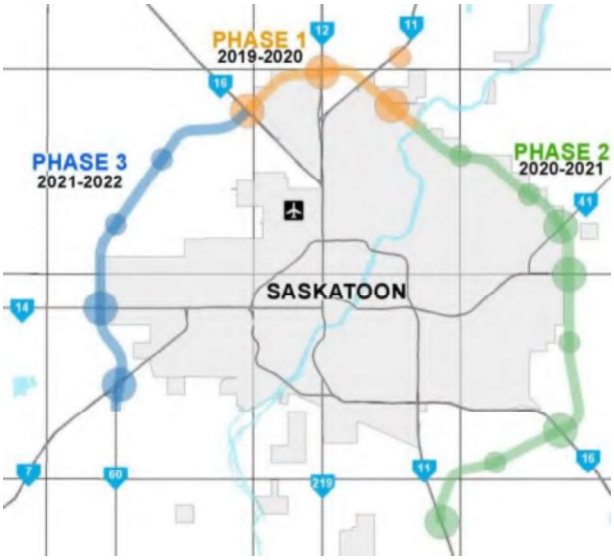


Figure 1.2: Saskatoon Freeway Functional Planning Study Phasing

1.3 Schedule of Work

This report marks the completion of Phase 1. Phase 2 is now underway and is scheduled to be completed in early 2022. Phase 3 will be completed in the future and is not part of the current SFFPS scope. The final deliverable will include a summary report finalizing the details of all completed phases. This summary report is anticipated to be delivered late 2022.

1.4 Project Governance Structure and Communications

Project communication between the Ministry and the design team was primarily between the Ministry's Senior Project Manager and the design team Project Director, Deputy Project Director, and Project Technical & Commercial Manager. All communication regarding the PSA, project scope was done between the Project Sponsor and the Ministry Project Manager.

While the Project Director (David Stearns) was the Ministry's communication point, the Deputy Project Director (Allan Duff) was an integral part of the team to ensure that communication between the Ministry and the design team was seamless. This was done with coordination meetings with the Technical Working Group (TWG) Leads and project wide engineering specialists to ensure the integration of the engineering disciplines as well as managing the design interfaces.

The project was governed in accordance with the structure shown in the organizational chart shown in **Figure 1.3**. The TWGs were staffed by personnel as shown in the figure and supplemented by Ministry experts and other stakeholders.

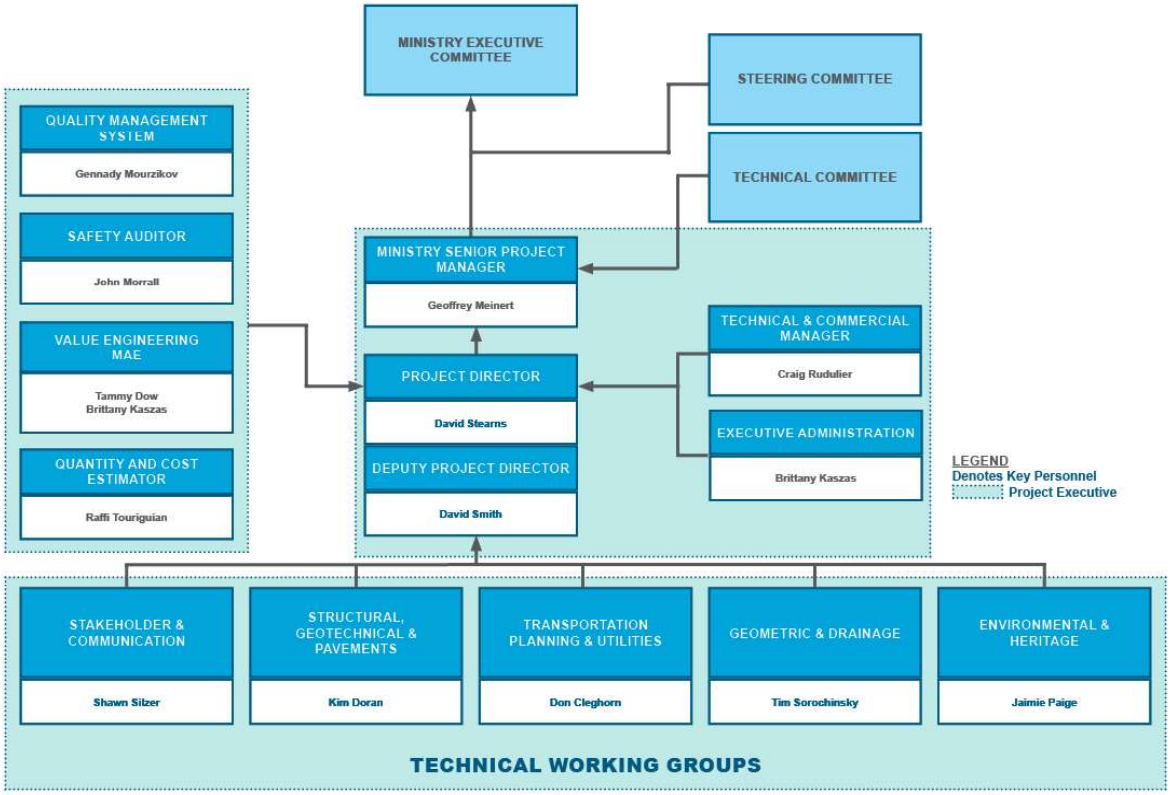


Figure 1.3: Project Management Reporting Structure

1.4.1 Ministry Executive Committee

The Ministry Executive Committee generally meets on a bi-weekly schedule to discuss critical projects within the Ministry's programs, with the SFFPS as a key project. The Ministry's Senior Project Manager (Geoffrey Meinert) provides a brief presentation on the status of the project and any key issues requiring direction. The Project Director/Deputy Project Director and others may be invited to the Executive meeting as needed. There was no requirement for SNC-Lavalin's attendance during Phase 1.

1.4.2 Steering Committee

Representatives from the CoS, Ministry of Government Relations, North Saskatoon Business Association (NSBA), Saskatoon Tribal Council (STC), Meewasin Valley Authority (MVA), Saskatoon Chamber of Commerce, City of Warman, City of Martensville, the Rural Municipality (RM) of Corman Park, and the Ministry sat on the Project Steering Committee. These representatives helped guide the project at a high-level, providing direction on the design options to ensure they met acceptance to their respective organizations. Consensus from this group was required for the ultimate approval of the proposed Functional Design. The team held bi-monthly meetings with the Steering Committee to discuss formal approval requirements from the major stakeholders.

1.4.3 Technical Committee

The Technical Committee was composed of representatives from the CoS, City of Warman, City of Martensville, the RM of Corman Park, Saskatoon North Partnership for Growth (P4G), various Ministry personnel including the Ministry's Senior Project Manager and senior personnel from the Design Branch, Network Planning and Investment Branch, and the Central Region Operation and Maintenance Branch. The committee meetings were also attended by discipline leads from AECOM and SNC-Lavalin as well as the Project Director, Deputy Project Manager, and Project Controller. The Technical Committee met bi-monthly to update the ministry Technical Committee on the progress of each discipline team.

1.4.4 Technical Working Groups

The TWGs met bi-weekly or as required and were the primary tool for internal communication. Each TWG was comprised of project team staff, applicable Ministry staff and third-party stakeholders from the CoS, RM of Corman Park and other organizations that had pertinent issues on the agenda. During the TWG meetings, outstanding technical issues within each discipline were discussed and the schedule and deadlines were communicated.

When input was needed from the Ministry or other stakeholders, the appropriate people were invited. These external TWG members had an open invitation to add agenda items and to attend meetings as often as they felt were required.

1.5 Functional Design Methodology

A functional planning study, sometimes referred to as a functional design, determines the form and function of a road based on projected traffic volumes and road user needs. A functional design is typically done 2-10 years in advance of the detailed design and construction. The reason for the delay between the functional design and detailed design is to provide adequate time for proper public communication, land acquisition and time to arrange for funding.

The form of the road is the physical characteristics of the road:

- Number of driving lanes required to meet future needs;
- Need for auxiliary lanes for turning, enforcement or rest area;
- Road alignment;
- Need for interchanges or intersections; and
- Interchange layout.

The form of the road helps set the route and width of the right of way required. This information generates preparation of the Land Acquisition Plan and is the basis for explaining the project to the public.

The function of the road is the purpose of the road:

- Set speed limits;
- Access control;
- Set design vehicle for turning and weight requirements; and
- Pedestrians/bicycles - allowed or prohibited.

The function of the road helps set adjacent land use, or in some cases, the function can be set to best serve existing/future adjacent land use.

Setting the form and function of a road relies on considering many things, such as physical constraints (buildings, power poles, underground utilities), environmental constraints (aquatic protection, endangered species, noise impacts) and natural constraints (rivers, topography, geologic conditions). Public and stakeholder input, and safety concerns are other major considerations.

A functional planning study also looks at benefits and costs of all components and how construction of the new road can be staged based on projected traffic volumes. Construction staging provides flexibility for project funding as the entire cost does not have to be available initially.

Key deliverables for the SFFPS are:

- Report detailing the form and function of the new freeway;
- Property acquisition plan; and
- Report detailing Public Engagement.

2 Background

2.1 Previous Studies

Previous studies were reviewed as part of the Saskatoon Freeway Functional Planning Study (SFFPS) planning stage. Studies specific to the Phase 1 area of the project are presented in **Table 2.1** and summarized below.

Table 2.1: Summary of Previous Studies

STUDY	AUTHOR	DATE
East Perimeter Highway Functional Planning Study	UMA Engineering Ltd.	June 2005
Perimeter Highway Phase 2 Route Location and Functional Planning Study	UMA Engineering Ltd.	November 2006
Saskatoon NW Access Management Study	Associated Engineering	July 2009
Highway 5 East Functional Planning Study	iTrans Consulting Lit.	March 2010
Future Perimeter Highway, Highway 16 to the Proposed North Bridge Functional Planning Study	Associated Engineering	January 2012
Highway 11 and Highway 12 Phase 1 Long-Term Transportation Plan	AECOM	January 2012
Highway 11/12 Planning Study	MMM Group Ltd.	February 2013
Highway 11 and 12 Interchanges Functional Planning Study Phase 1	Associated Engineering	September 2013
Saskatoon Perimeter Highway Validation Study	Tetra Tech	May 2014
Saskatoon West Connector Route Feasibility Study Report	Stantec Consulting	November 2016
South Saskatoon Freeway General Location Study	Associated Engineering	November 2017

East Perimeter Highway Functional Planning Study

The East Perimeter Highway Function Planning Study was commissioned to define the alignment for the Perimeter Highway around the east side of Saskatoon between Highway 11 to the south and Highway 16 to the north. The recommended alignment attempted to minimize impact on existing development while accommodating future City of Saskatoon (CoS) growth sectors. Features of the route included:

- Utilizing predetermined interchange sites at Highway 11 and Highway 16, minimizing impact on existing development;
- Compatibility with the Future East Residential Development Sector between Highway 41 and Highway 16;
- No requirement to remove existing businesses at the junction of Highway 5 and Highway 41;
- Avoided the University of Saskatchewan Kernen Research Farm;

- Provided ample spacing between interchanges at Highway 5 and Highway 41; and
- Provided the most route continuity and directness, as well as, least impact on commercial properties between the South Saskatchewan River and Highway 16.

Traffic projections for the Perimeter Highway were based on a future population of 400,000. A key recommendation of this report outlined the need for a shared-purpose river crossing, serving both City and highway traffic needs.

Perimeter Highway Phase 2 Route Location and Functional Planning Study

The purpose of this report was to define an alignment for the Perimeter Highway around the west side of Saskatoon between Highway 16 (west) to the north and Highway 14 to the south. The proposed corridor would establish the highway right-of-way and identify interchange locations. The selected alternative minimized proximity to residential sites and provided perpendicular crossings at major intersections.

Saskatoon NW Access Management Study

The objective of the Saskatoon Northwest Access Management plan north of Saskatoon was to assess existing and future road classification, land use development and establishment of access to roadways and adjacent land. The study area of this report included areas north of 60th Street and the Saskatoon International Airport, west from Wanuskewin Road, west of Highway 16, and south of the Future Perimeter Highway. Three options were developed based on the assessment of existing and future land use and traffic demands. The preferred access management plan identified the proposed access points:

- System level interchanges locations where the Perimeter Highway intersects with Highway 11, Highway 12, and Highway 16;
- Service level interchanges at Highway 16 at 71st street, Highway 16 at Marquis Drive, Highway 12 south of the Perimeter Highway, Highway 11 south of the Perimeter Highway, and Idylwyld Drive at Marquis Drive; and
- Removal of access at Idylwyld Drive and 71st street (except southbound right turn), Idylwyld Drive at 60th street, and additional at-grade intersections.

The preferred option provided the most flexibility in providing the ultimate interchange configurations. It was recommended that 800 m and 500 m radii control circles be reserved at system level and service level interchanges, respectively until functional plans could be developed (Associated Engineering, 2009).

Highway 5 East Functional Planning Study

This study aimed at providing configuration and alignment alternatives along Highway 5 from McOrmond Drive intersection to the future Perimeter Highway Intersection east of Highway 41. Intersection concepts were evaluated at three intersections. The recommended alternatives at the necessary locations were as follows:

- Highway 5/McOrmond Drive – Parclo AB, with loops in the SE and NE quadrants;
- Highway 5/Highway 41 – Parclo AB, with loops in the SE and NE quadrants; and
- Highway 5/Perimeter Highway – Full clover with collector-distribution roads in all directions.

Additional analysis was recommended once land use and density plans are established to confirm the selected intersection configurations remain valid.

Future Perimeter Highway, Highway 16 to the Proposed North Bridge Functional Planning Study

The report aimed at providing a single line functional design of the future Perimeter Highway North of Saskatoon from Highway 16 west to the future north river bridge crossing. System level interchange concepts were developed for Highway 16, Highway 11, and Highway 12, while a service level interchange was considered at the intersection of Wanuskewin Road. Multiple alternatives were developed at each location. Evaluations utilized a triple bottom line approach, placing value on environment, economics, and social value criteria. Traffic demand models forecasted peak hourly traffic to the year 2075, representing a city population of 400,000 people. A major recommendation from this report eliminated a segment of Highway 11 from the Perimeter Highway south into the CoS. Traffic using this route would be required to use Wanuskewin Road or Highway 12 via the Perimeter Highway to gain access/egress to Saskatoon.

Highway 11 and Highway 12 Phase 1 Long-Term Transportation Plan

Highway 11 and Highway 12 Long-Term Transportation Study investigated the two corridors between the alignment of the Future Perimeter Highway to the South Osler Access on Highway 11 and the future alignment of Highway 305 on Highway 12. Phase 1 of the study focuses on providing alternatives for immediate implementation based on analysis of existing operations and an in-service safety review. Collision information gathered for both corridors displayed that nearly half of all collisions were right-angle collisions or rear-end collisions. Level of Service analysis assessed each existing intersection's operational efficiency and effectiveness. Intersections at Highway 11/Highway 305, Highway 11/Wanuskewin Road, and Highway 12/Main Street received LOS F ratings. Observations and alternatives are provided for every corridor and intersection within the study area. Major recommendations include the following:

- Highway 11/Wanuskewin Road – Install a slot left-turn lane at this intersection for the southbound left-turn;
- Highway 12/Twp Rd 375-A – Install a northbound right-turn bay;
- Highway 12/Twp Rd 380 – Install a northbound right-turn bay and southbound left-turn bay; and
- Highway 12/Lutheran Road – Southbound acceleration lane will be constructed with a northbound left-turn bay.

Additional recommendations throughout multiple intersections and corridors include reflective delineation, pavement markings and a variable message sign, upgrading Rurall Municipality (RM) of Corman Park roads to primary weight standards, improve turning radius, and signage improvement.

Highway 11/12 Planning Study

Phase 2 of the Highway 11 and Highway 12 Planning Study provided long-term network planning for the study corridors. Capacity analysis identified severe congestion based on anticipated future traffic volume demand, suggesting that grade separation intersections would be required. Peak hourly traffic volumes using a 35-year forecast are anticipated to increase 195 – 300 percent on Highway 11, and 140 – 380 percent on Highway 12. Six service level interchanges were recommended to be constructed north of the future Perimeter Highway located at the following intersections:

- Highway 11 – Highway 305, Warman Central Street, and a new mid-block location between Lutheran Road and South Warman Access; and
- Highway 12 – Highway 305, Martensville Main Street, and Lutheran Road.

The recommended locations were selected using an evaluation matrix, assessing criteria such as RM and provincial road network, interchange spacing, community access, land availability, among others. The order and timing of constructing each intersection was a function of cost and traffic growth. This study identified future intersection locations to be protected but did not prioritize or sequence intersection construction. An access management plan was established; however, such a plan would be heavily impacted by the functional plan for interchanges along Highway 11 and Highway 12. Several short-term modification alternatives were provided to address existing safety concerns.

Highway 11 and Highway 12 Interchanges Functional Planning Study Phase 1

A functional study of one of the recommended intersection locations proposed in *Highway 11/12 Planning Study* along Highway 11 was completed. The functional design of a midblock interchange on Highway 11 between Twp Road 382 and Twp Road 384 was put forward. The largest constraint identified in constructing an interchange at this location was the proximity to the existing railroad tracks running parallel along the west side of Highway 11. Three interchange configurations were evaluated, the preferred configuration consisted of diamond ramps on the west side and a full clover leaf on the east side of the intersection.

Three highway alignment configurations options were presented in the report:

- Option 1 – Leave alignment in place, additional structure and retaining wall construction would be required to avoid impacting the railroad right-of-way;
- Option 2 – Relocation of the existing alignment of Highway 11 for 3.4 km, at grade railroad crossing with grid road (requires two S curves on Highway 11); and
- Option 3 – Relocation of the existing alignment of Highway 11 for 7.8 km, construction of a service road between the highway alignment and railroad (eliminates the need for S curves).

Costs of the options outlined ranged from $73 million to $98 million, presented in 2013 dollars.

Saskatoon Perimeter Highway Validation Study

The validation study aimed at assessing conditions that may have changed since approval of the route of the Perimeter Highway around the CoS. The CoS and RM of Corman Park have identified future development areas that may extend outside of the proposed Future Perimeter Highway, northeast of its existing alignment. The perimeter highway location detailed in the 2005 functional planning study may provide problematic future access points for the City to support their future land use. A conditions assessment was completed to identify conditions that had changed between the approval of the route and the time of writing (2005 to 2014), results of which included:

- Population growth and traffic demand accelerated beyond what was initially considered;
- Existing and future changes to land use around Saskatoon raised concerns over the future geometric requirements and traffic operations of the Perimeter Highway; and
- There was no need to consider moving Perimeter Highway based on other road networks. Adequate access will be provided to adjacent land with some modification.

Invalid sections of the route were deemed to be the South terminal at Highway 11 and between Highway 11 south to Highway 5 due to adjacent land development constraints. The South terminal should be considered at a location that would facilitate a west connection should the Perimeter Highway continue further through the southwest area of the city. The southeast corridor is considered invalid due to geometric and operational concerns at the Highway 16 east intersection. Moving the perimeter further east would allow for a system level interchange to be constructed and for city land use plans for the Holmwood neighborhood to be fulfilled.

Saskatoon West Connector Route Feasibility Study Report

The study area of this report was located on the west side of Saskatoon, between Highway 16 and the South Saskatchewan River. This feasibility study was commissioned to provide interim traffic flow solution to be implemented prior to the Saskatoon Freeway. Feedback from stakeholders indicated lack of access for over-weight and over dimensions vehicles, particularly in gaining access to Circle Drive South. Based on traffic modeling information there was no conclusive evidence that development of a west connector route would attract significant traffic in the short term.

South Saskatoon Freeway General Location Study

The purpose of this study was to define a 500 m wide corridor from which the detailed location of the future Perimeter Highway could be established. The study area for the South Saskatoon Freeway alignment extended from south of Highway 5 on the east to the south terminal on Highway 11, and from Highway 14 to Highway 7 in the southwest. Connections from Highway 11 south to Highway 7 were eliminated from the scope as cost benefit analysis indicated this corridor was not warranted. The southeast recommended alignment intersects Highway 11 South of the Grasswood Commercial Node and is relatively similar to the previous proposed alignment. The proposed alignment in the west would connect the Saskatoon Freeway north of Highway 7 to Highway 60 south of Highway 7.

2.2 Existing Conditions

2.2.1 National Highway System

Canada's National Highway System ties key highways together as illustrated in **Figure 2.1**. The national highways are a critical component of the economic wellbeing of Canada, Provinces, Municipal Governments, and First Nations.

Canada's National Highway System is an evolution of the Trans-Canada Highway concept originally launched in 1949. Construction of the Trans-Canada Highway began in 1950 under the authority of the Trans-Canada Highway Act. In 1962 Prime Minister John Diefenbaker officially opened the Trans-Canada Highway, although construction continued until 1971. A key goal of the Trans-Canada Highway was to connect all the provinces together by highway, which was pursued through a cost-sharing partnership between federal and provincial governments to upgrade existing roadways to "Trans-Canada" standards. (Council of Ministers Responsible for Transportation and Highway Safety, 2019)

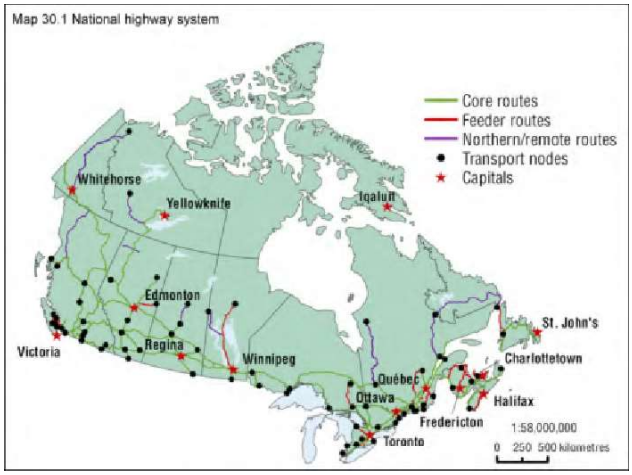


Figure 2.1: Canadian National Highway System (Transport Canada, 2018)

Canada's National Highway System is a network of highways across Canada that serves road transportation which is the dominant mode for moving both freight and passengers across Canada. (Transport Canada, 2018)

In 2017, Canada's National Highway System (NHS) had over 38,098 lane-kilometers, including:

- 72.8% classified as "core" routes
- 11.7% classified as "feeder" routes
- 15.5% classified as "Northern and remote" routes

The total travel on the provincial highway network during 2018 was approximately 9,762 million vehicle-km (Ministry, personal communication, March 31, 2020). Approximately 4,670 million vehicle-km occurred on the Provincial National Highway System or approximately 48% (Ministry, personal communication, March 31, 2020) of all travel in Saskatchewan occurs on Saskatchewan's national highways illustrated in **Figure 2.2**.

The Saskatchewan Ministry of Highways (Ministry) Plan for 2019-20 (Saskatchewan Ministry of Highways and Infrastructure, 2019) includes a Ministry goal: Efficient Travel for People and Goods. A key action stemming from this goal is to "Continue functional planning for the future traffic demand around Saskatoon to reduce the amount of land currently restricted for development."

The Saskatoon Freeway encompasses three national highways: Highway 11, Highway 16, and Highway 7 as illustrated in **Figure 2.2**. Saskatchewan's portion of the National Highway System is comprised of 2,687.5 km of Provincial Highways (Council of Ministers Responsible for Transportation and Highway Safety, 2019).

The 2018 provincial truck travel was 1,924.50 million veh-km. The truck travel was 1,111.13 million veh-km in 2018 on the provincial National Highway System, or 58% of overall truck travel (Saskatchewan Ministry of Highways and Infrastructure, 2020). The Ministry has defined a Core Highway Network, which is made up of approximately 10,000 km of provincial highways (including national highways in the vicinity of the CoS) which makes up approximately 37% of the total highway network but accommodates approximately 78% of the total travel on provincial highways (Ministry, Personnel Communication, March 30, 2020). The Core Highway Network accommodates approximately 84% of

Figure 2.2: Saskatchewan's National Highway System

the truck travel in Saskatchewan. Saskatoon is a key hub where three National Highways intersect: Highway 7, Highway 11, and Highway 16, as well as the Core Highway Network, which includes Highway 5, and Highway 12, Highway 14, Highway 41.

2.2.2 Geotechnical

Surficial geology

The Saskatoon Group makes up the surficial deposits evident at the surface within the Phase 1 area. These deposits comprise till, glaciofluvial sediments, and glaciolacustrine deposits.

The till (a heterogeneous mixture of grain sizes ranging from clay to boulders) is soft and oxidized, with clasts commonly comprising igneous and metamorphic rocks, limestone, and marine shale. Till forms planar to hummocky deposits and underlies the Highway 11 and Highway 16 interchanges.

The glaciofluvial deposits consist of sand and gravel and may be bedded. It forms flat to terraced topography with kettles. Glaciofluvial sediments are found at surface at the Highway 12 interchange, along the east/west portion of the proposed freeway to the west of the interchange, and along the proposed freeway to the east of it, up to, including and just past Highway 11.

Glaciolacustrine units are fine-grained: they comprise grey silt/clay deposits. Topography is undulating to flat. Glaciolacustrine sediments underlie the southeast portion of the proposed Highway 11 interchange and part of the proposed freeway extending to the southeast from it. These fine-grained deposits also underlie the Penner Road interchange and the proposed alignment of Highway 11 extending north from it (as well as the existing Highway 11).

The proposed highway crosses over planar fluvial deposits of Holocene age on either side of the South Saskatchewan River crossing. These consist of clay, silt, sand and gravel.

At depth, the various units of the Saskatoon Group are interbedded with nonglacial sediments (fluvial silt/sand/gravel/organics, lacustrine silt/clay, aeolian sand, and paleosols).

Older glacial deposits, consisting of thick till/intertill sequences, underlie the Saskatoon group. The latter consist of clay, silt, sand, and gravel, (rarely, gravel/sand only), while the till units are grey, with a silt/clay matrix and varying carbonate content. These tills generally have significantly higher clay contents than those of the Saskatoon Group.

The Tertiary Empress Group underlies the oldest till/intertill units and overlies bedrock. It comprises stratified fluvial quartzite and chert gravel that is well rounded for the most part, but also includes igneous, metamorphic, and carbonate rocks. Finer clastic deposits, organic-rich sediments, fine-grained lacustrine, and fine to coarse-grained colluvial deposits may be present as well.

Bedrock geology

The Upper Cretaceous Bearpaw Formation is the uppermost bedrock unit in the area. It is composed of dark grey to grey non-calcareous marine claystone, silty claystone, and siltstone, commonly forming discrete units of interbedded sandstone/siltstone or siltstone/claystone. Minor brownish-grey silty sandstone, sandstone, concretionary beds and thin beds of bentonite may also be present.

2.2.3 Environment and Heritage Resource Review

The Environmental and Regulatory Review and Heritage Resource Overview for the SFFPS are included in **Appendix A**. The information below presents a summary of the existing environment heritage resources in Phase 1 of the project. Climate and Socioeconomic data were omitted in this summary but are presented in **Appendix A**.

Terrain and Soils

Soils within Phase 1 are primarily Bradwell, Biggar, and Weyburn soils, as well as complexes of these soil types. Alluvium soils are found in the Hudson Bay swale, and Runway soils are located along the South Saskatchewan River Valley (**Figure 2.3**).

Soil Capability for agriculture ranges from Class 3 and 4 soils in the upland areas of Phase 1 to Class 5, 6 and 7 soils in the Hudson Bay Swale and South Saskatchewan River Valley (**Figure 2.3**). Class 3 and 4 soils are soils suitable for agriculture only with considerable conservation practices. Class 5 and 6 soils are typically only used as pastureland due to their severe limitations for crop production, and Class 7 soils have no capability for agriculture (found only in the South Saskatchewan River Valley) (**Figure 2.4**).

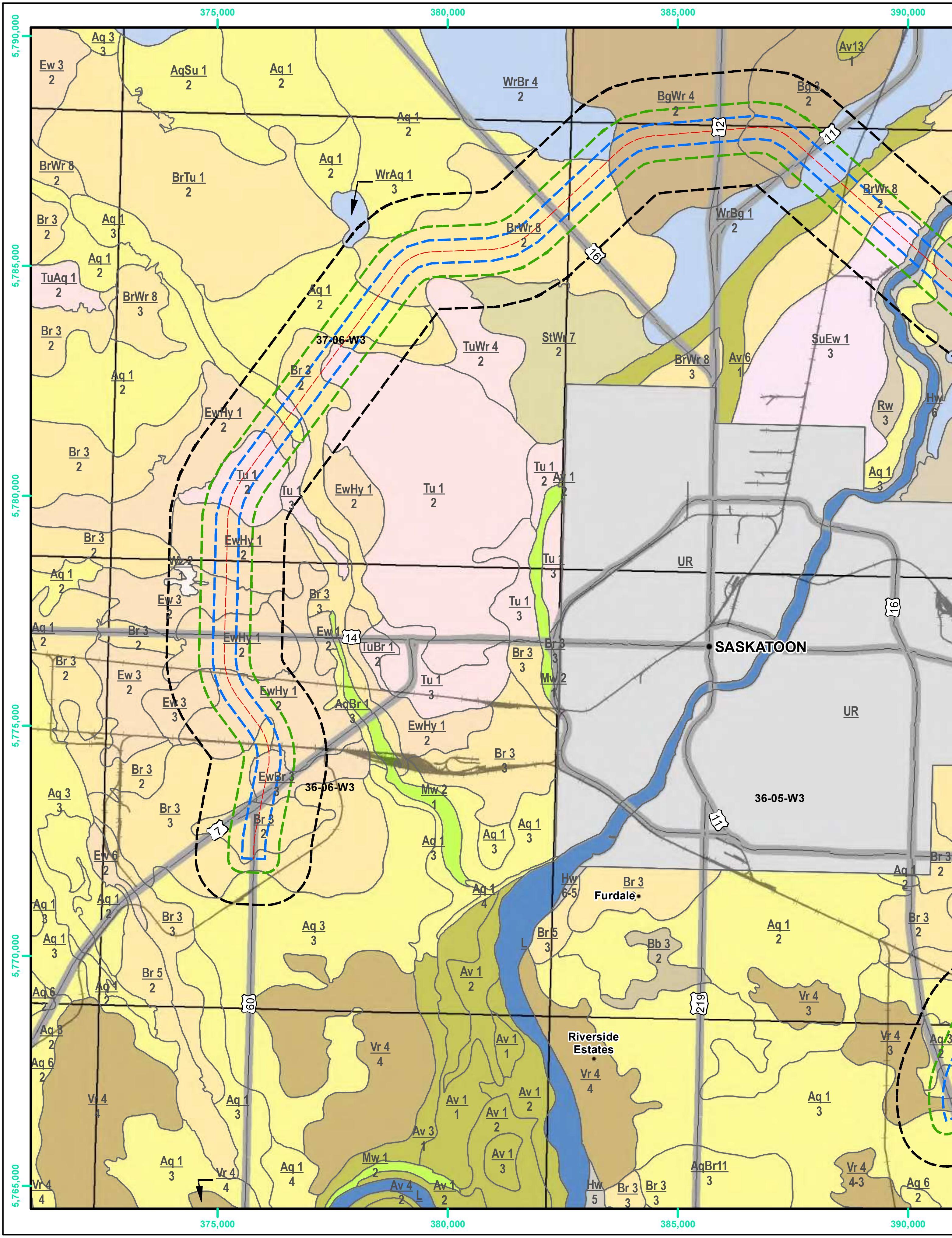
Land Cover and Land Use

No federal or provincial lands requiring environmental protection were identified within the study area or project corridor.

Phase 1 of the proposed freeway corridor intersects approximately 24 quarter sections. Paved and gravel roads are present throughout the Phase 1 corridor. Land use between Highway 12 and Highway 16 (the western half of the phase) within the corridor was dominated by cropland **(Figure 2.5**). Very little undisturbed habitat remains in this area, with the best quality wildlife habitat located within planted tree rows, as well as some small to medium sized wetlands.

Immediately east of Highway 16 is a native dominant pasture in NW 33-27-05-W3. This quarter has been at least partially seeded but includes sections of native vegetation. The Hudson Bay Swale is in the eastern section of the Phase 1 corridor, approximately one-kilometre west of the South Saskatchewan River. The Hudson Bay swale extends across approximately eight quarter sections, two of which are within the Saskatoon Freeway corridor. The swale is located in a native vegetation dominated pasture. The swale is bordered by a railroad track on its eastern end and has a significant development in NW 27-37-05-W3 that has built into the wetland and may have impacted the wetland shape and how the water flows through the area.

The area east of the Hudson Bay Swale is primarily cropland. At the eastern end of Phase 1 is the South Saskatchewan River Valley, a relatively undeveloped valley that consists of native prairie vegetation along its upper slopes, and riparian vegetation along its lower slopes.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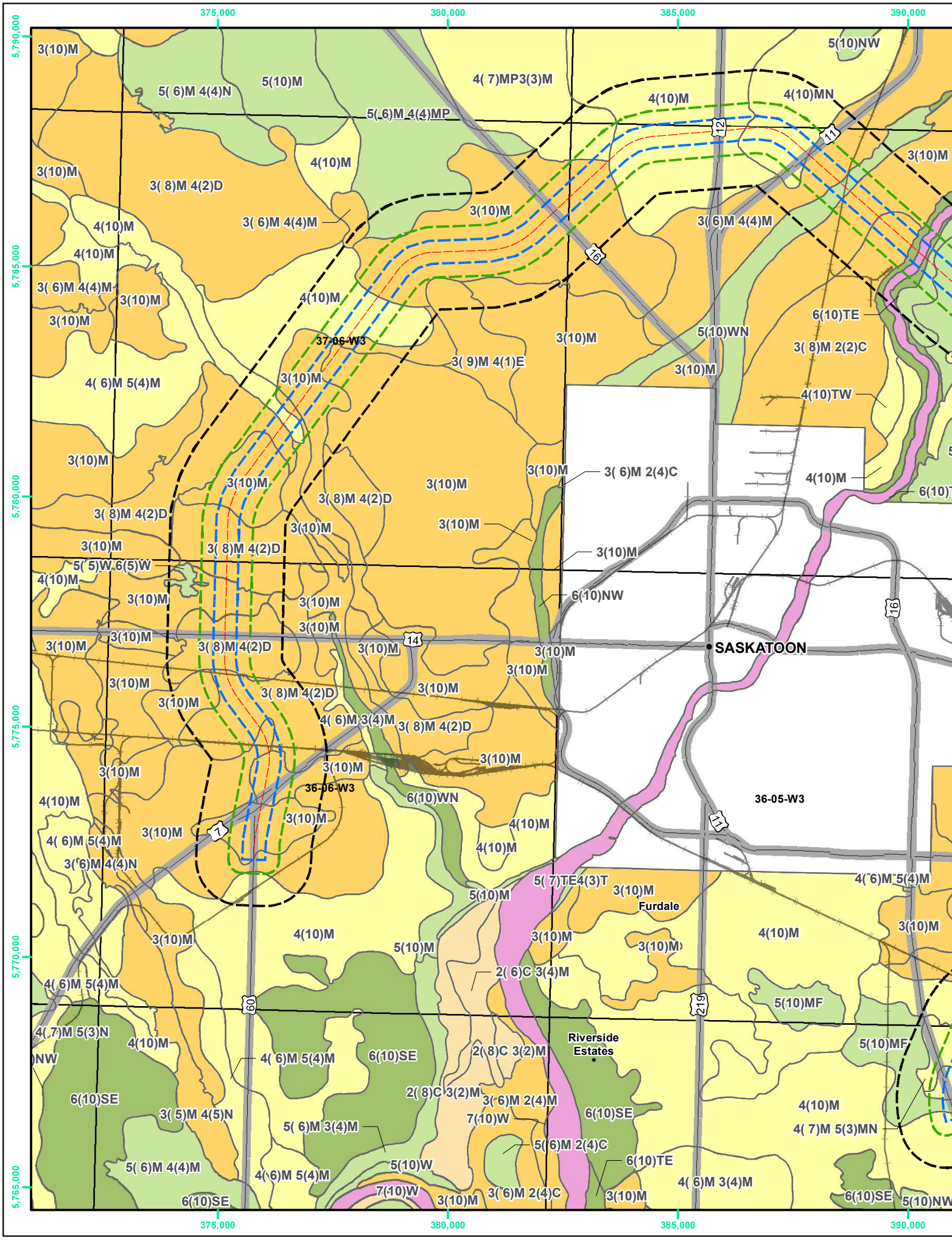
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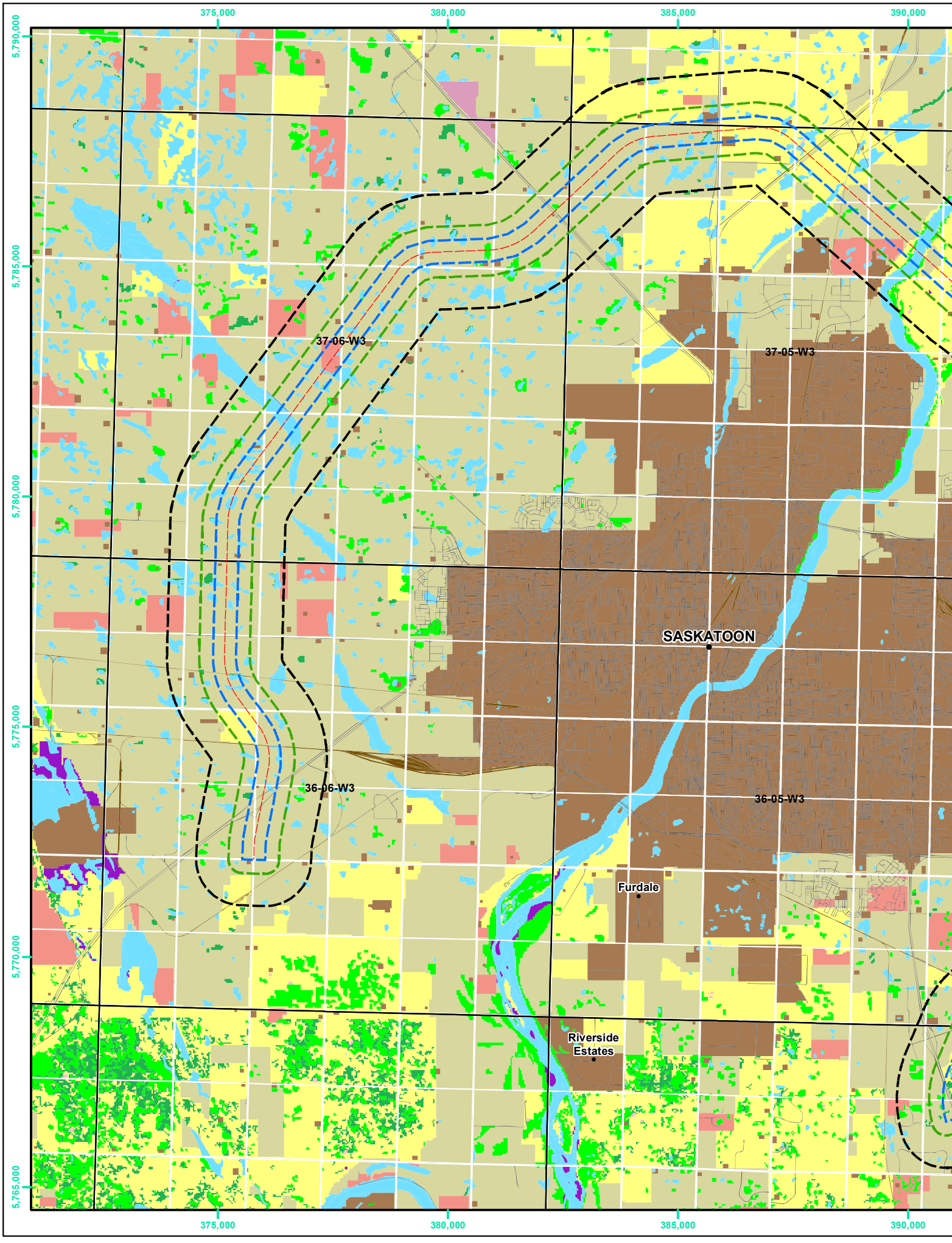
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Vegetation and Wetlands

The portion of the vegetation and soils study area that is located within Phase 1 is located within the Moist Mixed Grassland Ecoregion of the Prairie Ecozone and is entirely within the Saskatoon Plain Landscape Area (**Figure 2.6**).

The Saskatoon Plain Landscape Area is a level glacial lake and eroded glacial till plain with very gently undulating topography (Acton et al. 1998). It encompasses most of the CoS and the surrounding areas located north and west of the city. Cereals are the major crop, and most of the land within the Saskatoon Plain has been converted to cropland. Native moist mixed grassland vegetation is limited to sandy sites in the South Saskatchewan River valley. Grassland and shrubland communities associated with sandy soils are common on upland sites, while saline depressions are vegetated by salt-tolerant species like Nuttall's alkaligrass and red samphire. Trembling aspen stands occur frequently in non-saline areas with high water tables, such as the South Saskatchewan River's riparian corridor.

There are 43 plant Species of Conservation Concern (SOCC) with recorded occurrences in the Saskatoon Plain Landscape Area (SKCDC 2020a). However, only two species were found previously recorded within the vegetation and soils study area in Phase 1:

- Menzie's catchfly; and
- Rocky Mountain sedge (SKCDC 2020a).

These occurrences were located near the South Saskatchewan River (**Figure 2.6**). Previous studies in the area (Golder 2015; Stantec 2012, 2013a, and 2013b) did not identify any plant SOCC within the vegetation and soils study area, but some were located nearby in Phase 1.

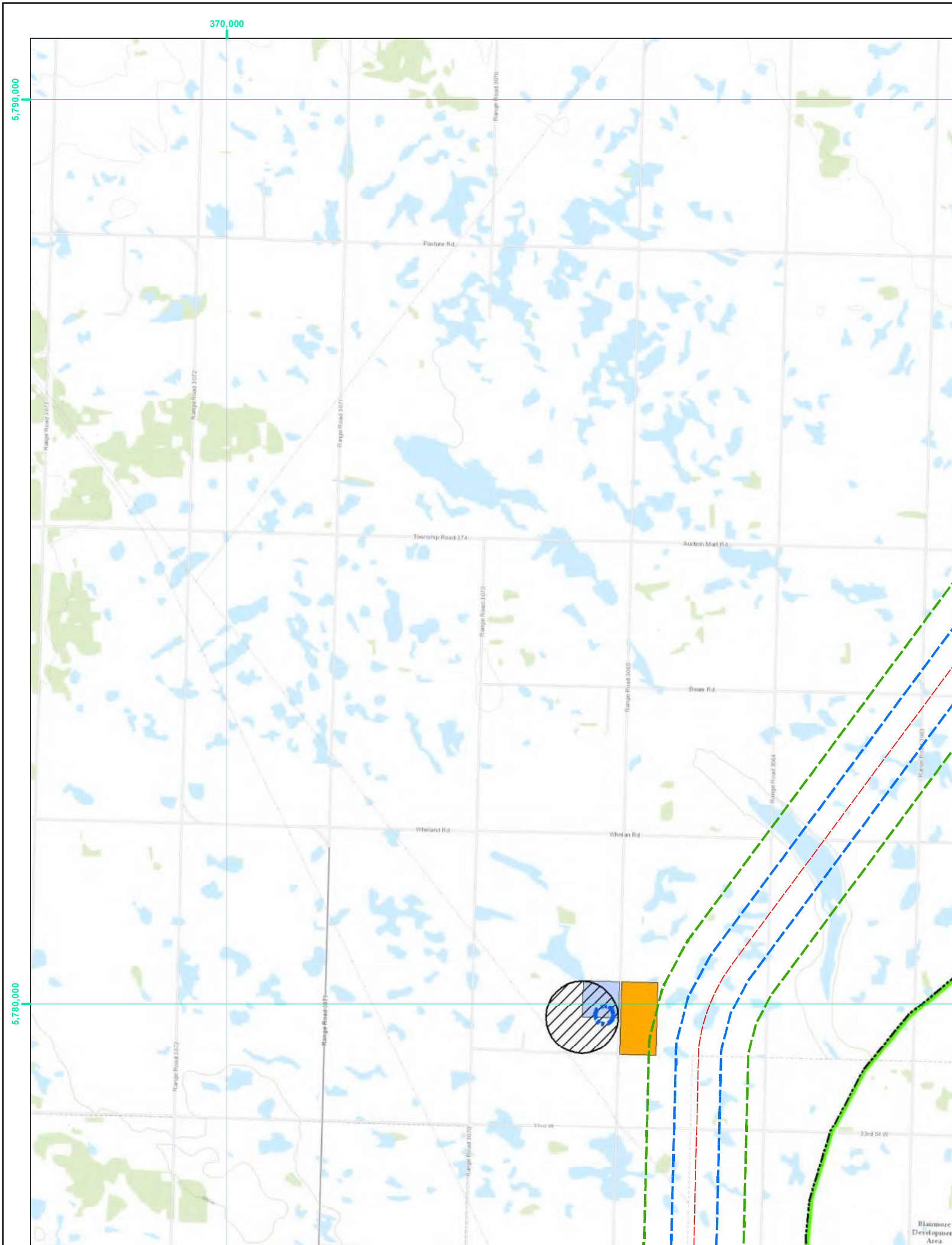
The desktop and field studies also identified a number of wetlands in Phase 1 (**Figure 2.7**). Approximately 72.4 hectares of wetlands were observed. Many of these wetlands likely contain suitable habitat for SOCC/Species at Risk (SAR) plants.

Wildlife and Wildlife Habitat

Phase 1 of the project is entirely within the Moist Mixed Grassland Ecoregion. The Ecoregion supports 51 mammal species, 13 reptile and amphibian species, and 198 migratory and resident birds. Phase 1 of the project was assessed by both desktop and field studies. Seventeen quarter sections within Phase 1 were assessed in the field. A total of 57 wildlife species were observed in the 17 quarter sections during the field studies within Phase 1. This consisted of two mammal species and 55 bird species.

Both the Hudson Bay Swale and the pasture in NW 33-27-05-W3 contained suitable habitat for a number of SOCC and SAR. Both these areas contained significant patches of native vegetation and provide habitat for rare species. The quarters contained several dugouts that have the potential to support overwintering amphibians. Multiple completed breeding bird nests were also observed in these locations.

Four SOCC were also observed in Phase 1, including American white pelican (Pelecanus erythrorhynchos), eared grebe (Podiceps nigricollis), great blue heron (Ardea herodias), and turkey vulture (Cathartes aura); none of these are considered SAR. No amphibians were observed during the survey, but suitable habitat was noted and their presence is considered likely.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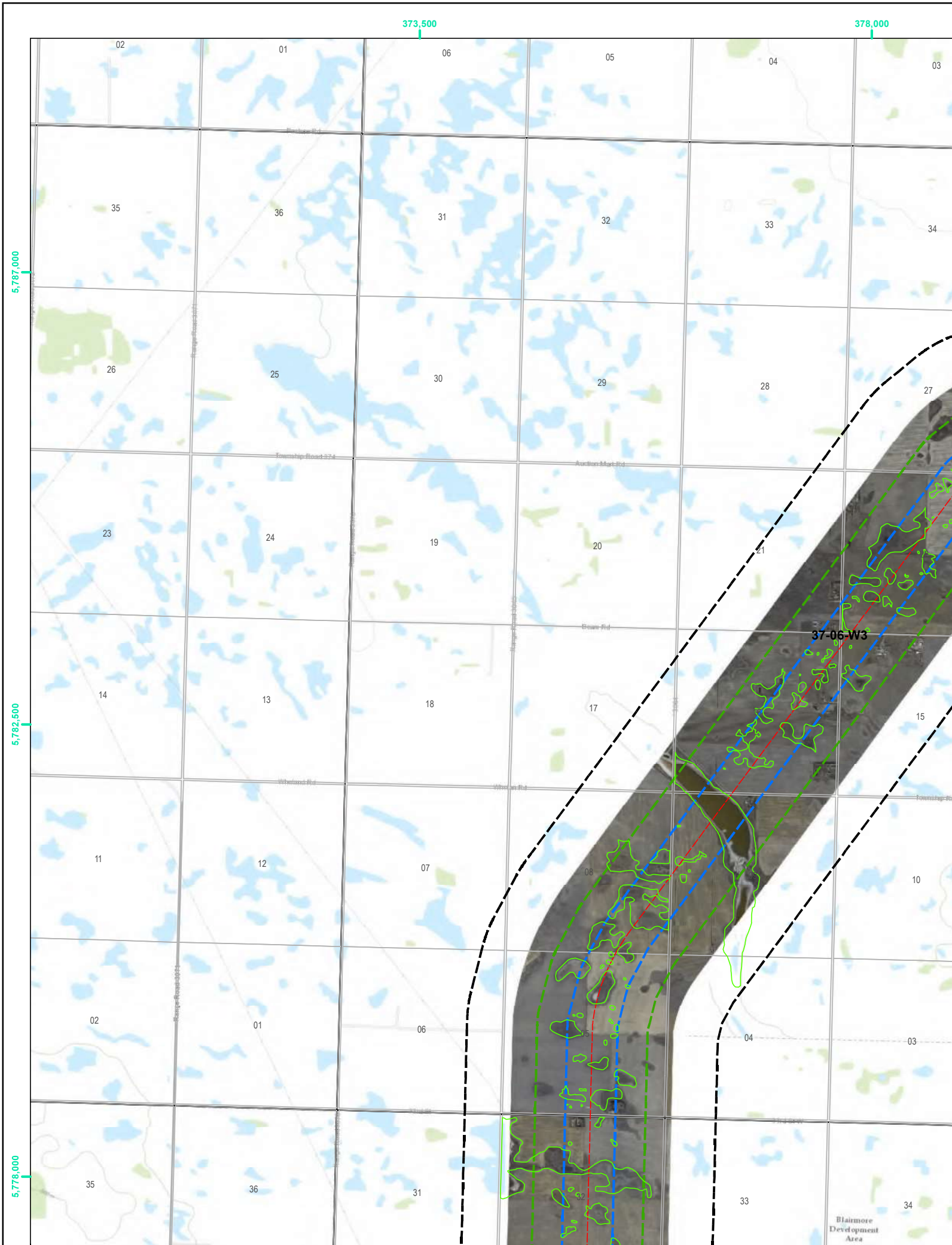
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A small number of SOCC/SAR have been previously identified in the wildlife study area during other studies that took place within Phase 1 including:

› Baird's sparrow; and
› Sprague's pipit (Golder 2015; Stantec 2012, 2013a, and 2013b).

Fish and Fish Habitat

Phase 1 of the project crosses the South Saskatchewan River, where at least 34 species of fish have been previously captured within the river and its tributaries (Knight Piesold 2010; Atton and Merkowsky 1983; Miles and Sawchyn 1988; Acton et al. 1998, SPRR 1991).

Six fish species that have the potential to be found in the vicinity of the proposed river bridge crossing are identified as SOCC (SPRR 1991; **Table 2.2**). These species have been previously observed in the South Saskatchewan River. One fish SOCC (lake sturgeon, *Acipenser fulvescens*) element occurrence was identified in the HABISask query. A total of 83 individual lake sturgeon were captured and radio tagged by the Water Security Agency from 2009 to 2012 (ENV 2019), and the river contains habitat important for this species.

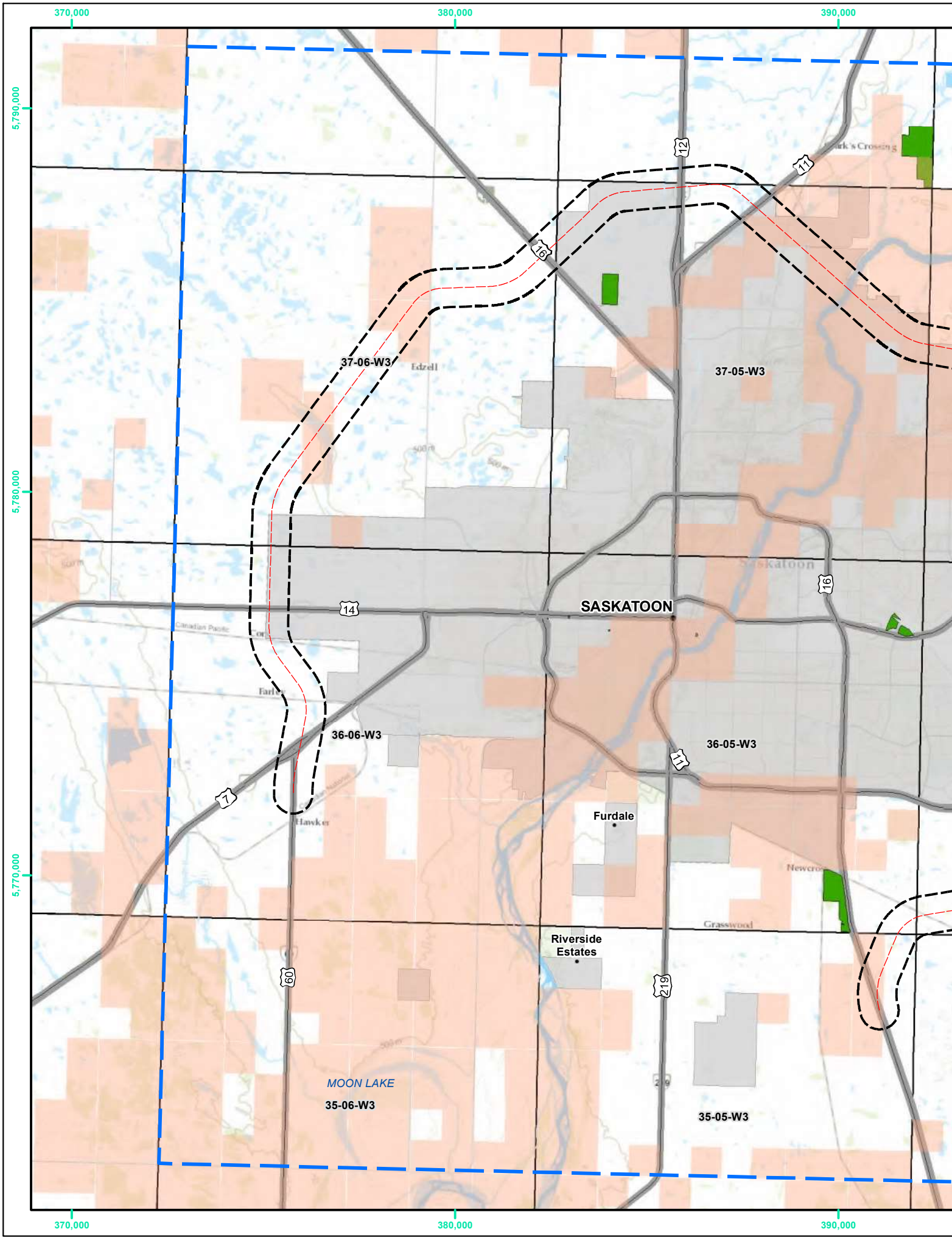
Table 2.2: SOCC fish occurring within the South Saskatchewan River.

COMMON NAME	SCIENTIFIC NAME	SKCDC RANK	COSEWIC STATUS	SARA STATUS
Blacknose Dace	Rhinicthys obtusus	S3	Not ranked	Not ranked
Common Shiner	Luxilus cornutus	S3	Not ranked	Not ranked
Flathead Chub	Platygobio gracilis	S3	Endangered	Not ranked
Lake Sturgeon	Acipenser fulvescens	S2	Not ranked	Not ranked
Moon Eye	Hiodon tergisus	S3	Not ranked	Not ranked
River Shiner	Notropis blennis	S3	Not ranked	Not ranked

Source: SPPR 1991

Heritage Resources

There are nine heritage sensitive quarter sections within the Phase 1 corridor. There are no previously identified heritage sites within the Phase 1 corridor, but a significant number are located nearby, concentrated within the Wanuskewin Heritage Park (**Figure 2.8**). Three archaeological sites were identified in the proposed freeway corridor but none of these sites are located within Phase 1 (**Figure 2.9**). No cemeteries were identified within Phase 1.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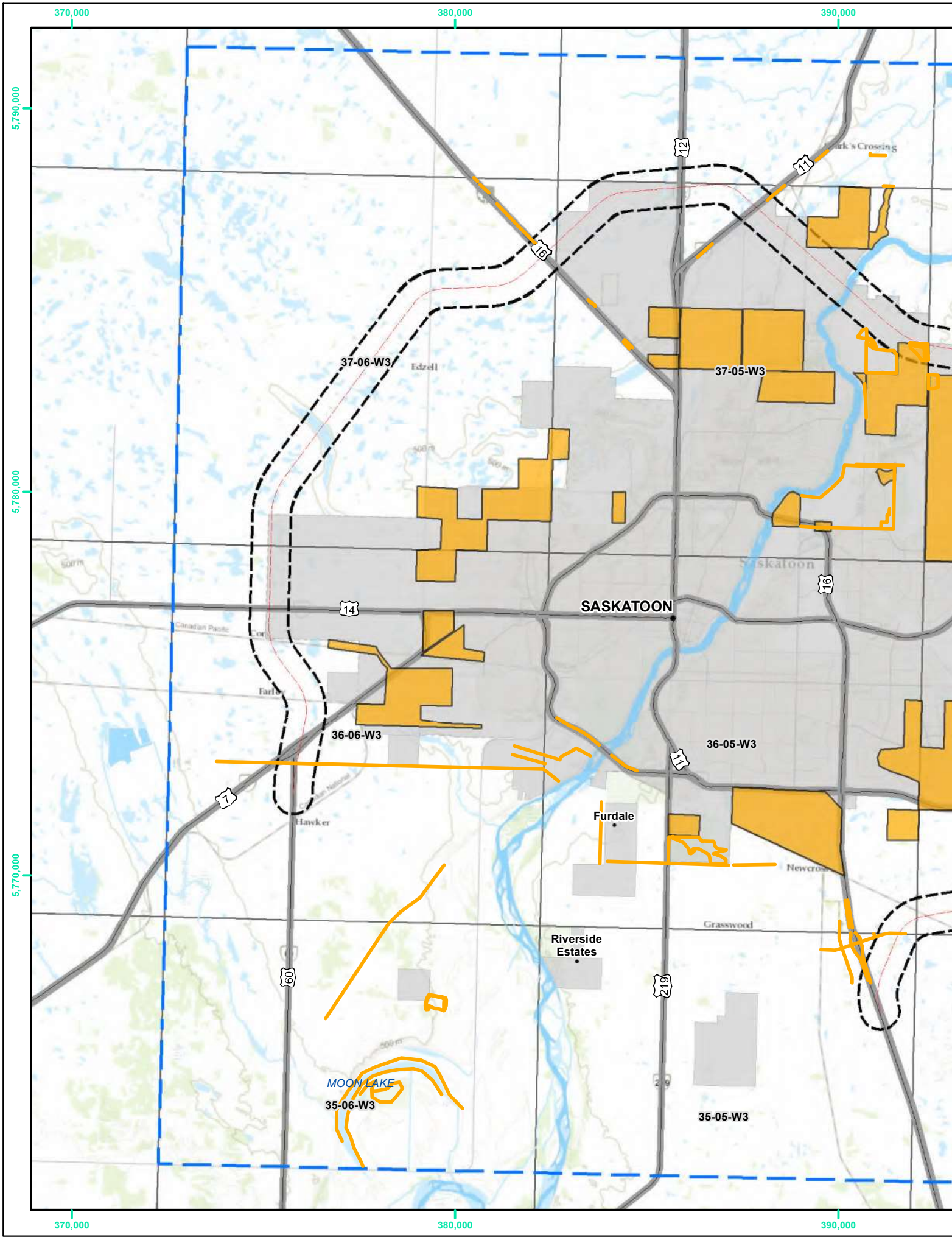
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2.2.4 Constraints/Considerations

There are a number of existing conditions which present challenges to completing Phase 1 of the functional planning study for the Saskatoon Freeway and interchanges. Notable features include:

- South Saskatchewan River, which requires complex bridge construction with minimal disruption to the river valley;
- Wanuskewuin Heritage Park, which has high heritage value, and has applied for UNESCO World heritage status. The Park has a 1.8 km diameter buffer area measured from the centre of the Park that requires all future developers that wish to develop within the buffer to assess the impacts to the Park and mitigate or eliminate negative impacts;
- Hudson Bay Swale along with an area of environmental, ecological, or low-lying ground which is located the west of the CN Rail Line;
- CN Rail has a major freight line corridor crossing the projects proposed roadways in five locations. High speed or high-volume rail crossings should be grade separated. Future expansion of the railway operation should be provided for in the freeway design; and
- Utilities, including a SaskPower high voltage corridor crosses the proposed mainline alignment between the existing Highway 11 and Wanuskewin Road.

Key constraints/existing conditions are illustrated in **Figure 2.10**. Additional details on existing structures, utilities, and environmental constraints are discussed in more detail in the following sections.

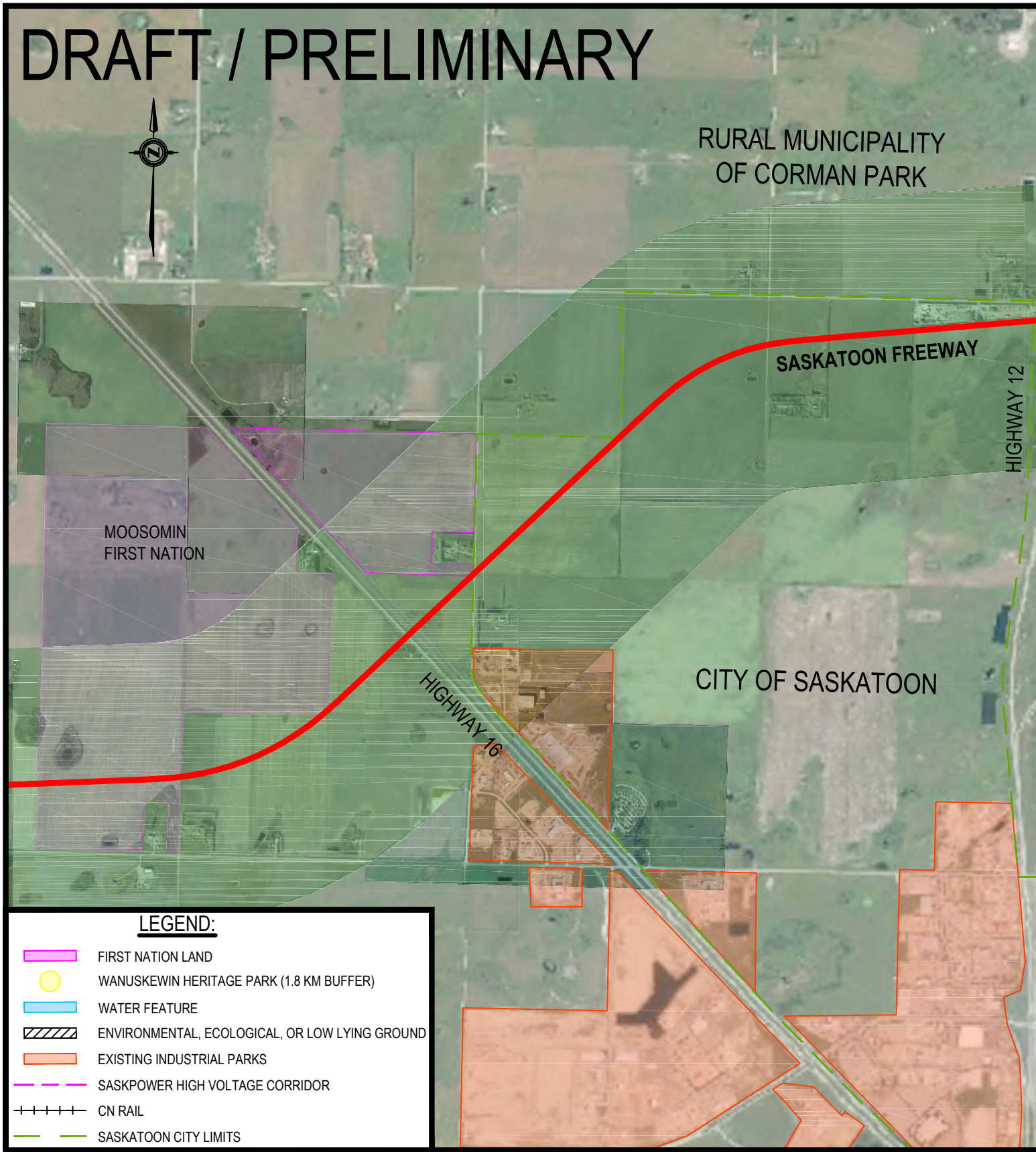
Structural/Buildings

East Cory Industrial Area is located between Highway 11 and Highway 12, immediately south of the proposed freeway. Saulteaux First Nations owns land adjacent to the Highway 11 interchange. Additional industrial / commercial properties are located in the northeast quadrant of the Highway 12 crossing and southeast quadrant of the Highway 16 crossing. There is also a large area in the vicinity of the Highway 16 interchange that is First Nation Land, belonging to the Moosomin First Nation.

Utilities

The proposed alignment of the Saskatoon Freeway intersects several communications, electrical, energy, and water and sewer utilities located overhead and underground. SNC-Lavalin began contacting utility stakeholders in January 2019 to identify locations of utilities that are located within the corridor and where mitigation may be required. The following stakeholders were contacted during utility mapping:

- Access Communications;
- Alliance Pipeline;
- Bell Canada;
- CoS Light and Power;
- CoS Water and Sewer;
- CNOOC Ltd.;
- Highway 41 Water Utility;
- Rogers Communications Inc.;
- SaskEnergy;
- SaskPower;
- SaskTel;
- SaskWater;
- Shaw Communications Inc.;
- Telus Communications Inc.; and
- TransGas.



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SASKATOON FREEWAY FUNCTIONAL PLANNING STUDY

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Utility locations were confirmed again by stakeholders in January 2020 (follow-up action as part of a Utility TWG meeting on 10 December 2019). Utility details were obtained where possible in CAD format and uploaded to SNC-Lavalin's GIS database and web viewing applications. Where only PDF records could be obtained, the files where digitized by SNC-Lavalin and geo-referenced as accurately as possible. Utility location accuracy is considered commensurate with the requirements of the functional plan.

There were no known utility conflicts with Alliance Pipeline, CNOOC, Access Communications, and CoS Light and Power. All known utility locations for the entire corridor are shown in **Figure 2.11**, and utilities identified for each phase are summarized in **Table 2.3.** Detailed compilation of utility conflict locations is presented in **Table B1 (Appendix B)**. Specific conflict details for Phase 1 are discussed in the following sections.

Table 2.3: Utility Type Summary by Phase

PHASE 1	PHASE 2	PHASE 3
SaskEnergy (Distribution)	SaskEnergy (Distribution)	SaskEnergy (Distribution)
SaskEnergy (TransGas))	SaskEnergy (TransGas))	SaskEnergy (TransGas))
SaskPower (Distribution)	SaskPower (Distribution)	SaskPower (Distribution)
SaskPower (Transmission)	SaskPower (Transmission)	SaskPower (Transmission)
SaskTel	SaskTel	SaskTel
SaskWater	SaskWater	SaskWater
CoS Water and Sewer	CoS Water and Sewer	CoS Water and Sewer
Shaw Communications	Highway 41 Water Utility	Shaw Communications
	Bell Communications	
	Rogers Communications	
	Telus Communications	

Communications Utilities

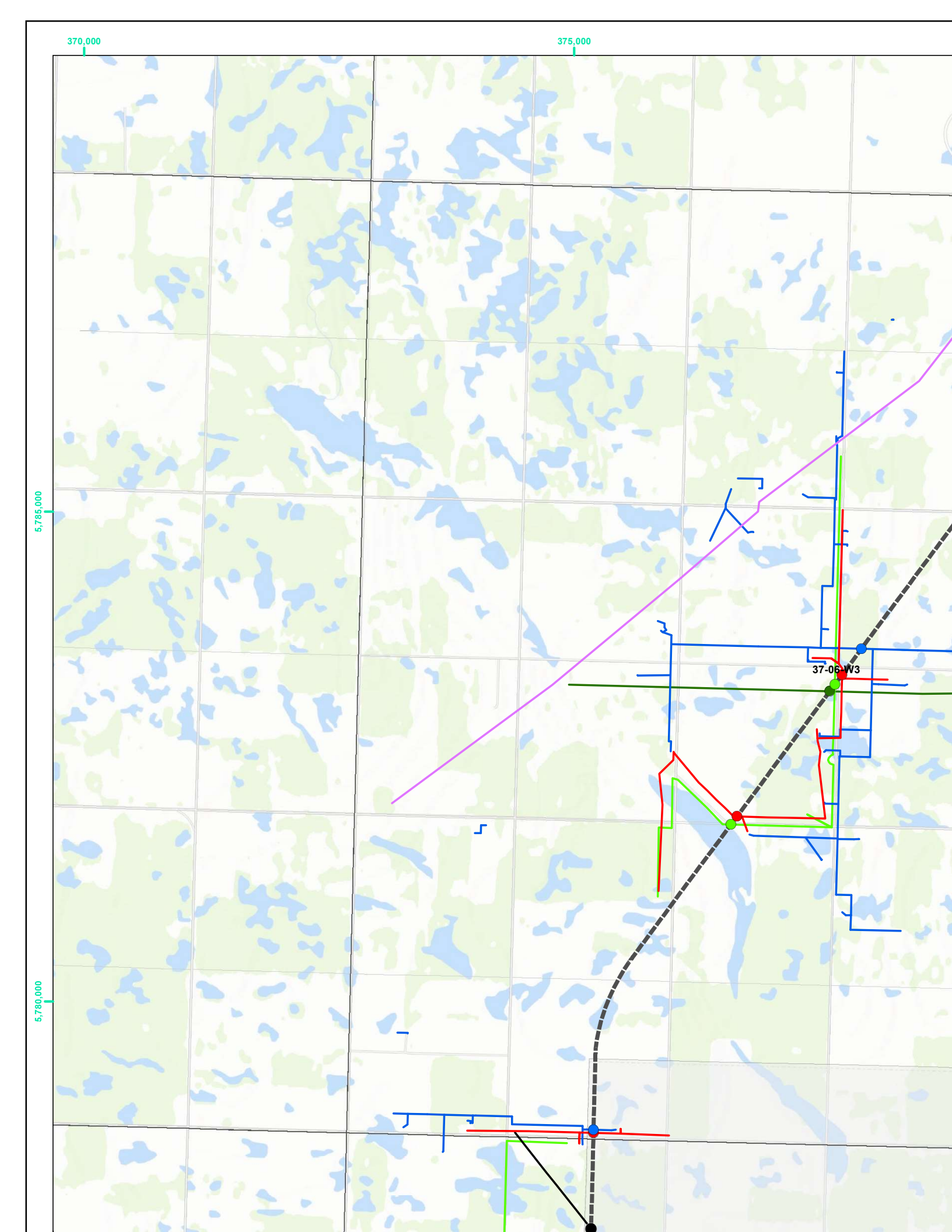
All communication utility stakeholders in the project area were contacted and maps or .kmz files of existing utilities were obtained. Bell, Rogers, Telus, SaskTel, and Shaw all identified conflicts with their infrastructure and the project footprint including underground fiber and copper cables, overhead fiber and copper cables, and pedestals. The conflicts are shown in **Figure 2.12** with the larger conflicts labelled.

Energy Utilities

Energy companies including TransGas, SaskEnergy, and SaskPower identified conflicts with the proposed alignment of the Saskatoon Freeway and their own infrastructure. These conflicts are shown in **Figure 2.13**.

Water and Sewer Utilities

The CoS, Highway 41 Water Utility, and SaskWater have identified conflicts with their existing and planned water utilities. These conflicts are shown in **Figure 2.14**.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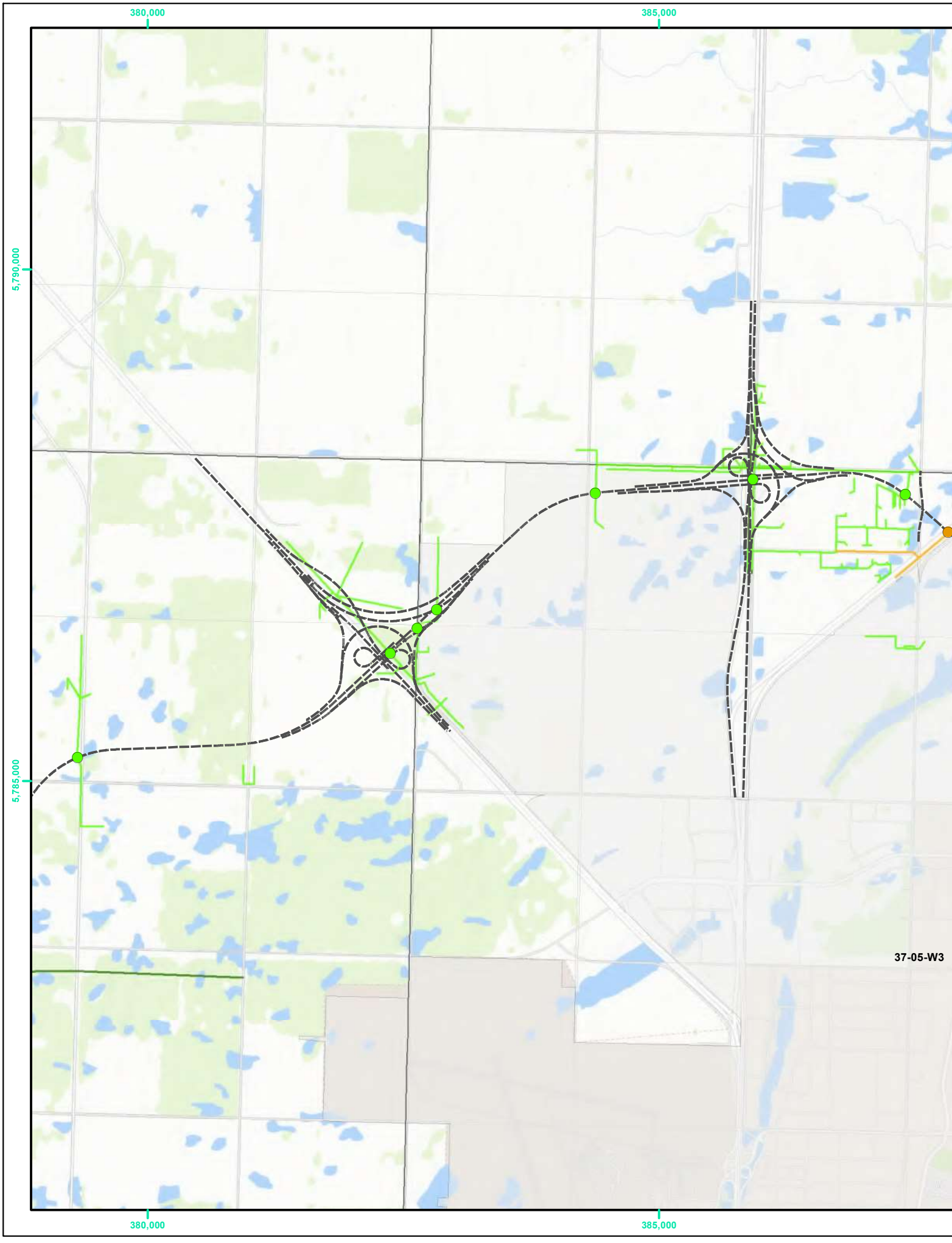
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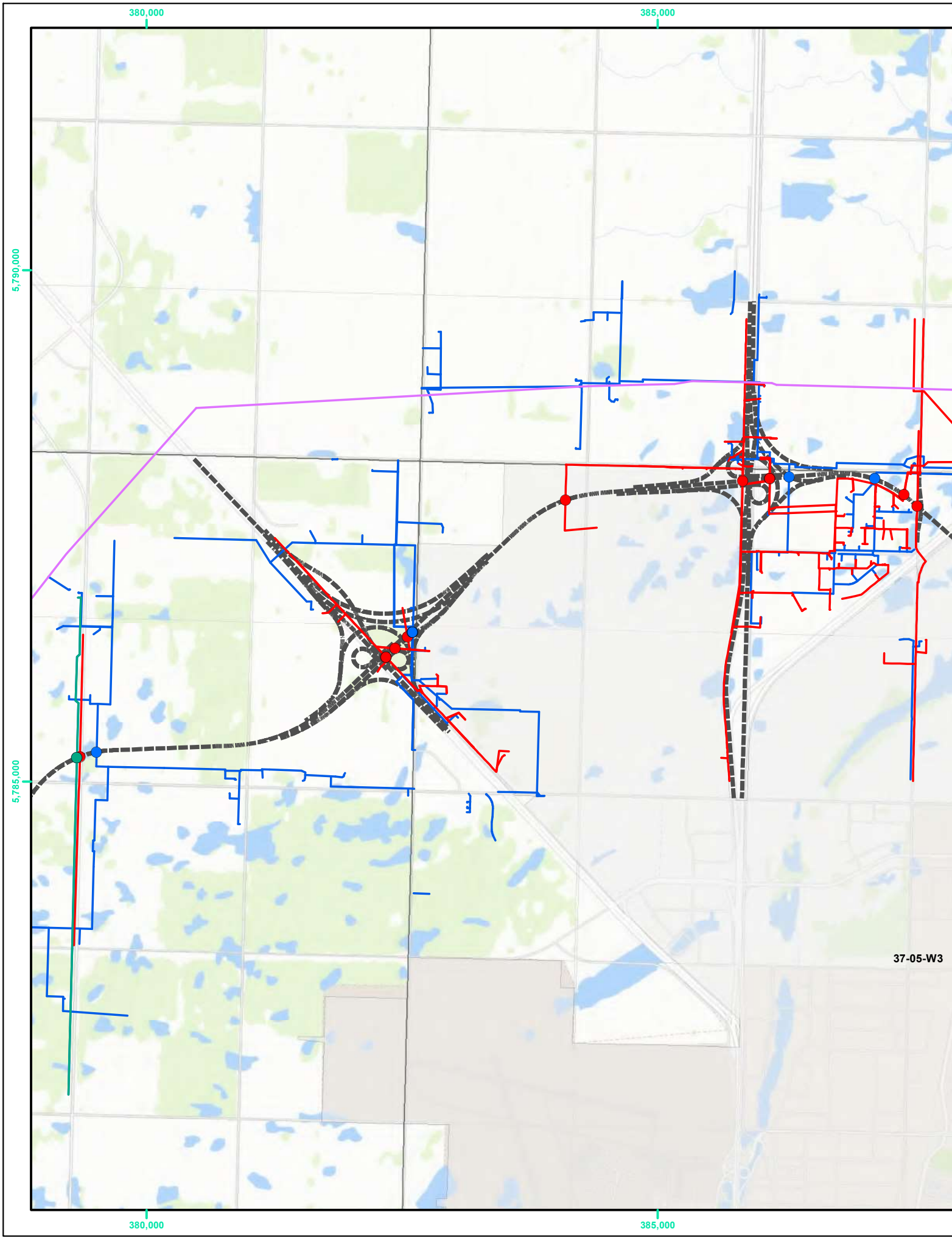
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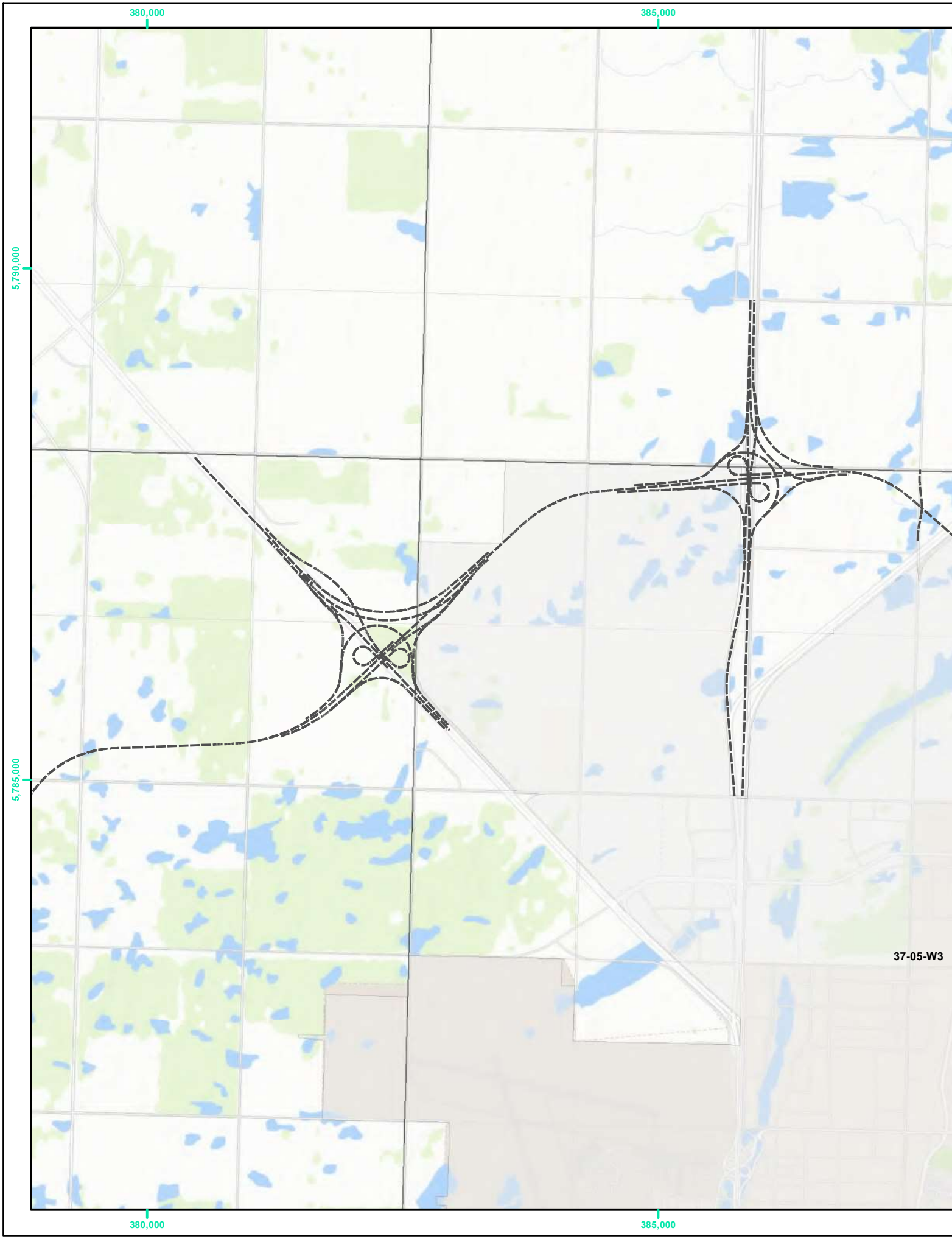
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Wetlands

The wetlands within Phase 1 may pose as a constraint as wetlands are protected under a combination of federal and provincial legislation. Wetlands also provide habitat for a number of wildlife species, including SOCC and SAR species, which may act as additional constraints. Approximately 72.4 hectares of wetlands are found within Phase 1 corridor, and up to 127.7 hectares are within the Phase 1 Vegetation and Soils study area.

Native Grasslands

Unseeded and native-dominant grasslands within Phase 1 provide important habitat for a variety of wildlife and plant species. Although most plant species are not legally protected in Saskatchewan, and grasslands themselves do not have legal protections like wetlands, grasslands may be home to SOCC and SAR species that have legal protections. Native grasslands may act as a constraint as proponents in Saskatchewan may be required to compensate for the loss of this habitat based on approval requirements (i.e. compensation has been a condition in some recent ministerial decisions).

Wildlife and Nesting Birds

The majority of bird species are protected under both federal and provincial legislation, the disruption or loss of active migratory nests, or harm or loss of eggs, young, and breeding adults is strictly prohibited. Permits will be required to: scare migratory birds; collect, destroy, or dispose of migratory bird eggs; remove, relocate, and/or destroy birds/nests/eggs.

It is very likely that nesting birds will be encountered during project construction. Bird species will breed in almost any habitat, and may be a temporary or long-term constraint, depending on the species. If a legally protected nest is found on within the work area, an appropriate setback (generally 30 m) will be established to allow nesting to continue without disturbance. While the setback is active, no personnel is permitted to work in the area. Modifications to activities within the setback may be required.

Most mammal wildlife is also protected under provincial legislation, and disturbance or killing of protected wildlife is prohibited. While most wildlife will disperse on its own during construction, breeding wildlife or wildlife that establish semi-permanent residences (such as American badgers) may be a potential constraint. Permits from federal and/or provincial governments will be required if relocation or removal of any protected wildlife is required.

Species of Conservation Concern (SOCC) and Species at Risk (SAR)

In additional to protections granted to all wildlife, SOCC and SAR species have additional protections. These species may act as constraints and may require significantly larger setbacks than non SOCC/SAR wildlife. Saskatchewan Activity Restriction Guidelines (ARG) are used to determine setback distances to avoid key habitats of these species during sensitive periods (**Table 2.4**). Additional SOCC/SAR are also likely to be discovered during additional surveys and may require different setbacks. Permits from federal and/or provincial governments will be required if relocation or removal of any protected wildlife is required. However, in many cases, permits will not be issued for SOCC/SAR species and waiting until the species disperses from the area naturally is the only option.

Table 2.4: Saskatchewan ARG for plant and wildlife SOCC identified within Phase 1

COMMON NAME	SCIENTIFIC NAME	TAXONOMIC GROUP	ARG FOR SPECIES OR FEATURE	RESTRICTION ACTIVITY PERIODS	RECOMMENDED SETBACK DISTANCE
American White Pelican	*Pelecanus erythrorhynchos*	bird	Nesting colony	Apr 1 – Jul 31	1000 m
Baird's sparrow	*Centronyx bairdii*	bird	n/a	n/a	n/a
Eared grebe	*Podiceps nigricollis*	bird	Nesting colony	Apr 1 – Jul 31	1000 m
Great blue heron	*Ardea herodias*	bird	Nesting colony	Apr 1 – Jul 31	1000 m
Sprague's pipit	*Anthus spragueii*	bird	breeding bird	Apr 21 – Aug 31	250 m
Plant (SAR)*		plant	occurrence	year round	300 m
Plant (tracked)**		plant	occurrence	year round	30 m
Turkey vulture	*Cathartes aura*	bird	n/a	n/a	n/a

*Plants listed under the Species At Risk Act (SARA) as *Endangered, Threatened, Special Concern, or Extirpated* and/or plants listed in the *[Saskatchewan] Wildlife Act,* 1998.
**Plants listed on the Saskatchewan Conservation Data Centre (SKCDC) tracking list (e.g., usually ranked S1, S2, S3, SX, SH).
Source: (ENV 2017; Government of Saskatchewan 2020; SKCDC 2020b and 2020C)

Fish and Fish Habitat

Phase 1 of the project involves the construction of a bridge to cross the South Saskatchewan River. Fish presence within this river will act as a potential constraint as construction will likely lead to a small, permanent loss of fish habitat, and the project may cause the death of fish during in-water pier construction. Permitting and authorizations from the federal and provincial government will be required for any in-water work or work that is expected to impact fish species. Options can also be evaluated to avoid in-water pier construction.

Heritage Resources

The project corridor passes through areas that have the potential to contain heritage resources, as many heritage sensitive quarters are present. The large number of sites near the Wanuskewin Heritage Park indicates that additional heritage resources may be located nearby in Phase 1. If heritage resources are found and are sufficiently significant, they could be a potential constraint and may require extensive mitigation, avoidance, or excavation.

3 Public and Stakeholder Engagement

3.1 Methodology and Approach

The Saskatchewan Ministry of Highways (Ministry) identified from the onset that stakeholder consultations, effective and engaging communication, and community dialogue are extremely important components of the Saskatoon Freeway Functional Planning Study (SFFPS). Throughout Phase 1 of the SFFPS, Praxis Consulting Ltd. (Praxis) worked as part of the Project Team as a collaborative partner of the Ministry to build rapport with stakeholders and the public, to create safe environments for information sharing and feedback, and to develop appropriate engagement and communication solutions that were respectful and responsive to the needs of stakeholders.

The guiding methodology of the ongoing stakeholder engagement and communications for Phase 1 was rooted in the International Association for Public Participation (IAP2) methodology. IAP2 provides a framework for involvement of the public and stakeholders through the Spectrum of Public Participation, as shown below in **Figure 3.1**.

Figure 3.1: Spectrum of Public Consultation (International Association for Public Participation (IAP2)

3.1.1 Stakeholder Engagement and Communications Technical Working Group

Throughout Phase 1, the Stakeholder Engagement and Communications Technical Working Group (TWG) met bi-weekly to discuss all stakeholder engagement and communications updates and plans. The TWG was comprised of representatives from the following:

- The Ministry;
- SNC-Lavalin;
- AECOM;
- Praxis;
- City od Saskatoon (CoS);
- Rural Municipality (RM) of Corman Park;
- Saskatoon Tribal Council (STC)[1]; and
- Saskatoon North Partnership for Growth (P4G)[2].

These TWG meetings sought feedback and input from the attendees at the IAP2 level of Involve.

3.1.2 Stakeholder Engagement and Communications Approach

Phase 1 began with an intent to inform the public of the SFFPS, in alignment with the IAP2 methodology. Key stakeholder interviews took place in the winter of 2019 in order to gain background information and insight in the achievement of two objectives:

1. Identifying key stakeholder groups; and
2. Identifying best approaches to adopt when informing the public of the study.

Key stakeholders consulted during the winter of 2019 are listed below in **Table 3.1**:

[1] STC member nations include: Kinistin Saulteaux Nation; Mistawasis First Nation; Muskeg Lake Cree Nation; Muskoday First Nation; One Arrow First Nation; Whitecap Dakota First Nation; Yellow Quill First Nation.
[2] Cities of Saskatoon, Martensville and Warman, the Town of Osler and the RM of Corman Park formed the P4G. The partners are developing a Regional Plan.

Table 3.1: Phase 1 Key Stakeholders Consulted

NAME	ORGANIZATION	CONSULTATION DATES
Rebecca Row	RM of Corman Park	January 25 and February 1, 2019
Steve Shaheen	Ministry	February 4, 2019
Jennifer Fertuk	Ministry	February 4, 2019
Mike Velonas	Meewasin Valley Authority (MVA)	February 3, 2019
Keith Moen	North Saskatoon Business Association	February 5 and April 16, 2019
Colleen McKee	CoS	February 5, 2019
Gilles Dorval	CoS	February 16, 2019
Judy Harwood	RM of Corman Park	February 19, 2019
Adam Tittemore	RM of Corman Park	February 19, 2019
Louise Jones	Northeast Swale Watchers	February 21, 2019
Darla Lindbjerg	Greater Saskatoon Chamber of Commerce	February 20, 2019
Alex Fallon	Saskatoon Regional Economic Development Authority	February 21, 2019
Geoffrey Meinert	Ministry	March 12, 2019
Dr Ernie Walker	Wanuskewin Heritage Park	April 16, 2019
Tara Janzen	Wanuskewin Heritage Park	April 16, 2019
Dana Soonias	Saskatoon Tribal Council	April 4, 2019

Key information discussed during these stakeholder interviews included:

- The history of public engagement and participation in the project area;
- Predominant sensitivities within the project area regarding its benefit as well as potential impacts;
- Identification of direct and indirect stakeholders;
- Recommendations on organizations and community leaders who should be engaged; and
- Insights on credible avenues for communication as well as approaches to engaging with stakeholders.

Through these interviews, as well as background documentation reviews and TWG member input, the approach for Phase 1 stakeholder engagement and communications was further refined. This led to the development of a stakeholder engagement and communications strategy (referred to as the Playbook) that was used to guide Phase 1 stakeholder engagement and communications activities. The playbook categorized the stakeholder identified for Phase 1 into four pillars:

- Indigenous partners;
- Environment/Heritage partners;
- Landowners; and
- Industry/Associations.

As a first step towards communicating and engaging with the public, the SFFPS website was developed (saskatoonfreeway.org) and was used throughout Phase 1 as a primary communication and engagement tool. Blog posts were updated on the website regularly and three separate surveys were hosted on the site.

The stakeholder engagement and communications team worked with the Ministry to strategically engage and communicate with specific stakeholders in the Phase 1 area as they were identified. Groups such as Wanuskewin Heritage Park, the RM of Corman Park and companies with over-dimensional load requirements were included on the Involve Level of the IAP2 spectrum. The input from these stakeholders enabled the design team to better understand specific needs for important aspects of Phase 1, such as traffic flow and access.

A collaborative Design Workshop (Workshop) was hosted in Warman on 27 June 2019 and 29 June 2019 to seek further input on selected technical aspects of the Phase 1 alignment. The Workshop was facilitated by AECOM and featured technical experts from the Ministry, AECOM, and SNC-Lavalin. The following Phase 1 key stakeholders were also invited to attend:

- Randy Donauer, CoS;
- Jay Magus, CoS;
- Mike Velonas, MVA;
- Keith Moen, North Saskatoon Business Association (NSBA);
- Craig Habermehl, RM of Corman Park;
- Judy Hardwood, RM of Corman Park;
- Tara Janzen, Wanuskewin Heritage Park; and
- Neil Sarnecki, P4G.

The Workshop utilized a Value Engineering (VE) process and Multiple Account Evaluation (MAE) process to enable all participants to score multiple design concepts for interchange options proposed for Wanuskewin Road, Highway 11, Highway 12, and Highway 16. Details and outcomes of the Workshop are presented in **Section 5.2**

Further engagement and communications efforts were conducted following the Workshop to ensure key stakeholders were provided with the latest design concepts. For example, Indigenous partners, landowners, and other high-interest groups were the first to be engaged in early fall 2019 with the Workshop outcomes, before a plan was set to disseminate the information to remaining stakeholders and the general public. The full scope of these efforts is further detailed in **Section 3.3**.

Following the Workshop, two public information sessions were held on November 26, 2019 and November 27, 2019 to gain public feedback on the refined Highway 11, Highway 12, and Highway 16 interchange concepts. Feedback acquired from these two information sessions, as well as completion of a MAE by the project team was used to further refine the concepts. An access plan for roads intersected by the freeway was developed following the first information session to address questions about access to and from the freeway. A final public information session was held on February 26, 2020 to validate what was heard at the November sessions and subsequent refinements and keep the public involved in accordance with the IAP2 model framework.

Attendees at all public information sessions were provided with a survey to gather feedback, which enabled the public to be involved at the IAP2 level of Consult. The surveys were also made available online for two weeks following each public information session. The details of the public information sessions and corresponding surveys are further detailed in **Section 3.4** of this report.

3.2 Communications Channels

The main channel of communication for the public and stakeholder groups was the Saskatoon Freeway website (saskatoonfreeway.org). This site provided frequent updates on the progress of the SFFPS for all to access. The site featured pages to inform the public of the following:

- About the Study;
- Frequently Asked Questions; and
- News.

The website also hosted three surveys throughout summer 2019 to winter 2020. The details of these surveys are relayed in the **Section 3.5** of this report.

Advertisements to make the public aware of the November and February information sessions included:

- Roadside advertisements;
- Two newspaper advertisements per event in the Saskatoon Star Phoenix and Clark's Crossing Gazette (weekly newspaper);
- Facebook advertisements (2-3 per event);
- Website blog posts (3 per event);
- Mailchimp newsletter (3 per event); and
- Formal invite letters to key stakeholders and landowners distributed via email and mail.

Additionally, specific channels of communication were utilized to engage each of the stakeholder pillars; these are identified in further detail in the following sections of this report. Communication tools utilized included face to face meetings, phone calls, larger group presentations, emails, and letters.

3.3 Stakeholders

Phase 1 activities included the identification of major stakeholder groups. As previously mentioned, these groups were categorized into four pillars:

- Landowners;
- Environmental/Heritage partners;
- Indigenous partners; and
- Industry/Associations.

Efforts to engage and communicate with these groups were over and above those used with the general public.

The pillars were created so members of the stakeholder engagement and communication team could properly target stakeholders with similar interests and potential concerns. While the stakeholder engagement and communications team acknowledged that each individual stakeholder is different, the

methods to engage and communicate with each pillar were approached in a similar fashion throughout and was customized as required.

A summary of the activities undertaken for each of the four pillars is outlined in the following sections.

3.3.1 Stakeholder Pillar 1: Landowners

The Landowners Pillar in Phase 1 is focused on communicating the design concepts and potential impact of the Saskatoon Freeway to all individuals, businesses, or Indigenous groups with land near the Phase 1 500 m wide corridor.

Who did we engage with?

The Landowner Pillar originated with approximately forty parcels of land identified by SNC-Lavalin and the Ministry as parcels that may be potentially impacted by the Saskatoon Freeway alignment in Phase 1. These landowners were first contacted by a letter from the Ministry in May of 2019 to inform them of the SFFPS. The letter directed the landowners to the saskatoonfreeway.org website for more information and encouraged landowners with any questions or concerns to directly contact the Ministry's Senior Project Manager.

Ownership of the land parcels contacted included:

- Individual ownership;
- Corporations and business ownership;
- Holding companies; and
- First Nations landownership.

Following the Design Workshop in June of 2019, it was identified that changes were required to the Penner Road area connecting to the Saskatoon Freeway. These potential changes led to six additional land parcels identified as potentially impacted in the future by the Saskatoon Freeway alignment in Phase 1. These additional landowners were first sent a letter in July of 2019. This letter was similar to the original letter sent to landowners in May 2019, providing general information about the SFFPS.

How did we engage with them?

Direct Mail Letters

The main method of engagement with landowners was through direct mail. All letters were sent on behalf of the Ministry's Senior Project Manager, Senior Project Manager with the Ministry. The letters provided updated information on the SFFPS, directed the recipients to the SFFPS website for more information and encouraged anyone with questions or concerns to contact the Ministry's Senior Project Manager for more information. The Ministry's Senior Project Manager responded directly to all requests for a face to face meeting or a phone call as a follow up to these letters.

The original forty land parcel owners and post-Design Workshop six land parcel owners were first sent a letter in May 2019 and July 2019, respectively. The letters communicated that the SFFPS was underway, that the Ministry was aware of their land parcel, and that efforts would be made to continue to keep them informed. They were invited to reach out to the Ministry if they wanted to discuss the project further or had

any questions. They were notified that more specific alignment details would be available in the Fall of 2019. They were invited to visit the project website for updates. In addition, the July 2019 letter outlined potential alignment changes from the Design Workshop.

In September of 2019, all identified landowners received a follow up letter providing more information, as promised in the May 2019 and July 2019 letters. These letters featured the most up to date design concept maps, as an outcome of the Design Workshop process, for the following interchanges:

- Highway 11 including Penner Road;
- Highway 12; and
- Highway 16.

Landowners were once again invited to contact the Ministry's Senior Project Manager directly for a face to face meeting or phone call. They were also directed to the SFFPS website for more information.

Leading up to the two occurrences of the Public Information Session 1 (26 November 2019 and 27 November 2019), landowners received a letter approximately four days in advance of the events, inviting them to the information sessions. These letters also provided detailed images of the two proposed interchange concepts each for Highway 11, Highway 12, and Highway 16 that were going to be shared at the information session. This allowed Phase 1 landowners to see the design concepts in advance of the general public. Landowners were encouraged to attend the public information sessions for more information or to contact the Ministry's Senior Project Manager directly.

At the public information session, all attendees were given a survey to provide feedback and input on each of the design concepts. Those that could not attend the public information session were able to complete the survey online at the SFFPS website. The survey was left on the website for two weeks following the public information sessions in November 2019.

A final landowner letter for Phase 1 was sent in February 2020 in advance of the Public Information Session 2 held on 26 February 2020. This letter included a large-scale image of the Phase 1 preferred alignment including interchanges for Highway 11, Highway 12, and Highway 16, as well as access road plan. Once again, landowners were invited to attend the session in person or contact the Ministry's Senior Project Manager directly. At the public information session, all attendees were given a survey to provide final, general feedback on the Phase 1 preferred alignment and public engagement process. Those that could not attend the public information session were able to complete the survey online at the SFFPS website. The survey was left on the website for two weeks following the Public Information Session 2.

Saskatoon Freeway Website

Landowners were directed to the SFFPS website for additional information. Updated design concepts were featured on the site as they became available, including images of all poster boards that were shared at the Public Information Sessions 1 and Public Information Session 2. These boards were up on the website within at least 24 hours of the information sessions.

In July 2019, a blog post was featured on the SFFPS site to highlight interactions with landowners. This blog post featured a personalized interview with the Plant Manager at ERCO Worldwide, where the Ministry's Senior Project Manager attended a face to face meeting to learn more about the ERCO Plant

Manager's land concerns pertaining to his business. The ERCO Plant Manager had an opportunity to ask questions and provide feedback on areas of the land that were most important to the future of his business.

What did we hear?

Concerns Impacting Business Activity

Some landowners had particular concerns related to their ability to do future business on their land. This included the following:

- Moosomin First Nations' economic development indicating future plans for their land;
- Mining company, ERCO Worldwide indicated future drilling placements that ideally would be accessible in the future; and
- Impact Asphalt & Concrete Crushing Ltd. expressed concern about customer access and ability to zone the land for future intended uses.

Many of these landowners had ongoing discussions about their concerns with the Ministry's Senior Project Manager and Land and Property Manager with the Ministry.

Concerns Around Access

Some business owners and individual landowners living on the land expressed concerns around access to their land when reviewing the design concepts. This feedback was heard at the public information sessions in November 2019. The second public information session addressed some of these concerns by providing design details for the proposed access roads. This was sent to all landowners in advance of the second information session on 26 February 2020.

Willing to Sell

Some landowners understood that their land would need to be acquired when the Saskatoon Freeway goes into construction. With the construction planned for at least 10 years out, some landowners wanted to understand the acquisition procedure, timing and possible options, including selling the land early (upon willing buyer/willing seller) and leasing until construction begins.

3.3.2 Stakeholder Pillar 2: Environment & Heritage

Understanding and mitigating/offsetting the impact that the proposed Phase 1 route for the Saskatoon Freeway may have on cultural, heritage and environmental assets is the focus of interest for stakeholders within this pillar.

Who did we engage with?

The stakeholder engagement and communication team identified three primary organizations as the focus of its engagement efforts throughout Phase 1:

- Wanuskewin Heritage Park;
- Meewasin Valley Authority (MVA); and
- Northeast Swale Watchers (NESW).

Under the umbrella of NESW, the stakeholder engagement and communication team also worked with the following organizations:

- Ducks Unlimited;
- Wild About Saskatoon;
- Saskatoon Nature Society;
- Canadian Parks and Wilderness Society (Western Canada);
- Saskatchewan Environmental Society; and
- Nature Conservancy Canada (SK branch).

The Endangered Grasslands Alliance provided the stakeholder engagement and communication team with notice that they wanted to be kept up to date on developments and news regarding Phase 1 work but did not wish to participate in a more formal engagement effort at this time.

Environmental and cultural heritage impacts identified by Indigenous groups as part of Phase 1 were not within the mandate of this stakeholder engagement and communication team; these are discussed in detail in **Section 2.2.3**.

How did we engage with them?

A variety of engagement techniques were employed in the course of working with these stakeholders.

Technical Working Group

Wanuskewin Heritage Park, the MVA, and the NESW were all members of the SFFPS Environment and Heritage TWG in Phase 1. The group met on a nearly monthly basis throughout Phase 1 (via phone and face-to-face meetings) to review the environmental/cultural heritage assessment work led by SNC-Lavalin engineers and environmental advisors.

A draft Heritage Report summarizing this work (which included a combination of desktop research and in-person visits to potentially noteworthy field locations) was prepared by SNC-Lavalin in the fall of 2019 and circulated to TWG membership for comments before a final report was published in December 2019.

Dedicated Workshops

An evening workshop with the NESW leadership group was hosted by the stakeholder engagement and communication team in June 2019. The event provided NESW leadership with a forum for a detailed Q and A with the SFFPS Ministry's Senior Project Manager. In addition, the forum gave the stakeholder engagement team a unique opportunity to solicit the NESW's input on objective-based design principles that could be used to guide the work of Saskatoon Freeway design engineers. A follow-up workshop to review and finalize these objective-based design principles was planned for the fall of 2019 but was postponed at the request of NESW. The stakeholder engagement team again proposed this workshop to NESW in spring 2020; NESW responded that they were not willing to participate if a larger discussion regarding the need for the Saskatoon Freeway was not part of the agenda. Despite this, the stakeholder engagement team maintains ongoing dialogue with NESW.

Government Official Meetings

In August 2019, the stakeholder engagement and communication team arranged and attended a private meeting with the Ministry's Senior Project Manager so the NESW leadership could better understand the business planning assumptions that have informed work to-date.

In August 2019, the stakeholder engagement and communication team arranged a private meeting so NESW leadership could share their concerns with the Acting Assistant Deputy Minister of Design and Construction for the Ministry. The Ministry's Senior Project Manager and stakeholder engagement and communication team members also attended.

Website

In the summer of 2019, the stakeholder engagement team worked with Wanuskewin Heritage Park to prepare and post a blog on the Saskatoon Freeway design project web site; this posting summarized meetings held between the two organizations and outlined how Wanuskewin Heritage Park's concerns were being addressed.

The stakeholder engagement and communication team approached both MVA and NESW in order to prepare and post similar blogs to highlight meetings held with these organizations and summarize how concerns were being addressed; both organizations accepted the offer but deferred on implementation until 2020.

Other Stakeholder Engagement and Communications Techniques

The following techniques were also employed as the team engaged with Wanuskewin Heritage Park, MVA, and NESW throughout Phase 1:

- Face to face meetings with the lead contact for each primary stakeholder group (Wanuskewin Heritage Park, MVA, and NESW), as well as regular email and telephone conversations to provide updates, solicit input, and confirm existing engagement arrangements remained appropriate;
- Face to face meetings/presentations with the Board of Directors for Wanuskewin Heritage Park and MVA;
- Face to face meetings/presentations with the leadership group for NESW;
- Posting information on the dedicated Saskatoon Freeway website and sending automatic updates on these posts to Wanuskewin Heritage Park, MVA and NESW subscribers;
- Invitations to Wanuskewin Heritage Park and MVA to participate in design workshops/planning sessions;
- Invitations to Wanuskewin Heritage Park, MVA and NESW to attend public information sessions in November 2019 and February 2020; and
- Site tours: Members of the Saskatoon Freeway design project team took part in a site tour at Wanuskewin Heritage Park in June 2019:
  - A site tour of the Swale was planned for the stakeholder engagement and communications team in September 2019 (to coincide with an MVA public event) but was postponed due to scheduling conflicts; and

› A site tour of the Swale was planned for the stakeholder engagement and communications team in December 2019 (to coincide with an MVA public event) but was postponed due to weather and resulting scheduling conflicts.

What did we hear?

A summary of feedback regarding Phase 1, as shared by each stakeholder group, is summarized below:

Wanuskewin Heritage Park

Wanuskewin Heritage Park's feedback focused on ensuring that the SFFPS project team strike a balance between making it easier for visitors to come to Wanuskewin Heritage Park while also not impinging on the viewscape and soundscape surrounding Wanuskewin Heritage Park. These are both factors that will be crucial in any application that Wanuskewin Heritage Park makes for UNESCO status.

In December 2019, Wanuskewin Heritage Park advised the stakeholder engagement and communication team that the Wanuskewin Heritage Park Board of Directors has endorsed the route being proposed for Phase 1 and the Ministry is anticipating a formal submission of endorsement.

Northeast Swale Watchers

The NESW were clear in their opposition to the proposed route for the Saskatoon Freeway, which will impact all phases of the functional study. That being said, through discussion at the TWG meetings, as well as other meetings and ongoing dialogue with the stakeholder engagement team, the NESW did identify key issues that have been addressed, at least in part, by the SFFPS project team during Phase 1 work, including:

› Designing road drainage systems so storm water from the freeway does not enter any part of the Swales; and

› Advocating for additional research in order to gain a better understanding of the environmental assets currently found in the Swale. Details on action taken to initiate this research during Phase 1 are provided below.

The NESW have consistently advocated that elected officials consider a broader decision-making framework for the SFFPS that more closely reflects a triple bottom line methodology and considers wider economic and environmental criteria in evaluating the project, including:

› Alternatives to truck transport;

› Impact of noise and air pollution on adjacent neighbourhoods; and

› Putting an economic value on natural heritage so that it can be more fully quantified in traditional business planning/infrastructure needs assessment models.

Additionally, the NESW group has called for the Stakeholder Engagement and Communication team to pursue wider engagement efforts with Saskatoon and area residents, with a focus on building broader education/awareness regarding the Northeast Swale.

The Stakeholder Engagement and Communication team has worked close with the NESW throughout Phase 1 and has clearly and repeatedly articulated the scope limitations built into the stakeholder engagement framework for the SFFPS via phone calls, emails and/or face-to-face meetings.

Meewasin Valley Authority

Due to MWA's reputation in the Saskatoon area as a strong environmental steward with a respected history of research and collaboration, the MVA was pivotal in facilitating effective dialogue between all members of the Environment and Heritage TWG and identifying CoS efforts regarding Swale/urban planning that the project was not initially aware of.

MVA was an active participant in the TWG and joined with NESW in advocating for additional research to gain a better understanding of the environmental assets currently found in all Swales. Details on action taken to initiate this research are provided below.

In its role as an advocate for increased awareness of the Swales, MVA has spoken at the TWG regarding its long-term plans for increased public access and trails within the Swales. As a result, the SFFPS team is in a better position to incorporate those long-term plans in more detailed design work.

Stakeholder Input Drives Research

Through their participation in the TWG, MVA and NESW informed the SFFPS team that there is a deficiency of research regarding the environmental assets found within the Swale; the Ministry responded by undertaking this recommended additional research, which was completed by the MVA in the spring of 2020.

3.3.3 Stakeholder Pillar 3: Indigenous Partners

With respect to Indigenous partners and initial Phase 1 planning, key objectives included a focus on informing all identified stakeholders of the project, ensuring clear lines of communication were established, and then providing stakeholders with an opportunity for direct face-to-face input and feedback. It was also important for our project team to be informed in terms of how Indigenous partners wanted to be consulted and involved.

As Phase 1 work progressed, the team maintained regular communication and contact and provided the opportunity for ongoing involvement either with leadership and/or other Indigenous colleagues.

Who did we engage with?

Through the initial stakeholder identification work and leadership interviews completed between January and April of 2019, the following Indigenous Partners, Stakeholders, and Landowners were identified:

- The STC (8 Member Nations);
- Cowessess First Nation/Cowessess Ventures Ltd. (south Saskatoon landowners);
- Whitecap Dakota First Nation (a member of the STC);
- Moosomin First Nation (landowner near Highway 16);
- Red Pheasant Cree Nation (urban reserve landowners within the CoS city limits);
- Saulteaux First Nation (landowner near Highway 11);
- English River/Des Nedhe Development Corporation (south Saskatoon developers/landowners);
- Saskatchewan First Nations Economic Development Network;
- The Metis Nation – Saskatchewan;

- Wanuskewin Heritage Park (addressed more directly in the Environmental/Heritage pillar); and
- CoS (Gilles Dorval as an engagement partner and resource).

Subsequent to this initial stakeholder identification process, and as a result of communication and engagement activities throughout the spring to winter months of 2019, the following additional Indigenous Partners were recognized:

- Beardy's and Okemasis Cree Nation (given regional proximity to the North Phase 1 section of the Saskatoon Freeway study as well as the planned Saskatchewan River bridge crossing location);
- One Arrow First Nation (a member of the STC, as well as given regional proximity to the Phase 1 section of the SFFPS as well as the planned Saskatchewan River bridge crossing location);
- Saskatoon Metis Local #11, Local #126, and Local #165 (regional proximity to the North Phase 1 section of the Saskatoon Freeway study as well as the planned Saskatchewan River bridge crossing location);
- Little Pine First Nation; and
- Muskoday First Nation (a member of the STC that noted interest in receiving greater information and material).

How did we engage with Stakeholders?

Depending upon the stakeholder and any pre-existing relationships and communication, a variety of activities were used to further involve and engage with stakeholders beyond the general communication activities ready noted.

Initial Email/Phone Call Communication

After the initial identification phase was completed, the project team reached out to key contacts either through email communication or through direct phone calls with Indigenous colleagues, Leadership, and/or Executive. This preliminary interaction was useful in terms of building rapport and seeking guidance on how Indigenous stakeholders would like to be involved and become better informed. These initial points of contact also helped to clarify who we should be updating and communicating with on a regular basis, and who was our best contact in terms of reaching members of Leadership. Prior to organizing a more direct form of engagement, the email dialogue and phone call discussions also helped clarify the best form of future engagement and level of involvement.

Formal Information Sharing

Indigenous partners were provided with preliminary materials (e.g., a project map, copy of a general overview slide deck, etc.) and directed to the website to address any immediate questions that may arise. This information sharing aided stakeholders in terms of potential questions they may wish to pose at later face-to-face meetings and determine who should attend.

Face-to-Face Leadership and Executive Presentations

This format usually involved facilitating and supporting the Ministry's Senior Project Manager in hosting and planning a number of PowerPoint slide deck presentations (e.g., STC - Board Presentation Spring 2019 and a Story Blog posted in August of 2019 highlighting the discussion and outcomes of the meeting). These

meetings proved to be quite productive in terms of addressing questions that arose from the presentation, as well as determining if further engagement, information, and meetings were required.

Other Engagement Activities

In addition to the above:

- Facilitate introductory meetings and discussion with project technical resources, Ministry officials, and stakeholder leadership representatives. This approach was utilized for all the above noted Indigenous stakeholders and landowners;
- Request/organize face-to-face or teleconference meetings and Presentations with Board of Directors of the stakeholder organization;
- Share initial "Key Findings" with stakeholder leadership representatives; and
- Organize Validation and "Next Steps" Meeting with Leadership.
    - Formal Letters of Invitation were mailed out to all Indigenous Stakeholders regarding the two November 2019 Public Information Sessions. There was particularly strong representation and involvement from Moosomin and Saulteaux First Nation leadership and staff, and
    - Organize follow-up Site-Specific Visits/Tours (with stakeholders, Ministry officials, and technical staff from the SFFPS consulting team), to improve understanding/objectives.

What did we hear?

An overview of feedback heard by the stakeholder engagement and communications team regarding the Indigenous Partners Pillar is summarized below:

Saskatoon Tribal Council

The STC is interested in maintaining its role and presence on the TWG and appreciated the one-on-one meetings with the Tribal Chief as well as the update PowerPoint presentation to the eight Board of Director members. Moving forward, they are interested in continuing in this information-sharing capacity, having representation on the project structure, and future procurement partnership opportunities, but do not want to assume the role and authority of each Nation when it comes to more direct issues. Specific land questions, functional design alignment planning options, and Nation impact questions will be addressed with each Nation directly if/when required.

Cowessess First Nation/Cowessess Ventures Ltd.

The stakeholder engagement and communications team communicated with Cowessess early in the process via email and phone discussion with their CEO of Cowessess Ventures. They wanted to be kept informed throughout Phase 1, but their interests align with Phase 2; their land of ownership is south of Saskatoon.

Whitecap Dakota First Nation

Whitecap Dakota First Nation were informed initially through our Board meeting with STC and appreciated being kept informed. Their greater interested and involvement begins in Phase 2 given proximity of landownership and commercial development interests.

Moosomin First Nation

The stakeholder engagement and communications team, along with the Ministry's Senior Project Manager, met with representatives of the Moosomin Development Corporation in May of 2019, with a follow-up meeting in September. As well, most of Chief and Council attended the Public Information Session 1 in November of 2019. As follow-up to discussions had and questions raised during the Information Session 1, the stakeholder engagement and communication team organized a larger direct group meeting that occurred in December 2019 in Saskatoon with the Ministry's Senior Project Manager present. Their expressed interest relates to land in and around the Highway 16 interchange footprint along the northeast and southwest sides of Highway 16. Areas of greatest concern are access to the land as well as land valuation.

Red Pheasant Cree Nation

Upon further review and consideration, it was determined that the Red Pheasant Cree Nation was not a stakeholder in the process. Their land is not close in proximity to the proposed Saskatoon Freeway and they are not a member of the STC.

Saulteaux First Nation

The project team made initial contact with the Saulteaux First Nation through the land manager and advisor. From there, we were introduced to the Saulteaux First Nation Councillor. A meeting and PowerPoint presentation was then set up with the Saulteaux First Nation Chief, Councillor, and other Saulteaux First Nation officials in the Fall of 2019. We were fortunate to also have strong representation at the November Information Sessions from the Nation. The Saulteaux First Nation owns land near the Highway 11 interchange. Their main points of interest/concern are regarding access to their land, and impact/opportunity related to future commercial land development opportunities.

English River/Des Nedhe Development Corporation

The project team communicated with the President and CEO for Des Nedhe Development, and ended up meeting with a representative of the Des Nedhe Corporation. They wanted to be kept informed throughout Phase 1, but their more direct interest begins in Phase 2.

Saskatchewan First Nations Economic Development Network

Based on feedback from Indigenous partners, it was determined upon further review and consideration that the Saskatchewan First Nations Economic Development Network was not a stakeholder in Phase 1 of the SFFPS. There is no indication that this should change for Phase 2 or 3.

The Metis Nation – Saskatchewan

The project team communicated and met with the Area Director for the Metis Nation – Saskatchewan. They are interested in continuing to be informed and kept up-to-date as the functional planning study progresses. They also noted that the Metis Local organizations would likely have a strong interest in meeting regarding the outcomes of the study.

Little Pine First Nation

The project team was introduced to the Little Pine First Nation Chief and a representative regarding Little Pine First Nation and their interest in better understanding the impact and outcomes of the SFFPS. Initial material and information items were shared to aid in determining future engagements. From there, members of the project team were invited to North Battleford in the Fall of 2019 to provide the Chief and other Little Pine officials with greater project detail as well as field questions and generate greater discussion. Moving forward, Little Pine First Nation has requested continued updates and general communication.

Muskoday First Nation

Muskoday First Nation is a member of the STC and expressed interest early-on in receiving ongoing information and material. To that end, the project team has ensured regular updates and email-based communication is maintained.

Duty-to-Consult

The Ministry has determined that Duty-to-Consult protocols are required for the proposed South Saskatchewan River bridge crossing. The Ministry decided to proceed with a Level 3 letter after additional consideration. A Level 3 Letter requires direct consultation with First Nation and Metis rights holders with geographic proximity. According to the Ministry, there is still further review and consideration to take place, but a reasonable next step was to finalize a formal Letter of Duty-to-Consult to impacted Indigenous rights holders. With the support of the stakeholder engagement and communication team and the Ministry of Government Relations, a Level 3 Letter was developed and distributed by the Ministry. Recipients of the Letter included: Beardy's and Okemasis Cree Nation; One Arrow First Nation; Whitecap Dakota First Nation; and Saskatoon Metis Local 11, Metis Local 126, and Saskatoon Local 165.

3.3.4 Stakeholder Pillar 4: Industry/Sector Partners

Who did we engage with?

- CoS;
- RM of Corman Park;
- P4G Members;
- City of Warman and Martensville;
- NSBA;
- Greater Saskatoon Chamber of Commerce/Regional Chambers of Commerce;
- Saskatoon Regional Economic Development Authority (SREDA);
- Saskatchewan Trucking Association (STA);
- Colliers International; and
- Regional Transportation Groups.

How did we engage with stakeholders?

In addition to the regular and monthly communication channels established, other engagement activities included the following:

Project Introductory Meetings

Consultation generally began by facilitating and organizing introductory meetings between the organization and project team members depending on the stakeholder and level of awareness. These introductory meetings served to inform the stakeholder on project details, as well as detail future opportunities for information sharing and providing feedback.

Formal Information Sharing

Formal information sharing was generally completed as face to face meetings and presentation, followed up by providing materials (e.g. project map, copy of the meeting presentation, etc.) and directing stakeholders to the website to address any follow-up questions that may arise. This information sharing aided in addressing issues or questions of transparency and was useful with having information dispersed to a wider audience.

Public Sector/Industry Meetings

Other than the public information sessions, the only other open/public forum attended by the SFFPS team was the NSBA Luncheon in May of 2019. Offers were extended to also present at other member luncheons and business breakfast meetings; however, it was generally preferred by stakeholders to hold-off until Phase 2 before organizing another such event. As well, most requests from industry/sector partners were for more direct face-to-face meetings.

Organization-Specific Presentations

Meeting directly with an organization, a sector association, and/or its Board of Directors was a highly utilized engagement method. Depending upon the stakeholder group and potential questions, we were able to also augment the meeting with additional Ministry officials and technical staff from the project team.

Key Dates/Specific Dialogue Opportunities

- **CoS –** in addition to having a representatives on the Stakeholder and Communications, Environment and Transportation Planning TWG's, the Steering Committee, and the Technical Committee, the CoS has been directly involved throughout Phase 1 through the following more specific opportunities: leadership meetings in February and March of 2019, involvement in the July 2019 Design Workshop, as well as development and presentation of a specific Technical Briefing document for the City in October of 2019.

- **RM of Corman Park –** the RM was also a member of the Stakeholder and Communications TWG as well as the Steering Committee, and the Technical Committee. Additional dialogue with the RM included leadership meetings in February of 2019, involvement in the July 2019 Design Workshop, as well as a **Technical** Briefing slide deck presentation in October 2019.

- **NSBA –** the NSBA is a member of the project Steering Committee. Additional dialogue with the NSBA included a **leadership** meeting in April of 2019, the May 23, 2019 NSBA Members Luncheon where Ministry officials presented an SFFPS update, as well as participation in the July 2019 Design Workshop.

- **P4G –** P4G was a member of the Stakeholder and Communications TWG, Transportation Planning TWG, as well as the **project** Technical Committee. Additional dialogue with P4G included a leadership meeting in May of 2019, presentation to the larger P4G memberships in June of 2019, participation in the July 2019 Design Workshop, and a SFFPS update presentation in September of 2019.

What did we hear?

An overview of feedback is summarized below:

- Continue with constant messaging and updates with leadership and representatives;
- Participation on the project team is critical;
- Ensure continued communication on the project itself;
- A theme of general support for the project; and
- Consistent, clear, and transparent information that is up-to-date will help manage any possible land sale and development disruption.

3.4 Public

As outlined in **Section 3.1** of this report, two key strategies used to engage and consult the general public included executing public information sessions in November of 2019 and February of 2020, as well as administering three surveys in both a paper-based and online format.

3.4.1 Public Information Session & Survey Overview

Three surveys were conducted throughout Phase 1 of the SFFPS. The first survey was launched with the Saskatoon Freeway Website. It allowed the general public to weigh in on their overall perception of the SFFPS. The second and third surveys were administered in relation to each public information session. Survey findings are summarized in **Section 3.5**.

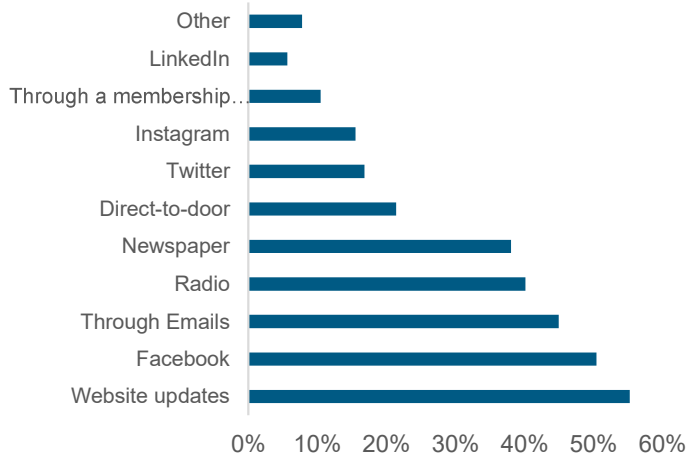
The public information session in November 2019, held over two days, had a final attendance of over 200 people. The session featured two concepts for each of the Highway 11, 12, and 16 interchanges. Attendees were provided with a survey to indicate their preferences and concerns around each concept. For those that could not attend the public information session, verbatim information from the event on the design concepts and accompanying details (such as environmental and heritage studies) was posted on the Saskatoon Freeway website. The survey was also posted online for two weeks following the public information sessions.

A final public information session was held on February 26, 2020 to present the preferred alignment and interchange configurations. The public information session was attended by approximately 140 people. The preferred alignment and interchange configurations development was aided by public feedback, including feedback from the November 2019 public information sessions, and a second MAE conducted by the project team. During this public information session, one preferred alignment concept was presented for each of the Highway 11, 12, and 16 interchanges. The February event also featured high level Phase 1 access plan detail. Attendees were provided with an exit survey where they could provide general feedback on whether they felt anything was missed or overlooked in the designs. In a consistent manner to the November information sessions, the information featured at the February public information session was shared on the Saskatoon Freeway website for those that could not attend in person. The survey was also hosted online for two weeks following the event.

3.5 Survey Results

3.5.1 Survey No. 1 Findings

The first survey was launched alongside the Saskatoon Freeway website. It ran from August to November of 2019 and was completed by 480 participants. General findings are discussed in the following sections.



Survey respondents would like to be informed about news or updates regarding the Saskatoon Freeway through multiple channels, with the following methods being the most important:

- Website Updates (55%)
- Facebook (50%)
- Emails (45%)
- Radio (40%)
- Newspaper (38%)

Figure 3.2: Survey Results – Engagement Topics and Channels

More than half of respondents believe the following areas of focus are most important to the public:

- Road design, such as detailed route location, access locations, interchange locations, etc. (83%);
- Estimated cost of future construction (60%);
- Schedule, such as timeline of the planning study, when information will become available, when there will be opportunities to provide feedback, etc. (60%);
- Impact to neighbourhood, such as noise, traffic volumes, road safety, etc. (58%);
- Environment, such as native grasslands, biodiversity, wetlands, recreation uses, plant species, wildlife, ecosystems, etc. (55%); and
- Most respondents (78%) were interested in remaining up-to-date regarding the SFFPS and potential engagement opportunities.

Perception of Engagement

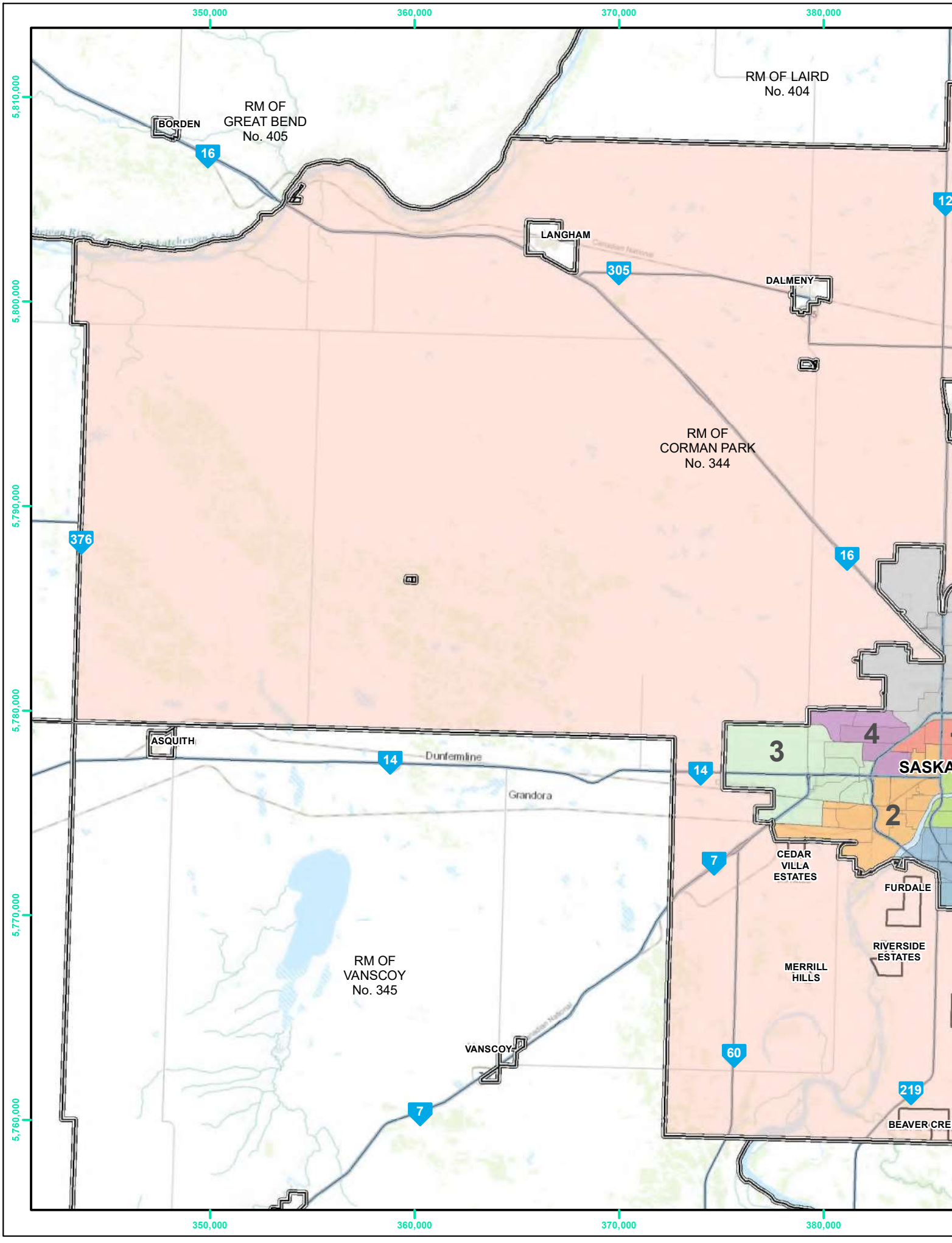
At the time of the survey, most respondents did not feel sufficiently informed regarding the Saskatoon Freeway (73%). However, most respondents (69%) had not yet been involved with any activities regarding the Study, such as an open house, online engagement session, or a discussion with a representative from the Ministry (i.e., face-to-face, over the phone, email exchanges).

Respondent Profile

Survey No. 1 respondent profile is summarized below in **Table 3.2**. Ward boundaries are presented in **Figure 3.3**.

Table 3.2: Respondent Profile

I AM A RESIDENT OF:	FREQUENCY
Saskatoon Ward 10	16.30%
RM of Corman Park	9.90%
Saskatoon Ward 6	9.70%
Other rural municipality	9.30%
Saskatoon Ward 1	8.50%
Saskatoon Ward 7	6.80%
Saskatoon Ward 9	6.80%
Other urban municipality	6.00%
Saskatoon Ward 5	5.80%
Saskatoon Ward 2	5.20%
Saskatoon Ward 8	3.70%
Prefer not to answer	3.70%
Saskatoon Ward 3	3.50%
Saskatoon Ward 4	3.50%
I do not live in the Saskatoon region	1.40%


350,000
360,000
370,000
380,000
5,810,000
5,800,000
5,790,000
5,780,000
5,770,000
5,760,000
RM OF LAIRD
No. 404
RM OF
GREAT BEND
No. 405
BORDEN
16
LANGHAM
305
DALMENY
RM OF
CORMAN PARK
No. 344
376
16
ASQUITH
14
Dunfermline
Grandora
14
3
4
2
SASKA
7
CEDAR
VILLA
ESTATES
FURDALE
RIVERSIDE
ESTATES
MERRILL
HILLS
RM OF
VANSCOY
No. 345
VANSCOY
60
7
219
BEAVER CRE

3.5.2 Survey No. 2 Findings

The second survey was made available for attendees of the November 26 & 27, 2019 public information session and was posted online for two weeks following the session. Survey No. 2 findings and notable survey respondent comments are summarized below.

Perceptions of Highway 11 Concepts

- Six out of 10 survey respondents shared their perceptions about Highway 11 concepts 11-1 and 11-2. Public opinion was almost evenly split on which concept they prefer—14% preferred 11-1, 12% preferred 11-2 (and 4% liked both);
- Those who preferred 11-1 tend to cite smoother traffic flow and a simpler, cleaner design. Concept 11-1 was noted to look smoother and more intuitive as to flow from N-S and E-W. *"I like concept 11-1 because there are less reasons to slow down, and it has a higher traffic flow rate"*;
- Those who preferred 11-2 liked the compact design and larger loops. "I like how tight the whole interchange is." … "Concept 11-2 has larger loops on exit ramps, easier for large vehicles";
- The 11% who did not like either option either disagreed with the Saskatoon Freeway in general (because of cost or environmental impact), or they have their own suggestions about location and design;
- Approximately 14% of respondents had concerns about the environmental impact of Highway 11 concepts, particularly on Wanuskewin Heritage Park and the Northeast Swale. Another 14% cite concerns about access and traffic flow, and a few (5%) were concerned about inconsistent or lower speeds; and
- When asked what one change they would like to see included in Highway 11 concepts, 26% of respondents offered design suggestions. Although no single suggestion dominates opinion, frequent suggestions included more lanes, room to safely accelerate/decelerate into traffic, good wayfinding signage or larger traffic loops to accommodate trucks and icy winter conditions.

Perceptions of Highway 12 Concepts

- Five out of 10 survey respondents shared their perceptions about Highway 12 concepts 12-1 and 12-2; concept 12-2 which was chosen by 22% and concept 12-1 which was chosen by 8%;
- The most frequently cited reason for preferring concept 12-2 was the "free flow" of traffic. "No traffic lights! High speeds better!" … "No stops, traffic can keep flowing". Traffic flow and access were also the main reasons respondents provided for preferring Highway 2 concepts in general, without specifying a favourite;
- Similarly, those with concerns about concept 12-1 almost all cite traffic flow: "Appears to have more impediments to traffic." … "Has lights that will slow it down." … "Looks like there will be more backups. … Having stop and go intersections on a highway is unsafe."; and
- When asked what one change they would like to see included in Highway 12 concepts, 27% of responses referenced some aspect of design. Again, no single theme dominated but frequent suggestions included removing traffic lights, consistent highway speed limits and ample merge lanes.

Perceptions of Highway 16 Concepts

- Four out of 10 survey respondents shared their perceptions about Highway 16 concepts 16-1 and 16-2—and the largest percentage (27%) said they like both: "Both are good with easy access all directions." … "Both options appear well thought out.";
- Few had concerns about specific Highway 16 concepts, although 8% had general concerns. These ranged from use of land to height of overpasses to impact on wildlife. Approximately 5% were

concerned about the impact on First Nation Land: "The freeway will be running through First Nations land.";

- Again, when asked what one change and what they would like to see included in Highway 16 concepts, 16% offered design suggestions, similar to those referenced for Highway 11 (e.g. more lanes, larger loops); and
- Approximately 7% of respondents wanted to ensure First Nation consultation for any sale of land.

Respondents Stated Many Factors Are Important in Design

- Survey respondents identified a broad range of factors as important when making design decisions about the Saskatoon Freeway. Leading the list was Wanuskewin Heritage Park—60% of respondents felt the park needs to be considered in making design decisions about the Freeway;
- Cost is important—59% said capital cost should be taken into consideration, 58% said operating cost, 55% said maintenance cost, and 52% said safety cost. Respondents were also concerned about the cost to themselves in terms of travel time (53%) and vehicle operating cost (47%);
- More than half of respondents said it is important to consider environmental factors, including wildlife & plants (58%), water quality (57%) and greenhouse gas emissions (52%); and
- More than half also said it is important to consider alignment with municipal development plans (57%), public input (55%), business development/access (51%), and employment during construction (49%).

Attended an Information Session

- Approximately 42% of survey respondents attended one of the two public information sessions held in November 2019. In total, more than 215 participants attended the public information sessions and 132 people responded to the online survey;
- More than half of respondents who attended a public information session said they heard about it through traditional media, including 44% via print newspaper, and 13% via television or radio;
- Another 31% heard about the sessions through social media, 21% through word-of-mouth, 15% via roadside ads, and 6% through the community or family; and
- A few heard about the information sessions through email (6%) or mail (6%) notification, meaning they had signed up to receive notices of upcoming events and news.

Say Information Session Was Convenient

- Nine out of 10 respondents who attended a public information session said the venue was convenient (88%) and the timing of the session was convenient (86%).

Agree the Public Information Session Provided Enough Information

- Seven out of 10 (73%) survey respondents who attended a public information session agreed they were given enough information from the information boards and project team members at the stations to have a good understanding of the functional aspects of Saskatoon Freeway designs.

Satisfied with Saskatoon Freeway Public Engagement Process

- Six out of 10 (60%) survey respondents who attended a public information session were satisfied with the overall Saskatoon Freeway public engagement process.

Factors in Freeway Design

Q. In order of importance, with 1 being most important, please rank the factors you think should most be taken into account when making design decisions for the Saskatoon Freeway? Multiple responses were allowed.

- Most survey respondents cited a broad range of factors as important when making design decisions about the Saskatoon Freeway;
- Leading the list was Wanuskewin Heritage Park—60% of survey respondents felt the park needed to be considered in making design decisions about the freeway;
- Cost is important—59% said capital cost should be taken into consideration, 58% said operating cost, 55% said maintenance cost, and 52% said safety cost. Respondents were also concerned about the cost to themselves in terms of travel time (53%), and vehicle operating cost (47%);
- More than half of respondents said it is important to consider environmental factors, including wildlife & plants (58%), water quality (57%), and greenhouse gas emissions (52%); and
- More than half said it is important to consider alignment with municipal development plans (57%), public input (55%), business development/access (51%), and employment during construction (49%).

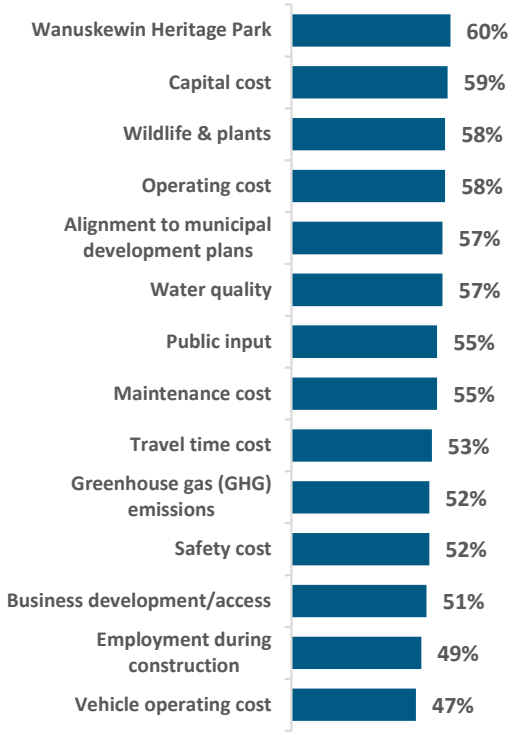


Figure 3.4: Survey Results - Design Factors

Respondent Profile

Q. How would you describe yourself?

- More than a third (35%) of survey respondents described themselves as a potential user of the new freeway;
- Approximately 13% said they were a property owner who lives in the vicinity of the freeway;
- Another 9% described themselves as a stakeholder concerned about the environment, 5% as a commercial road user, 3% as a local business and 1% as an industrial sector stakeholder; and
- Other (17%) included respondents who described themselves as a combination of the above, as residents of nearby First Nations or other communities, and as interested Saskatoon taxpayers.

3.5.3 Survey No. 3 Findings

The third survey was made available for attendees of the February 26, 2020 public information session and was posted online for two weeks following the session; it was completed by 78 participants.

More than Half Attended an Information Session

› Approximately 56% of survey respondents attended the public information session held in February of 2020; and

› Those who attended heard about the session through social media (25%) and word-of-mouth (25%), followed by traditional media such as print newspaper (16%), and TV or radio (11%).

Most Say Information Session Was Convenient

› Eight out of 10 respondents who attended a public information session said the venue was convenient and 9 out of 10 said the timing of the session was convenient.

Agree the Public Information Session Provided Enough Information

› Six out of 10 survey respondents who attended a public information session agreed they were given enough information from the information boards and project team members at the stations to have a good understanding of the functional aspects of Saskatoon Freeway designs, while 25% of respondents were neutral about this statement.

Satisfied with Saskatoon Freeway Public Engagement Process

› Five out of 10 survey respondents who attended a public information session were satisfied with the overall Saskatoon Freeway public engagement process.

Respondent Profile (Figure 3.5)

Q. How would you describe yourself?

› Approximately a quarter (28%) of survey respondents said they were a property owner who lives in the vicinity of the freeway. Another quarter (26%) said they are potential users of the new freeway;

› Another 15% described themselves as a stakeholder concerned about the environment, 8% as a local business, 6% as an industrial sector stakeholder, and 1% as a commercial road user; and

› Other (15%) included respondents who described themselves as a combination of the above, as residents of nearby First Nations or other communities, and as interested Saskatoon taxpayers.

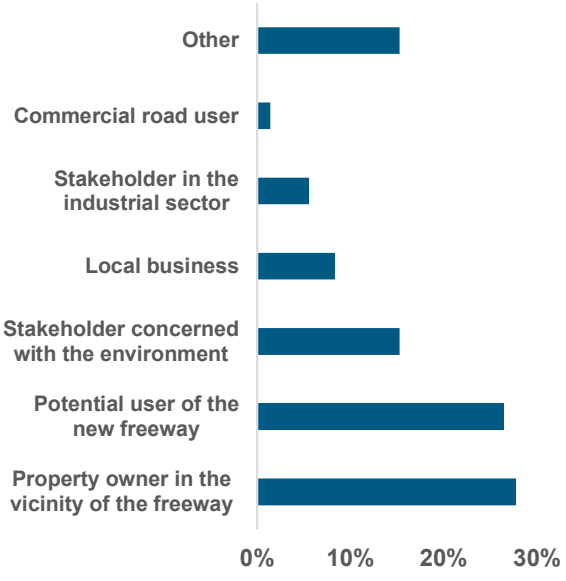


Figure 3.5: Respondent Profile

4 Transportation Planning

4.1 Traffic Modelling

4.1.1 Overview

4.1.1.1 Purpose

The transportation modelling component of the Saskatoon Freeway Functional Planning Study (SFFPS) is intended to provide support to the advancement of the design concept for the Saskatoon Freeway by assessing the forecast interactions between the future freeway system and the planned and anticipated future developments in the area. This work is based upon a calibrated model of the study area developed previously. This model was reviewed at a high level for general structure and operation, and validation was done to get an indication as to whether it was continuing to perform as intended when originally developed. Then the model was modified for use in the SFFPS in several ways:

- Updating of planned development within the study area based on new sector planning work that has been carried out since the model was initially built in 2013-2015, and correction of future development assumptions that no longer stand. This included updating of zone residential and employment forecasts, as well as addition and/or modification of zone connectors and arterial road links as necessary to load the anticipated development onto the network in a reasonable manner, in the absence of developed road network plans in areas of future development;
- Updating the representation of the Saskatoon Freeway within the model to something closer to the current planning concepts, including locations of interchanges and, particularly in the southeast quadrant, the general alignment of the freeway; and
- Modification of network elements to correct model operations where it became evident it was not producing realistic assignments in the 2063 horizon year.

These steps are described in more detail in the sections that follow.

4.1.1.2 Model Structure

The forecasts prepared for this functional planning study were prepared using the Saskatoon Regional Travel Demand Model (SRTDM) which was developed by HDR Corporation and completed in April 2015, jointly for the Saskatchewan Ministry of Highways (Ministry) and the City of Saskatoon (CoS). The original model and report (HDR, 2015) were reviewed to confirm the model validity. That report describes the development process and structural details of the model. The following provides a brief summary of the model development process carried out to create the model. The original report should be consulted for additional details.

The model was calibrated to the 2013 base year using applicable household survey data to consider trip purposes including employment and education. The application of calibration factors was implemented directly in VISUM as a series of automated procedures. The factors developed included generation factors to adjust total trip volumes to observed demand by purpose and trip distribution factors to adjust global Origin-Destination (OD) matrices to observed demand by purpose.

The model was then extended to the prescribed horizon years based on land use forecasted by Urban Systems, with cooperation from the CoS and the Saskatoon North Partnership for Growth (P4G) Task

Force, comprised of the Rural Municipality (RM) of Corman Park, and Cities of Martensville and Warman. It should be noted that Urban System's forecasts assume that the CoS population will grow at a compound annual growth rate (CAGR) of 2.5% based on a medium growth scenario prepared by the City's Mapping and Research Group.

Table 4.1 shows land-use information that the HDR model originally provides. It appears that population per household is anticipated to decline over the 50-year horizon.

Table 4.1: HDR Model

HORIZON YEAR	HDR SCENARIO NAME	HDR REPORT STATED POPULATION[1]	MODEL DWELLING UNITS (DUs)	CALCULATED MODEL POPULATION PER DU	TOTAL EMPLOYMENT
2013	Base-year	247,000[2]	119,195	2.07*	133,883
2021	300k	300,000	147,315	2.04	161,464
2032	400k	400,000	201,603	1.98	218,354
2041	500k	500,000	257,707	1.94	272,797
2063	50-year	850,000	464,892	1.83	463,428

Note: [1]Population horizon is calculated based on the population of the CoS, not the entire region.
[2]Calculated from Appendix B; Urban System Land Use Forecasts part of the SRTDM report.
Source: SRTDM HDR Model Development Report (Table 7-5).

Internal passenger trip forecasts were produced by running the model with updated land use and networks for the corresponding horizon year. The actual factors used to inflate external travel (from the base year) were 1.25 for the 300K scenario, 1.70 for the 400K scenario, 2.05 for the 500K scenario and 3.00 for the 50-year horizon. These were distributed based on taking the counts at the Ministry's external stations and using this information to construct a synthetic matrix.

It is noted that the 2.5% growth rate is consistent with the expected growth in jobs in the CoS, whose compound annual growth rates range between 2.5% and 2.6%, as shown in **Table 4.2** below (the City's job growth rates are slightly higher, which is consistent with the City and its economic climate being a major driver in long-distance truck traffic growth to and from the City).

Table 4.2: Projected City of Saskatoon Employment Growth

HORIZON	2013	2021	2032	2041	2063
Total Employment	122,673	148,988	198,651	248,313	422,000
CAGR wrt 2013	-	2.5%	2.6%	2.6%	2.5%

Source: SRTDM HDR Model Development Report (Table 7-6)

The model incorporates approximately 33,000 links representing freeway, arterial, collector, local streets as well as rural roads in the study area. However, the local and rural network is represented just for visual

context and those links are not calibrated or assigned in the modelling. A total of 361 Traffic Analysis Zones (TAZ) are defined, each representing an area of land with its existing or anticipated homes and jobs used to represent demand within the TAZ corresponding with existing and proposed development plans.

The original modelling includes anticipated network modification (in the future 50-year horizon (2063) model, also presented in **Table 4.3** and on **Figure 4.1**:

Table 4.3: HDR Model Anticipated Network Modifications

NEW CONSTRUCTION	UPGRADE TO EXISTING FACILITY
Martensville Interchange (Ministry)	Highway 7 twinning (Ministry)
Warman Interchange (Ministry)	Highway 16 twinning (Ministry)
Highway 305 realignment (Ministry)	7 upgraded interchanges (CoS)
North Perimeter Highway (Ministry)	8th Street upgrades (CoS)
McOrmond South Extension (CoS)	Traffic Bridge (CoS)
North Commuter Parkway (CoS)	
West Connector Route	

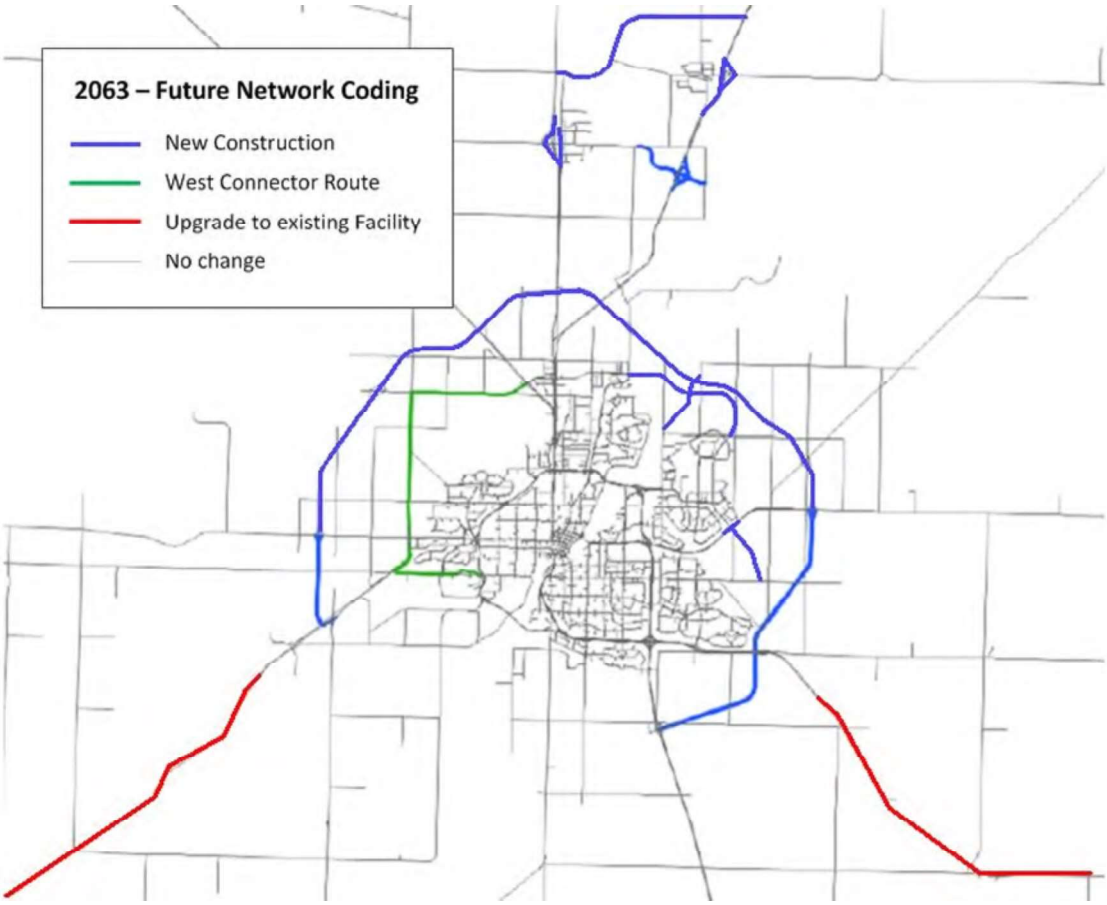


Figure 4.1: Future Network Enhancements (2063)

Validation

While the original model was calibrated and validated as documented in the 2015 report, an effort was made as part of the SFFPS to spot-check that the model is still performing reasonably five years after it was published, and 7 years after the original base calibration year. A couple of approaches were tried, based on readily-available information, and the constraint that the model's first horizon year is 2021. The checks were therefore essentially looking at whether recent actual planning and traffic data available appears consistent with the model. This is described in the following sections.

Bridge volumes

A standard measure of macroscopic modelling performance is the fit of assigned volumes at screenlines, with one of the best being a river crossing, and the South Saskatchewan River is a prominent feature in this model. River crossings are particularly good tests as they have limited crossing points which are typically major roads and so are well-reflected in the model. The overall total volumes crossing screenlines give a check of the distribution of origins and destinations in the model, and since the crossing links are usually high order connections, the volumes individually or in localized clusters can also indicate the effectiveness of the model's network capacity in routing traffic to appropriate crossings. The CoS bridge network is presented in **Figure 4.2**.

Figure 4.2: Bridge Network in the City of Saskatoon

The City provided all 7 bridge traffic counts conducted in spring 2019, which was compared with the original model's base and 2021 horizon scenarios to see any correlation in traffic volume. It should be noted that both Traffic Bridge and Chief Mistawasis Bridge were opened in 2018 so they were not modelled in the 2013 base model, but they were counted by the City in 2019. As shown in **Figure 4.3** and **Figure 4.4** below, the City's bridge traffic count generally aligns well with the model projections, indicating that for the fundamental river screen-line in the study area, the model is performing reasonably well.

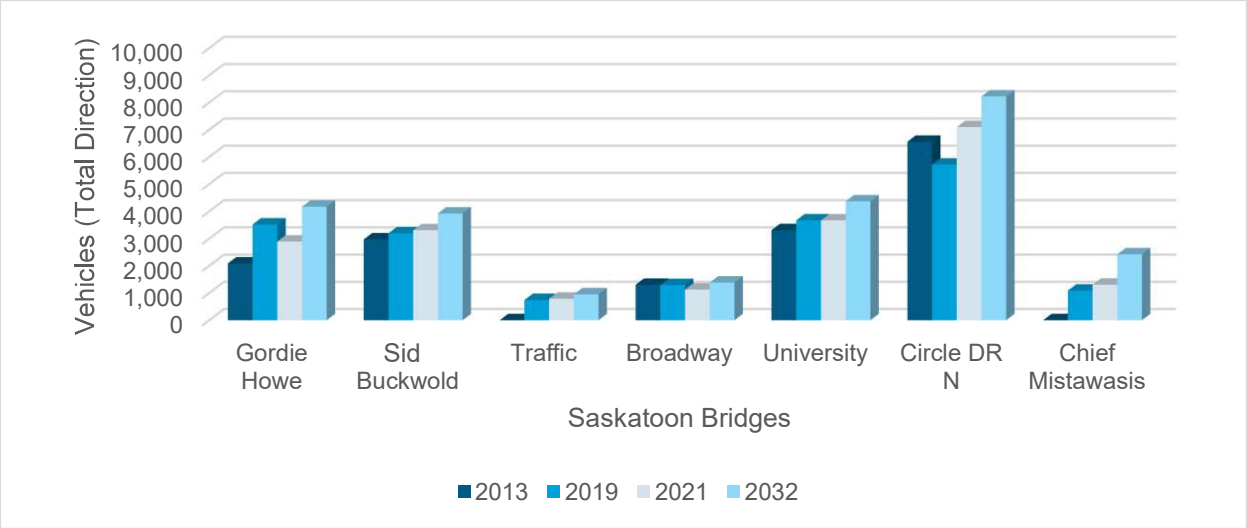


Figure 4.3: Bridge Traffic Volume Comparison (AM Peak Hour)

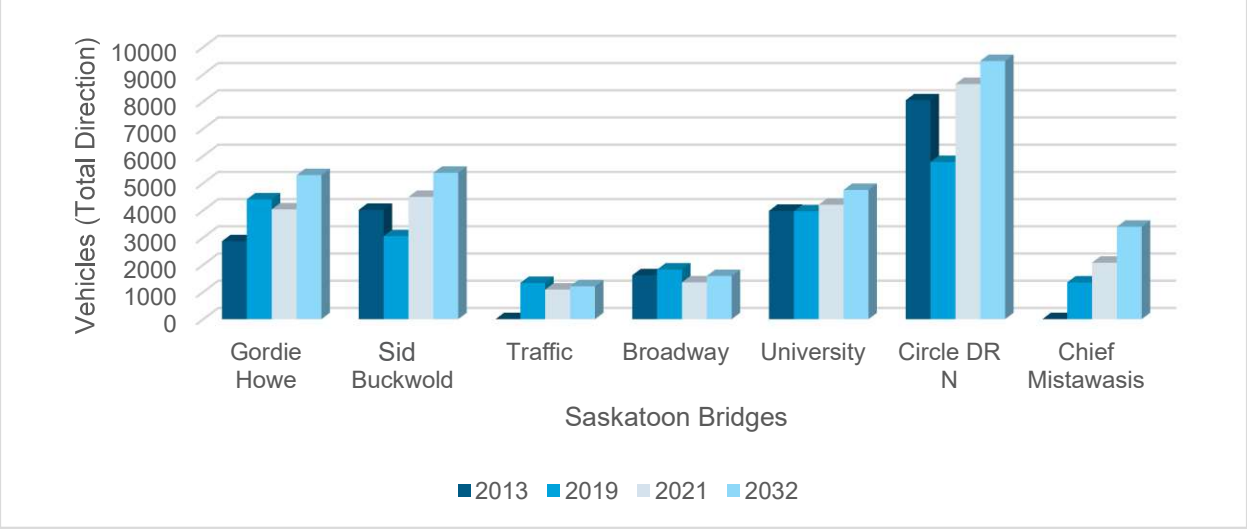


Figure 4.4: Bridge Traffic Volume Comparison (PM Peak Hour)

The bridge count compared very well to the interpolated model forecast between 2013 and 2021 models in both AM and PM Peak hour. **Table 4.4** and **Table 4.5** show the comparison between the 2019 volume and

interpolated 2019 volume using 2013 and 2021 data. In the AM peak hour, the total bridge volume is off by less than 1.5% from the interpolated model forecasts. However, the model appears to forecast about 13% higher than observed volume for 2019 in the PM peak hour. This could be due to some spreading of peak demand in the observed data. For the purposes of the SFFPS work this result is satisfactory.

Table 4.4: 2019 Counts (AM Peak)

HORIZON YEAR	GORDIE HOWE	Sid BUCKWOLD	TRAFFIC	BROADWAY	UNIVERSITY	CIRCLE DR N	CHIEF MISTAWASIS	TOTAL
2019	3516	3192	742	1291	3668	5719	1087	19215
2019 (Interpolated)	2690	3222	593	1170	3579	6962	979	19194

Table 4.5: 2019 Counts (PM Peak)

HORIZON YEAR	GORDIE HOWE	Sid BUCKWOLD	TRAFFIC	BROADWAY	UNIVERSITY	CIRCLE DR N	CHIEF MISTAWASIS	TOTAL
2019	4403	3051	1332	1826	3967	5777	1349	21705
2019 (Interpolated)	3742	4374	816	1417	4152	8493	1556	24552

Having more lanes on a given bridge could cause the bridge to attract more traffic. **Table 4.6** shows the number of lanes on each bridge are mostly consistent except for Chief Mistawasis bridge. In 2013 the model did not incorporate the bridge because it was not opened until 2018. In the 2021 model, it shows one lane less in each direction, which could attract less traffic. However, the 2019 counts are not approaching capacity of even a 4-lane bridge, so the additional open lanes are evidently not yet a sufficient draw to divert traffic from the bridges to the south. Even so, the Circle Drive North bridge in the 2013 model is busier than in the City 2019 count but this decline in volume is explained by the opening of the Chief Mistawasis Bridge in 2018.

Table 4.6: Bridges in the City of Saskatoon

BRIDGE NAME	OPENING DATE	# LANE TOTAL (2020)	# LANE TOTAL (2013)	# LANE TOTAL (2021)
Gordie Howe	2013	6	6	6
Sid Buckwold	1966	6	6	6
Traffic	1916, reopened in 2018			
Broadway	1932	4	4	4
University	1916	4	4	4
Circle Drive North	1983	6	6	6
Chief Mistawasis	2018	6	(not open)	4

Dwelling Units

The CoS census data was provided to compare against the original 2013 base and 2021 horizon model scenarios. The City also provided their 2018 counts of dwelling unit by neighbourhood. All these data sets are shown in **Figure 4.5**.

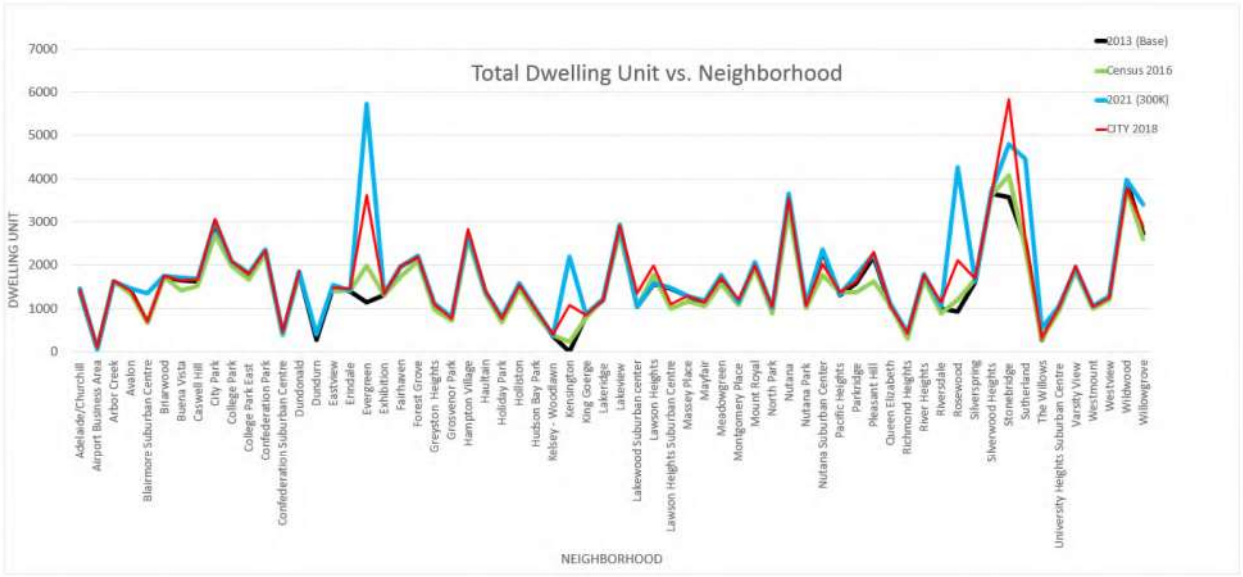


Figure 4.5: Example of Model Validation

In general, the comparison shows reasonable agreement between the modelled and measured data from 2013 to 2021. In specific locations, for example Evergreen, Kensington, and Rosewood, the dwelling unit counts grow reasonably from the 2013 base model to the 2021 model horizon year. In most neighbourhoods there is negligible growth, as expected for mature areas of the City.

In a few locations the 2018 City count already exceeds the forecasted 2021 model totals, most notably in Stonebridge. The City commented that the Stonebridge community might be at capacity now with many infill developments taking place recently. It was agreed that the model forecast Dwelling Units total for this neighbourhood should be matched to the City's 2018 counts.

4.1.2 Updating

Modification of the model for use in the SFFPS was carried out carefully, with the guiding principle being to change as little as possible in order to minimize the invalidation of the model calibration that was achieved by the original effort in 2015. However, some changes were necessary to accommodate the freeway itself, and new plans for development. Changes were also needed to correct poor behaviour in future year models, such as excessive use of U-turns and traffic taking unrealistically circuitous routes. Corrections to the model were also required such as removal of roads that existed in 2013 but will not remain connected once the freeway is in place (e.g. Range Road 3055 between Township Road 374 and Township Road 380).

The initial stage of model modification included review of the model documentation along with the actual model as implemented in the VISUM software. This effort revealed a number of cases of the model implementation not being aligned with the documentation or with the current plans of study area authorities. For example, the original model showed 62,000 dwelling units and 67,000 employment in Traffic Area Zone (TAZ) 272, however in discussions with TWG members, it was concluded this would not happen in the future.

Growth Plan Updates

It was noted from the HDR model development report that the forecasts done in the model are expected to be updated in future as P4G and other regional stakeholders continue to carry out their own land use planning processes. This updating was carried out through review of a number of relevant sources, listed in **Table 4.7**.

Table 4.7: Model modification data sources

DEVELOPMENT SECTOR	SOURCE	URL
P4G Regional Plan	P4G website	https://partnershipforgrowth.ca/regional-plan/
Blairmore Sector Plan	CoS Website	https://www.saskatoon.ca/sites/default/files/documents/community-services/planning-development/future-growth/sector-planning/approved_blairmore_sector_plan_amendment_march_7_2011.pdf
Holmwood Sector Plan	CoS Website	https://www.saskatoon.ca/sites/default/files/documents/community-services/planning-development/future-growth/sector-planning/holmwood_sector_plan_2017_final.pdf
Riel Industrial Sector Plan	CoS Website	https://www.saskatoon.ca/sites/default/files/documents/community-services/planning-development/future-growth/sector-planning/riel_industrial_sector_plan_-_amended_january_25_2016.pdf
University Heights Sector Plan	CoS Website	https://www.saskatoon.ca/sites/default/files/documents/community-services/planning-development/future-growth/sector-planning/UniversityHeightsSectorPlan2013Amendment.pdf
P4G Regional Plan	P4G website	https://partnershipforgrowth.ca/regional-plan/
Blairmore Sector Plan	CoS Website	https://www.saskatoon.ca/sites/default/files/documents/community-services/planning-development/future-growth/sector-planning/approved_blairmore_sector_plan_amendment_march_7_2011.pdf

It was confirmed that the P4G report development zone boundaries are generally aligned with the boundaries of the Saskatoon City limits and development sector plans. The one exception was an area of apparent overlap between the City's current limits and the future P4G lands in the north of the Holmwood Sector Plan (TAZ 417, discussed below). However, the impact of this mismatch is negligible as the current model data for this TAZ is rather minimal (14 Dwelling Units and 13 Employments).

City of Saskatoon Sector Plans

Four Sector Plans had been developed (shown in **Figure 4.6**) in more detail following the completion of the original base model, so these were reviewed and added to the 2063 horizon year model. This required both modifications to the model network and adjustments to the zone growth forecasts. The four new sector plans are described below.

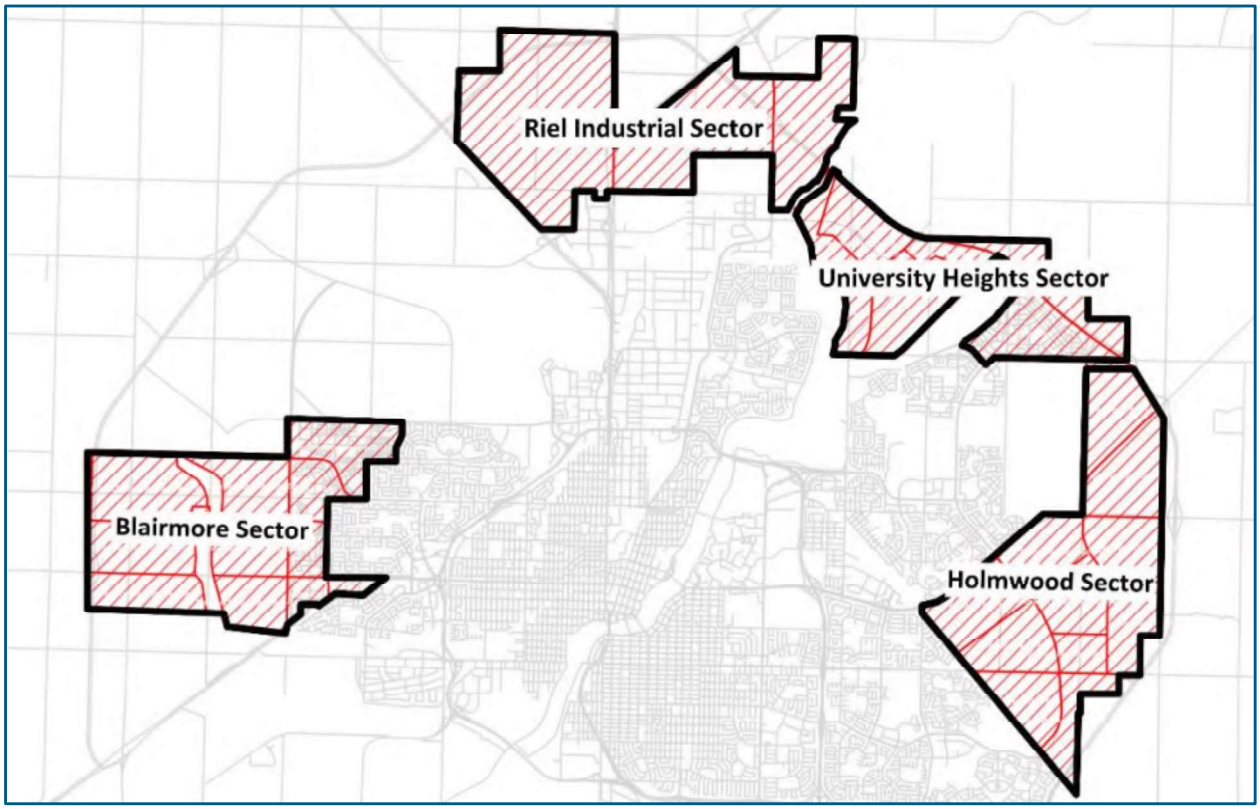


Figure 4.6: Four Sector Plan Locations

Blairmore

The Blairmore sector is located east of Perimeter Highway; north of the Canadian Pacific Railway rail line; west of Hampton Village, Dundonald, Confederation Park, Pacific Heights, and Parkridge neighbourhoods; and south of Beam Road (RM of Corman Park road). There are five main roads that form the major arterial links within the Blairmore sector; 33rd St W, 22nd St W, Diefenbaker Dr, McClocklin Rd, and Claypool Dr. Five additional major roads were added to provide better network connections including connection to the freeway at the future Claypool Drive interchange.

Holmwood

The Holmwood Sector Plan report states the sector is Saskatoon's newest Suburban Development Area (SDA) for future urban expansion and the majority of the lands remain unserviced and undeveloped at this point in time. The updated model has added major roads and intersections within the sector to provide better network connection.

Riel Industrial

The Riel Industrial Sector is north of the Marquis Industrial Area and northeast of Highway 16, south of the Perimeter Highway alignment, and west of the South Saskatchewan River. The Riel Industrial Sector will accommodate fully-serviced light and heavy industrial, four commercial nodes, recreation areas/facilities, and the incorporation of the wetland complex. The Riel Industrial Sector is anticipated to employ 32,000 employees at full build out.

University Heights

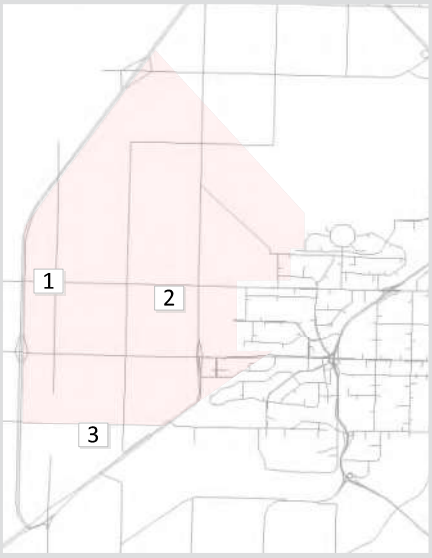
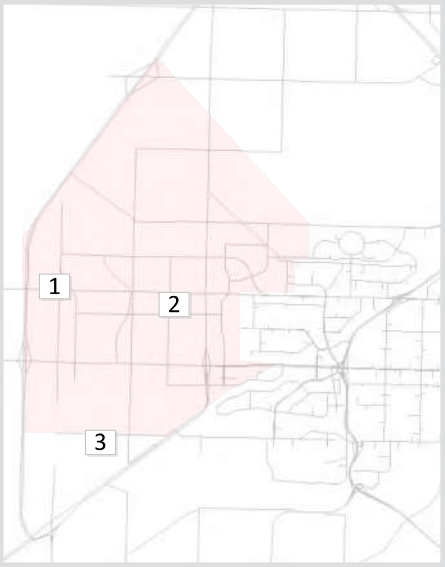
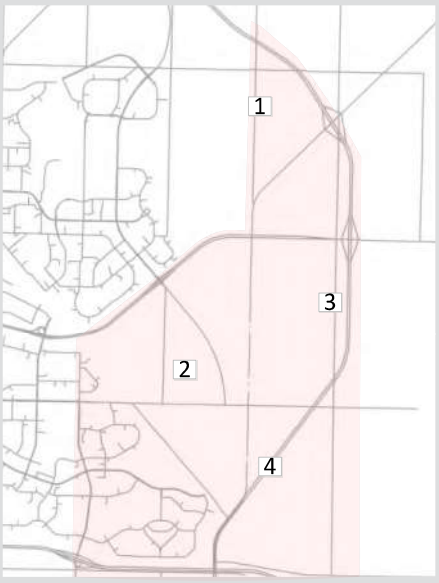
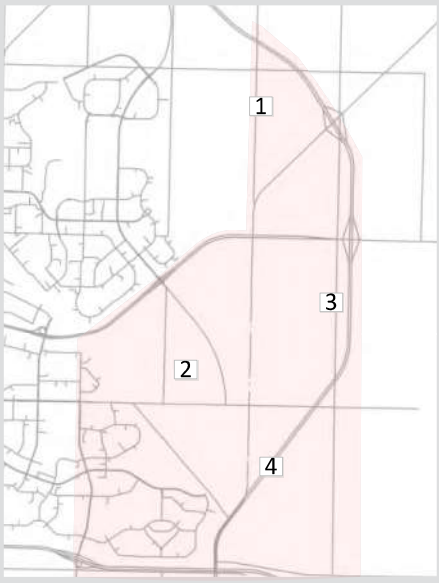
The University Heights SDA is made up of Saskatoon's northeast neighborhoods, the University of Saskatchewan (University) lands, Agriculture and Agri-food Canada research lands, and future urban development lands.

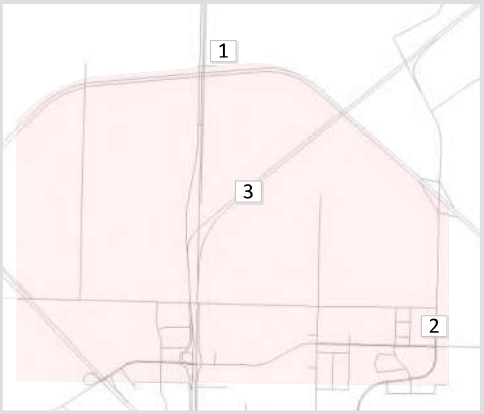
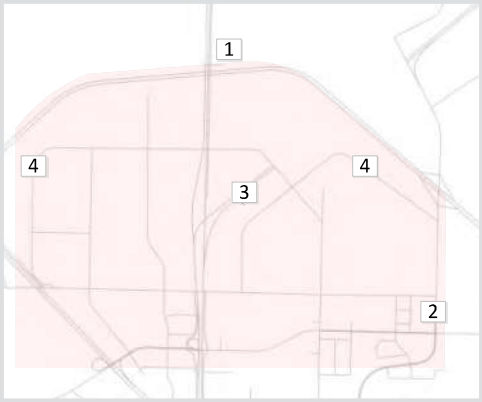
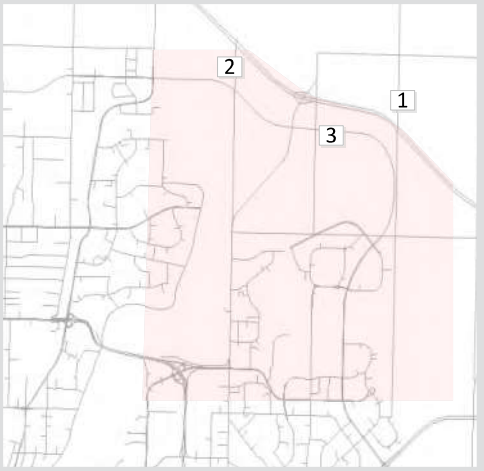
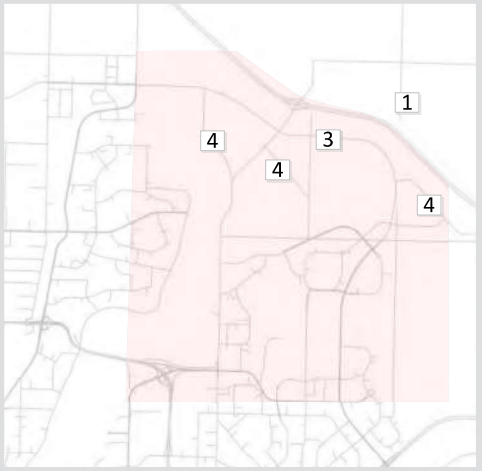
Updating the model to accommodate the four sector plans required modification to the network in the model including zone connectors. As these details were added in each sector a number of flow checks were done, often using the VISUM "flow bundle" tool to check that the major vehicle flows were making reasonable route choices. Through these checks a number of network shortcomings were observed and changes made to mitigate the issues. For example, some interchanges were modelled in the original network where there were none planned in any of the sector plans and links and nodes were disabled or removed in places to produce more realistic traffic flow. Other network adjustments were made to reduce misuse of low capacity links and eliminate routes that will not exist in future (e.g. roads that cross the future freeway alignment were typically remaining in the original 2063 model). For zones, the numbers of connectors were modified in every development area to provide a better connection between the zone and the road traffic network. For example, one of the connectors modelled as crossing over the freeway which would not be realistic once the freeway is in place (see **Figure 4.7**)

Figure 4.7: Connector changes in 2063 model (Riel Industrial Sector)

The following **Table 4.8** shows the key modifications made in the model to incorporate and account for future traffic flows specific to each of the four sector plans. This table does not show every modification made, but the most significant ones and examples of typical sorts of changes that were implemented in the 2063 modified network.

Table 4.8: Key Modifications for Sector Plan Updates in the Model

DEVELOPMENT SECTOR	ORIGINAL 2063 MODEL	UPDATED 20163 MODEL
Blairmore		
Key Modifications	Removal of links in model (provided freeway crossing where the sector plan didn't indicate). Removal of links & nodes (interchange with 33rd Street West), which is not shown in the sector plan. Grade separation modification at the Township Road 364 crossing of the freeway (grade separation, not an interchange).	
Holmwood		
Key Modifications	Removal of existing road link that crosses the freeway where no grade separation was indicated in the sector plan. Created collector and arterial links including new interchanges at the intersection of 8th Street and the freeway as per the Holmwood sector plan.	

DEVELOPMENT SECTOR	ORIGINAL 2063 MODEL	UPDATED 20163 MODEL
Riel Industrial Sector		
Key Modifications	Removal of link at Highway 12 service road because it is too attractive compared to future congested Highway 12 (misleading flow resulted). Wanuskewin road existing south of Marquis is 4-lane major arterial, north it reduces to 2-lanes. However, in future with freeway to the north, 4-lane should be extended through the interchange all the way to Highway 11. This section was changed to Major Arterial all the way to Highway 11. Removed Highway 11 crossing the freeway. Created arterial and collector links including new intersections as per the Riel Industrial sector plan.	
University Heights		
Key Modifications	Removed link which accessed the freeway where there is no interchange planned. Existing Central Avenue road straight part was removed in University of Heights sector plan because traffic showed diverting from the future network/should not be continued in the future. Removed link in model because connection unlikely as a new interchange is right beside it. Created arterial and collector links including new intersections as per the University Heights sector plan.	

Saskatoon North Partnership for Growth

The P4G Regional plan was used to develop the rural area land-use. A review of the model zones in the area surrounding the CoS was carried out to establish the content of the model and data available. A visual check by overlapping the model network with the P4G map image (**Figure 4.8**) determined that the boundary lines in the model essentially match the P4G geography.

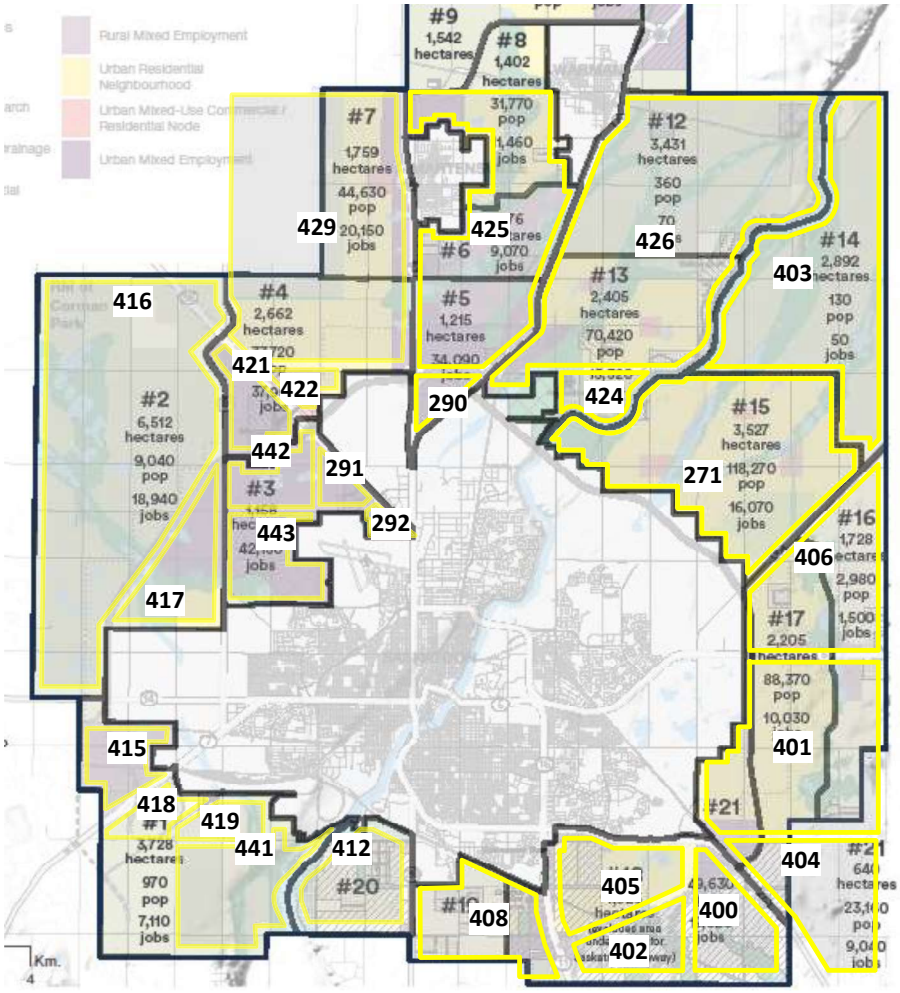


Figure 4.8: P4G Area Map Overlaid on the model TAZ system

Table 4.9 shows the VISUM model contains all TAZ boundaries that are generally aligned with the boundaries of the Saskatoon City limits, and so in most cases each P4G zone corresponds to one or more whole model TAZ. In some cases, one P4G area covers some fractional combination of model TAZ as indicated in the table.

Table 4.9: P4G Model Zone

P4G AREA	TAZ	MODEL ULTIMATE			P4G		P4G MODEL	
		Dwellings Total	Population	Jobs Total	Population	Jobs	Population	Jobs
1	415+418+419+441	30.3	55	21	970	7,110	915	7,089
2	416+417	57.3	105	63	9,040	18,940	8,935	18,877
3	291+292+442+443	14.2	26	891		42,150	-26	41,259
4	421+422+1/3 of 429	62.8	115	24	77,720	37,950	77,605	37,926
5	290+1/3 of 425	122.8	225	588		34,090	-225	33,502
6	1/3 of 425	114.0	209	460		9,070	-209	8,610
7	1/3 of 429	46.1	84	16	44,630	20,150	44,546	20,134
8	1/3 of 425	114.0	209	460	31,770	11,460	31,561	11,000
9	427	198.9	364	184	18,520	6,410	18,156	6,226
10	1/3 of 426	43.1	79	37	18,840	17,960	18,761	17,923
11	423	114.8	210	116	60	4,520	-150	4,404
12	1/3 of 426	43.1	79	37	360	70	281	33
13	424+1/3 of 426	52.5	96	49	70,420	15,320	70,324	15,271
14	403	610.1	1,117	39	130	50	987	11
15	271	0.0	-	19,888	118,270	16,070	118,270	-3,818
16	1/2 of 401 + 1/2 of 406	95.0	174	27	2,980	1,500	2,806	1,473
17	1/2 of 401 + 1/2 of 406	95.0	174	27	88,370	10,030	88,196	10,003
18	400+402+405	557.7	1,021	987	49,630	19,820	48,609	18,833
19	408+407	1278.3	2,339	2,612			-2,339	-2,612
20	412	3720.5	6,808	164			-6,808	-164
21	404	31.9	58	1,110	23,160	9,040	23,102	7,930
		Totals:	**13,547**	**27,800**	**554,870**	**281,710**	**541,323**	**253,910**

There was one significant modification made in the model, being TAZ 272 shown in **Figure 4.9** just west and south of Wanuskewin Heritage Park. In the original 2063 model, this particular TAZ contained over 60,000 Dwelling units (approximately 113,000 population). However, it was agreed in discussion among the TWG that there was little chance of residential development in this TAZ owned by the CoS but leased to Wanuskewin and slated for introduction of buffalo (N. Sarnecki personal communication, October 15, 2019). As such all dwelling units were removed from TAZ 272 in the model.

Figure 4.9: Modification in TAZ 272

An additional change developed in TWG discussions was the addition of 100,000 population in the model to the east of the Saskatoon Freeway (see **Figure 4.10**). Land-use data at three TAZs (271, 401, and 406) were modified based on distributing the population simply by the area of the TAZ.

It is noted that total population of the network had slightly reduced from original HDR model. This is due to the updating of population and dwelling unit land-use information using the new sources, for example most of the employment was removed in the Blairmore development area as the sector plan shows most of the area planned as residential. Below **Figure 4.11** and **Figure 4.12** are representing the land-use difference between original model and modified model.

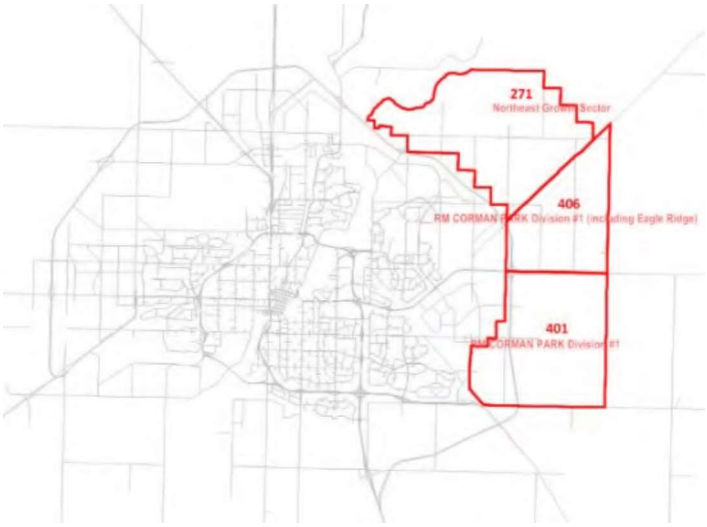


Figure 4.10: Additional 100k population modification

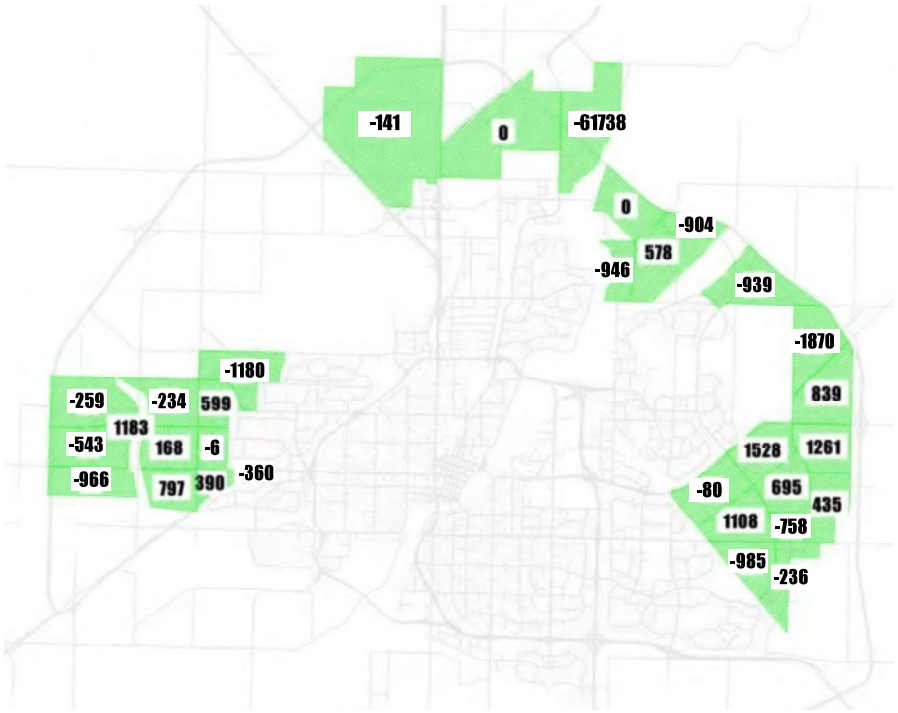


Figure 4.11: Dwelling Units data changes between original and modified

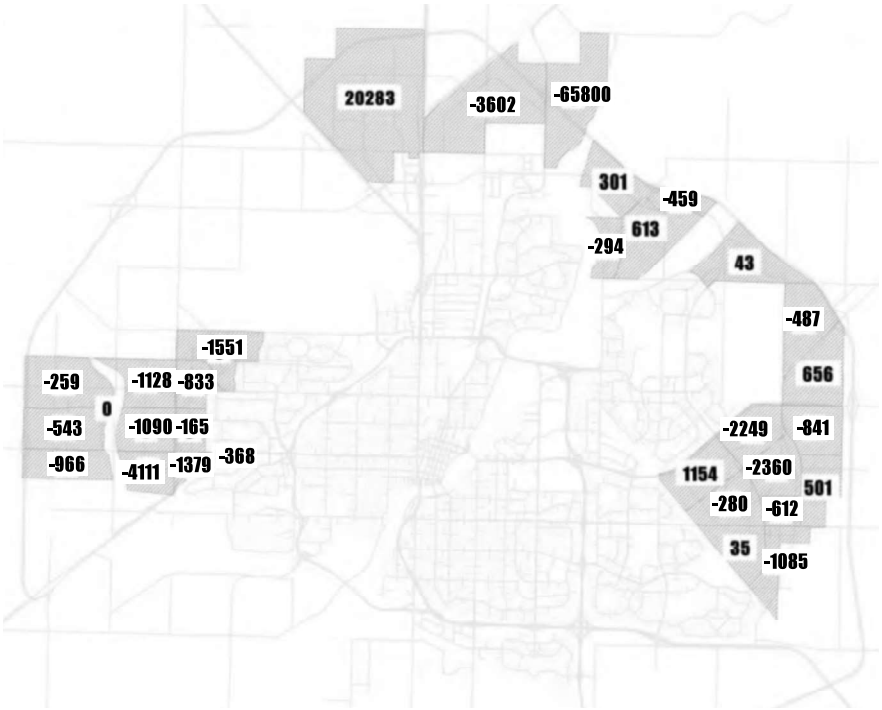


Figure 4.12: Employment data changes between original and modified

Thus, the modified 2063 model contains approximately 830,000 population totals for the entire model with approximately 400,000 employments (using 1.83 conversion factor (population/DU) to calculate the input value of dwelling unit in the model based on the original model's 2063 assumption as noted earlier). 2063 Dwelling Unit, Population, and Total Employment totals are presented in **Table 4.10**.

Table 4.10: 2063 Dwelling Unit and Employment Information

LAND	TOTAL DWELLING UNIT	POPULATION	TOTAL EMPLOYMENT
Inner CoS	349,098	638,848	352,761
Outer CoS (P4G Area)	59,642	109,145	24,228
City of Martensville	21,963	40,193	5,125
City of Warman	23,324	42,683	11,506

Martensville & Warman

The City of Martensville official community plan (September 2016) notes the Statistics Canada 2011 population of 7716 and experience of robust annual population growth of 55% over the last five years. However, it was agreed in the TWG meeting that no modification would be made from the original model long term growth assumption of 4% CAGR.

The City of Warman official community plan (December 2014) also states that average annual growth rate between 2000 and 2013 is 6.8% with a median annual change of 6.6%. It was agreed with City of Warman (B. Toth, personal communication, September 4, 2020) that a 4% annual growth rate is a reasonable long-term estimate given fluctuations above and below that figure.

The TAZ P4G map overlay image confirms that the TAZ boundaries for Martensville are well aligned, but the zone boundaries are not completely aligned for the City of Warman. For the purposes of assessing the usage of the new freeway however, the exact alignment of TAZ with the limits of these Cities is not critical, as they are not directly adjacent to the freeway corridor, and so the future development is still likely to access the same freeway interchanges to the south of the cities regardless of the precise arrangement of development in Warman. This was agreed in a TWG meeting and as such, the Warman zones were not modified in the model.

4.1.3 Forecasting

The 2063 horizon model, with the modifications described in the preceding sections of this report, was used to the test the impacts of planned Saskatoon Freeway interchanges in the Phase 1 (northeast quadrant) area of the Saskatoon Freeway. The Wanuskewin Road and Highway 11 Interchanges with the Saskatoon Freeway were of particular interest due to their close proximity and the effect of the nearby river crossing potentially forming a bottleneck in the Phase 1 section of the future freeway. The AM and PM peak hour travel volumes by all modelled modes are summarized in **Figure 4.13**.

Figure 4.13: Total Travel Demand (Vehicle Trips) 2063 horizon

The need for lanes on the freeway was assessed particularly at the South Saskatchewan River crossing where the initial assumption of a basic 4-lane freeway cross-section showed capacity would be exceeded. The location where the Saskatoon Freeway, Highway 11 and Wanuskewin Road traffic merges to go east across the river was examined in greater detail to select a lane arrangement to merge these three traffic streams on to the bridge. To test the performance of this merging area with different lane arrangement PTV VISSIM was used to carry out micro-simulation analysis.

The detailed analysis was prepared in a VISSIM micro-simulation model using the forecast volumes in VISUM to estimate the impacts at the merge of Wanuskewin Road, Saskatoon freeway and Highway 11 to the west of the river. Multiple different interchange configurations were tested to investigate the sensitivity of operations. A report discussing the microsimulation scenarios, results and recommendations is included in **Appendix C**.

4.2 Route Continuity

Driving a vehicle involves six basic driving conditions (SGI, 2019):

- Driver Condition
- Vehicle Condition
- Light Condition
- Weather Condition
- Road Condition
- Traffic Condition

Most important is the Driver Condition so that the driver *"…can adjust to all the other conditions…"* (SGI, 2019). Road conditions *"change from one kind of road to another…"*. Freeway driving involves increased speed and multiple lanes of traffic along with many other features. The driver's task load increases with complexity. *"The degree of this risk is a function of the traffic volumes on the minor road, the complexity of the curved alignment, and the complexity of the intersection geometry"* (Saskatchewn Minsitry of Highways and Infrastructure, 2009).

Route continuity refers to the provision of a directional path along and throughout the length of a designated route (TAC, 2007). *"The principle of route continuity simplifies the driving task in that it reduces lane changes, simplifies signing, delineates the through route, and reduces the driver's search for directional signing"* (TAC, 2007). *"Desirably, the through driver, especially the unfamiliar driver, should be provided a continuous through route on which it is not necessary to change lanes and through traffic vehicular operation occurs on the left of all other traffic. In maintaining route continuity through cities and bypasses, interchange configurations need not always favour the heavy movement but rather the through route"* (TAC, 2007). The Transportation Association of Canada (TAC) definition of Route Continuity states that it is not necessary to change lanes; however, the Ministry has accepted that some lane changes are acceptable if direction is provided well in advance, given that additional lanes are being added between Highway 16 and Highway 11 for capacity requirements.

Highway 11 and Highway 16; which are National Highways, share a segment of the Saskatoon Freeway illustrated in **Figure 4.14** purple and green highway routes.

A major fork design can be used at points where a shared freeway segment begins. *"A major fork occurs when a terminating freeway/expressway divides into two directional ramps that connect to another crossing freeway or when a freeway branches into two connecting ramps to separate high-speed road routes of equal importance. In effect, there is a left exit"* ramp and a right exit ramp with no through movement. A high ramp design speed should be provided" (TAC, 2007). Major connectors are used where two freeways merge into one shared freeway.

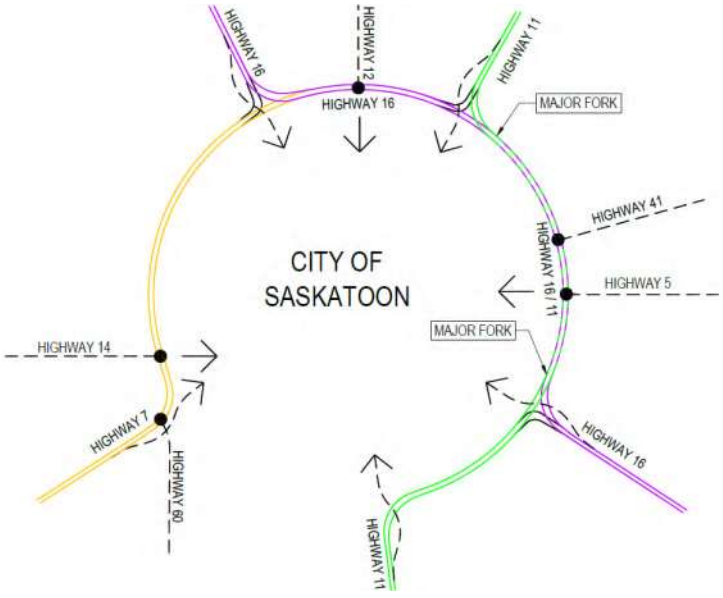


Figure 4.14: Highway 11 and Highway 16 Route Continuity

In simple terms a driver should not have to exit Highway 16 or Highway 11 to stay on these routes. Additionally, the driver should be able to maintain the posted speed along the highway route. The point in Phase 1 where Highway 11 and Highway 16 separate into two separate freeways from the shared portion of the Saskatoon Freeway occurs at the Highway 11 Interchange; therefore, the functional design concept incorporates a major fork design as a means of maintaining route continuity. Route continuity is considered an important freeway attribute for these national highway routes.

The Highway 12 and Highway 16 interchanges also incorporate major fork design features even though they do not involve shared segments of provincial highways. This was implemented as a means of achieving design consistency and improve driver expectations.

5 Functional Design

5.1 Design Criteria

5.1.1 Freeway

The Saskatoon Freeway will be designed, as a minimum, divided four-lane freeway with a 130 km/h design speed. The freeway will be classified as a D-130-7430 roadway in accordance with the Saskatchewan Ministry of Highways (Ministry) Design Manual (DM) and Standard Plans (SP), Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads, and the Ministry Supplement to the TAC Geometric Design Guide (SKS). The freeway includes a 32 m median, and would be constructed within a minimum Right-Of-Way (ROW) width of 101.4 m. A summary of the geometric design standards for the Saskatoon Freeway is provided below in **Table 5.1.**

Table 5.1: Highway Geometric Design Standards

ITEM		GEOMETRIC DESIGN STANDARD
Functional Highway Classification		D-130-7430 (Divided) Provincial Highways Saskatoon Freeway
Minimum ROW Width (m)		101.4 m
Equivalent Minimum "K" Factor	Crest	195
	Sag	75
Minimum Stopping Sight Distance (m)		290 m
Decision Sight Decision (m)		375 m
Maximum Grade (%)	Upgrade	3%
	Downgrade	5%
Minimum Grade (%)		0.0%
Maximum Superelevation (%)		6%
Minimum Radius (m)		950 m
Minimum Spiral "A" Parameter (m)		300 m
Number of Lanes		4
Through Lane Width (m)		3.7 m
Shoulder Width (m)	Inner	1.0 m
	Outer	3.0 m
Standard Cross-Fall (%)	Lanes	2%
	Inner Shoulder	2%
	Outer Shoulder	5%
Median Width (m)		32 m

Divided Mainline Side Slope (Standard Plan 21010, except as noted in adjacent columns)	Fills 0-4 m	6:1
	Fills 4-5 m	Slope variable, toe fixed at 24 m
	Fill over 5 m	4:1, widen subgrade and finished surface by a width of 0.9 m each side for guardrail where required
Surfacing Structure		Standard Pavement - Asphalt Concrete

The Saskatoon Freeway crosses the following three highways through the Phase 1 limits:

Highway 11: North of the Saskatoon Freeway, Highway 11 is a divided four lane highway with a 130 km/h design speed and connects the City of Saskatoon (CoS) with Prince Albert. Highway 11 is part of the National Highway System and presently connects with Highway 12 south of the Saskatoon Freeway and becomes Idylwyld Drive though the CoS. Highway 11 continues through the CoS and connects with the City of Regina.

Highway 12: Highway 12 is a divided four lane highway with a 130 km/h design speed within the study limits. In the future, Highway 12 will function as a freeway north of the Saskatoon Freeway. The function of Highway 12 south of the freeway is under study by the CoS at this time. It is not known if the road will be an arterial or freeway. Interchange layout concepts for Highway 12 will be designed to accommodate a potential future widening to six lanes through the study limits.

Highway 16: Highway 16 is a divided four lane highway with a 130 km/h design speed within the study limits. Highway 16 is part of the National Highway System and connects the CoS with the City of Edmonton to the north and the City of Winnipeg to the east.

5.1.2 Interchanges

Within the Phase 1 study limits, system level interchanges are recommended along the Saskatoon Freeway at Highway 16 and Highway 11. As discussed previously in this report, these highways are part of the National Highway System and share a segment with the Saskatoon Freeway. As such, these provincial highways will be designed to the same D-130-7430 standard as the Saskatoon Freeway and will diverge from the Saskatoon Freeway utilizing a major fork design. Major forks are being used due to the equal importance of the National Highway System and the Saskatoon Freeway. A fork will also be used on south bound Highway 12 to eliminate a need for a left-hand exit. The major fork will allow the 130 km/h design speed to be maintained along the National Highway System route with other movements being designed at a lower speed.

In addition to the two system level interchanges, Phase 1 includes service level interchanges along Saskatoon Freeway at Highway 12, and along Highway 11 at Penner Road.

The geometric design standards for interchange ramps are summarized in **Table 5.2** below:

Table 5.2: Interchange Geometric Design Standards

ITEM		GEOMETRIC DESIGN STANDARD
Single Lane Ramp Width (m)		4.8 m
Minimum Design Speed of Loop Ramp (km/h)		50 km/h
Ramp Spacing From Mainline (m)		105 m
Shoulder Width (m)	Left	0.6 m
	Right	2.5 m
Minimum Radius of Curve	DS=50*	90 m
	DS=60*	130 m
	DS=70*	190 m
	DS=80*	250 m
	DS=90*	340 m
	DS=100*	440 m
	DS=110*	600 m
	DS=120*	750 m
	DS=130*	950 m
Equivalent Minimum "K" Factor Crest (Sag)	DS=50*	10 (10)
	DS=60*	15 (15)
	DS=70*	25 (25)
	DS=80*	40 (30)
	DS=90*	50 (35)
	DS=100*	85 (45)
	DS=110*	125 (55)
	DS=120*	165 (65)
	DS=130*	195 (75)
Desired Minimum Mainline Grade Height Above Natural Ground (DM 402-1)		0.6 m

*50 km/h design speed to be used for loop ramps only. 60 km/h – 90 km/h design speed to be used for Highway – Arterial connections. 100 km/h – 120 km/h to be used for Highway – Highway connections. 130 km/h Design speed to be used along Saskatoon Freeway and maintaining route continuity between National Highways (Highway 16, Highway 11, and Highway 7).'

In addition to the above, the following design standards were considered in the development and evaluation of interchange concepts:

Interchange Spacing: Based on the Saskatchewan Roadside Management Manual (RSMM 430-30), the Saskatoon Freeway is considered 'U-1' access management level which represents the highest level of urban control and is considered a freeway standard. At-grade intersections are not permitted at this access management level and interchanges are to be spaced at a minimum of 3.2 km. Additionally, a minimum weaving length will be maintained to ensure efficient operation on freeways. In particular, Section 3.7.3.3 of TAC Geometric Design Guide for Canadian Roads recommends 'weaving length between a freeway interchange and an arterial interchange normally should be in the range of 800 m to 1000 m and between arterial interchanges in the range of 550 m and 700 m.

Consecutive Exits: One exit point per direction of travel will be permitted at each interchange. An exception is allowed at interchanges where major forks are provided such as the Saskatoon Freeway westbound at the Highway 11 and Highway 16 interchanges. Collector-Distributor C-D roads (or sub-collectors) will be utilized along eastbound Saskatoon Freeway to combine consecutive exits at each interchange. C-D roads will be designed as single lane exits from the freeway with a separation of 17 m between mainline and C-D driving lanes.

Ramp Design: Direct tapers shall be used for freeway exit and entrances. TAC Figures 10.8.2 and 10.8.7 shall be used for tapered exit and entrance lanes, respectively.

Design Vehicles: Critical interchange movements and at intersections along the National Highway System (as described in **Section 2.2.1**) will be designed to accommodate at a minimum WB-20 design vehicle (**Figure 5.1**), as well as consideration to Long Combination Vehicle (LCV) trucks permitted in Saskatchewan.

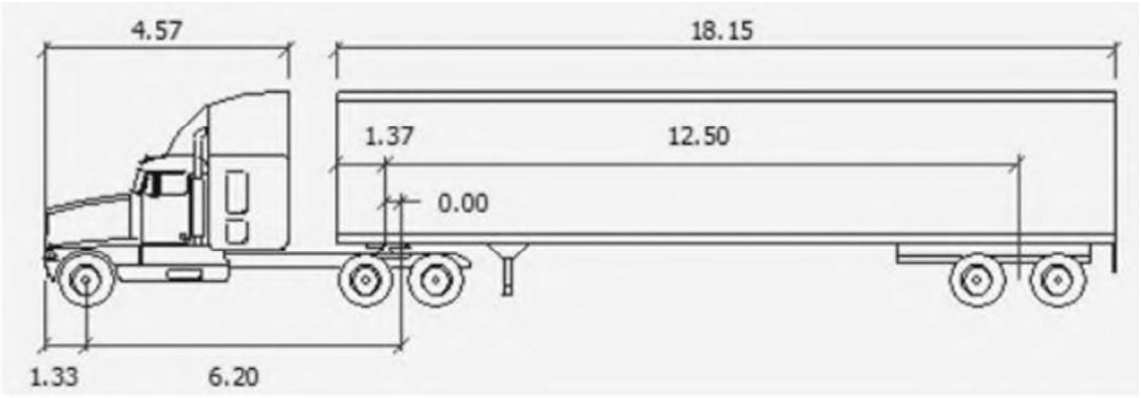


Figure 5.1: WB-20 Design Vehicle Dimensions

Roundabouts: Roundabouts will be considered at ramp terminal intersections as a concept to signalized intersections. If warranted, roundabouts will be designed in accordance with the Alberta Transportation Design Bulletin 68, Roundabout Design Guidelines on Provincial Highways. The Alberta Ministry of Transportation standards (Design Bulletin #68/2010) for roundabouts was used for the Regina Bypass Project, which requires a minimum WB-21 design vehicle (**Figure 5.2**) and is recommended to be used for the Saskatoon Freeway. Currently only single lane roundabouts are allowed in Saskatchewan.

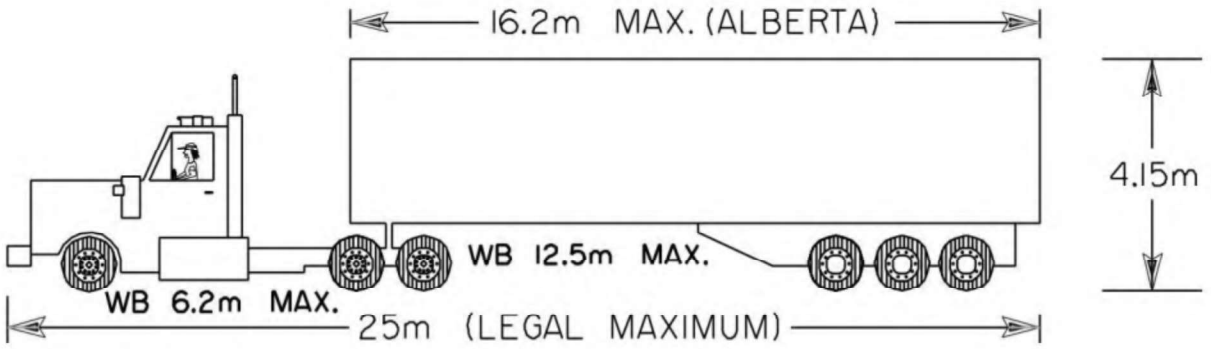


Figure 5.2: WB-21 Design Vehicle Dimensions

Pavement Widening at Structures: Mainline pavement widening (including speed change lanes for ramps, forks, and connectors) adjacent to the South Saskatchewan River to begin a minimum of 100 m from the structure abutments.

5.1.3 Secondary Roads

Wanuskewin Road is a two-lane road with a posted speed of 90 km/h through the study limits. Wanuskewin Road connects to Highway 11 north of the Saskatoon Freeway and widens to four lanes just north of 71st Street. It runs north-south along the west side of the CoS and becomes Warman Road south of Lenore Drive.

Millar Avenue is a two-lane road through the study limits. South of 71st Street, Millar is a four-lane road with a posted speed of 60 km/h. Millar Avenue ends at Circle Drive. Rock Ridge Road (Range Road 3053) starts north of the present alignment of Highway 11 and has the same north/south alignment as Millar Avenue. Rock Ridge Road continues north to Martinsville. It has intersections with Township Road 380 and Cory Road.

Penner Road (Township Road 380) is a two-lane road that runs east-west and provides primary access to the Wanuskewin Heritage Park and Cathedral Bluffs.

The Rural Municipality (RM) of Corman Park surrounds the CoS and includes over 1200 km of municipal roads spanning over 2,000 km^2. The roadway standards for an Industrial Paved Road in the RM of Corman Park are summarized below in **Table 5.3**.

Table 5.3: RM of Corman Park Standards – Industrial Paved Road

ITEM	GEOMETRIC DESIGN STANDARD
Minimum Right-of-Way Width (m)	46.0 m
Design Speed (km/h)	100 km/h
Finished Top Width (m)	4.5 m/lane
Standard Cross-Fall (m/m)	0.02
Minimum Radius (m)	440 m
Side Slope	3:1 to 4:1
Ditch Bottom Width (m)	4.0 m to 7.0 m
Maximum Road Gradient (%)	5%
Stopping Sight Distance (m)	200 m

Additional details are provided in the Design Criteria Memorandum located in **Appendix D**.

5.1.4 Bridge

The Bridge Design Criteria is documented in the "Structure Design Criteria Summary" dated April 15, 2020 included in **Appendix E**. The roadway geometry determines the bridge opening for the roadway and railway overpasses. Vertical and horizontal clearances have been set to meet Ministry bridge requirements and the use of open abutments with headslopes set at 3:1 (H:V). The use of Mechanically Reinforced Earth (MSE) retaining walls are an option to reduce bridge span lengths and will be preferred at overpass locations with a high skew angle to the underlying roadway. Foundation support for the abutments will be independent of the MSE walls.

In general, the following Ministry standards are used for the conceptual design of the roadway, railway and river bridges:

- Bridge Design Criteria BD100-Ver 2018-1;
- Standard Plans 20150, 20152 & 20154; and
- TAC Geometric Design Supplement SKS2.2.10-A.

Vertical Alignment: A minimum longitudinal grade of 0.5% has been provided on bridge decks that are not located on vertical curves. Bridges located on vertical curves shall have the crest of the vertical curves located beyond the length of the superstructure and approach slabs and in no case shall more than 20 m length of bridge have a gradient less than 0.5%.

Vertical clearance for roadway overpasses shall be a minimum of 5.3 m clear from the top of the underlying roadway to the underside of the superstructure.

Vertical clearance for railway overpasses shall be a minimum of 7.31 m from the top of rail to the underside of the superstructure.

Horizontal Alignment: The location of abutments, piers, straddle bents and MSE retaining walls is based on providing lateral clearances shown on Standard Plan 20154 – Lateral Clearances at Underpasses for Roadway Structures. A minimum clearance of 9.0 m shall be provided from the edge of the lane to the face of from abutment, pier, straddle bent or MSE retaining wall.

Locations of abutments and pier for all railway overpasses shall provide clearances and allowance for a second future track, a maintenance road and a multi-use pathway in accordance CN Rail and Transport Canada Standards.

Overpass widths shall accommodate the lane and shoulder widths of the roadway.

5.1.5 Drainage

The functional drainage design considered standards and recommendations from several sources. Detailed information on where these criteria were applied are found throughout the Drainage Concept section of this report (**Section 5.5**).

The primary focus of the functional drainage design was to identify and pass existing watershed(s) with no change to the flow or drainage path. The design also considered the Freeway's impact on peak runoff and how that flow might be detained along each section of the Freeway.

The *TAC Geometric Design* Guide for Canadian Roads and the *Saskatchewan Supplement to the Geometric Design Guide for Canadian Roads* were both referenced:

- Table SKS 2.2.8-A.1 in the Geometric Design Guide Supplement (Interim) indicates minimum ditch grades. In areas where drainage influenced the Freeway profile the desirable minimum outer and median ditch grades were applied;
- To ensure a desirable ditch depth ≥ 1.2 m, the standard ditch depths were not adjusted. Rather, the road embankment was raised to allow existing drainage to pass; and
- The standard maximum culvert spacing of 800 m was not necessary to achieve functional drainage. Therefore, the location of additional culverts required to meet this standard will be left to the detailed design phase.

This provides a conservative design at this stage that meets all requirements. In the detailed design stage the drainage plans may be refined to optimize trade-offs between ditch gradient, ditch depth and embankment profile.

Rainfall Intensity data was sourced from the *CoS New Neighbourhood Design and Development Standards Manual*.

Through correspondence the Saskatchewan Water Security Agency provided guidance on detention of increased peak runoff, lost retention, and impacts on the Hudson Bay Swale and downstream Opimihaw Creek, which is a site specific consideration.

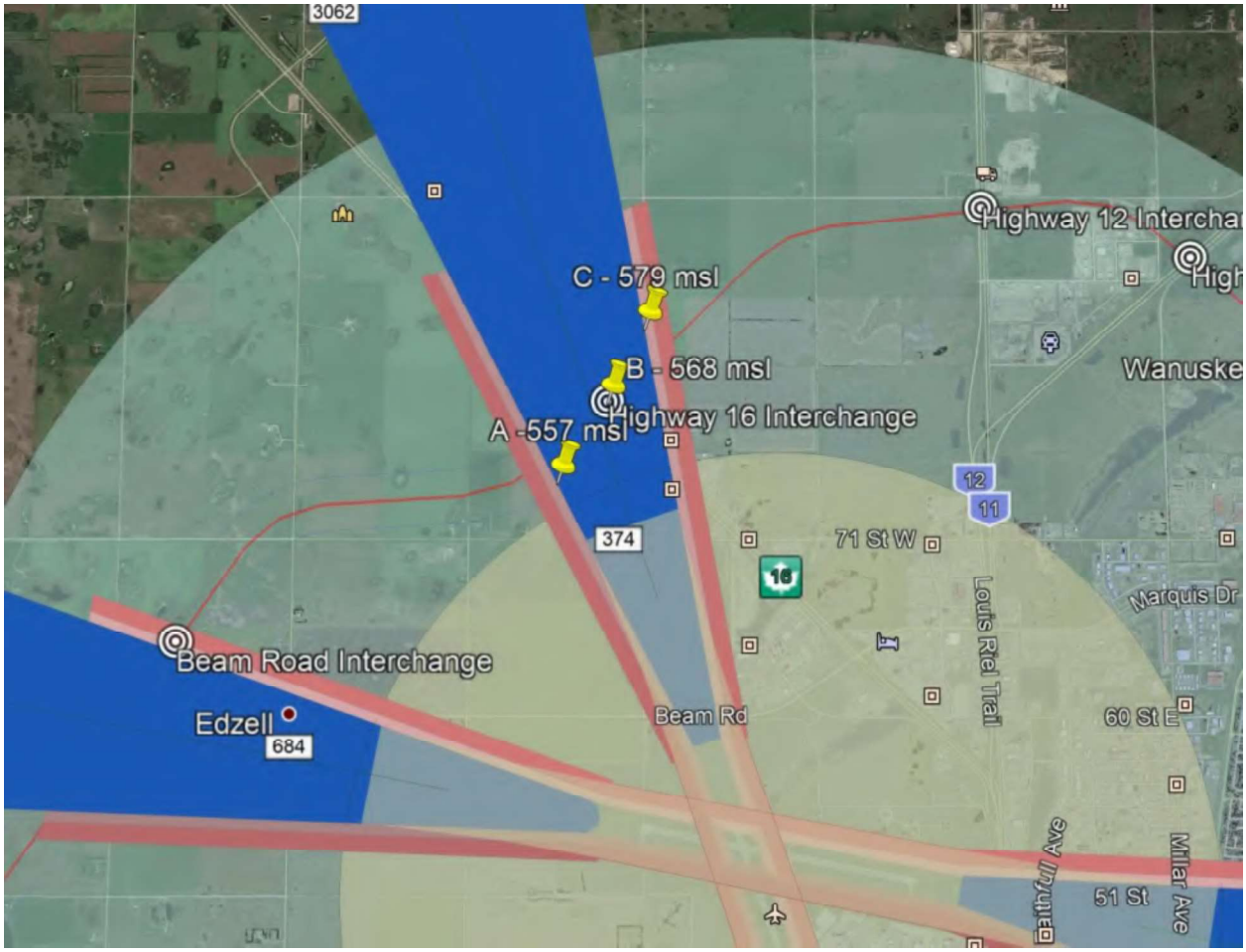
5.1.6 Airport

The Saskatoon Airport Authority was contacted for information on the Airport Zoning Regulations and local restrictions that may influence the drainage design near the John G. Diefenbaker International Airport. Two design requirements have been highlighted in the drainage report: proximity of water bodies to the airport and height restrictions. The Phase 1 functional designs are compliant with both criteria.

Water bodies created through deep type earth borrow sources should be located outside of a 4 km radius unless bird mitigation measures are designed and approved by the Saskatoon Airport Authority. **Figure 5.3** illustrates the proximity of the Saskatoon Freeway to the desired 4 km restriction zone.

A review on the height restrictions related to the airport was completed. The Highway 16 interchange is approximately in line with runway 15/23 as illustrated in **Figure 5.4**. The elevation of the approach slope, near the Highway 16 interchange, is approximately 61 m above ground level; therefore, the interchange does not encroach into approach slope. Notwithstanding it is recommended that the Saskatoon Airport Authority is contacted to ensure interchange full lighting and other ancillary appetences will not interfere with airport operations.

Figure 5.3: John G. Diefenbaker International Airport Water Bodies 4 km Restriction Zone



NOTE: msl = mean sea level

Figure 5.4: John G. Diefenbaker International Airport Runway Approaches

5.2 Design Workshop

A diverse group of agencies and groups with strong local knowledge, as well as members of the design team, were invited to participate in a design workshop from June 27 to June 29, 2019 to help the Ministry determine the best alignment and interchange layout for the Phase 1 of the Saskatoon Freeway. The design workshop was structured to enable an innovative atmosphere in which a diverse group of stakeholders collaborate to generate and select a framework that address the complex north section of the Saskatoon Freeway. The goal of the design workshop was to provide the Province with advice on the freeway design that addresses local needs for today and meets the future capacity needs for the CoS of up to 750,000 people. That advice was provided after participants considered technical input from highway design specialists on road design standards, as well as environmental, geotechnical and safety concerns.

The objectives of the Design Workshop were for the participants to:

- Review the four (4) alternatives developed by the design team and determine if other alternatives exist;
- Provide input from the perspective of individuals who work and live in the community;
- Identify best value performance criteria and evaluate which alternative will provide the best value; and
- Provide considerations for the design team to examine during design of the preferred alternative.

Design workshop participants were asked to provide their issues, concerns, and requirements with respect to the Phase 1 section of the project, which allowed for the group to understand issues from each participant. Participants were asked to provide constructive criticism of scenarios or to identify opportunities to make the design better for road users or the local municipalities. Several examples of issues of concern were listed to generate discussion: land issues such as severance, changing land values and encroachments, access to and from the freeway as well as across the freeway, impacts on the environment and driver comprehension (i.e. is the design confusing to motorists).

In addition to the local stakeholders, engineers were present to help explain technical issues like interchange design standards, traffic capacity and safety, constructability and cost. **Table 5.4** illustrates the number of attendees from each company or stakeholder of the two-day session.

Table 5.4: Workshop Participants.

LAST NAME	FIRST NAME
AECOM	4
CoS	3
Meewasin Valley Authority (MVA)	1
North Saskatoon Business Association	1
RM of Corman Park	2
Saskatoon Tribal Council	1
Ministry	6
SNC-Lavalin	2
Wanuskewin Heritage Park	2

Table 5.5: Workshop Agenda

The Workshop utilized the principles of a Value Engineering (VE) analysis to enable all participants to quantify their level of support for interchange options proposed for Highway 11, Highway 12, and Highway 16. A previous study conducted in 2012 by Associated Engineering suggested four interchanges on the Saskatoon Freeway from Highway 16 in the west to the Saskatchewan River crossing were required. SNC-Lavalin generated several other interchange options for the corridor that suggested only three interchanges were required. A key outcome of the Design Workshop was that the three interchange scenarios meet the Ministry's interchange spacing and would be more efficient than the four-interchange scenario. Another key conclusion was the proposed Penner Road/Highway 11 intersection (access to the Wanuskewin Heritage Park) should be a separate interchange. Numerous other issues were identified concerning drainage, environmental, future development and vehicle access to adjacent land. Full Design Workshop results are included in **Appendix F**.

The key recommendations included the following:

- Realignment of Highway 11 to Wanuskewin Road;
- Providing an interchange on Highway 11 at Penner Road;
- Interchanges at Highway 12 and at the realigned Highway 11 with the Saskatoon Freeway;
- East/west connector from Millar Avenue to Wanuskewin Road; and
- A flyover across the Saskatoon Freeway at Millar avenue/Rock Ridge Road.

5.3 Interchange Layout Concepts

Following the Design Workshop, a number of interchange concepts were developed at each location to address the system and service interchange needs. Initially, nine concepts were considered for Highway 11/Wanuskewin, five concepts for Highway 12, and five concepts for Highway 16 interchange. These preliminary concepts were developed to a thick line level of detail and subjected to a screening-level assessment. A complete set of the preliminary concepts is provided in **Appendix G**. Directional descriptions within this section utilize a from – to or origin – destination convention. For example, the description of "Ramp N-W" describes traffic flow originating from the north, with an ultimate destination west of the interchange.

In conjunction with the Design Workshop, a Design Criteria was developed which recommended maintaining route continuity (**Section 4.2**) for Highway 11 and Highway 16 which are part of the National Highway System. Once the Project Team had a better understanding of the overall transportation needs and design constraints, the interchange concepts were refined and two concepts at each location were presented to the public at Public Information Session 1 (November 26 & 27, 2019). The following sections describe the development and evaluation of interchange concepts at Highway 11 and Penner Road, Highway 12, and Highway 16.

5.3.1 Highway 11 and Penner Road

To increase separation between the Highway 11 and Highway 12 interchanges, most of the long list of interchange concepts focused on realignment of Highway 11 to the east such that it aligns with Wanuskewin Road to provide a four-legged interchange.

A total of 13 interchange concepts were developed as part of long list of concepts at Highway 11 (**Appendix G**). Concepts 1-9 which were developed early in the study, were screened out since they did not provide adequate route continuity between the Saskatoon Freeway and Highway 11 for the E-N and N-E moves. Concepts 11A to 11D were developed with a greater focus on route continuity. Concept 11B was screened out due to insufficient weaving distances along the westbound lanes of the Saskatoon Freeway between Ramp N-W and Ramp E-S. Concept 11C was screened out due to higher costs associated with extending Wanuskewin Road to Penner Road with a direct connection to Highway 11, and higher impacts to the Wanuskewin Heritage Park. The remaining two concepts 11A and 11D were presented to the public at Public Information Session 1, as Concept 11-1 and Concept 11-2, and were the subject of a Multiple Account Evaluation (MAE). These concepts are discussed below.

Concept 11-1

Highway 11 continuity is maintained with a fork to the right with 130 km/h design speed. The northbound and southbound Wanuskewin Road lanes are split through the interchange and connect directly to Highway 11 north of the interchange. Due to very low traffic projections (<10 veh/h peak hour demand), no W-N access is provided from Saskatoon Freeway. A diamond interchange is proposed at Penner Road which provides full access to Penner Road and the Wanuskewin Heritage Park. This concept requires a three-level interchange with Saskatoon Freeway and 10 structures. Concept 11-1 is presented in **Figure 5.5**.

Advantages: This concept includes right exits/entrances for all ramp movements. Splitting the northbound and southbound lanes through the interchange provides an opportunity to transition speeds along Highway 11 southbound to Wanuskewin. Construction can be staged with low to moderate impacts to traffic as the Wanuskewin split can be constructed first with a temporary connection to existing roadway. From an operational perspective, the minor road (Wanuskewin Road) passing over the major roads (Saskatoon Freeway and Highway 11) is preferred.

Disadvantages: No W-N access provided from Saskatoon Freeway (<10 veh/h peak hour demand) which will result in out of way travel for vehicles traveling from the west to the north. The Wanuskewin split and associated loop ramps is a non-conventional interchange configuration and will be challenging to sign and may be more challenging to navigate. There are potential weaving concerns between the S-W on-ramp and E-S off-ramp which may require sub collector lanes to separate from the mainline. Impacts to SaskPower Transmission Corridor will require relocation of newly constructed towers and potential realignment of the corridor. There are potential lane balance challenges to drop lanes in advance of the South Saskatchewan River structure. This concept has moderate impacts to the Wanuskewin Heritage Park and has a comparative cost of approximately 10% higher than Concept 11-2.

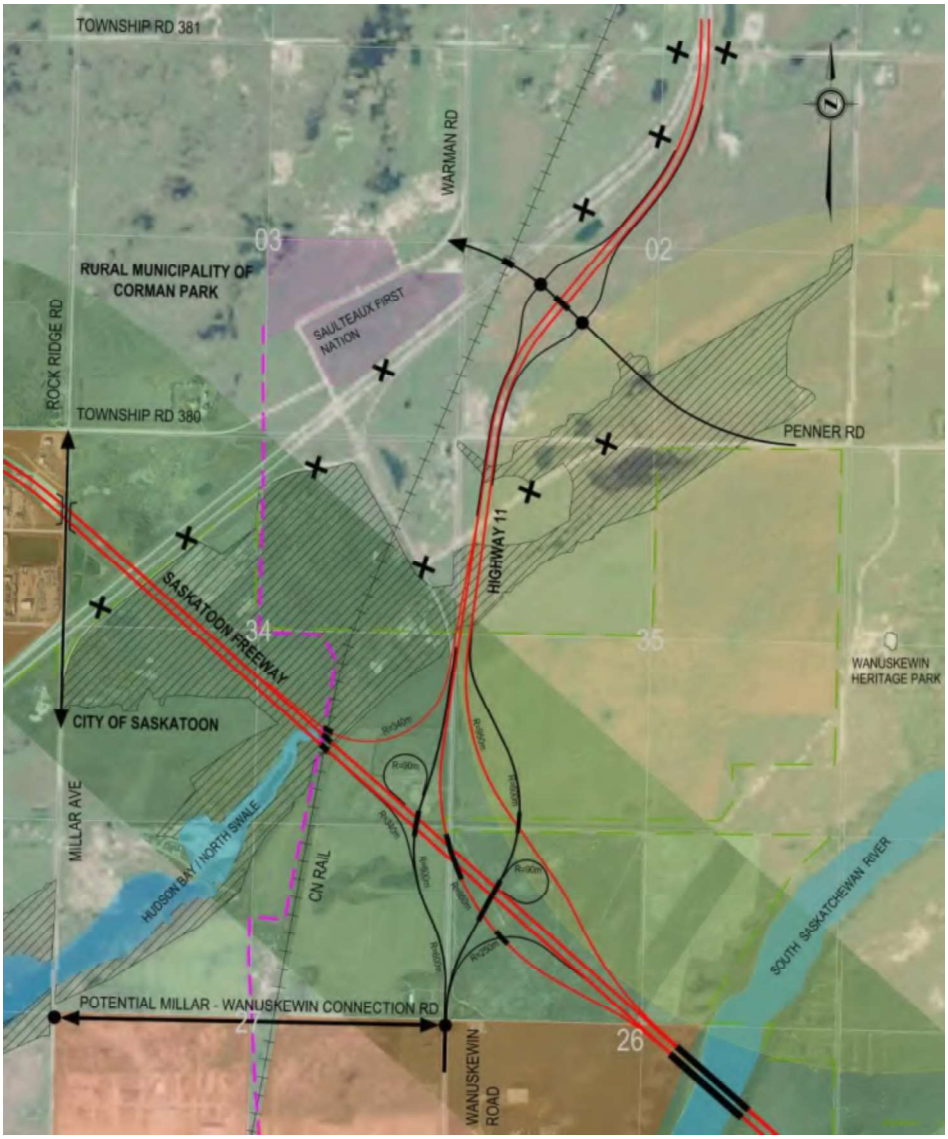


Figure 5.5: Concept 11-1

Concept 11-2

Highway 11 continuity is maintained with a fork to the right with 130 km/h design speed. Wanuskewin Road connects directly to Highway 11 north of the interchange. Saskatoon Freeway crosses over Wanuskewin Road and Highway 11 and connects through a service interchange. A more traditional Parclo configuration is provided at the interchange. All movements are provided at the Highway 11 and Wanuskewin interchange, however a left exit is required to access westbound Saskatoon Freeway from northbound Wanuskewin Road. As part of this concept, a diamond interchange will be provided at Penner Road which provides full access to Penner Road and the Wanuskewin Heritage Park. This concept requires a two-level interchange with Saskatoon Freeway and 10 structures. Concept 11-2 is presented in **Figure 5.6**.

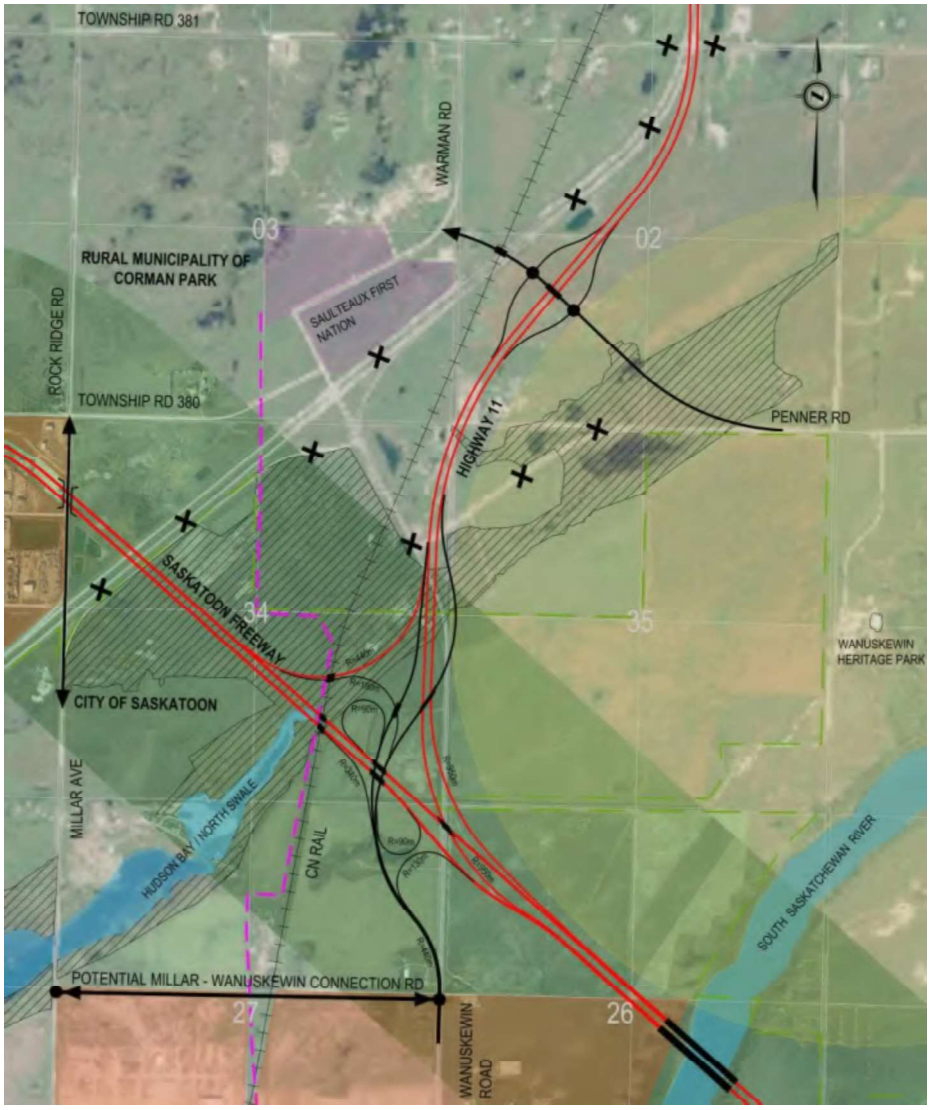


Figure 5.6: Concept 11-2

Advantages: This concept has a smaller footprint than Concept 11-1 which helps reduce landlocked area between Highway 11 and CN Rail. Additionally, the smaller footprint has minimal environmental impacts to the Wanuskewin Heritage Park. This configuration allows for all movements at the interchange since the W-N loop ramp provides access to northbound Wanuskewin Road and Highway 11. A curvilinear alignment along Highway 11 southbound to Wanuskewin promotes speed reduction. This is considered a less complex interchange configuration (navigation, signage, etc.) than Concept 11-1 with a lower overall construction cost.

Disadvantages: The S-W ramp requires a left exit from NB Wanuskewin Road, but this could be mitigated by providing a left turn or separate speed change lane. The merging of the S-W ramp with the N-W ramp may result in some traffic conflict due to different design and operating speeds, which can be addressed in the detail design. Construction of the Saskatoon Freeway over Wanuskewin Road requires a large fill embankment with potential challenges with sourcing additional earth fill. This concept has reduced spacing

between the Wanuskewin merge and Penner off-ramp with potential weaving concerns along northbound Highway 11. Ramp N-W will result in slightly greater impacts to the environmental, ecological or low-lying area associated with the Hudson Swale. There is a high complexity of construction staging which will require moderate throwaway costs to temporarily connect Wanuskewin to the existing roadway. Impacts to SaskPower Transmission Corridor will require relocation of newly constructed towers and potential realignment of the corridor.

Based on a trade-off of advantages and disadvantages, and confirmed through the MAE, Concept 11-2 was selected as the preferred interchange configuration.

5.3.2 Highway 12

A total of 7 interchange concepts were developed as part of long list of concepts at Highway 12. (**Appendix G**). Many of the concepts developed would be compatible with the CoS's option of converting Highway 12 to an arterial roadway with intersections south of the Saskatoon Freeway. Many of these concepts relied on roundabouts at ramp terminals along Highway 12. Given the uncertainty of the future status of Highway 12 through Saskatoon, Concepts 2 and 3 which relied on roundabouts were screened out. Concepts 4, 5, and 6 were screened out based on high degrees of complexity, unconventional configurations and three level interchanges. Concepts 12-1 and 12-7 were adapted to allow for interim configurations with intersections in addition to providing full ramp movements in the ultimate scenario. Concepts 1 and 7 were presented at the Public Information Session 1 on November 26 & 27, 2019 as Concept 12-1 and Concept 12-2 and were the subject of an MAE.

Concept 12-1

As described above, Concept 12-1 was developed assuming a staged approach which allows for construction of a Parclo A4 configuration in the interim. The interim stage would require signals at the north and south ramp terminal intersections and would be compatible with the CoS's option of converting Highway 12 to an arterial roadway with intersections south of the Saskatoon Freeway. In the future, the signals could be removed, and the W-N/S and E-N/S ramps would be replaced by direct ramps including flyovers for W-N and E-S ramps. This concept would be constructed as a two-level interchange requiring 2 structures in the interim, and 8 structures in the ultimate configuration. Concept 12-1 is presented in **Figure 5.7**.

Advantages: This concept allows for staged construction of the ultimate interchange. The interim configuration results in significantly lower up-front construction cost with a relatively low complexity to construct. The signalized intersections provide an opportunity to transition speed along Highway 12 southbound from freeway to arterial through the interchange. This concept has a smaller property impact in the interim configuration with additional property impacts in the ultimate configuration.

Disadvantages: In the interim configuration, high traffic volumes for the E-N and E-S movements may lead to slowdowns and queuing along the E-N/S ramp. The high through traffic on Highway 12 may also lead to slowdowns and queuing between terminal intersections. The ultimate flyover ramps would be intrusive on the adjacent landscape and would be more expensive and complex to construct in the future.

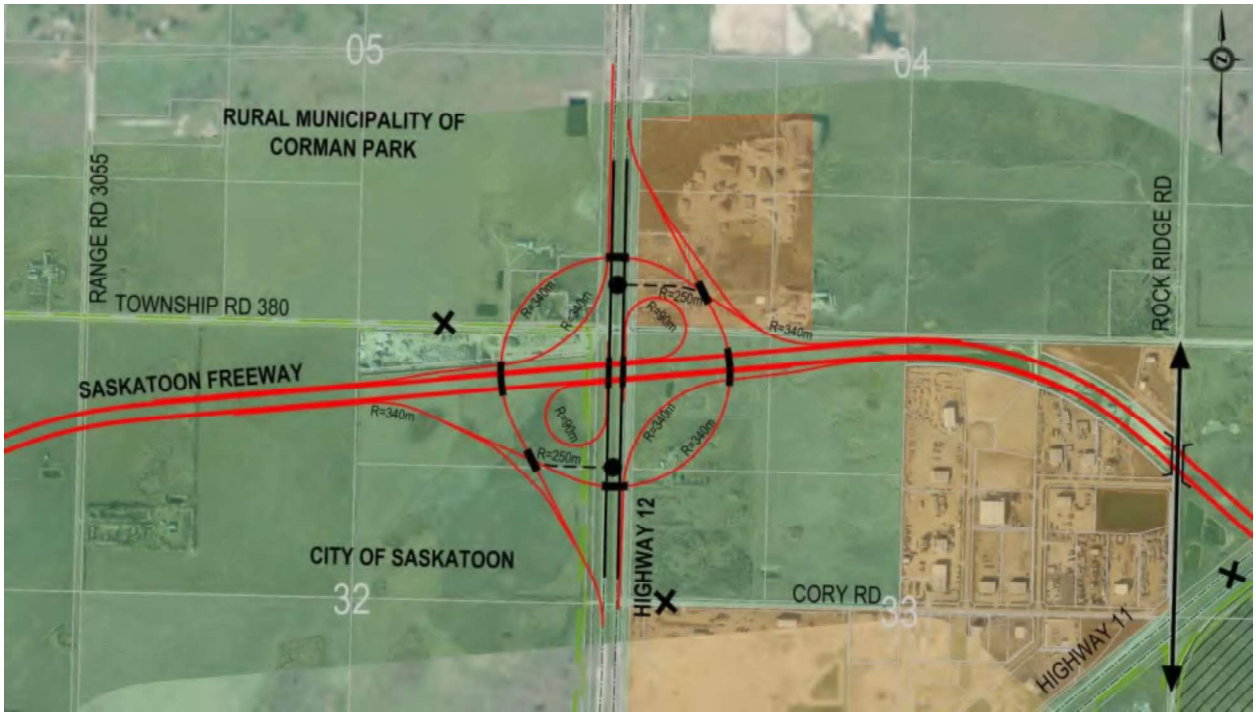


Figure 5.7: Concept 12-1

Concept 12-2

Concept 12-2 was also developed assuming a staged approach. The Highway 12 median was reduced to allow for a single structure crossing over the Saskatoon Freeway. This would allow for the construction of an interim northbound left turn with a signalized intersection at Highway 12 southbound with a connection to the N-W ramp. The direct S-W ramp would be deferred to the future when warranted. The interim configuration would be compatible with the CoS's option of converting Highway 12 to an arterial roadway with intersections south of the Saskatoon Freeway. Concept 12-2 is presented in **Figure 5.8**.

Parclo B loop ramps provided for W-N and E-S traffic. Highway 12 northbound and southbound lanes are split through the interchange to provide right exit / right entrance to freeway.

Concept 12-2 includes direct ramps for the E-N and N-E moves utilizing a fork design similar to concepts developed at the Highway 11 interchange and at the Highway 16 interchange. Loop ramps are provided for W-N and E-S traffic. This concept would be constructed as a two-level interchange requiring 3 structures in the interim, and 6 structures in the ultimate configuration.

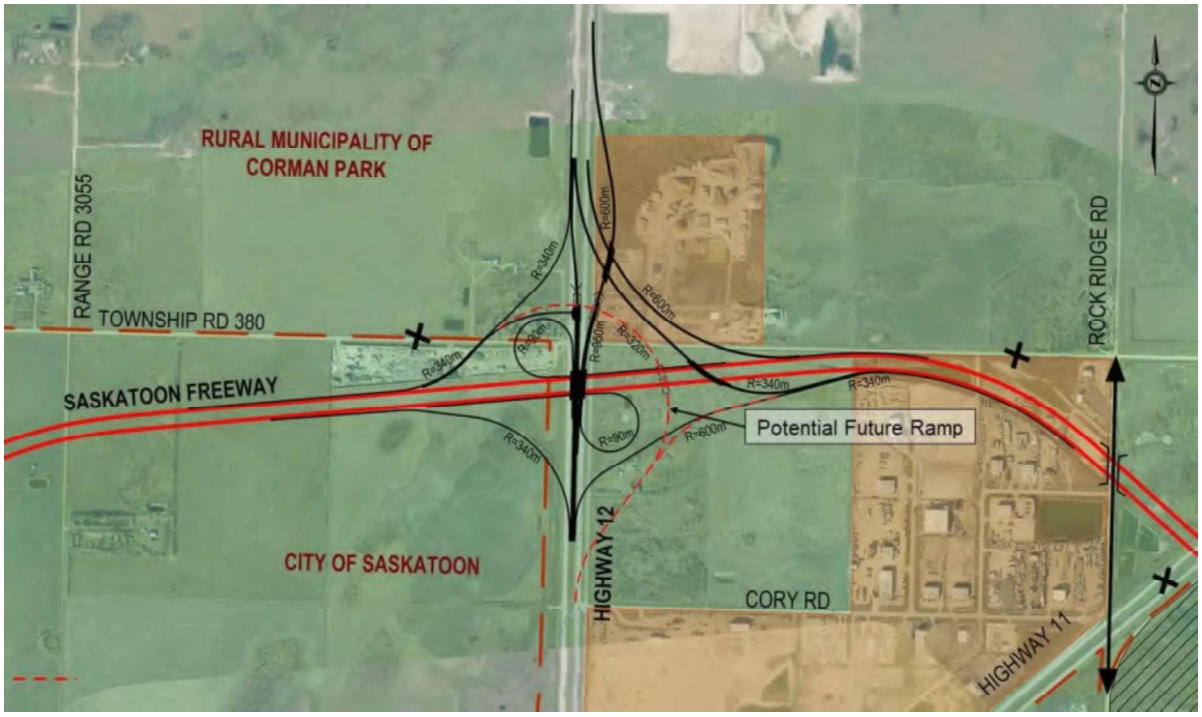


Figure 5.8: Concept 12-2

Advantages: This configuration provides direct fork ramp configurations for N-E and E-N movements which are similar to concepts proposed for interchanges at Highway 11 and at Highway 16. This promotes driver familiarity through Phase 1 which could result in improved safety. In comparison to Concept 12-2, there is a higher complexity to construct the single Highway 12 structure over the Saskatoon Freeway within the existing median of Highway 12. This concept has a slightly smaller interchange footprint relative to Concept 12-1. The ultimate cost is lower than Concept 12-1 since fewer structures are required to provide full interchange access.

Based on projected traffic volumes the E to S Loop requires two lanes. In the horizon year, the loop is projected to operate close to peak capacity. If required, it is possible to replace the two-lane loop in the future with a full directional ramp. To allow for this possibility, the plans show proposed property lines that account for the possible construction of the directional ramp in the SW quadrant

For concept 12-2 the S-W directional ramp could be deferred to the future by constructing an interim northbound left turn lane with a partially signalized intersection with Highway 12 southbound, along with a temporary connection to Ramp N-W per **Figure 5.9**.

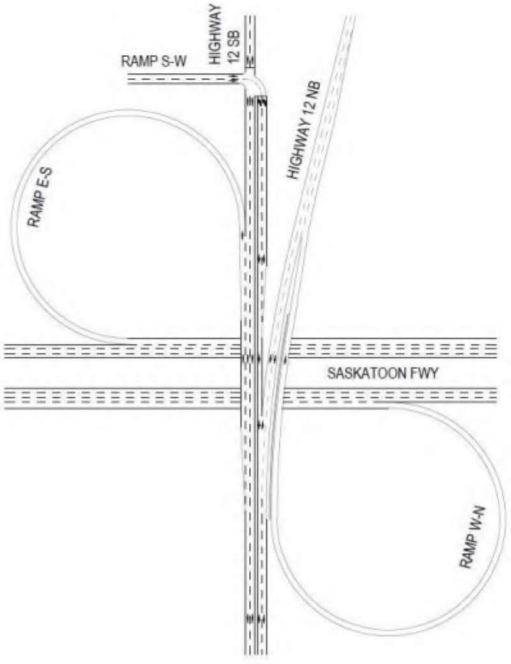


Figure 5.9: Concept 12-2 Interim Configuration

Disadvantages: The S-W ramp movement in the interim configuration is unconventional as it requires northbound movements to turn left across southbound Highway 12 lanes at a signalized intersection. A loop ramp is proposed for a high-volume Ramp E-S, which could potentially result in operational concerns. This concern could be partly mitigated by providing a two-lane loop ramp for this move. This concept also has a higher up-front construction cost in comparison to Concept 12-1.

Based on a trade-off of advantages and disadvantages, and confirmed through the MAE, Concept 12-2 was selected as the preferred interchange configuration.

Millar Avenue Flyover

The Millar Avenue Bridge over the Saskatoon Freeway will include a 3.0 m wide sidewalk for combined use by pedestrians and cyclists on both sides of the bridge as requested by the CoS. A concrete barrier will separate the sidewalk from vehicular traffic. A concrete barrier or concrete curb/railing will also be provided along the exterior edge of the sidewalk.

5.3.3 Highway 16

A total of 8 interchange concepts were developed as part of long list of concepts at Highway 16 (**Appendix G**). Concepts 1-5 which were developed early in the study, were screened out since they did not provide adequate route continuity between the Saskatoon Freeway and Highway 16 for the E-N and N-E moves. Concepts 16A, 16B and 16C were developed with a greater focus on route continuity. Concept 16B was screened out since the N-E ramp merges with the eastbound Saskatoon Freeway on the right side, which is inconsistent with concepts considered at Highway 11. The remaining two concepts 16A and 16C were presented at the Public Information Session 1 on November 26 & 27, 2019 as Concept 16-1 and Concept 16-2 and were the subject of an MAE.

Concept 16-1

Highway 16 continuity is maintained by providing a design speed of 130 km/h for E-N and N-E moves. Exit and entrance ramps to the Saskatoon Freeway are on the right side of Highway 16. Loop ramps are provided for the E-S and W-N movements with direct ramps for all other movements. This concept requires a 2-level interchange with 7 structures. Concept 16-1 is presented in **Figure 5.10**.

Advantages: This concept provides route continuity from Saskatoon Freeway to Highway 16 for the E-N and N-E moves. It includes right exits/entrances for all ramp movements and requires fewer structures than Concept 16-2.

Disadvantages: Highway 16 on the left side of the fork may be counter intuitive and not consistent with concepts considered at Highway 11 and would require additional signage. There are limited opportunities to mitigate projected high traffic volumes on the E-S loop ramp. Both Highway 16 concepts have moderate impacts to Moosomin First Nation Land.

Figure 5.10: Concept 16-1

Concept 16-2

Route continuity is maintained by providing a design speed of 130 km/h for E-N and N-E moves. Highway 16 westbound movement follows intuitive movement to the right. Saskatoon Freeway is a left exit on Highway 16 westbound and a right entrance to Highway 16 eastbound. Loop ramps are provided for the E-S and W-N movements with direct ramps for all other movements. This concept requires a 2-level interchange with 8 structures. Concept 16-2 is presented in **Figure 5.11**.

Advantages: This concept provides route continuity from Saskatoon Freeway to Highway 16 for the E-N and N-E moves. The left exit for westbound Saskatoon Freeway allows Highway 16 westbound to follow the intuitive movement to the right. Additionally, a right entrance for eastbound Saskatoon Freeway on Highway 16 eastbound is the preferred configuration. Movements to and from the north in Concept 16-2 are similar to Concept 11-2. Similar interchange types promote driver familiarization which could lead to driver safety benefits. This option also allows for a sub-collector to mitigate projected high traffic volumes on the E-S loop ramp.

Disadvantages: This concept requires a high skew angle structure for the N-E ramp. Both Highway 16 concepts have moderate impacts to Moosomin First Nation Land.

Based on a trade-off of advantages and disadvantages, and confirmed through the MAE, Concept 16-2 was selected as the preferred interchange configuration.

Figure 5.11: Concept 16-2

5.4 Access Management Concepts

The Ministry standards require a minimum spacing of 3.2 km between access points on a freeway. Desirable spacing is 8.0 km. Access points are to be grade separated interchanges with no access permitted between interchanges.

Based on the three interchange scenarios generated in the Design Workshop, the distance between the centre point of the Highway 11 interchange and the centre point of the Highway 12 interchange is 3.5 km Distance between Highway 11 interchange and Penner Road interchange is 2.52 km. This spacing does not meet Ministry design standards and requires special attention to merging and weaving conditions. It is noted that the TAC Geometric Design Guide for Canadian Roads does acknowledge that interchange spacing in urban areas can range between 2.0 km and 3.0 km. The distance between the Highway 12 interchange and the Highway 16 interchange is 4.2 km.

The Ministry's long-range Access Management plans for Highway 11, Highway 12 and Highway 16 show these roads to have arterial highway designation with R-1 access level and proposed interchanges at Highway 12/Lutheran Road and Highway 16/Dalmeny Access. The spacing of these proposed interchanges to the freeway interchanges exceed the minimum spacing of 3.2 km and are compliant with existing planned interchanges to the north of the freeway. The Highway 11, Highway 12 and Highway 16 corridors will eventually be fully controlled with no direct access except at interchanges.

The new freeway will sever existing roads and parcels of land creating a barrier. Access management concepts were generated that illustrate how local property owners, business and road users can use a

system of existing and new secondary roads to access the three interchange locations. The three interchanges allow full access to the freeway and a method to cross over or under the freeway. Another option that allows access across, but not onto, the freeway are flyovers. The proposed interchanges may also require closure of existing highway intersections due to their close proximity to interchange ramps. The Access Plan illustrates which existing highway intersections are impacted and may be closed at some point.

The new freeway is located immediately adjacent to and north of the CoS. The City's Riel Industrial Sector Plan identifies future roadways within the City limits and several routes that extend north connect to roads within the RM of Corman Park. The Roadways Plan (Figure 6) from the Riel Industrial Sector Plan is presented in **Appendix H**. The Access Management Plan should consider the CoS and the RM of Corman Park development plans.

Two different scenarios were developed and are described in more detail. The first concept maximizes the use of existing roads to provide access to and from properties impacted by the new freeway. The second concept provides a new service road to provide more direct access. Common to both concepts, is potential flyovers at Millar Road and at Range Road 3055.

5.4.1 Access Concept 1

Concept 1 provides minimal new secondary road construction, but still has some form of access to all parcels of land impacted by the freeway. By minimizing new road construction, property acquisition and initial capital cost is lower. In addition, the responsible road authority will have the lowest long-term maintenance costs. In some cases, roads that are severed by the freeway are not realigned and are closed with a cul-de-sac. **Figure 5.12** illustrates all new roads and cul-de-sac locations. Beam Road is shown to be realigned to create a 90° intersection angle with the freeway, this detail will be further reviewed in Phase 3.

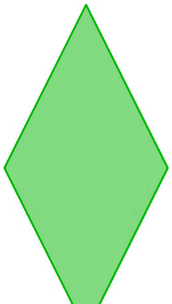
5.4.2 Access Concept 2

Concept 2 provides a system of services roads that will create more direct access to adjacent parcels of land. Additional new roads will be required as compared to Concept 1. This increases the amount of property acquisition and initial and long-term capital and operating costs, but the additional roads increase development potential. **Figure 5.13** illustrates all new roads and cul-de-sac closures. As with Concept 1, several existing roads are closed using cul-de-sacs and Beam Road has been realigned to create a 90° intersection angle.

LEGEND

SASKATOON FREEWAY
PROJECT (PHASE 1)

SASKATOON FREEWAY
PROJECT (PHASE 3)



SASKATOON FREEWAY
FUTURE INTERCHANGE

5.5 Drainage Concepts

Phase 1 of the Saskatoon Freeway is located within a watershed that is complex and dynamic. It is characterized by an evolving blend of rural, country residential, urban, commercial, and industrial developments, as well as the confluence of a busy transportation network that includes three provincial highways (Highway 11, Highway 12, and Highway 16). The multitude of developments within the watershed has vastly changed drainage patterns. The drainage design for the Saskatoon Freeway predominately retained existing drainage patterns and provided storage retention where runoff patterns were changed or increased. Drainage design for this phase focused on four parts:

- Quantify and Manage Existing Drainage;
- Interchange and Freeway Design;
- River Outfall; and
- Regulatory Agencies and Stakeholders.

The Ministry Hydraulic Manual (2014, Section 605-00) was used as the basis for design criteria. **Table 5.6** sets out the various design flows for the Ministry. **Table 5.7** outlines the freeboard requirements.

Table 5.6: Road Class and Design Flows

Class of Road	Design Frequency (Instantaneous Peak Flow)
National Highway System	1/50
CoS	1/25
Other Roads	1/5 to 1/10
Class of Road	**Design Frequency (Maximum Mean Daily Flow)**
Provincial Highways and Provincial Roads	1/50 to 1/100
Other Roads	1/25

Table 5.7: Freeboard Requirements

Item	Freeboard (mm)*	
	Desirable	Minimum
*Freeboard Grade Height	300	
Dwelling Units	1000	300
Yard Buildings and Wells	300	0
Sheds and Bins	0	0
Allowable Headwater (fill > 3.0 m)	2x Culvert Diameter	

5.5.1 Quantify and Manage Existing Drainage

Data Acquisition

Natural Resources Canada (NRCAN) geometric data was acquired to analyse the natural drainage paths. It was determined that these natural drainage paths have been modified to some degree by being intercepted and diverted by the grid road system. The geometric data was used to define the current catchment boundaries in areas that were not covered by LiDAR data.

The Green Network Pilot Project report was prepared by the CoS as part of Saskatoon North Partnership for Growth (P4G). Although the City advised that the analysis was completed at a high level, it still proved to be a valuable tool and was referenced to determine culvert locations and drainage paths. To date, much of the watershed data in the report has been determined automatically by GIS software; however, some uncertainty in drainage paths and catchment areas was identified. The City also shared their culvert survey data in the P4G study area, which led to refining the delineation of several catchment areas. Culvert elevations were raised by 0.084 m to match the CGVD2013 datum used for the Ministry LiDAR data. Due to the low degree of topographic relief, influence of drainage patterns by the grid road system, and potential for splits in drainage paths, a thorough drainage investigation and survey during the detailed design phase is essential.

LiDAR data along the Saskatoon Freeway route was acquired by the Ministry and additional data was obtained from P4G. This additional data was used to refine some of the drainage paths and catchment areas. It is important to note that these data sources are not on the same vertical datum. An adjustment of approximately - 0.3 m to the P4G LiDAR is recommended based on the following:

- The Ministry LiDAR was based on vertical datum CGVD2013 with geoid CGG2013 and referenced monument 965001. The station report indicates CGVD28 is 0.304 m higher; and
- The RM of Corman Park LiDAR was based on CGVD28 with geoid CGG2000 using HT2.0 transformation. They referenced monument 79S004. The station report indicates CGVD28 is 0.297 m higher.

The Ministry culvert database was reviewed to identify culverts along Highway 11, Highway 12, and Highway 16. This information also led to refining catchment areas that had been based on the P4G Green Network report. Finally, satellite images and Google Street View were referenced to identify missing culverts and to further refine the catchment areas.

The catchment areas identified in this report are based on the best available data. However, this phase of the Saskatoon Freeway has a very complex drainage system which can be influenced by ongoing development in the RM of Corman Park and Cities of Saskatoon, Martensville, and Warman. Whether intentional or not, future development and drainage projects may alter the size and drainage path of catchment areas, which may impact the flow intersected by the Saskatoon Freeway. Furthermore, the uncertainty associated with varied vertical datums, geoids, and unknown LiDAR quality makes it difficult to validate the predicted watershed patterns. It is strongly recommended that the detailed design include a thorough investigation and survey of the catchment areas impacting this phase of the project. **Figure 5.14** summarizes the catchment areas used in this design.

The catchment areas outlined in the report are based on effective areas and further analysis during detail design will need to determine if ineffective areas will contribute to the drainage and impact the Saskatoon

Freeway and if extreme rainfall events will affect drainage paths as water may over top municipal roadways and temporarily change drainage paths.

The RM, City and the Ministry have different standards and regulatory requirements. As development occurs in the area, different design standards will be used depending on the location of the development and can change depending on future municipal boundary alterations. Further discussions between these parties are needed to address the challenging drainage in the area and how it will be integrated once fully developed. As part of future development in the area an overall drainage strategy should be developed between the municipalities, Ministry, and regulatory agencies.

Drainage Paths

The overall drainage pattern of the watershed is generally southeasterly where it is intercepted by the CoS stormwater system, Hudson Bay Swale, or Opimihaw Creek. Review of the sub-catchment areas within the watershed indicates the drainage from the Saskatoon Freeway will join one of four existing drainage paths (**Figure 5.14)**:

Drainage Path 1

The west portions of the Highway 16 interchange will drain to the west ditch of Highway 16 which flows south east towards Saskatoon. It is understood that this drainage eventually flows to a large slough north of the airport. During periods of high-water levels, it may continue to drain along the west Highway 16 ditch and reach a series of ponds at the Idylwyld Drive/Avenue C interchange, where it is then intercepted by the City's storm sewer system;

Drainage Path 2

From Highway 16 east to Range Road 3055, the Saskatoon Freeway will drain to the west ditch of Highway 12, where it then flows south. There are several contributing drainage paths including the east ditch of Highway 16. The P4G drainage map shows these drainage paths all flowing east to join the west ditch of Highway 12. It is understood that flow continues south to a series of ponds along Highway 11/Idylwyld Drive and then into the City's storm sewer system;

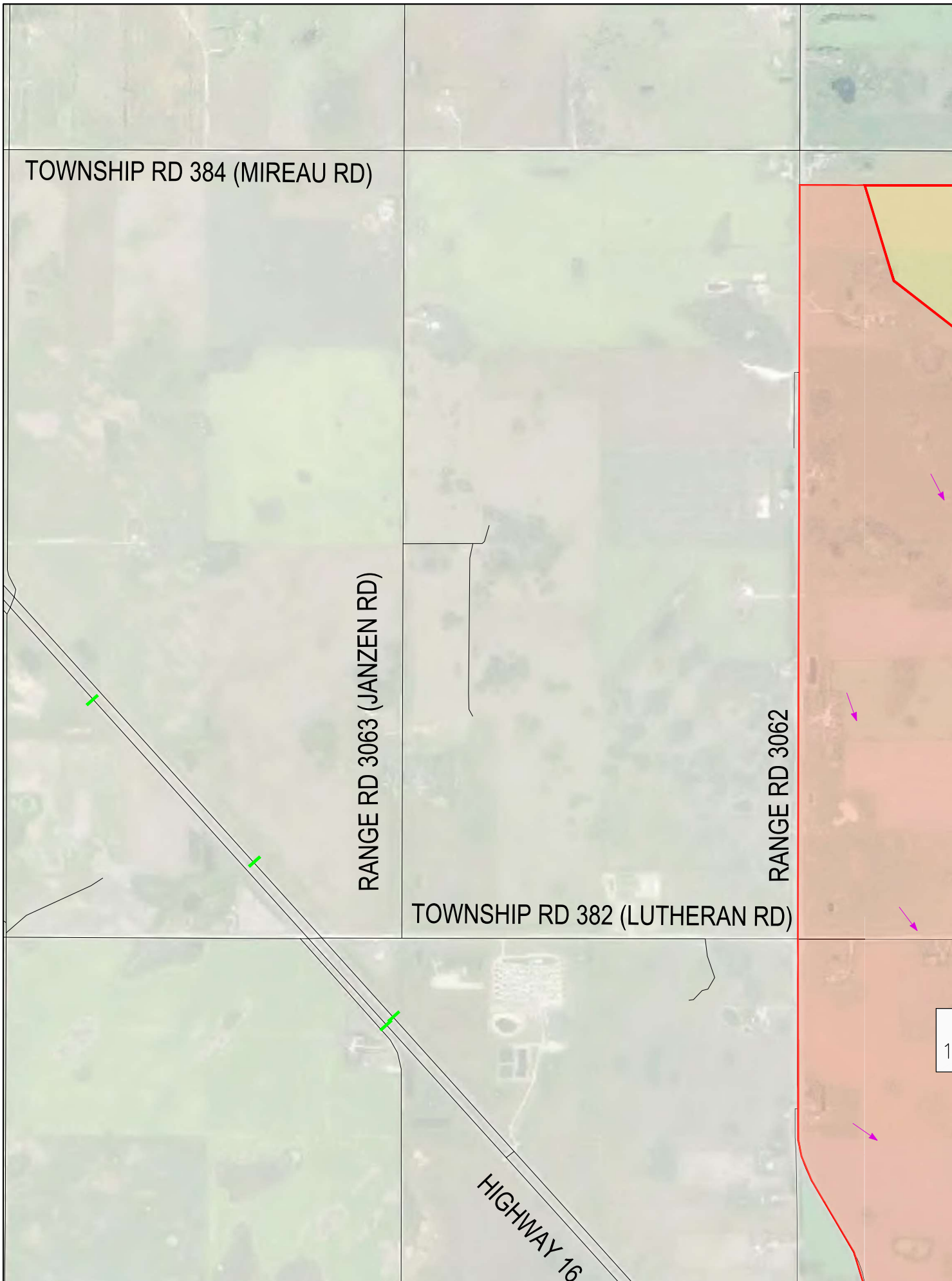
Drainage Path 3

From Range Road 3055 east to Wanuskewin Road, drainage flows to the Hudson Bay Swale, which spills to Opimihaw Creek. This is a complex watershed with numerous drainage paths entering the swale or creek tributary at various locations; and

Drainage Path 4

From Wanuskewin Road east to the South Saskatchewan River, the sub catchment areas drain to the South Saskatchewan River.

Fish passage is not anticipated to be required in this area as these upland drainage areas are a tributary to Opimihaw Creek. They are ephemeral in nature and normally dry except in spring freshet.


TOWNSHIP RD 384 (MIREAU RD)
RANGE RD 3063 (JANZEN RD)
RANGE RD 3062
TOWNSHIP RD 382 (LUTHERAN RD)
HIGHWAY 16

Dynamic Drainage Paths

There are areas within the watershed where the drainage paths are dynamic (**Figure 5.14)**. These are locations where changing conditions may direct flow in more than one direction. They can be caused by scenarios such as:

- Multiple culverts at an intersection draining in different directions;
- New development diverting flow in an alternate direction;
- Removal of upstream infrastructure that has been diverting flow; and
- Residential development such as driveways that can block ditch flow and result in backwater that finds an alternate path. This may occur where there is no culvert, undersized culvert, or plugged culvert.

Due to the low amount of topographic relief in the watershed and constructed alterations of the drainage patterns described above, a definitive allocation of these sub catchment areas is challenging and may change under different water level scenarios and large rainfall events. Quantifying the distribution of the split or diverted flows is difficult to predict, as it is influenced by headwater levels, tailwater levels, and condition of the downstream ditches and culverts. As a conservative approach, the dynamic areas were allocated to both potential sub catchments. Three dynamic areas were identified; along Township Road 380 at the intersections of Range Road 3060 and 3055, and east of Rock Ridge Road. The area east of Rock Ridge Road is not currently dynamic, but the drainage path may be affected by the Highway 11 decommissioning. It is recommended that a more thorough investigation be completed in future detailed design.

Catchment Areas

The Phase 1 watershed of the Saskatoon Freeway is composed of 17 catchment areas, as shown in **Figure 5.14**. Details illustrating calculated areas and drainage paths for each of the Catchment Areas are in presented in **Table I1 (Appendix I)**.

5.5.2 Proposed Culvert Locations

Culverts listed in **Appendix I** (**Table I2**, **Table I3**, **Table I4**, **Table I5**, and **Table I6**) are approximations and are used in the Functional Design to determine cost estimates and maintain existing drainage paths. Additional culverts will be required to maintain the Ministry's standard for maximum spacing at 800 m. All culverts will need to be designed according to the Ministry's Hydraulics Manual. The Interchange culverts listed in **Table I6** are the estimated number of culverts required to transfer flow from inside the interchanges to the downstream ditches and are not included in **Table I2** through **Table I5**.

All stations are approximate and subject to change in the detailed design stage. Because the roadways are double lane with median ditches, most locations indicate a pair of culverts (one under each set of lanes). Some locations will also include culverts under interchange ramps.

The major and minor culvert sizes are an indication of the expected flow they will need to pass. Generally, a minor culvert will only pass runoff from the roadway and a relatively small local catchment area. Minor culverts are a minimum 800 mm diameter. Major culverts are expected to be around 1500 mm diameter or multiple 800 mm culverts where cover is an issue. Major culverts are required when they must pass a significant existing drainage course, large or combined catchment areas, or runoff from more than 800 m of roadway.

Redirected Flow

The freeway alignment along Catchments C and D along with the corresponding culverts (13+800, 14+200, 14+800, 15+215) will affect the existing flow paths that may be desirable to landowners.

First, this section the freeway parallels the natural contours so that grades are very shallow. The overland sheet flow in Catchment C will be intercepted and directed into one of the two culverts which will concentrate the sheet flow into channelized flow. There are no existing ditches to direct the flow after crossing the freeway, so water will pond and find its own path. This may be a concern to downstream landowners. There are several ways to address concerns:

- Include additional through-grade culverts to distribute the flow more broadly;
- Ditches outside the right-of-way could be constructed to eliminate ponding and pass flow to existing downstream drainage paths more directly;
- Flow could enter long dugouts that would retain most flow and broadly distribute flow when it spills. An advantage of this approach is that the effective grade becomes the water surface and is essentially flat. The dugout can be used in place of a graded ditch allowing for a lowering of the upstream Freeway ditch elevation; subsequently reducing the embankment height; and
- The flat profile offers an opportunity for a unique cross section. By lowering the profile to allow for a low-height backslope (approximately 0.15 m high) and designing a flat ditch on the downstream side of the freeway, flow could be distributed along the entire toe of backslope. This would saturate the backslope topsoil. During high flow events runoff would spill along the entirety of this section. This would maintain the natural overland drainage patters, and costs are reduced by lowering the embankment height. However, this would create a pool of standing water within the ditches that would only drain through evaporation and infiltration;

Second, two dugouts have been identified in NE 31-37-05-3 and NW 32-37-05-3. A field ridge in Section 31 and a treeline in Section 32 appear to be purposely built to direct some overland flow towards the dugouts. This may be intentional and desirable to the landowners. Due to the shallow grades, the freeway ditch and Range Road 3055 could be configured to provide supply of drainage flow to the dugouts. It is recommended that this is discussed during land negotiations and considered as part of the detailed design.

5.5.3 Interchange and Freeway Design

From a drainage perspective, the freeway design consists of two typical cross sections:

- Rural – road surface runoff is collected and conveyed by median and outer ditches; and
- Urban – road surface runoff is directed to catch basins by curbs or barriers then conveyed along storm sewer pipe which outlet into ditches.

Rural Cross Sections

All the main freeway, portions of the interchanges, and service roads will have a rural cross section. In addition to conveying road runoff, the ditches also intercept existing drainage paths. Ditches are graded so that existing drainage paths are maintained wherever possible. Flow in the upstream and median ditches will cross the freeway at the proposed culvert locations. The culverts and downstream ditches outlet into existing low areas. The following standards were key design considerations:

- Saskatchewan Highways standard Plan 21010 indicates a desirable ditch depth ≥1.2 m from top of subgrade to ditch bottom.

› Table SKS 2.2.8-A.1 from the Saskatchewan Highways Geometric Design Guide Supplement (Interim) indicates the minimum ditch grades, as presented in **Table 5.8.**

Table 5.8: Minimum Ditch Grades

	OUTER DITCH	MEDIAN DITCH
Desirable Minimum	0.10%	0.20%
Tolerable Minimum	0.05%	0.10%

A review of the initial freeway profile showed that most ditches follow the longitudinal grade of the freeway. However, this is not the case for the two locations. The first location is between Highway 16 and Highway 12; the freeway alignment parallels the contours for a distance of approximately 3.5 km. Accordingly, the culverts will govern the road profile and require full road embankment with no ditch cuts. To maintain existing drainage paths, the culverts were spaced more closely. The freeway profile was then adjusted to match proposed culvert locations using desirable minimum ditch grades (0.1%). The grade of the road itself is a minimum of 0.3%. This means that the ditch can be flatter than the road itself and allowed for the ditch and road PVI's to be in different locations. Road high points were adjusted to meet minimum ditch depth and minimize embankment. These profile adjustments have been made at a functional level and numerous variables influence the governing culvert elevations. Changes to these variables may allow the profile to be refined for cost savings, such as:

› Using tolerable minimums;

› Purchasing land and draining to lower detention / retention ponds rather than overland drainage; and

› Improving grid road ditches or cutting new overland drainage ditches.

The second section where the ditch grade deviates from the road grade is the proposed low point at 19+470. From this low point, the freeway is rising as it approaches the Highway 11 interchange. The natural lower point is at approximately 19+950. From 19+470 to 19+950, the ditches may be graded down past the PVI while the road is graded up to the overpass. The ditches will then outlet into the Hudson Bay Swale.

Urban Cross Sections

Portions of the interchanges will have curbs or barriers that direct runoff to catch basins. The catch basins are connected to storm sewer pipe which will direct flow to the nearest downstream ditch. The interchanges with urban cross section (curbs / barriers) will include catch basins and storm pipes with outlets to the freeway ditches.

Design and spacing requirements for catch basins fall under TAC Section 2.2.8.3. Subsection 6 indicates that "The spacing of catch basins and drainage inlets is based on the lateral spread objectives described earlier, and vary in accordance with roadway width, longitudinal grades, and the size and nature of the areas that contribute surface drainage to the roadway". These requirements result in catch basin spacing typically in the range of 50 m to 150 m".

Drainage Outlets

The four drainage paths described in **Section 5.5.1.2** indicate where each section of the freeway or interchange will drain to. More detailed drainage paths are discussed in both the catchment and culvert tables.

Detention/Retention

The goal of runoff detention is to maintain the existing peak flow for a given drainage path. Detention is generally achieved by throttling a drainage outlet using an appropriately sized culvert or other hydraulic structures. The culvert is sized to allow the pre-development flow to pass while additional flow is backed up (detained). Although not a ministry standard detention/retention may be looked at in certain areas to mitigate drainage issues. For this project, flow can be detained in several locations:

- Upstream outer ditches and median ditches. Ditch blocks can be used to step the flow down and create multiple points of detention.;
- Within interchange ramps;
- Borrow pits (dugouts) with access to a lower ditch;
- Ponds constructed in parcels of land that have been cut off by the freeway and are not suitable for future development. Several such parcels can be found between the Highway 11 interchange and Penner road overpass; and
- Expanding the capacity of existing natural wetlands and water bodies. The Hudson Bay Swale is a good candidate because its large surface area can detain a large volume of water with small increases in water levels. As well, the Hudson Bay Swale is the major natural detention area upstream of the outlet to the tributary to Opimihaw Creek. Expanding portions of the Hudson Bay swale into isolated parcels of land along the Freeway will increase detention capacity. It may also provide opportunities for wetland compensation and sourcing borrow material.

In areas where detained flow may result in damage to infrastructure, the use of overflows is recommended. An overflow will cap the detention at a certain elevation and allow all additional flow to pass. Overflows need to weigh the infrastructure being protected against the risk of downstream infrastructure.

During correspondence with the Water Security Agency they indicated that *"Along with detention (active) type facilities, it is recommended the design incorporate retention (permanent) type facilities to counteract lost natural storage due to infilling"*. Retention ponds do not have an outlet, so storm water is stored (retained) for a longer duration. Capacity is restored through evaporation, infiltration, and in some cases, it may be pumped. Borrow pits (dugouts) are the most common opportunity to create stormwater retention.

The specific location of detention and retention ponds is subject to numerous factors. Many will not be determined until the detailed design phase. For example, the location and size of borrow pits that can be used for both detention and retention will be based on the cut/fill and mass haul designs, and not necessarily for stormwater storage requirements. Detention/retention of drainage is not a Ministry standard or regular practice; further discussions with Water Security Agency are required when the project moves to detailed design.

The Rational Method was used to estimate peak runoff for pre- and post-construction rather than the Ministry's standard practice to obtain flow rates from Water Security Agency. This was done due to the area having significant sheet flow and few defined drainage channels and the Ministry felt the Rational Method would result in more accurate flow estimates. The critical runoff event for smaller watersheds (less than 2500 ha) is expected to be rainfall-derived rather than snowmelt-derived for smaller catchment areas, such as those contributing to runoff in the Phase 1 watershed. The 24 hour duration was considered to be the critical event. Using Intensity-Duration-Frequency data from the CoS New Neighbourhood Design and Development Standards Manual a rainfall intensity of 3.5 mm/hr was determined for the 1:50 year return period. The post-development asphalt area was estimated for the various drainage paths and a runoff coefficient of 0.95 was applied to calculate flow. A runoff coefficient of 0.25 was applied to the same area to determine the pre-development flow. These flows represent the average over a 24 hour rainfall event and the difference between the two determines the increase in peak runoff after construction.

Applying the runoff values for 24 hours yields the desirable storage volume. The increased peak runoff volume is the volume of water that should be detained during a 1:50 year rainfall event. Further analysis will be needed during the detail design process.

Drainage Path 1 (West of Highway 16 interchange) – The catchment area and runoff will need to be determined when Phase 3 of the Freeway is completed.

Drainage Path 2 (Between Highways 16 and 12) – The relatively flat topography of this section required numerous high and low points. The runoff area draining to each culvert in this section is relatively small and the estimated increase in post development runoff over 24 hours ranges from 600 m^3 to 1,500 m^3. These volumes can be detained within the upstream and median ditches without encroaching on the 300 mm freeboard requirements. This section will be almost completely embankment and will likely require borrow pits that may also be used for detention. The section immediately west of the Highway 16 interchange has a steeper grade so ditch blocks may be required to step down the storage areas in a series of low-slope ditch sections. The interchange also offers additional storage areas within the ramps. Detailed design for this area should consider the airport development zones discussed in **Section 5.1.5**. The drainage path is show in **Figure 5.14**.

Drainage Path 3 (Between Highway 12 and Wanuskewin Road plus Highway 11 and Penner Road) – Runoff from these sections flows to the Hudson Bay swale or the Opimihaw Creek tributary (**Figure 5.14**). It is estimated that the increased peak runoff over 24 hours will be 230,000 m^3. In addition to detaining flow in ditches, borrow pits and between interchange ramps, this section may require some additional detention ponds. Following are three proposed locations for constructing detention ponds:

- Between the CN right-of-way and north west of the proposed Highway 11 interchange;
- Triangle between the old Penner Road, farm access, and east of the proposed Highway 11; and
- At approximately 19+460 the proposed freeway grades up to the Highway 11 interchange. At this point, the ditch will need to continue grading down to the Hudson Bay swale. These locations can be expanded for borrow and detention.

Drainage Path 4 (Wanuskewin Road to the South Saskatchewan River) – Runoff from this section flows directly to the river. The effect of increased runoff does not have the same impact as the other drainage paths. Rather than mitigating downstream flooding of the river outfall, detailed design should attenuate the flow to mitigate erosion of the river bank. The estimated volume over 24 hours is 16,000 m^3. The proposed

culverts at 21+000 can also be sized to detain the estimated increase in peak runoff. The estimated volume over 24 hours is 8,000 m^3.

Runoff into the river would require an approval from Water Security Agency and would likely come with requirement to ensure water is not turbid or contaminated. A settling pond or biofiltration area (e.g. a wetland) would potentially accomplish this.

5.5.4 South Saskatchewan River Outlet

The west side of the South Saskatchewan River features a high and steep riverbank at the proposed river crossing. The terrain drops roughly 30 m in 160 m (19% grade). Bank erosion caused by stormwater runoff would need to be mitigated by diverting the ditch flows. The catchment areas intercepted by the freeway ditches and drained to the riverbank are less than 10 hectares. Most of the flow will come from the freeway right-of-way itself between 21+200 to 21+900.

Rather than a major excavation along the river embankment to accommodate a drop structure and pipe, it is recommended to explore using existing natural drainage routes on either side as illustrated in **Figure 5.15**. These routes are already protected from erosion by dense vegetation and the grade is less steep. The freeway ditch will intersect the riverbank at an elevation of approximately 491.7 m. Heavy vegetation extends to an elevation of approximately 492 m on the southwest side and approximately 491 m on the northeast side and treed vegetation rises to approximately 482 m. The advantages of this design are:

- Diverting the flows to these natural drainage paths will significantly reduce the cost of constructing a river outfall compared to a major structure;
- Drainage will be better distributed thereby reducing concentrated flows;
- The vegetation will capture sediment;
- For storm events more severe than the design return period, flow is directed away from the bridge structure;
- The design should result in more consistent runoff that would promote more vegetation growth and increase the natural erosion protection;
- Trees and vegetation will provide a more naturalized appearance than an engineered structure of concrete or riprap; and
- The ditch blocks discussed below will also provide a crossing for the multiuse pathways.

The following are considerations for detailed design:

- Erosion protection may be required in the ditches as they approach the riverbank;
- Rip-rap and geotextile may be added to the standard ditch section;
- Areas of the steep riverbank section without heavy vegetation should be protected by means such as flexible concrete block mats that are anchored to the bank and allow vegetation to grow between the blocks to provide further anchoring;
- Culverts to direct flow from the median ditch to both outer ditches. This provides redundancy should one be blocked, in order to provide further protection to the freeway. Downstream from the culverts, the median will have a ditch block to prevent flow down the riverbank near the river bridge;

- Ditch blocks with culverts will attenuate the flow before it drops down the riverbank. They will limit the peak flow and use the freeway ditches as detention storage. The ditch blocks should be armored, and the top will provide a spill crest for extreme storm events. The crest elevation is set to ensure roadway freeboard would not be exceeded; and
- Pads and blocks to disperse flow before it reaches the natural vegetation. This will prevent major flows from cutting into the bank.

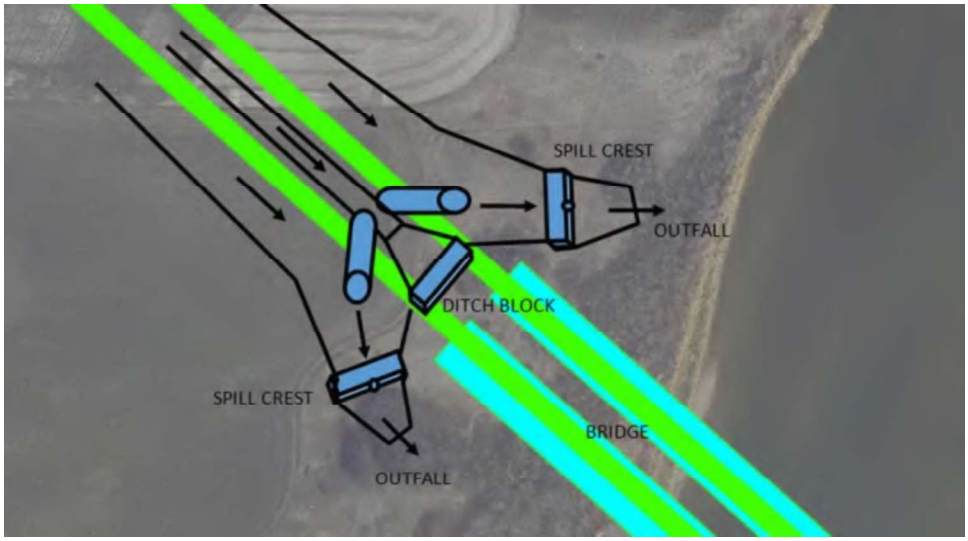


Figure 5.15: South Saskatchewan River Outlet

5.6 Bridge Concepts

5.6.1 Saskatchewan River Bridge Concepts

The alignment crosses the South Saskatchewan River to the southeast of the Highway 11 interchange with a profile that lowers from the northwest to the southeast at 1.755% grade. As shown on **Figure 5.16**, the profile requires a cut on the northwest bank in order to accommodate the grade lines. The cut will reduce the height of driving force on the northwest bank, but disturbance to the slope is an imperative geotechnical consideration.

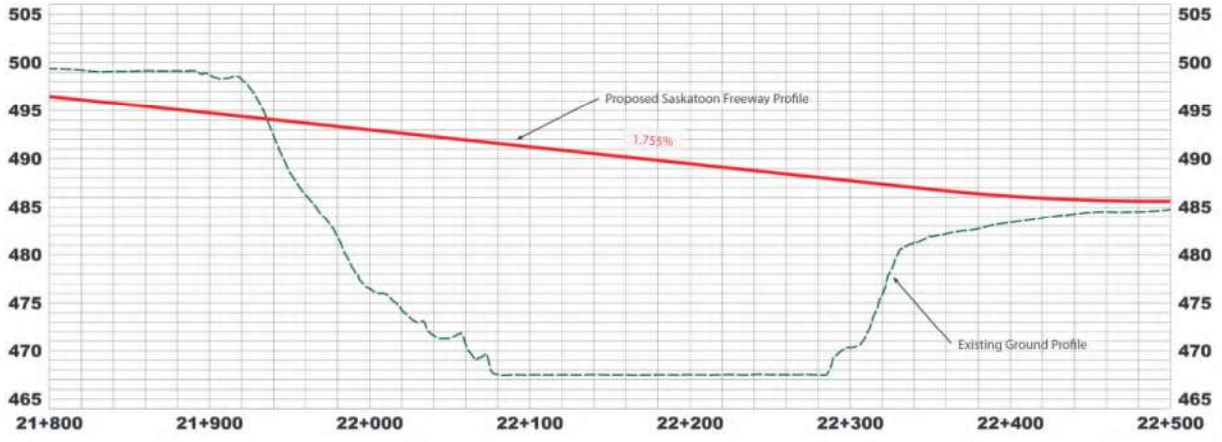


Figure 5.16: South Saskatchewan River Crossing – Gradeline Profile

The laning requirements, as dictated by the traffic demand model, are to include at initial phase, a minimum of 3-lanes of traffic in each direction and a minimum of one lane in each direction allocated to multi-use path (MUP). The ultimate configuration could include four lanes in both the northwest and southeast direction with an additional width for a MUP. As an alternative the MUP could moved under the bridge if required. The ultimate cross section could include a maximum of five-lanes of traffic in the eastbound direction. The ultimate typical bridge cross section is depicted in **Figure 5.17**.

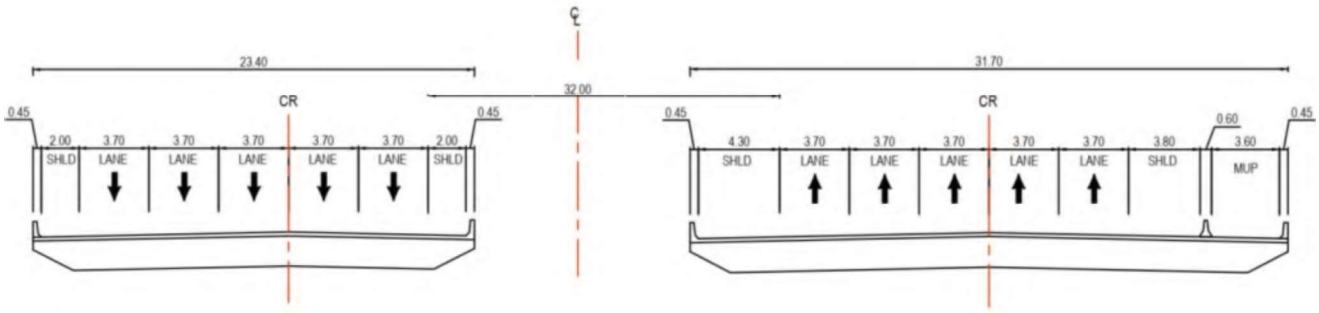


Figure 5.17: Ultimate Typical Bridge Cross Section

The complexity of the river crossing, geotechnical stability risk and limiting environmental factors led to the undertaking of a bridge option study. SNC-Lavalin engaged Leonardt, Andra and Partner (LAP) to complete the bridge option study. Phase 1 of the study included consideration of 15 bridge types detailing the layout and cross section configuration of each. A key driver of geotechnical stability risk and environmental impact is related to the construction. The Phase 1 report also included general information in regard to the intended construction approach. The full study completed by LAP is documented in **Appendix J**.

Engaging the Ministry in evaluation of the options, as noted in subsequent MAE section of the report, the study was consolidated to 4 of the 15 bridge types including:

› Option 2: Steel Composite Girder Bridge;

› Option 6: Through Arch Bridge;

› Option 10: Unsymmetrical Cable Stay Bridge; and

› Option 14: Single Tower Cable Stay Bridge.

Progressing the bridge option study through Phase 1, LAP completed further assessment of the selected bridge options including further structural design, assessment of structural loading and foundation reactions. This information was provided to the project team in order to evaluate foundation options and further defining comparative deep and shallow foundation options for the bridge types. Further explanation of construction means and methods and a matrix of maintenance and durability requirements for each bridge type were also provided. LAP's Phase 2 report including all details of the four bridge types is included in **Appendix J**.

A bridge option workshop was developed and facilitated, including members of the project team and Ministry representatives, in order to review the 4 bridge types. Further details of the MAE process that was followed is provided in subsequent sections of the report. The result of the bridge option workshop concluded 2 bridge types being considered for detailed capital cost estimation. The bridge types are visually depicted in **Figure 5.18**.

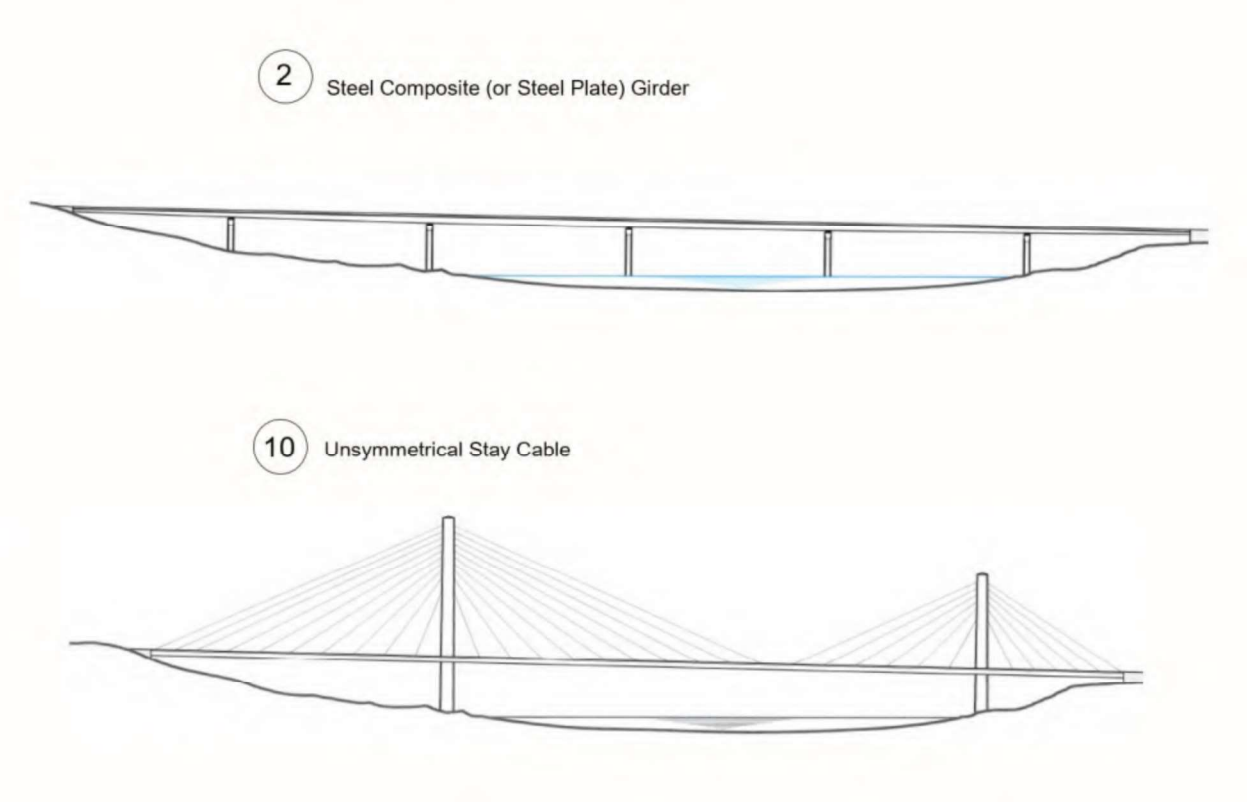


Figure 5.18: Concluded Bridge Types from Phase 1 of the Bridge Option Study.

A detailed bill of quantities for each of the bridge type was developed by LAP and presented to SNC-Lavalin for bottom-up cost estimation. The bottom-up cost estimate included, but not limited to, consideration of construction means and methods, materials, equipment, labour, indirect costs and schedule to arrive at final cost for each option. Through the process of quantity definition and assignment of costs, it became

apparent that two viable tower options should be considered for the Unsymmetrical Cable Stay Bridge (Option 10) which included steel tower and concrete tower options.

Both the Steel Composite Girder Bridge (Option 2) and the Steel Tower Unsymmetrical Cable Stay Bridge (Option 10) arrived at similar total estimated capital costs. The Steel Composite Girder Bridge (Option 2), being considered the standard bridge type, is escalated in capital construction cost due to the extensive environmental permitting and schedule impacts related to work in the river as well as geotechnical stabilization of the slope as a result of the required pier within the river bank. Public input on the two bridge options will be sought in Phase 2 of the Saskatoon Freeway Functional Planning Study (SFFPS) and will be used in the selection of the preferred bridge type.

A geotechnical investigation will be completed within the river valley. The scope of the geotechnical investigation is dependent on the river bridge crossing type and as such will be completed subsequent to the selection of the preferred bridge type.

The requirement for a fifth lane in the southeast bound direction crossing the river is a consideration of the geometric design concept for future construction. The integration of the fifth lane would need to be considered at initial bridge design and construction, however the capital expenditure could be phased with future construction. Based on structural experience, it is expected that approximately 60% (Option 10) and 30% (Option 2) of the additional cost for the fifth lane would be incurred at initial construction.

5.6.2 Interchange Bridge Concepts

The development of the interchange bridge concepts was governed by roadway vertical and horizontal alignments. Vertical clearance for the roadway overpasses allows for the use of prestressed concrete (NU girders) or steel girder bridges with a concrete deck, waterproofing membrane and asphalt wearing surface.

The locations of the abutments, piers, straddle bents and MSE retaining walls is dictated by the horizontal alignment of the roadway with respect to the underlying roadway or railway while providing the required lateral clearances.

Constructability issues for bridges located on curved alignments and/or with variable deck widths was considered as part of the development of the bridge concepts. Generally, the use of variable girder spacings, variable deck overhangs and varying the skew angle of adjacent spans would allow for the bridge deck to accommodate the horizontal alignment of the roadway. For bridges on tighter curves, the use of curved steel girders may be necessary.

For highly skewed bridges, the use of straddle bent piers will be necessary to conform to the horizontal clearances specified in the Ministry standards. These highly skewed bridges will also require the use of retaining walls to avoid embankment slopes from spilling onto the underlying roadway. These retaining walls will likely consist of MSE walls running parallel to the underlying roadway and turning back to run parallel to the face of the abutments. Geotechnical input will be necessary to address any issues with the slope stability and settlement of the embankment fills.

5.7 Property Acquisition

As part of the Functional Design process, a new right-of-way will be determined to accommodate the Saskatoon Freeway, interchanges, and associated improvements. Right-of-way widths will adhere to the Ministry Standard Plan 21009T and 21010, and will be wide enough to accommodate roadway grading, drainage plus 3 m on each side for maintenance purposes and minimizing the risk of additional ROW required during detail design. In Phase 1, interchanges are closely spaced with entrance and exit lane tapers, lane drops between interchanges and high fill areas. It is unlikely there will be many consistent width right of ways between interchanges, rather it will be a variable width right of way. A standard 107.4 m right-of-way (101.4 m for a four-lane divided highway with 32 m median + 6 m for maintenance) will be considered as a minimum. The East Cory Industrial Park, between Highway 12 and 11, has development on both sides of the freeway and is an area where additional property acquisition may be challenging in the future. The development of the area was done with the knowledge of the freeway passing through, but the width planned was 100 m, while the required width based on the functional plan is 130 m-140 m. Additional property requirements have been identified at the Highway 12 interchange to allow for the flexibility of constructing a direct E-S ramp. Efforts have been made, where appropriate at key locations, to minimize the extent of property required to accommodate the recommended plan. The Ministry will negotiate the transfer of all necessary properties prior to construction. Additional widths for a utility corridor have been provided as discussed in **Section 6.2**.

5.8 Active Transportation

It is anticipated that cyclists and pedestrians will be prohibited from being on the Freeway with the estimated traffic volumes (up to approximately 100,000 Average Daily Traffic (ADT) by the year 2063). There are limited opportunities to provide Active Transportation for pedestrians and cyclists along the Saskatoon Freeway or on the three primary crossing roads due to the complex system interchanges. Since Highway 11, Highway 12 and Highway 16 do not currently have any formal Active Transportation infrastructure within the study area, opportunities were identified to integrate multi-use paths at the following three locations within the Phase 1 Study Area.

5.8.1 Saskatoon Freeway Bridge over the South Saskatchewan River

Conceptual plans for the bridge crossing include provisions for barrier separated multi-use paths along the outside of the structure in both eastbound and westbound directions. At the ends of the bridge, the multi-use paths would be interconnected to future trails parallel to the east and west banks of the South Saskatchewan River. The west bank trail would provide a connection to the Wanuskewin Heritage Park to the north, while both east and west bank trails would connect to planned or exiting trails in Saskatoon. The exact location and configuration of the interconnections would be determined in consultation with the MVA and Wanuskewin Heritage Park.

5.8.2 CN Rail Corridor under the Saskatoon Freeway

The Functional Plan for the Saskatoon Freeway includes 2 bridges crossing over CN Rail, one for westbound traffic and another for eastbound traffic. The adjacent Highway 11 interchange will require a third bridge for Ramps W-N/S, and a fourth bridge for Ramp N-W. Penner Road, west of Highway 11 also passes over the CN Rail. All five bridges will be constructed to accommodate the existing rail with provisions for accommodating future rail, a CN Access Road and a multiuse path on the east side of the rail. The

multiuse path would be separated with the rail by a 1.2 m fence. Additional consultation will be required with Stakeholders to determine connection points north and south of the Saskatoon Freeway.

5.8.3 Millar Avenue Flyover Extension over the Saskatoon Freeway

The Functional Plan for the Saskatoon Freeway includes a future crossing of Millar Avenue over the Saskatoon Freeway between Highway 11 and the CN Rail Corridor. Provisions for a barrier separated 3.0 m walkway on both sides of the Millar Avenue extension have been provided.

There may be opportunities to provide multiuse trails on future crossings which have not been identified as part of this study, such as Range Road 3055.

6 Utilities

Utility conflicts specific to each interchange, as well as a summary of stakeholder interest of a Transportation Utility Corridor (TUC) are discussed in the following sections.

6.1 Phase I Utility Conflicts

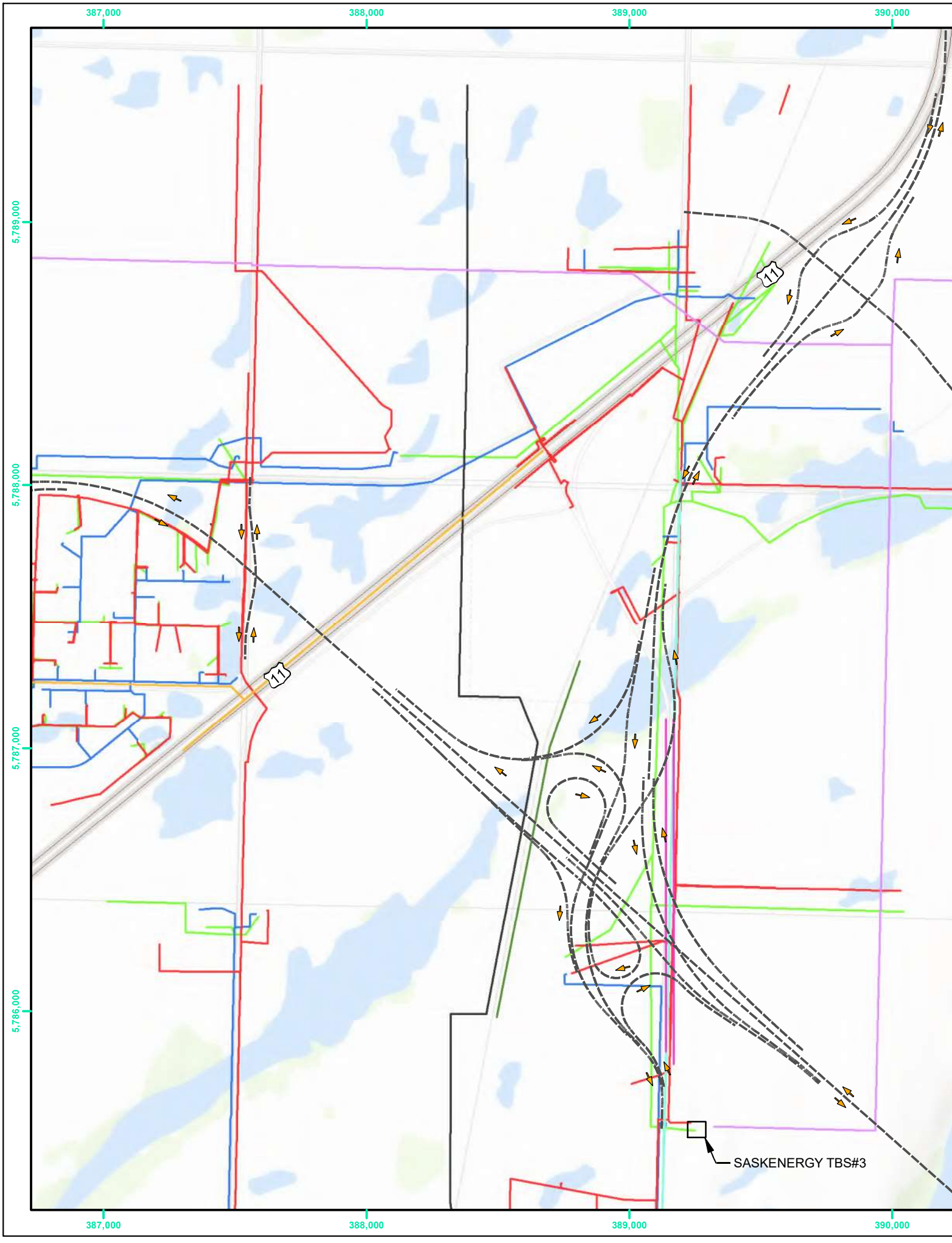
The preferred alignment and interchange configurations with Highway 11, Highway 12, and Highway 16 will require relocation of several utilities. Relocation will provide increased ground cover to facilitate road construction, avoid interchange footprints, or increase overhead clearance. Utility conflicts for the vicinity of each preferred interchange location are presented in **Table 6.1**. Utility conflicts and high-level quantity estimates of each utility to be relocated are discussed for each interchange in the following sections. For the purpose of the functional planning study worst case scenarios were assumed for the number of conflicts and relocation distances with the intention of developing conservative relocation quantities. Specific details for each utility crossing location will need to be developed in subsequent design phases.

Table 6.1: Utility Conflict Summary by Phase

HIGHWAY 11 AND PENNER ROAD	HIGHWAY 12	HIGHWAY 16
SaskEnergy (Distribution)	SaskEnergy (Distribution)	SaskEnergy (Distribution)
SaskEnergy (TransGas)	SaskEnergy (TransGas)	SaskPower (Distribution)
SaskPower (Distribution)	SaskPower (Distribution)	SaskTel
SaskPower (Transmission)	SaskTel	
SaskTel		
SaskWater		
City of Saskatoon (CoS) Water and Sewer		
Shaw Communications		

6.1.1 Highway 11 and Penner Road

Utility conflicts in and around the preferred Highway 11 and Penner Road interchange locations are presented in **Figure 6.1**.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388,000
389,000
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5,789,000
5,788,000
5,787,000
5,786,000
11
11
SASKENERGY TBS#3

SaskEnergy (distribution)

SaskEnergy operates several distribution lines within the Highway 11 and Penner Road interchange areas. Generally, for new road construction increased ground cover would be required over existing facilities. For the purpose of this functional planning study it is assumed that all SaskEnergy distribution lines crossing the preferred alignment or located within the preferred interchange footprints will require relocation to a greater depth, or outside the interchange area, respectively, to facilitate Freeway construction. There are no specific concerns by SaskEnergy with alterations that will be required to accommodate Freeway construction within this area (J. Humney, personal communication, January 16, 2020). SaskEnergy indicated that Town Border Station (TBS) #3 located adjacent (east) of Wanuskewin Road (SW-26-37-05-W3, **Figure 6.1)** is projected to be rebuilt in 2022/2023, and slight relocation, if required, to accommodate Saskatoon Freeway could be considered in consultation with adjacent landowners.

SaskEnergy (transmission/TransGas)

TransGas utility lines cross the preferred Freeway footprint just west of the South Saskatchewan River, as well as across the preferred Highway 11 alignment south of the preferred Penner Road interchange location. The infrastructure at both locations is NPS 12 pipe which will require relocation to a greater depth, as well as potential realignment of the crossing angle and removal of existing pipe. Although not in conflict with the preferred alignment, it is noted that an above ground station is located at the east edge in NE (1/4) LSD-01-03-38-05-W3, which may require consideration during construction activities.

SaskPower (distribution)

SaskPower operates a 25 kV overhead wire along Wanuskewin Road within the preferred Highway 11 interchange footprint. This line will require relocation from the interchange footprint location. There is also a 14.4 kV buried cable that services a nearby acreage. This line will require relocation from the preferred Freeway alignment footprint.

SaskPower (transmission)

A 138 kV overhead wire crosses the preferred Freeway alignment near the west edge of the preferred Highway 11 interchange, adjacent to the CN Railway. The Saskatoon Freeway vertical grade is elevated at this location to accommodate an overpass over the CN rail tracks. As such this wire will require relocation as there is anticipated to be insufficient overhead clearance between Saskatoon Freeway road surface and the overhead transmission wire.

SaskTel

SaskTel operates a rural copper network and major fiber line in the area of the preferred Highway 11 interchange location. The copper network is located along Wanuskewin Road within the preferred Highway 11 interchange footprint. The line branches off to service an acreage to the west of Wanuskewin Road, east along the Meewasin Valley Authority (MVA) walking trait to service Wanuskewin Heritage Park, and east to service SaskEnergy TSB #3. This line will require relocation from the interchange footprint location.

The major fiber line is located along the east side of the CN rail tracks. This line may be able to stay in place as a rail overpass is proposed for this location; however, it has been assumed for this functional planning study that this fiber line will require relocation.

SaskWater

SaskWater operates one high pressure 508 mm steel line and one high pressure 203 mm steel line along the east side of Wanuskewin Road, through the preferred Highway 11 and Penner Road interchange locations. The 203 mm pipe will require relocation from both interchange footprints. According to SaskWater (D. Bunnell, personal communication, May 15, 2020), the 508 mm pipe is in excellent condition and is assumed to be located at sufficient depth to accommodate vertical loading from interchange ramp and embankment fills. This should be confirmed by a geotechnical review at the detailed design stage. SaskWater would prefer not to relocate this pipe unless there is conflict with abutment or pier piles; however, for the purposes of this function plan, estimates have been provided for reallocation of this line from the interchange footprint. This recognizes the Saskatchewan Ministry of Highway's (Ministry) practice to not allow utilities under interchanges and that utilities are generally located around the interchange footprint.

CoS Water and Sewer

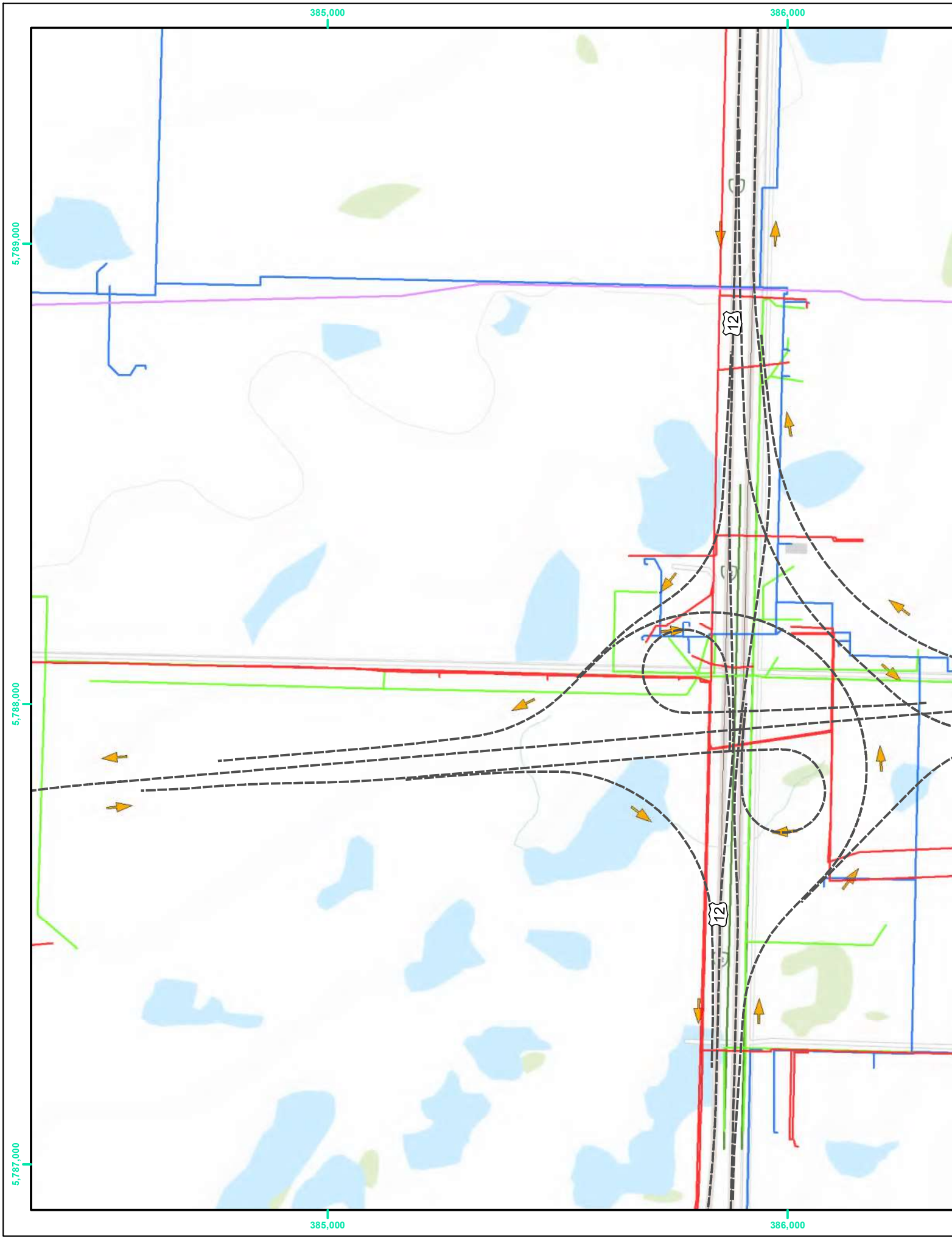
One 200 mm and one 250 mm sanitary sewer force main lines are located along the east side of Wanuskewin Road, through the preferred Highway 11 interchange footprint up to existing Penner Road. The lines then follow existing Penner Road to the east. The lines then conflict again along Penner Road east of Highway 11 where the proposed Penner Road realignment ties into the existing Penner Road alignment. According to the CoS (A. Cole, personal communication, May 20, 2020), generally, existing CoS water and sewer lines are buried to sufficient depth to accommodate road construction however, estimates have been provided for relocating these lines from the Highway 11 interchange footprint. This recognizes the Ministry's practice to not allow utilities under interchanges and that utilities are generally located around the interchange footprint.

Shaw Communications

A Shaw Communications fiber line is located along existing Highway 11 which crosses the preferred Freeway alignment east of Range Road 3053 (i.e. Millar Avenue/Rock Ridge Road). Relocation of this utility to greater depth will be required at this crossing.

6.1.2 Highway 12

Utility conflicts in and around the preferred Highway 12 interchange location is presented in **Figure 6.2**.


385,000
386,000
5,789,000
5,788,000
5,787,000
12
12

SaskEnergy (distribution)

SaskEnergy operates several distribution lines within the Highway 12 interchange area. Generally, for new road construction increased ground cover would be required over existing facilities. For the purpose of this functional planning study it is assumed that all SaskEnergy distribution lines crossing the preferred Freeway alignment or located within the preferred interchange footprint will require relocation to a greater depth, or outside the interchange area, respectively, to facilitate Freeway construction. There are no specific concerns by SaskEnergy with alterations that will be required to accommodate Freeway construction within this area.

SaskEnergy (transmission/TransGas)

One TransGas NPS 12 pipe runs east-west from Penner Road to approximately ¼ mile west of Range Road 3061 and crosses existing Highway 12 at the northern ramp terminals of the preferred Highway 12 interchange location. This utility line may or may not require relocation depending on actual location. For the purpose of this functional planning study it is assumed that the line at this location will require relocation to a greater depth

SaskPower (distribution)

SaskPower operates a 25 kV overhead wire along existing Highway 12 within the preferred Highway 12 interchange footprint. This line will require relocation from the interchange footprint location. There is also a 14.4 kV buried cable within the preferred interchange location that services nearby development to the north and east of the interchange. This line will require relocation out of the preferred interchange footprint. Another 25 kV overhead wire is located along the south side of the preferred Freeway alignment through the development east of the preferred ighway 12 interchange location. This line also crosses the preferred Freeway alignment at Rock Ridge Road. This line will require relocation to a greater depth in this area.

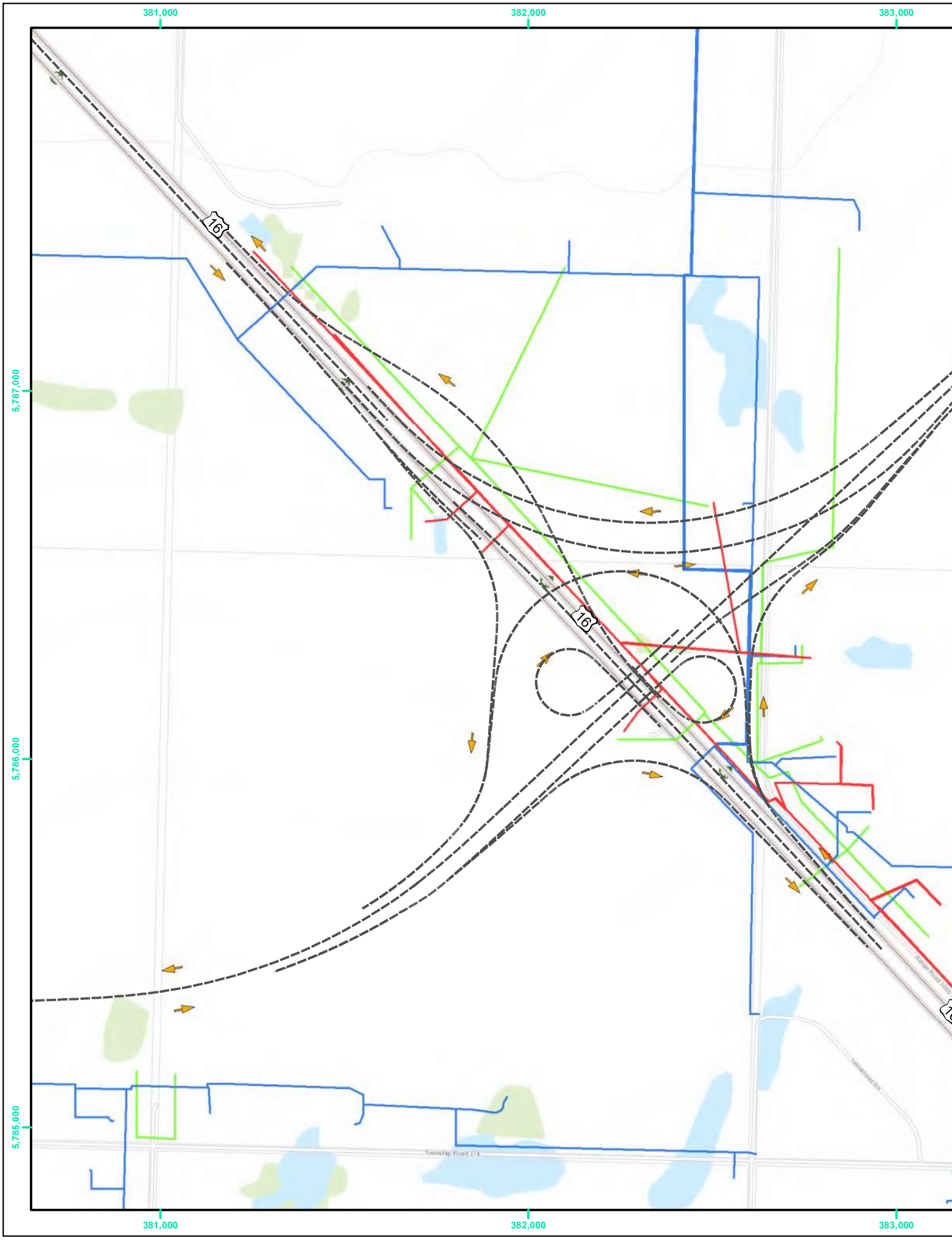
SaskTel

SaskTel operates a copper network and major fiber line in the area of the preferred Highway 12 interchange location. One copper line is located along Township Road 380 and crosses existing Highway 12 within the preferred Highway 12 interchange footprint. The second copper line is located along existing Highway 12 within the preferred Highway 12 interchange footprint. These lines will require relocation from the interchange footprint location. A copper network also services the development east of the preferred Highway 12 interchange location. Part of the network is located along the south side of the preferred Freeway alignment through the development east of the preferred ighway 12 interchange location. This line also crosses the preferred Freeway alignment at Rock Ridge Road. This line will require relocation to a greater depth in this area.

Two major fiber lines are located along existing Highway 12 and run north-south through the preferred Highway 12 interchange location. This line will require relocation out of the preferred interchange footprint.

6.1.3 Highway 16

Utility conflicts in and around the preferred Highway 16 interchange location is presented in **Figure 6.3**.


381,000
382,000
383,000
5,787,000
5,786,000
5,785,000
16
16
Township Road 374

SaskEnergy (distribution)

SaskEnergy operates several distribution lines within the Highway 16 interchange areas. Generally, for new road construction increased ground cover would be required over existing facilities. For the purpose of this functional planning study it is assumed that all SaskEnergy distribution lines crossing the preferred Freeway alignment or located within the preferred interchange footprint will require relocation to a greater depth, or outside the interchange area, respectively, to facilitate Freeway construction. There are no specific concerns by SaskEnergy with alterations that will be required to accommodate Freeway construction within this area.

SaskPower (distribution)

SaskPower operates a 25 kV overhead wire along existing Highway 16 within the preferred Highway 16 interchange footprint. This line will require relocation from the interchange footprint location. There is also a 14.4 kV buried cable and 14.4 kV overhead line that service a nearby homes to the north and east, respectively, of the preferred interchange location. The line servicing the home to the north will likely be abandoned as it is anticipated that this home will be relocated. The line servicing the home to the east will require relocation from the preferred Freeway alignment footprint. An additional 14.4 kV overhead wire crosses the preferred Freeway alignment just west of Range Road 3055. This line will require relocation to a greater depth.

SaskTel

SaskTel operates a rural copper network and customer fiber line in the area of the preferred Highway 16 interchange location. A copper line is located along existing Highway 16 within the preferred Highway 16 interchange footprint and will require relocation from the interchange footprint. The copper line branches off to service a nearby home to the north of the preferred interchange location. This line will likely be abandoned as it is anticipated that this home will be relocated. Another line branches off to service one home to the east and second home to the north of the preferred interchange location. This line will require relocation from the preferred Freeway alignment footprint. The major customer fiber line is located along existing Highway 16 within the preferred Highway 16 interchange footprint. This line will require relocation from the preferred Freeway alignment footprint.

6.1.4 Quantity Estimates

Quantity estimates for the utilities to be relocated in each phase presented in **Table B2 (Appendix B)**. The estimates are high level and should be revisited during design once specific relocation details for each crossing location are determined. The high-level quantity estimates account for removal of existing facilities and rerouting utilities around preferred interchange locations. Where utilities cross the preferred Freeway alignment it was assumed directional drilling would be used to install the new utilities. As such an additional 10 m length in addition to ROW width at each location was included to account for distance required to reach installation depths.

6.2 Transportation Utility Corridor

At the request of the Ministry, utility stakeholders were consulted for interest in a Transportation Utility Corridor (TUC) along the preferred Freeway alignment. Interest by stakeholders is summarized in **Table 6.2**. The TUC is currently highly conceptual and will require ongoing discussion with stakeholders.

The location and sizing of the TUC will be further defined through Phase 2 of the functional planning study and in Phase 3 when it is completed in the future.

Table 6.2: Transportation utility Corridor Interest Summary.

STAKEHOLDER	WIDTH REQUESTED (METERS)	WIDTH PLANNED (METERS)	INSIDE/OUTSIDE OF FREEWAY	SECTION(S) OF FREEWAY
SaskEnergy (Distribution)	10	10	Inside	Entire corridor
SaskEnergy (TransGas)	30	30	Either side	Entire corridor
SaskPower (Distribution)	10	10	Inside	Entire corridor
SaskPower (Transmission)	30 to 110	40	Either side	Entire corridor
SaskTel	10	10	Either side	Entire Corridor
Rogers Communications Inc.	1.5	1.5	Either Side	Entire Corridor
SaskWater	15	15	Outside	Phase 2
CoS Water and Sewer	12 to 50	15	Varies	Phase 1 and Phase 2

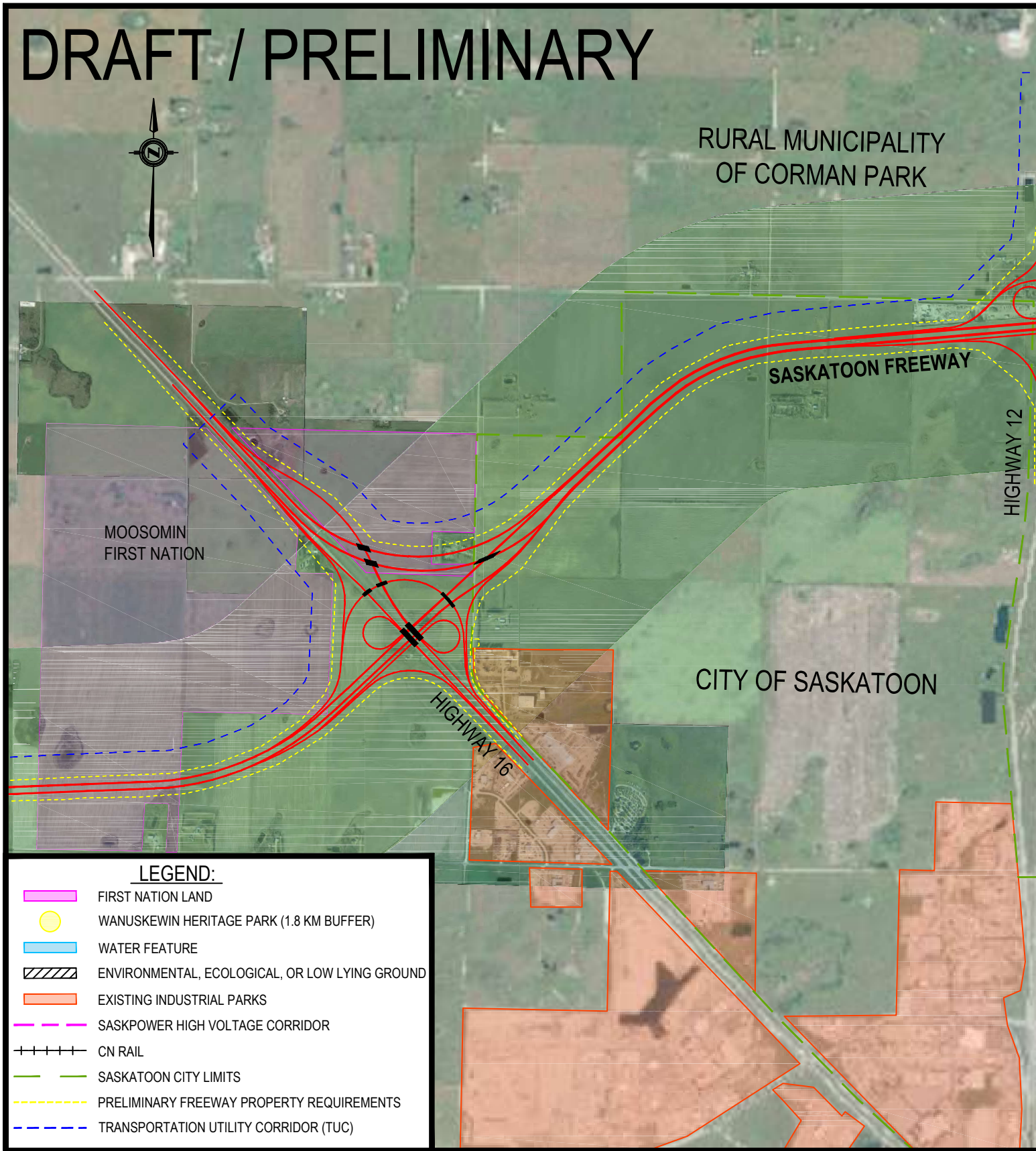
The total corridor width varies between 127 m to 165 m based on the feedback from utility stakeholders. It is understood that some utilities could share the corridor with other utilities and others cannot. These agreements would likely reduce the required TUC width; however, the details of these agreements are beyond the scope of this functional planning study. In the interest of creating a conservative estimate of potential land required for the TUC it is assumed that there would be no sharing of the corridor between utilities.

The corridor widths requested by the CoS are based on accommodating conventional excavation methods during installation of the utilities (N. Kahn, personal communication, May 28, 2020). Once installation is complete the final requirement for a corridor would be approximately 15 m. According to the CoS alternative installation technics (e.g. tunnelling) are less desirable than conventional excavation and installation due to cost and issues meeting specifications for small gradients.

SaskPower transmission corridor requested widths would vary depending on the line voltages installed within the corridor (30 m for 72 kV, 30 m to 40 m for 138 kV, and 40 m for 230 kV transmission lines). According to SaskPower (R. Lu, personal communication, June 2, 2020), it is conceptually possible to utilize multi-circuit structures to install multiple circuits in the same corridor, if logistics are satisfied. This would potently limit the required corridor width to 40 m. As it is unknown at this time on the line voltages and number of lines to be installed, and it is possible to install multiple circuits in a 40 m corridor, SaskPower transmission width of 40 m was assumed.

Generally TransGas requires a 30 m corridor; however this may be able to be reduced within a TUC due to limited public exposure to the utility.

Although the requested location of the TUC by utility stakeholders was considered, the location of the presented TUC in Phase 1 was predominantly determined by current development around Highway 16 and Highway 12, as well as the Wanuskewin Heritage Park buffer. The corridor is proposed to be located along the outside of the Freeway alignment from the Highway 16 interchange location, through the Highway 12 interchange location to avoid existing development, but does go through land owned by Moosomin First Nations near Highway 16. The TUC could then cross the Freeway between existing Highway 11 and CN rail line. Placing the TUC along the inside of the Freeway from the Highway 11 interchange location and the South Saskatchewan River prevents conflict with the Wanuskewin Heritage Park buffer. The TUC preliminary concept is presented below in **Figure 6.4**.



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SASKATOON FREEWAY FUNCTIONAL PLANNING STUDY

TUC P

7 Multiple Account Evaluation

MAE processes were used to assess shortlisted interchange functional plan concepts and to assess bridge type options for the South Saskatchewan River Crossing. A modified Delphi method was used to assess concepts.

A process of identifying alternatives and then evaluating them using MAE techniques can be applied to many phases of road infrastructure development and operation: planning phase, detailed design phase, construction phase, maintenance and operation phase. Functional planning is a stage of the planning phase. Road infrastructure planning has evolved to consider a broad spectrum of evaluation criteria which can be categorized into accounts. Common accounts and evaluation criteria; also referred to as elements, typically used road infrastructure follows (**Figure 7.1**).

Figure 7.1: Multiple Account Evaluation Accounts and Elements (Evaluation Criteria)

These accounts and elements can be standardized to address a specific road authority's mandate and/or modified to suit specific project attributes. Accounts and their respective elements (evaluation criteria) were developed and tailored to suit the Saskatoon Freeway Functional Planning Study (SFFPS) – Phase 1: Roadways and the South Saskatchewan River crossing bridge.

In its simplest form MAE can be completed using a modified Delphi method where a group of subject matter experts considers a range of criteria, respective weightings, ratings, and resulting evaluation points. Each participant provides their assessment of weightings and ratings anonymously. The weightings and rating

points are typically averaged and the alternative which exhibits the greatest number of points can be established as the preferred alternative. This structured communication process leads to a collective decision which inherently removes some of the bias potential of individual participants. The following is a brief description of the original Delphi process for easy reference:

> The Delphi method, also known as Estimate-Talk-Estimate [ETE]) is a structured communication technique or method, originally developed as a systematic, interactive forecasting method which relies on a panel of experts. The technique can also be adapted for use in face-to-face meetings and is then called mini-Delphi or Estimate-Talk-Estimate (ETE). Delphi has been widely used for business forecasting and has certain advantages over another structured forecasting approach. Delphi is based on the principle that forecasts (or decisions) from a structured group of individuals are more accurate than those from unstructured groups. The experts answer questionnaires in two or more rounds. After each round, a facilitator or change agent provides an anonymized summary of the experts' forecasts from the previous round as well as the reasons they provided for their judgments. Thus, experts are encouraged to revise their earlier answers in light of the replies of other members of their panel. It is believed that during this process the range of the answers will decrease, and the group will converge towards the "correct" answer. Finally, the process is stopped after a predefined stop criterion (e.g., number of rounds, achievement of consensus, stability of results), and the mean or median scores of the final rounds determine the results.
>
> (https://en.wikipedia.org/wiki/Delphi_method)

MAE can also be undertaken using a detailed and complex analysis of each evaluation criteria (element) and their respective cost streams over a planning horizon period. For example, road network macro modeling software can be used to determine total travel times for future network alternatives. A respective travel time cost can be determined through a detailed analysis of driver time costs of various types of vehicles. The future cost details can be calculated for an existing network where no changes are made (Base Case) and an alternative future state involving network changes (Alternative). This enables Net Present Values (NPV) and Benefit to Cost (B/C) ratios to be calculated; the Alternative cost is subtracted from the Base Case cost. The NPV can be normalized by dividing it by the capital cost for the Alternative resulting in a B/C ratio, as presented below.

- *Net Present Value (NPV) = Discounted Base Case - Discounted Alternative*
- *B/C = NPV/Capital Cost - 1*

MAE can also be used for portfolio management where NPV's are plotted considering different time horizons. This leads to an analysis of optimum timing for infrastructure investments. MAE can be based on volumes of traffic moved and/or on volumes of people moved. The latter considers an analysis of vehicle occupancy rates on road networks thereby enabling analysis of different modes of travel to move people (e.g. freeways versus light rail).

7.1 Roadway Multiple Account Evaluation

It is important to note that the SFFPS scope did not include re-evaluation of the freeway corridor route determined in previous location studies. However, consolidation of the interchanges proposed at the Highway 11 intersection with the Saskatoon Freeway and the Wanuskewin Road intersection with the

Saskatoon Freeway was determined at a Design Workshop described in **Section 5.2**. While this was not a change to the corridor identified, it was a change to the recommendations in the study regarding the number of interchanges. A MAE process was used at the Design Workshop; not all participants were design experts thus a modified method was used.

A detailed MAE analysis was not used for the SFFPS because of uncertainties associated with the travel demand model (TDM) assumptions: time horizon and population growth, employment growth, etc. The TDM assumptions are described in **Section 4.1** of this report. In addition, the functional concepts for each interchange location are similar; therefore, a detailed analysis is not warranted. This is highlighted by some of the evaluation criteria (MAE Elements) noted as "Equivalent" in the weighting process.

The modified Delphi method was used for Phase 1 of the SFPPS to assess alternative design concepts at each interchange location. The Penner Road interchange was not evaluated separately; it was considered as part of the Highway 11 interchange evaluation. The Delphi method was further modified where an initial draft MAE was completed by the geometric design team experts and then a follow up was made with the Environmental and Heritage Technical Working Group (TWG) experts and the Technical Comittee. The feedback received from the Environmental and Heritage TWG was incorporated into the final MAE analysis. This follow up method provided an opportunity for the Environmental and Heritage TWG to challenge the MAE evaluation criteria, weightings, and ratings. This also served as a quality assurance check on the evaluations.

Details of the MAEs for interchange alternatives and South Saskatchewan River bridge type alternatives for Phase 1 of the SFFPS is included in **Appendix K**.

Interchange functional plan concepts were evaluated using the following order of activities:

1. A wide range of concepts were developed for each location: Highway 11/Wanuskewin Road (13 concepts), Highway 12 (7 concepts), and Highway 16 (8 concepts). The concepts incorporated ultimate system level, hybrid, and service level interchange features. Interim staging concepts were also developed/considered;

2. Interaction between the designers, the Geometric Design and Drainage TWG, and the Project Technical and Steering Committees enabled shortlisting to two concepts at each location;

3. Background data was compiled for each shortlisted concept in preparation for an initial MAE session by the project team executive members. For example, high level parametric construction cost estimates were determined or each interchange concept allowing the MAE participants to make an informed judgement on how they might rate the alternative;

4. Excel workbooks were developed and used for each location. The workbooks included worksheets for completing the weighting and rating processes, data input worksheets to capture input from each participant, and a summary work sheet;

5. The applicable elements were determined for each location. Some elements were not applicable or were considered equal for each of the concepts at a specific location. For example, an assessment of the impact to the Wanuskewin Heritage Park was not applicable for the Highway 12 and Highway 16 interchange MAE process. In other words, each MAE was tailored to the specifics of each location; however, the same set of elements was used;

6. The weighting for each element was determined by each MAE participant by ranking them in order importance. For example, if 16 elements were being used then the most important was given a weighting of 16 and the least important was given a weighting of 1 by each participant;

7. The weightings were averaged for each element. As an example, Participant 1, Participant 2, and Participant 3 might weight the importance of Travel Time differently considering the array of elements being considered. Average weightings were calculated as a means of capturing the overall group of participants weighting minimizing potential bias for a specific concept. Note the weighting of the elements was completed in advance of participant ratings. This was also done to minimize the potential for bias when completing the weighting process;

8. Participants rated each of the elements on a scale of 0 to 4 (0 = Unacceptable, 1 = Marginally Acceptable, 2 = Acceptable, 3 = Excellent, 4 = Exemplary);

9. Results of the MAE were reviewed in detail with the Environmental and Heritage TWG and Technical Comittee. The initial MAE participants did not include an expert from this discipline. The Environmental and Heritage TWG provided comments and/or challenges to the initial results; and

10. The final MAE results were determined and used for selection of the preferred interchange functional plan concept.

7.2 South Saskatchewan River Crossing Bridge Multiple Account Evaluation

The South Saskatchewan River bridge type selection process utilized two MAE processes illustrated in **Figure 7.2**: Phase 1 and Phase 2. Both MAE's used a modified Delphi method; however, Phase 2 was more rigorous and was founded on a greater amount of detail than for Phase 1.

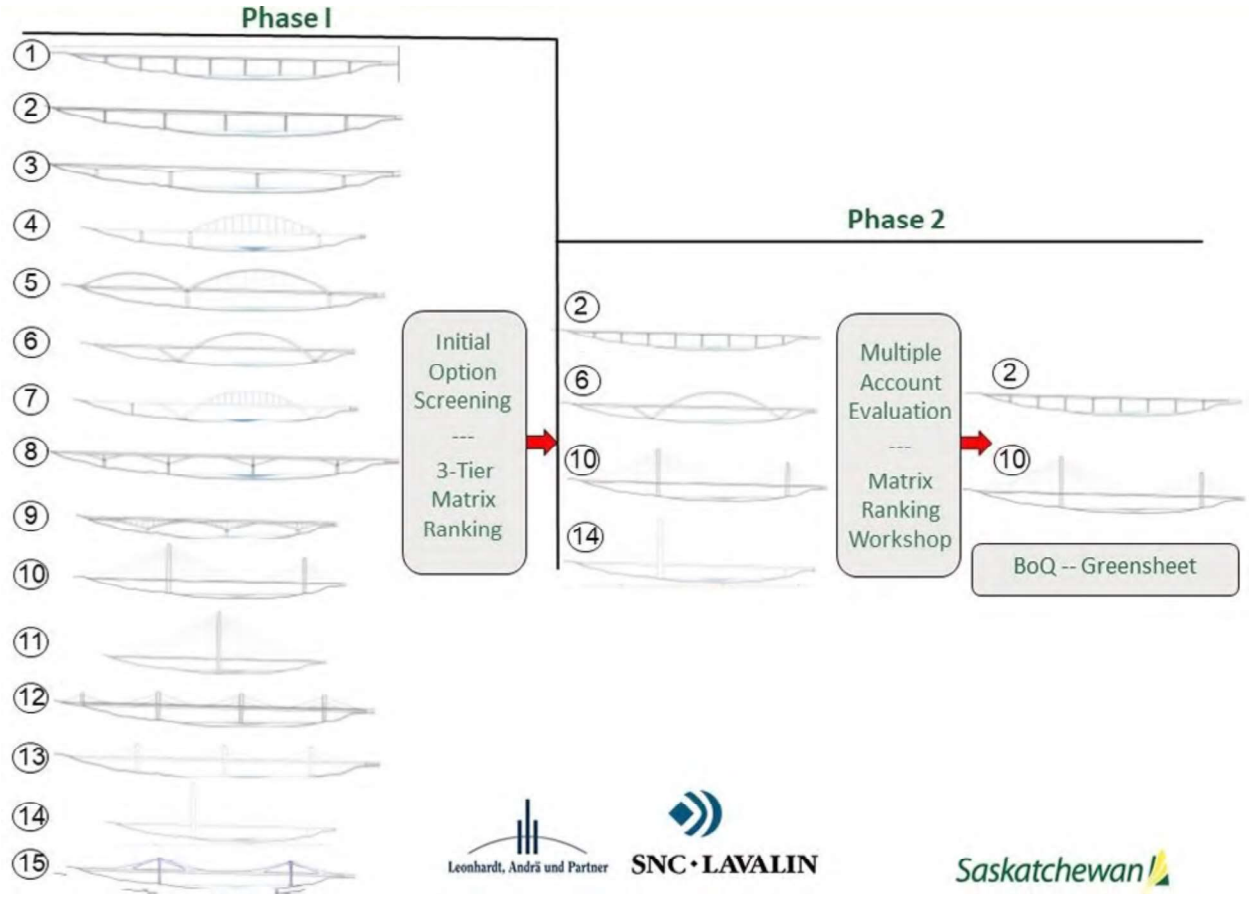


Figure 7.2: Multiple Account Evaluaiton Phasing - Selection of Bridge Types

The following order of activities was used for Phase 1 of the bridge type selection process:

1. The bridge option study for the South Saskatchewan River crossing was driven by consideration of alternative structure types that would reduce the geotechnical and environmental impact to the valley slopes and minimize in-water works. Leonhardt, Andrä und Partner (LAP) was subcontracted to assess alternative bridge types for crossing the South Saskatchewan River;

2. LAP relied on local knowledge and information provided by the project team. The assessment completed by LAP presented 15 feasible bridge types considering layout, cross section and construction details. The Phase 1 Bridge Option Study report completed by LAP is included in **Appendix J**;

3. LAP provided the results of Phase 1 to the Ministry in an initial presentation. LAP provided an overview of the 15 options and allowed a forum for the Ministry to ask questions and have open discussion around the 15 options;

4. The Phase 1 MAE was conducted at the time of the initial presentation with the Ministry and included open discussion around subjective evaluation criteria including:

- Slope Stability Risk;
- Environmental Considerations;
- Compatibility with Local Bridges;
- Constructability;
- Expandability for Future Lanes;
- Life-cycle/Operations & Maintenance Costs; and
- Aesthetics;

5. A ranking in each of the categories, poor, fair and good, was assigned to the 15 options corresponding to a value of 1 to 3 (poor to good). The 4 highest ranked options were chosen for further design development and consideration in Phase 1.

The following order of activities was used for Phase 2 of the bridge type selection process:

1. LAP undertook further design and detailed construction approaches for the 4 options that progressed through the Phase 1 MAE. The details of their analysis and results are presented in the Phase 2 Bridge Option Study Report presented in **Appendix J**;

2. A MAE for Phase 2 Bridge Option Study was developed to focus on key aspects of the bridge types impacting construction and long-term implications. In consideration of all elements, some were considered to be equal among both bridge types. The resulting MAE included accounts and elements as follows:

   - Environmental Account;
     - Heritage Considerations;
     - Piers in the River;
     - Construction in the River;
     - Geotechnical Risks – Slope Stability; and
     - Geotechnical Risks – Foundations;
   - Social Account;
     - Alignment with Development Plans;
     - Iconic Value/Aesthesis; and
     - Impact to Heritage Park, First Nations and Municipalities;
   - Economic Account;
     - Local Employment;
     - Financial Account; and
     - Operations and Maintenance.

3. The details of the work completed by LAP in Phase 2 was presented to the Ministry as part of the Bridge Option Study MAE workshop;

4. Participants at the workshop included representatives from the project team and the Ministry (12 participants in total). The initial worksheet allowed participants to weight the importance of the elements assigned to evaluate the bridge options. The elements were weighted from 1 to 10, 1 being of least importance and 10 being of greatest importance;

5. The weightings were averaged for each element. As an example, Participant 1, Participant 2, and Participant 3 might weight the importance of Travel Time differently considering the array of elements being considered. Average weightings were calculated as a means of capturing the overall group of participants weighting minimizing potential bias for a specific concept. Note the weighting of the elements was completed in advance of participant ratings. This was also done to minimize the potential for bias when completing the weighting process;

6. The MAE workshop then took the participants through each of the elements and presented them with a worksheet to evaluate the bridge options. For each element participants ranked the bridge options on a scale of 1 to 4 (1 being least favorable and 4 being most favorable) for each of the elements;

7. Results of the MAE were consolidated and presented to the participant group at the end of the workshop. The results of the Phase 2 MAE workshop further refined bridge option study to the top two bridge types;

8. A detailed Bill of Quantities (BoQ) was developed by LAP for each of the two bridge types that resulted from the Phase 2 MAE process. The project team developed detailed construction cost estimates for the two bridge options. The bottom up cost evaluation considered items including, but not limited it, materials, labour, equipment, construction processes and durations; and

9. The results of the MAE and bottom up cost evaluation for the final two bridge types was presented to the Ministry to conclude the Bridge Option Study.

8 Multi-Phase Supporting Information

8.1 Geotechnical Investigation

8.1.1 Proposed Geotechnical Investigation Plan

Geotechnical work is scheduled in 2020 therefore this section provides details of the proposed geotechnical investigation plan. Phase 2 and Phase 3 Functional Design reports will provide additional geotechnical information as those phases are completed.

The collection of reliable geotechnical information is a key component of a functional design. The proposed geotechnical investigation will provide factual data to understand subsurface conditions along the freeway alignment, as well as at the proposed locations for interchanges, railway crossings, South Saskatchewan River crossing, and swale crossings.

The geotechnical investigation and testing plan is based on Saskatchewan Ministry of Highways (Ministry) standards and the experience of SNC-Lavalin on projects similar in nature. Optimization of the field investigation has been completed through detailed geological review and consideration of existing boreholes within the project extent. The proposed geotechnical investigation includes drilling of preliminary, stratigraphic and foundation boreholes as outlined below.

Preliminary Boreholes: Preliminary boreholes will be drilled along the general roadway alignment and will be used to delineate surficial materials and define engineering properties of the subgrade. Drilling of preliminary boreholes will be in accordance with the specifications as outlined in the Ministry Construction Manual for Soils Testing (CM 303-01) and will be completed to a minimum depth of 4.6 m (15 feet) below existing ground surface. The information obtained from preliminary boreholes will be used for pavement design, route confirmation and soft soil delineation. Through review of existing borehole information, SNC-Lavalin identified significant amounts of soft soils along the alignment including several wetlands. The presence of which increase the value of the data that will be collected through the completion of preliminary boreholes.

Stratigraphic Boreholes: Stratigraphic boreholes will be drilled along the general roadway alignment and will be used to obtain soil stratigraphy and engineering properties of the subgrade and deeper foundation materials. Drilling of stratigraphic boreholes will be in accordance with the specifications as outlined in the Ministry Standard Test Procedures Manual for Stratigraphic Holes (STP 104-1) and Construction Manual for Soils Testing (CM 303-01). Stratigraphic boreholes will be drilled to a minimum depth of 13.5 m (45 feet) below existing ground surface. The information obtained from completion of stratigraphic boreholes will be used to interpolate the stratigraphy of the area, determine the engineering properties of the subgrade and foundation along the alignment, and determine the type and quality of expected adjacent borrow sources.

Foundation Boreholes: Foundation boreholes will be drilled at bridge/overpass locations in order to define the soil horizons and material properties of the supporting ground. Drilling of foundation boreholes will be in accordance with the specifications as outlined in the Ministry Construction Manual for Soils Testing (CM 303-01) and will be completed to a minimum depth of 24.4 m (80 feet) below existing ground surface. Cone Penetration Testing (CPTu) will be performed at structure locations to supplement the conventional borehole data and provide continuous profile of material strength with foundation depth. CPTu offers

continuous in-situ quantitative measurements that are not user dependent. Moreover, the continuous nature of CPTu allows thin weak layers to be captured that might be missed or disturbed and indistinguishable in auger drilling. This continuous, in-situ, quantitative measurement will directly correlate to more efficient design and reduced construction costs in addition to increased confidence in the parameters and design. This confidence is also expressed in relevant design codes including those published by the American Association of State Highway Transportation Officials (AASHTO), where higher resistance factors are utilized when determining bearing resistance of shallow foundations and piles dependant on the understanding of geotechnical conditions. Where sufficient CPTu data has been collected, the data provides a higher confidence in the soils; therefore, higher resistance factors can be utilized for design and shorter pile lengths will be required. A sufficient number of conventional drilled foundation borehole at each structure will be completed in order to collect soil samples for laboratory testing. In addition, visual inspection of the soils encountered is required to calibrate the results obtained from CPTu. The information obtained from the completion of foundation boreholes (conventional and CPTu) will be used to define soil capacities for design of structural foundations.

Foundation Boreholes for the South Saskatchewan River Crossing: Foundation boreholes to be drilled for the South Saskatchewan River crossing will target abutment and pier locations as defined by the selected structure type. Deep stratigraphic boreholes will be completed at abutment locations to anticipated depth of 100 m (330 feet) below existing ground surface. Foundation boreholes will also be completed at up to two pier locations defined by the structural configuration to anticipated depth of 30.4 m (100 feet) below existing ground surface. For pier locations within the river, drilling will be completed via barge during the summer months. Drilling via ice bridge construction was considered, however, it was deemed unsafe due to the release of warm water effluent discharged from the City of Saskatoon (CoS) sewage treatment plant upstream or excess water from power generation at Gardiner Dam. Boreholes drilled at the river crossing will be completed using mud rotary methods due to depth and complexity. Geophysical logging will also be completed on the deep stratigraphic foundation boreholes at the South Saskatchewan River. The boreholes will be geophysically logged using a Mount Sopris MGX II digital logging system and Matrix software. Natural gamma (NG), single-point resistance (SPR), and spontaneous potential (SP) readings will be collected for each hole. The information obtained from the completion of foundation boreholes at the South Saskatchewan River crossing will be used to define soil capacities for design of structural foundations.

- Drill supervisors will determine the final location of boreholes based on site conditions and oversee the drilling operation. Prior to any ground intrusive investigation, appropriate permits and utility clearances will be obtained. For each borehole, the drill supervisor will document soil descriptions, collect soil samples, and complete in-situ field testing. Standard Penetration Testing (SPT) and Shelby tube sampling will be performed at select stratigraphic depths. Soil samples collected during the field investigation will be tested to determine the geotechnical parameters of the soils. The following tests will be performed on selected samples:
- Natural water content (ASTM D2216);
- Atterberg limits (ASTM D4318);
- Wash sieve analysis (ASTM C117);
- Hydrometer and sieve test (ASTM D7928 and C136);
- Group index and classification (Ministry STP 205-2);
- Unconfined compression strength (for select Shelby tube samples, ASTM D2166);
- One dimensional consolidation (ASTM D2435);

- Unit weight (for select Shelby tube samples, ASTM D7263);
- Triaxial compression test (for foundation design, ASTM D4767);
- Carbonate content (for select glacial till samples, ASTM D4373);
- Organic content (for organic soil samples only, AASHTO T267); and
- Direct Shear (for slope stability analysis at the river bridge, ASTM D3080).

It is assumed that groundwater will be encountered during the drilling investigation. To record groundwater levels in the project area, standpipe piezometers will be installed at select stratigraphic borehole locations drilled along the general alignment. Due to the anticipated large fills at the interchanges and railway crossing locations, installation and monitoring of Vibrating Wire (VW) piezometers has been included in the geotechnical investigation plan. During drilling, the location and depth of piezometers will be determined based on the soils encountered and groundwater observed. Slope inclinometer (SI) casing will be installed during the drilling investigation at both the east and west abutments of the South Saskatchewan River crossing. This SI casing will be installed in order to monitor horizontal displacement of the valley slope and will also determine any potential slip surfaces that will require consideration for slope stability modelling.

Upon completion, borehole locations will be surveyed using a handheld GPS unit. Additional survey using a real time kinematic (RTK) surveying system will be completed for boreholes containing instrumentation. Preliminary and stratigraphic boreholes (up to 13 m) will be backfilled with the cuttings and/or bentonite chips. A cement/bentonite slurry mixture will be used to backfill deeper stratigraphic boreholes, boreholes with instrumentation installed, and boreholes with groundwater or environmental concerns.

8.1.2 Geotechnical Data Report

SNC-Lavalin will prepare a factual report documenting the findings of the geotechnical investigation in the Geotechnical Data Report (GDR). The GDR will include a summary of the field investigation undertaken, borehole logs complete with soil descriptions, field testing and laboratory testing results as well as instrumentation completion details and monitoring data collected up to the time of report generation.

8.2 Intelligent Transportation System (ITS)

The Ministry has a key action to “Advance the use of field devices and new technologies in project and service delivery through the Ministry’s Intelligent Transportation System (ITS) plan.” (Saskatchewan Ministry of Highways and Infrastructure, 2019).

The Saskatoon Freeway Functional Planning Study (SFFPS) incorporates ITS concepts. A high-level concept plan was developed as part of Phase 1 of the study as illustrated in **Figure 8.1**. This plan is in draft form and will be finalized with the project summary report.

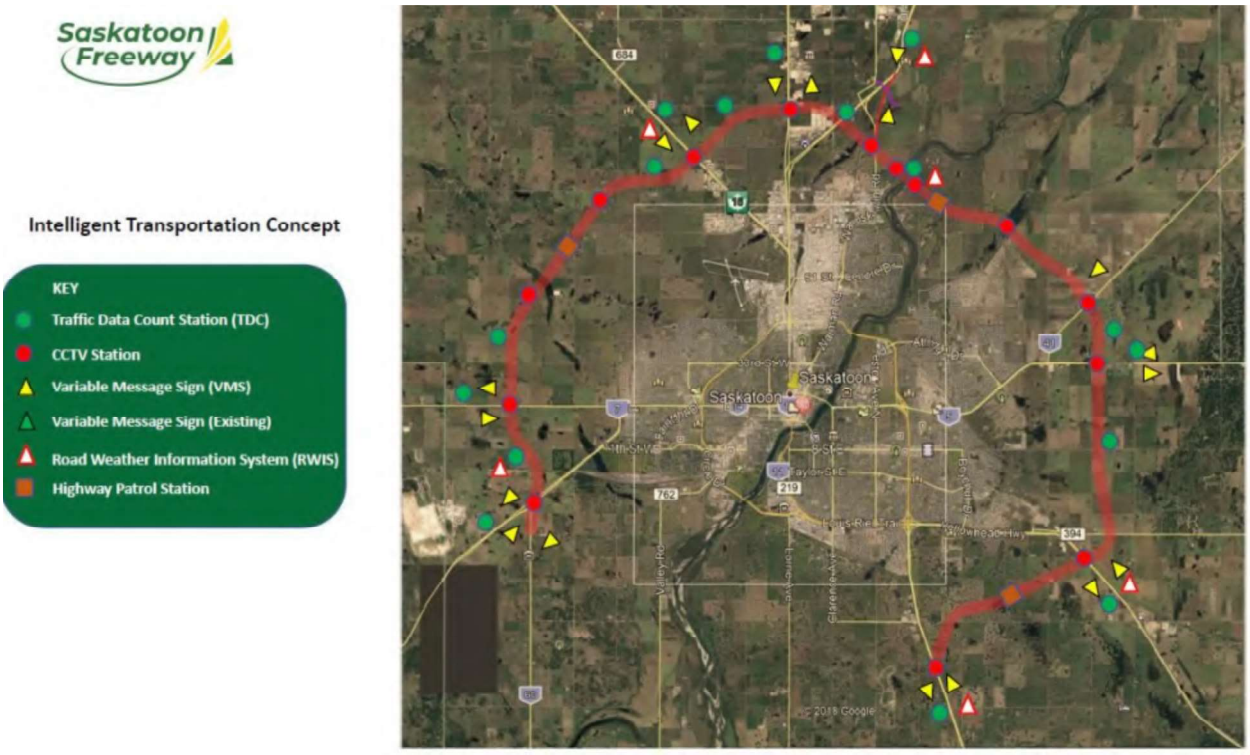


Figure 8.1: Draft Intelligent Transportation System Concept Plan

The ITS concept plan is being present with the Phase 1 report as a means of ensuring full documentation of the work undertaken in Phase 1. The Final project Report will encompass all ITS functional design information.

9 Recommendations

9.1 Interchange Design

9.1.1 Highway 11 & Penner Road

Following selection of Concept 11-2 as the preferred concept using the Multiple Account Evaluation (MAE), a number of minor modifications were made to the Highway 11 interchange configuration as follows:

- An eastbound sub-collector road was introduced to accommodate Ramps W-S and W-N;
- Longer and tighter curves were introduced along ramp N-S to further promote speed reduction; and
- Minor geometry changes to weaving lengths and tapers, including an increased radius for loop Ramp E-S.

At the Saskatoon Freeway interchange with Highway 11, a westbound fork design for the E-N and N-E ramp will be constructed to maintain route continuity to/from the east. A loop ramp will be provided for westbound access to southbound Wanuskewin Road (Ramp E-S). In the eastbound direction, a Collector Distributor (C-D) road will be provided along the Saskatoon freeway to combine the W-N and W-S ramp exits. Wanuskewin Road will connect directly to Highway 11 with ramps constructed to accommodate movements E-S, W-S, S-E and S-W. Ramp N-W will be provided, which allows for full movements at the interchange. The S-E ramp off NB Wanuskewin is only one lane due to lane reductions leading up to the river crossing and may not be sufficient to handle future traffic demand. This was deemed acceptable as the delays would not impact the Saskatoon Freeway. As part of the recommended plan, approximately 3 km of existing Highway 11, and 2.5 km of Wanuskewin Road will be closed.

Structures will carry the Saskatoon Freeway and C-D road over Wanuskewin Road (three structures), Saskatoon Freeway over the N-E ramp (one structure), Wanuskewin Road northbound over the N-E and E-N ramps (one structure), and Ramp S-W over southbound Wanuskewin Road (one structure). Additionally, five structures will be required to carry traffic over the CN Rail line, west of Wanuskewin Road (two structures for Saskatoon Freeway, one structure for Ramp W-N/S, and one structure for Ramp N/S-W and one west of Penner Road interchange).

A summary of key geometrics for Highway 11/Wanuskewin Road is provided in **Table 9.1** and the preferred interchange configuration is presented below in **Figure 9.1**. Functional Design plan and profiles for the interchange are presented in **Appendix L**.

Table 9.1: Highway 11 Interchange Geometrics

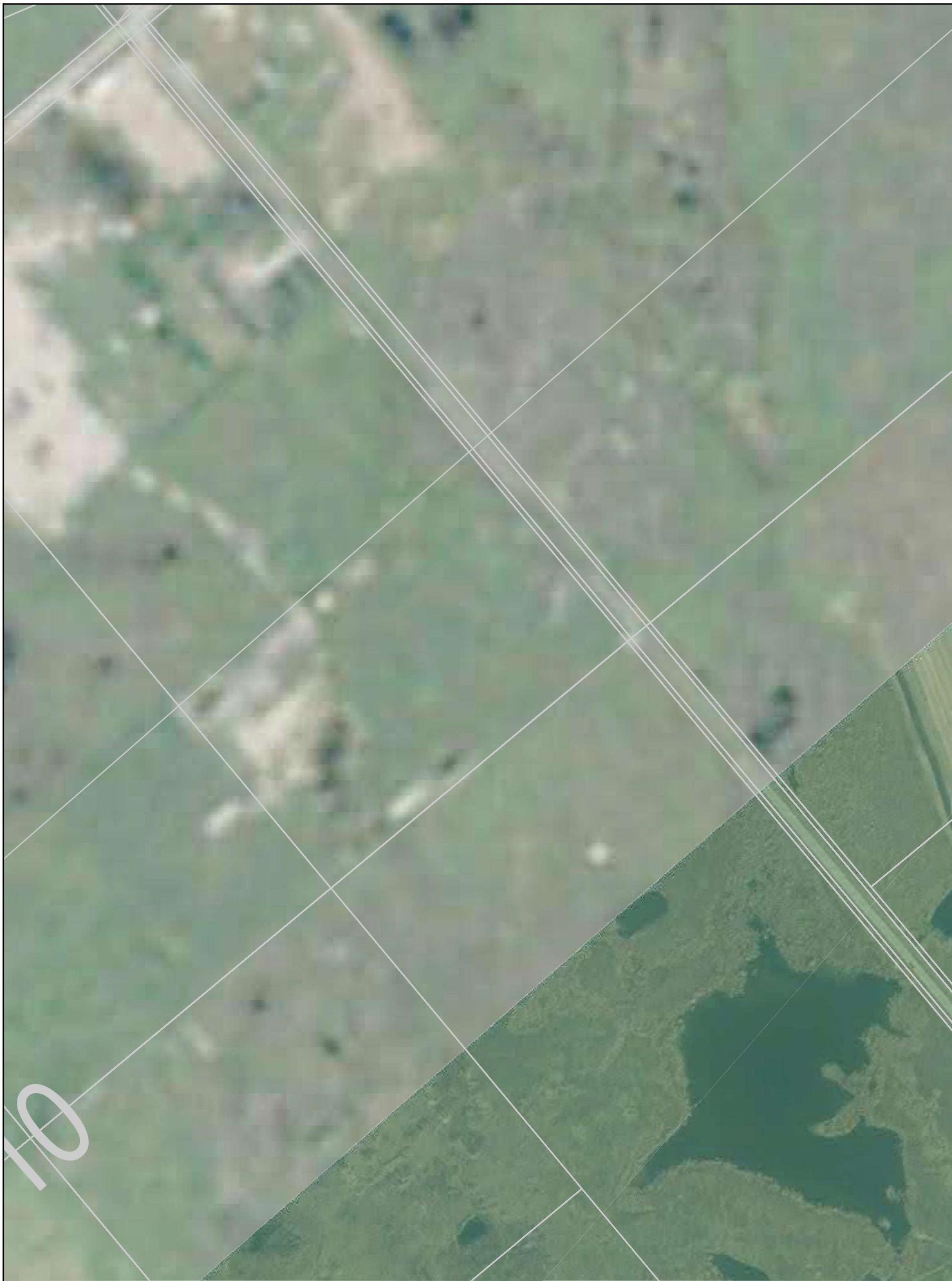
GEOMETRIC DESIGN STANDARD		RAMP W-S	RAMP W-N	RAMP S-E	RAMP S-W	RAMP E-N	RAMP N-E	RAMP E-S	RAMP N-W
Design Speed (km/h)		90	50	60	70	130	130	50	100
Number of Lanes		1	1	1	1	2	2	1	1
Lane Width (m)		4.8	4.8	4.8	4.8	2x3.7	2x3.7	4.8	4.8
Shoulder Width (m)	Left	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Right	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Minimum Radius (m)		340	90	130	190	950	950	110	440
Maximum Grade (%)		2.80	3.60	1.00	2.85	2.30	0.60	2.50	4.30

North of the Saskatoon Freeway, a new diamond interchange is recommended at Penner Road to provide access to the Wanuskewin Heritage Park. To increase separation along Highway 11 between the Saskatoon Freeway and Penner Road interchanges, Penner Road was realigned further north to provide more opportunities for more favourable connections with Warman Road. Full access will be provided at the Penner Road interchange with a diamond configuration with single lane ramps. Single lane roundabouts are recommended at both the east and west terminal intersections. The terminal intersections could also be implemented as signalized intersections with no changes to the ROW requirements or roadway alignments. Between the Saskatoon Freeway interchange and Penner Road interchange, Highway 11 will have three lanes in each direction with the third lane becoming a must exit / continuous speed change lane at the Penner Road interchange.

A summary of key geometrics for Penner Road is provided in **Table 9.2** and the preferred interchange configuration is presented below in **Figure 9.2**. Functional Design plan and profiles for the interchange are presented in **Appendix L**.

Table 9.2: Penner Road Interchange Geometrics

GEOMETRIC DESIGN STANDARD		PENNER ROAD	RAMP S-E/W	RAMP E/W-N	RAMP E/W-S	RAMP N-E/W
Design Speed (km/h)		80	60	60	60	60
Number of Lanes		2	1	1	1	1
Lane Width (m)		2x3.5	4.8	4.8	4.8	4.8
Shoulder Width (m)	Left	2.0	0.6	0.6	0.6	0.6
	Right	2.0	2.5	2.5	2.5	2.5
Minimum Radius (m)		250	130	130	130	130
Maximum Grade (%)		4.0	2.9	2.0	3.6	3.0
Minimum "K" Factor	Crest	30	100	N/A	50	80
	Sag	30	30	100	30	30



9.1.2 Highway 12

Following selection of Concept 12-2 as the preferred concept using the MAE, the following minor modifications were made to the Highway 12 interchange configuration:

- An eastbound sub-collector road was introduced to accommodate Ramps W-S and W-N;
- The bullnose for Ramp E-S was shifted further to the east to allow for a longer distance for vehicles to transition to slower speeds;
- Ramp E-N was reconfigured to merge on the right side of Highway 12 northbound;
- Reduced geometry for Ramp N-W to allow for a southerly shift of the Highway 12 southbound fork, and
- Minor geometry changes to weaving lengths and tapers, including an increased radius for loop Ramp E-S.

The recommended plan for Highway 12 interchange includes direct fork ramps for the E-N and N-E ramp, similar to the Highway 11 and Highway 16 interchange configurations. These ramps will be designed at a lower design speed than the other two interchanges as Highway 12 is considered a local/interprovincial highway and route continuity along the Saskatoon Freeway is not required.

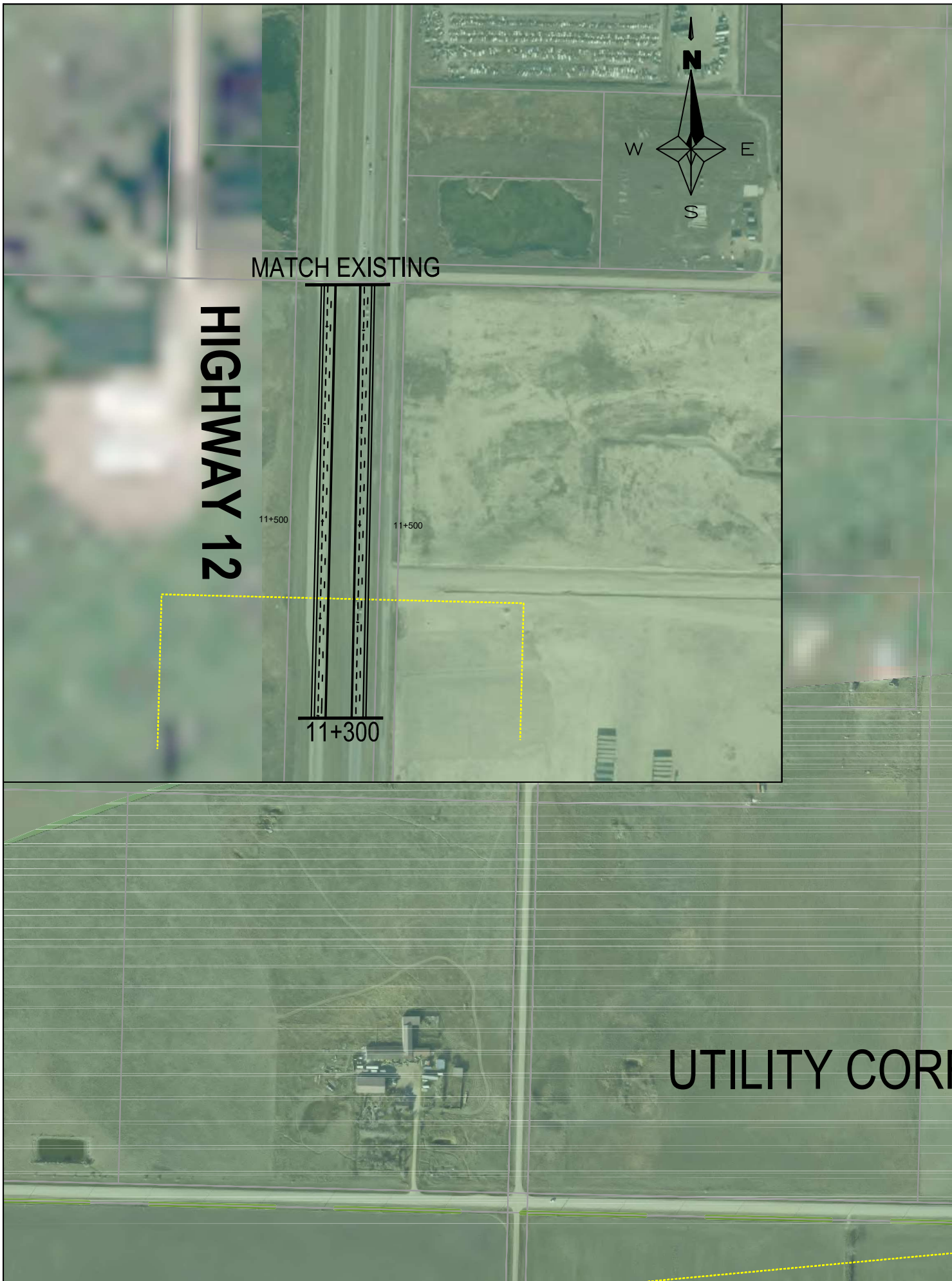
Direct ramps will be used for the W-S, S-E, and N-W ramps. This configuration allows for the construction of an interim northbound left turn with a signalized intersection at Highway 12 southbound with a connection to the N-W ramp (**Figure 5.9**). The direct S-W ramp would be deferred to the future when warranted. A single lane loop ramps would be constructed for W-N, with a two-lane loop ramp constructed for the E-S ramp to accommodate the high traffic volumes anticipated along the ramp.

Structures will carry Highway 12 traffic over the Saskatoon Freeway (one structure), Highway 12 northbound over Ramp S-W and Ramp N-E (two structures), Highway 12 soutbound over Ramp S-W (one structure), N-E ramp over Saskatoon Freeway (one structure), and Ramp S-W over Saskatoon Freeway (one structure).

A summary of key geometrics for Highway 12 is provided in **Table 9.3** and the recommended interchange configuration is presented below in **Figure 9.3**. Functional Design plan and profiles for the interchange are presented in **Appendix L**.

Table 9.3: Highway 12 Interchange Geometrics

GEOMETRIC DESIGN STANDARD		RAMP W-S	RAMP W-N	RAMP S-E	RAMP S-W	RAMP E-N	RAMP N-E	RAMP E-S	RAMP N-W
Design Speed (km/h)		90	50	90	90	110	90	50	80
Number of Lanes		1	1	1	1	2	2	2	1
Lane Width (m)		4.8	4.8	4.8	4.8	2x3.7	2x3.7	2x3.7	4.8
Shoulder Width (m)	Left	0.6	0.6	0.6	2.5	0.6	0.6	0.6	0.6
	Right	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Minimum Radius (m)		340	90	340	340	600	340	90	250
Maximum Grade (%)		3.00	2.40	3.47	4.00	4.00	4.75	2.50	3.88
Minimum "K" Factor	Crest	50	N/A	40	50	40	40	50	30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MATCH EXISTING
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11+500
11+500
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UTILITY CORI

9.1.3 Highway 16

Following selection of Concept 16-2 as the preferred concept using the MAE, two minor modifications were made to the Highway 16 interchange configuration. The Saskatoon Freeway alignment along with the Highway 16 interchange was shifted by 25 m to the northwest to provide a minimum separation of 22 m separation between the S-E/W ramp and the adjacent Service Road (Range Road 3060). A sub-collector (C-D) road along the eastbound Saskatoon Freeway was added to provide a single exit for Ramp W-S and Ramp W-N.

At the Saskatoon Freeway interchange with Highway 16, a westbound fork design for the E-N and N-E ramp will be constructed to maintain route continuity to/from the east. Direct ramps will be provided for the W-S, S-E, and N-W ramps with a flyover for the S-W ramp. Loop ramps will be provided for the E-S and W-N ramps. A C-D road will be used to combine the W-N and W-S ramps exits. Structures will carry Highway 16 traffic over the Saskatoon Freeway (two structures), N-E ramp over northbound Highway 16 and westbound Saskatoon Freeway (two structures), E-N ramp over northbound Highway 16 (one structure), and Ramp S-W over Saskatoon Freeway and Highway 16 (three structures).

A summary of key geometrics for Highway 16 is provided in **Table 9.4** and the recommended interchange configuration is presented below in **Figure 9.4**. Functional Design plan and profiles for the interchange are presented in **Appendix L**.

Table 9.4: Highway 16 Interchange Geometrics

GEOMETRIC DESIGN STANDARD		RAMP W-S	RAMP W-N	RAMP S-E	RAMP S-W	RAMP E-N	RAMP N-E	RAMP E-S	RAMP N-W
Design Speed (km/h)		90	50	90	90	130	130	50	90
Number of Lanes		1	1	1	1	2	2	1	1
Lane Width (m)		4.8	4.8	4.8	4.8	2x3.7	2x3.7	4.8	4.8
Shoulder Width (m)	Left	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Right	2.5	2.5	2.5	2.5	3.0	3.0	2.5	2.5
Minimum Radius (m)		340	90	340	340	950	950	90	340
Maximum Grade (%)		1.39	3.00	2.25	4.00	3.00	3.00	3.50	4.88
Minimum "K" Factor	Crest	100	50	40	40	125	125	40	30
	Sag	300	33	40	40	60	75	40	20


MATCH EXISTING
N
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HIGHWAY 16
5+500
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11+796
UTILITY CO

9.2 Mainline Alignment

Phase 1 of the study includes new construction of approximately 12.5 km of the Saskatoon Freeway from 2.6 km west of Highway 16 to 2.2 km east of the new Highway 11/Wanuskewin Road interchange. The Saskatoon Freeway will be designed to a 130 km/h design speed and in accordance with the design standards provided in **Section 5.1**.

Within the Phase 1 limits, there are three horizontal curves along the Saskatoon Freeway mainline, with additional curves required to facilitate the eastbound bump outs. The minimum horizontal curve along the mainline occurs east of Highway 12 and has a radius of 1000 m, exceeding the minimum requirement for a 130 km/h design speed. A horizontal curve with a radius of 1500 m occurs west of Highway 16 and a horizontal curve with a radius of 1200 m occurs between Highway 16 and Highway 12.

In general, the profile of the Saskatoon Freeway follows the existing ground profile as close as possible while providing a minimum 0% and 0.5% grades for rural cross section and structures, respectively, for drainage purposes. A maximum vertical grade of 2.70% is required east of Wanuskewin Road to ensure adequate clearance for the Saskatoon Freeway over the CN Rail line and Wanuskewin Road/Highway 11.

A standard median width of 32 m will be provided throughout the corridor with a minor bump-out of the eastbound lanes at the Highway 16 and Highway 11 interchanges to accommodate the geometry required for a major fork design. The ultimate configuration of the Saskatoon Freeway will have a typical 4-lane cross-section west of Highway 12, 6-lane cross-section between Highway 12 and Highway 11, and a 9-lane cross-section (4 westbound lanes and 5 eastbound lanes) east of Highway 11 over the South Saskatchewan River. In the westbound direction, the transition from 4 to 3 mainline lanes will occur at the fork with Highway 11 northbound, where the outside fourth lane will be designated as a ‘must exit’ to Highway 11 northbound. In the westbound direction, 3 lanes along the Saskatoon Freeway will be combined with two lanes from Highway 11 southbound, resulting in 5 eastbound lanes continuing across the South Saskatchewan River bridge.

An interior shoulder width of 2.5 m is recommended for freeway sections with a 6-lane cross-section based on Transportation Association of Canada (TAC) guidelines as there is no standard provided by the Saskatchewan Ministry of Highways (Ministry).

Additional auxiliary lanes will be provided within the interchange limits to facilitate deceleration or acceleration. The typical cross-section of the Saskatoon Freeway is provided below in **Figure 9.5**. Functional Design plan and profiles for the Saskatoon Freeway are presented in **Appendix L**.

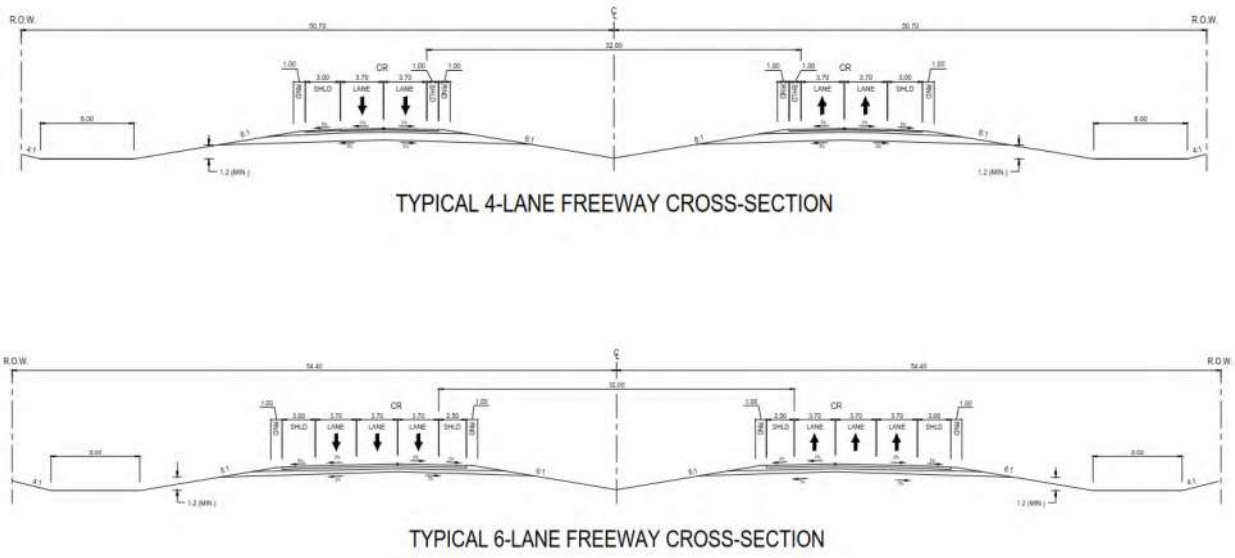


Figure 9.5: Typical Saskatoon Freeway Cross-Section

9.3 Secondary Roads

Secondary Roads are defined as all other roads except the freeway, interchange ramps and loops and numbered provincial highways. Secondary roads that intersect the Saskatoon Freeway are typically the responsibility of the adjacent Rural Municipality (RM) of Corman Park and the City of Saskatoon (CoS). This report will recommend a general alignment of all secondary road that are directly impacted by the proposed freeway. However; it is acknowledged that there will be considerable new development adjacent to the proposed freeway right of way before the freeway is opened to traffic. Future development will likely change the alignment or even the need for secondary roads that are illustrated in the study's recommended plan.

When property is acquired for the freeway over the next 5-10 years, remnant parcels of land may be created. All parcels of land require some form of legal land access to a road right of way. The property acquisition process should consider the cost of creating legal access to all remnant parcels created during the acquisition process. Property acquisition decisions could impact the recommended plan for secondary roads impacted by the freeway.

9.3.1 Millar Road

Millar Road (CoS) should extend across the freeway and connect directly to Rock Ridge Road (Rural Municipality (RM) of Corman Park). This new connection has significant positive impacts to level of service on several ramps in the Highway 11 and Highway 12 interchanges. Rock Ridge Road extends north to Martensville and will provide road users with another north south connection between Saskatoon and Martensville. Millar Road requires an overpass above the Saskatoon Freeway for vehicles, bicycles and

pedestrians. Based on the benefits to the province, it is recommended the Millar Road overpass be part of the Saskatoon Freeway project.

9.3.2 Range Road 3055

Range Road 3055 will extend across the freeway in the long term. Range Road 3055 is presently a low volume graveled north south road. Significant development north of the freeway is not expected for many years. Provision should be made in the CoS and the Rural Municipality development plans for this connection. However; due to the long-range need for the overpass, Range Road 3055 overpass should not be part of the Saskatoon Freeway project.

9.3.3 Penner Road

Penner Road east of Highway 11 requires significant relocation northward to connect with the proposed location of the interchange sets the alignment of Penner Road east and west of the Highway 11 interchange. West limits of the construction of Penner Road ends at Warman Road. The location of the Penner Road/Warman Road intersection is approximate and can be adjusted by 20 metres to suit future development.

9.4 Drainage

Recommendation details are outlined in **Section 5.5** (Drainage Concepts) of this report.

The catchment areas and drainage paths identified in this report are based on the best available data. Due to the complexity and ongoing development in the watershed impacting this phase of the Saskatoon Freeway it is recommended that detailed design include comprehensive survey and mapping of all drainage paths and catchment areas to address the following:

- The uncertainty associated with varied vertical datums, geoids, and unknown LiDAR quality makes it difficult to validate the predicted watershed patterns. If the Saskatoon North Partnership for Growth (P4G) LiDAR continues to be used by the Ministry, an adjustment of approximately - 0.3 m is recommended;
- The Dynamic Drainage paths discussed in the Design Concept are an important consideration and demonstrate the impact that changing conditions can have on drainage paths in this relatively flat terrain; and
- The grid road system and ongoing land development in the area has significantly altered natural drainage patterns. Whether intentional or not, future development and drainage projects may alter the size and drainage path of catchment areas, which may impact the flow intersected by the Saskatoon Freeway.

Several locations were identified where existing drainage may need to be maintained. Landowner consultation is recommended for the following locations:

- NE 31-37-05-3. A field ridge appears to be directing overland flow to a dugout south of the freeway. Most of this flow will be cut off by the Saskatoon Freeway. If feeding the dugout is desirable ditch grades can be adjusted accordingly. Refer to Catchment D in **Figure 5.14** for more detail;

- NW 32-37-05-3. An access road and treeline at 15+560 seems to be directing runoff into a wetland and dugout to the south. If the dugout is desired the freeway ditch grades can be adjusted accordingly. Refer to Catchment E in **Figure 5.14** for more detail;
- SW 31-37-05-3. An area of agricultural land, roughly 24 ha, will be cut off from natural overland flow from the northwest. Refer to Catchment C in **Figure 5.14** for more detail; and
- NE 31-37-05-3. An area of agricultural land, roughly 9 ha will be cut off from natural overland flow. Refer to Catchment F in **Figure 5.14** for more detail.

Recommended locations of culverts have been analysed and described in the Proposed Culvert Location section of this report. The standard maximum culvert spacing of 800 m was not necessary to achieve functional drainage. It is recommended that the location of additional culverts required to meet this standard be identified in the detailed design phase. However, the section between Highway 12 and Highway 16 required additional culverts to accommodate the overland sheet flow.

The detention of increased peak runoff can be achieved within the freeway ditches using an appropriately sized culvert to throttle the outflow. It is recommended that the increased peak flow from each interchange be similarly detained within the interchange ramps. In areas where detained flow may result in damage to infrastructure, the use of high-water-level overflows is recommended. Flow following Drainage Path 3 through the Hudson Bay swale may require some additional detention at the Hudson Bay swale. Several potential locations have been recommend as described in **Section 5.5.3.4** (Detention/Retention) and shown in **Figure 5.14**.

Given the deep cuts through the riverbank and the relatively small catchment sizes, it is recommended that the area southeast of 21+200 follows the freeway ditches to the South Saskatchewan River. To reduce the risk of bank erosion near the bridge structure, culverts are recommended to direct flow from the median ditch to the outside ditches and utilize existing natural drainage routes on either side. Specific recommendations regarding the control of flow to the river and protection of the infrastructure are provided in the South Saskatchewan River Outlet section of this report.

At the request of the Water Security Agency a plausible diversion of the Hudson Bay Swale was considered. The diversion described in **Section 5.5.3.4** (Detention/Retention) could reduce the need for adding detention capacity at the Hudson Bay Swale. A detailed analysis was deemed to be beyond the scope of this report. If the Ministry is interested in a diversion it is recommended that the concept be reviewed as part of the future detailed design phase along with additional stakeholder consideration. The Water Security Agency also recommended retention facilities to counteract loss of natural storage. The borrow pits required to construct this phase will provide substantial retention capacity. It is recommended that retention within these borrow pits be considered during the detailed design phase even though the Ministry is exempt from these requirements if maintain the existing drainage pattern.

The Saskatoon Airport Authority provided guidelines for the development of wetlands within the vicinity of the airport. The Freeway is located outside the 4 km regulation zone, but they also provided details for runway approach zones. It is recommended that no retention ponds be developed in these zones.

9.5 Access Management Plan

Based on comments received from adjacent municipalities and the general unknown nature of development abutting the freeway, minimizing the construction of new roads is the most prudent. Concept 1 (**Figure 5.12)** is recommended in principle and considered as the best option for today's conditions. However; it is very

likely to require amendments as future developments will occur prior to freeway construction and may require different roadway connections.

9.6 Bridges

The recommended bridge structures are summarized in the following sub-sections. Preliminary drawings showing the proposed plan and elevation of each bridge at each of the four interchanges are illustrated in **Appendix M**.

9.6.1 Highway 11

The general arrangement of the Highway 11 Interchange and the Structure ID Number is provided below in **Figure 9.6.** The recommended interchange consists of the following:

- 7 Main Interchange Bridges;
- 5 Railway Overpasses; and
- 1 Flyover at Millar Avenue.

Table 9.5 outlines the geometry of each bridge structure (number of lanes, shoulder widths, span lengths and skew) for Highway 11 Interchange, Penner Road Interchange and Millar Avenue/Rock Ridge Road Flyover.

Table 9.5: Highway 11 Interchange Structures

STRUCTURE ID	LOCATION	# OF LANES	SHOULDERS	SPAN LENGTH(S)	SKEW
11.1	SKTN FWY EB over Hwy 11 NB & SB	3 @ 3.7m	2.5m LT/2.5m RT	56.5m/56.5m	20^0 RHF
11.2	SKTN FWY WB over Hwy 11 NB & SB	4 @ 3.7m	2.5m LT/2.5m RT	56.5m/56.5m	20^0 RHF
11.3	Ramp S-W over Hwy 11 SB	1 @ 4.7m	1.0m LT/2.5m RT	53.0m	0^0
11.4	Ramp S-N over Ramp N-E & Ramp E-N	2 @ 3.7m	1.0m LT/2.5m RT	34m/40m/40m/40m	0^0
11.5	SKTN FWY WB over Ramp N-E	3 @ 3.7m	2.5m LT/3.0m RT	60m/60m	0^0
11.6	Ramp W-N over Hwy 11 NB & SB	1 @ 4.8m	1.0m LT/ 2.5m RT	56.5m/56.5m	20^0 RHF
11.7	Ramp W-S over CN Rail	2 @ 4.8m plus gore	1.0m LT/ 2.5m RT	24.5m/34.0m/24.5m	31^0 RHF
11.8	SKTN FWY EB over CN Rail	3 @ 3.7m	2.5m LT/3.0m RT	24.5m/34.0m/24.5m	31^0 RHF

STRUCTURE ID	LOCATION	# OF LANES	SHOULDERS	SPAN LENGTH(S)	SKEW
11.9	SKTN FWY WB over CN Rail	3 @ 3.7m	2.5m LT/3.0m RT	24.5m/34.0m/24.5m	31^0 RHF
11.10	Ramp N-W/S-W over CN Rail	2 @ 3.7m plus gore	2.5m LT/3.0m RT	19.8m/32.0m/19.8m	24^0 LHF
11.11	Penner Road over CN Rail	2 @ 3.5m	2.0m LT/2.0m RT	20.0m/32/.0/20.0m	0^0
11.12	Penner Road over Hwy 11	2 @ 3.7m plus median	0.5m LT/0.5m RT	43.2m/43.2m	0^0
11.13	Millar Avenue over SKTN FWY EB & WB	2 @ 3.7m	2.0m LT/2.0m RT plus 3.0m clear wide sidewalks on each side of bridge	48.9m/48.9	40^0 LHF

9.6.2 Highway 12

The general arrangement of the Highway 12 Interchange and the Structure ID Number is provided below in **Figure 9.7**. The recommended interchange consists of the following:

› 6 Main Interchange Bridges.

Table 9.6 outlines the geometry of each bridge structure (number of lanes, shoulder widths, span lengths and skew) for the Highway 12 Interchange.

Table 9.6: Highway 12 Interchange Structures

STRUCTURE ID	LOCATION	# OF LANES	SHOULDERS	SPAN LENGTH(S)	SKEW
12.1	Hwy 12 SB & NB over SKTN FWY SB & NB	3 @ 3.7m Hwy 12 SB	1.0m LT/2.5m RT Hwy 12 SB & Hwy 12 NB plus median	56.3m/56.3m	0^0
12.2	Hwy 12 SB over Ramp S-W	2 @ 3.7m	1.0m LT/3.0m RT	46.7m	9^0 LHF
12.3	Hwy 12 SB over Ramp S-W	2 @ 3.7m, 1 @ 3.5m	1.0m LT/2.5m RT	46.0m	9^0 LHF
12.4	Ramp S-W over SKTN FWY EB & WB	1 @ 4.8m	2.5m LT/ 2.5m RT	49.0m/49.0m	9^0 LHF
12.5	Hwy 12 NB over Ramp N-E	2 @ 3.7m, 1 @ 3.5m	1.0m LT/2.5m RT	65.0m	45^0 LHF

9.6.3 Highway 16

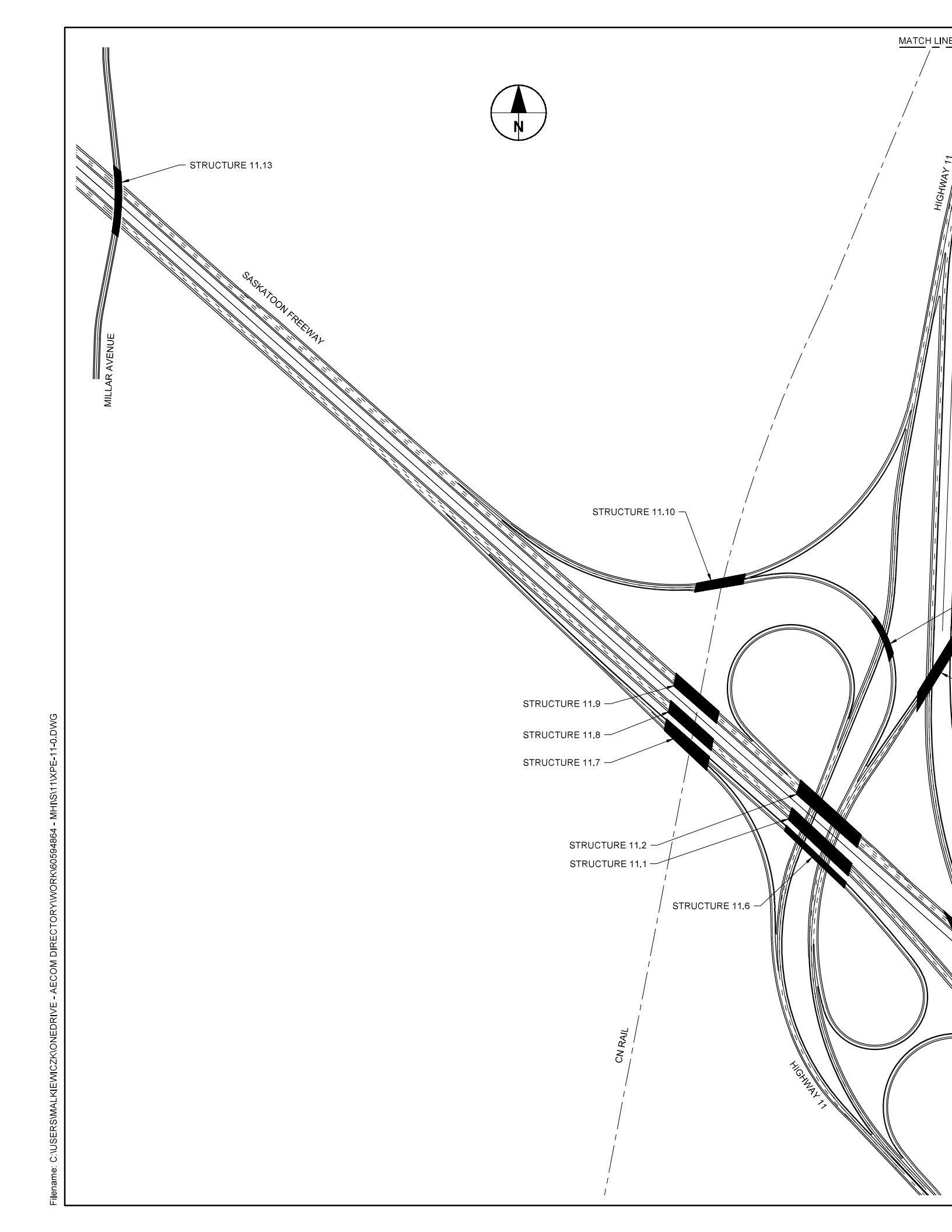
The general arrangement of the Highway 16 Interchange and the Structure ID Number is provided in **Figure 9.8**. The recommended interchange consists of the following:

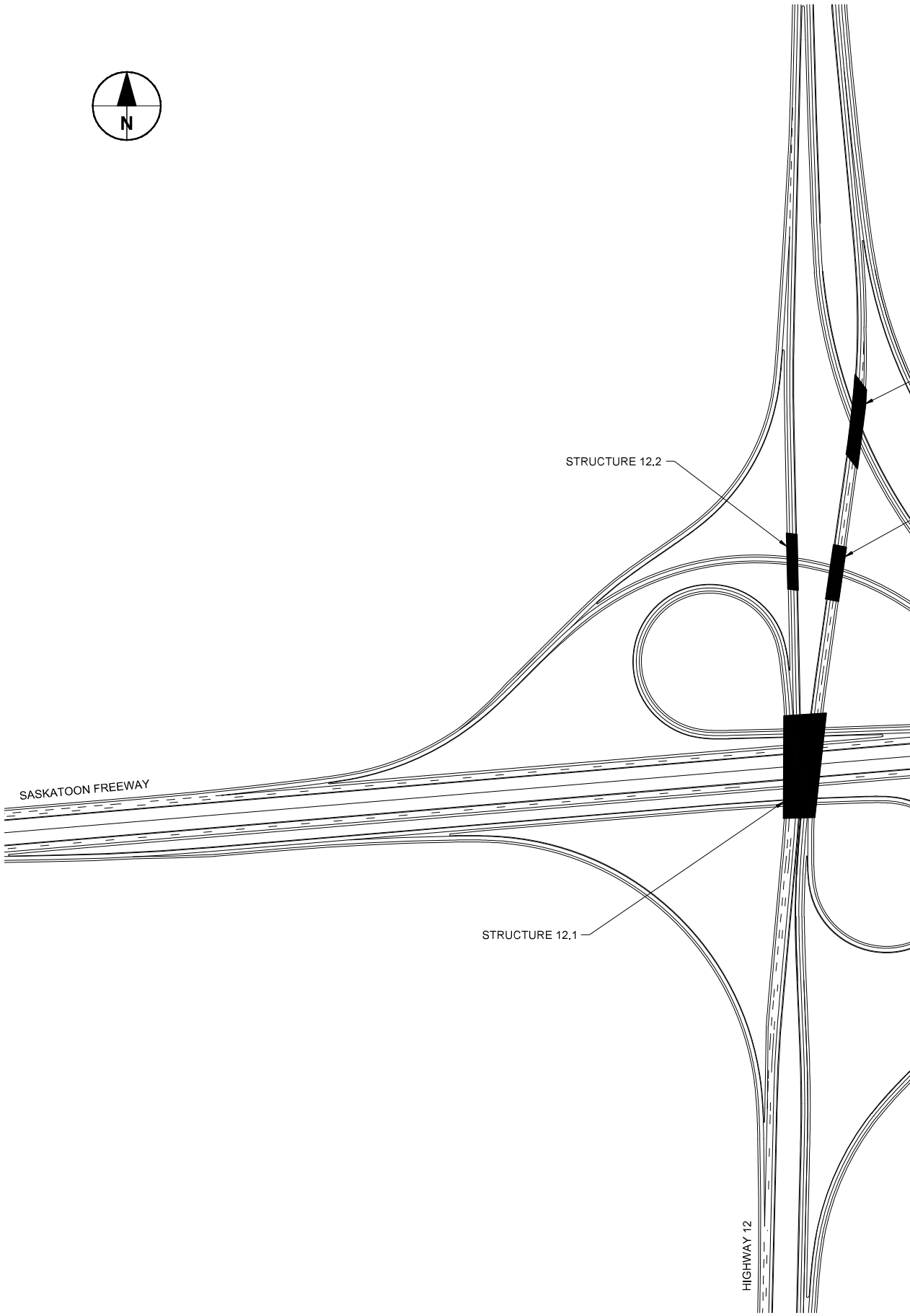
› 8 Main Interchange Bridges.

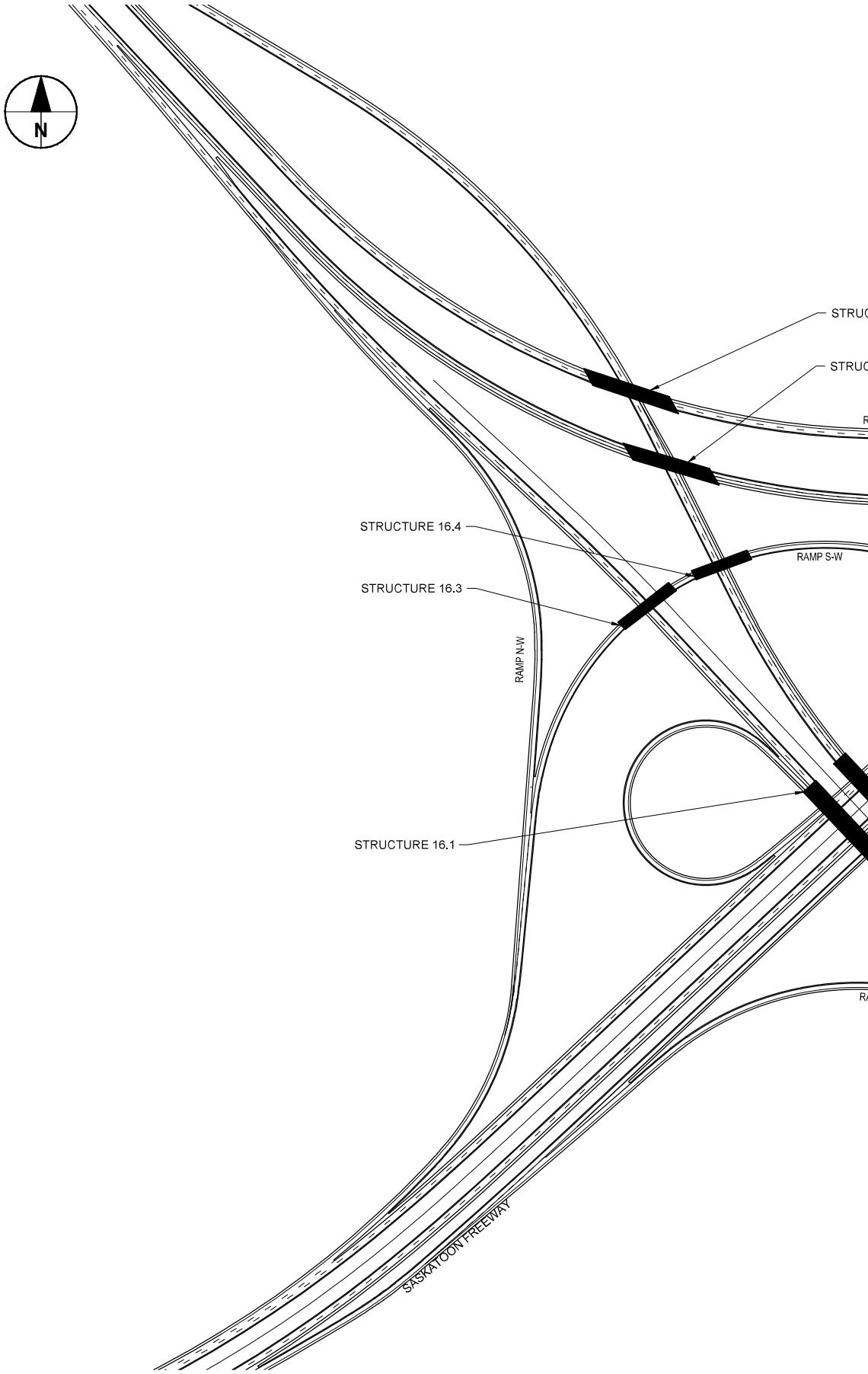
Table 9.7 outlines the geometry of each bridge structure (number of lanes, shoulder widths, span lengths and skew) for the Highway 16 Interchange.

Table 9.7: Highway 16 Interchange Structures

STRUCTURE ID	LOCATION	# OF LANES	SHOULDERS	SPAN LENGTH(S)	SKEW
16.1	Hwy 16 EB over SKTN FWY EB & WB & Ramp W-N	2 @ 3.7m, 1 @ 4.8m	1.0m LT/2.5m RT	53.7m/56.5m	0^0
16.2	Hwy 16 WB over SKTN FWY EB & WB & Ramp W-N	3 @ 3.7m	1.0m LT/2.5m RT	53.6m/56.6m	0^0
16.3	Ramp S-W over Hwy 16 SB	1 @ 4.8m	1.0m LT/2.5m RT	46.0m	7^0 RHF
16.4	Ramp S-W over Hwy 16 NB	1 @ 4.8m	1.0m LT/2.5m RT	46.0m	6^0 RHF
16.5	Ramp S-W over SKTN FWY EB & WB	2 @ 4.8m	1.0m LT/2.5m RT	48.3m/48.3m	6^0 RHF
16.6	Ramp N-E over Hwy 16 NB	2 @ 3.7m	1.0m LT/3.0m RT	54.1m	44^0 RHF
16.7	Ramp E-N over Hwy 16 NB	2 @ 3.7m	1.0m LT/2.5m RT	52.0m	48^0 RHF
16.8	Ramp S-W over SKTN FWY WB	2 @ 3.7m	1.0m LT/3.0m RT	55.0m/55.0m	0^0







9.7 Other Design Components

9.7.1 Over Height

Two over height routes exist within the Phase 1 area and are presented in **Figure 9.9**. The existing over height route southbound from Warman and Martensville utilizes Range Road 3052, Township Road 382 (Lutheran Road), Highway 684 (Dalmeny Road) to Highway 7. This over height route intersects the proposed Freeway alignment approximately at the intersection of Highway 684 and Highway 374. The over height route westbound from the CoS Agriplace Industrial Park utilizes Beam Road, Range Road 3070, Whelan Road, Range Road 3075/Highway 672 to Highway 7. This over height route intersects the proposed Freeway alignment approximately at the intersection of Beam Road and Range Road 3063. Both routes will be cut-off by the Saskatoon Freeway once constructed and an alternate route(s) will need to be provided.

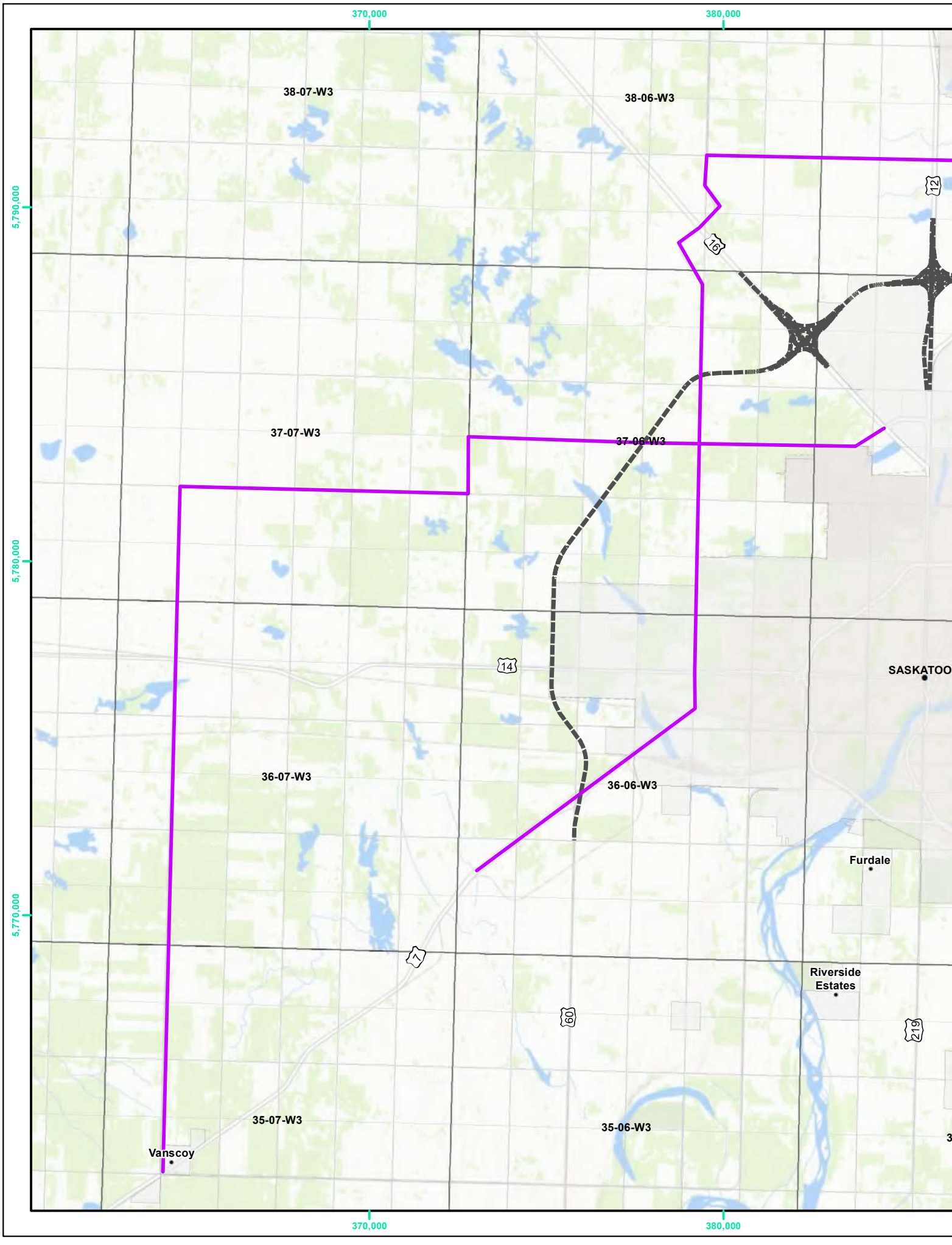
In general, opportunities for passage of over height vehicles along the Saskatoon Freeway are limited due to a number of underpass structures with clearances of 5.3 m at the following locations:

- Two underpasses at the Highway 16 interchange (Ramp S-W and Highway 16);
- Three underpasses at the Highway 12 interchange (Ramp N-E, Ramp S-W and Highway 12); and
- Millar Avenue underpass (between Highway 11 and 12).

Providing an over height route using the Saskatoon Freeway would provide an economic benefit by decreasing travel time (relative to the existing over height route) and reduce requirements for additional roadways or improvements to existing roadways for over height route use. Passage of over height vehicles can be accommodated along Highway 12 southbound from Martensville to westbound Saskatoon Freeway to northbound Highway 16. A over dimension route concept will be present with the Final Project Report.

9.7.2 Reverse Over/Under

It will be possible to reverse the interchange where the Saskatoon Freeway mainline can pass over minor highways as is the case at Wanuskewin Road. These are considered detailed design decisions which may be influenced by over dimension routing as well as other driving criteria. Discussion did take place regarding the Highway 12 interchange concept. As noted above the Final Project Report will address over dimension routing.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35-06-W3
12
16
14
7
60
219
SASKATOO
Furdale
Riverside
Estates
Vanscoy

9.8 Property Acquisition

9.8.1 Road Right of Way

The Functional Plans **(Appendix L)** illustrate the general requirements for road right of way. Road alignments and interchange layouts were selected with consideration to minimizing the need to acquire property occupied by residents or businesses. Setting property requirements also took into account potential changes in future development or road function that may require additional property in the future. The following considerations were included in the recommended property requirements:

- Regarding the Highway 12 interchange, if projected traffic volumes exceed predicted numbers, the E-S loop (two lane loop) may experience unacceptable lower level of service. Over time, development will occur up to the interchange right of way that may eliminate options to address the possible deterioration of the level of service for the loop. The recommended plan provides for the purchase of additional property to protect for this possible occurrence. Additionally, the final determination of the service function for Highway 12 south of the freeway may drive a configuration incorporating a E-S directional ramp;
- When this project is eventually constructed, it may be delivered by alternate delivery methods such as design-build. Sufficient property has been designated to allow flexibility for future D-B consortiums to reverse the over/under grade separations for the freeway and intersecting highway without the need for additional property purchase; and
- Over Height corridors are presently not designated for the freeway or any of the intersecting highways. Should there be requirement for over height corridors in the future, sufficient property has been provided. There may be several locations where short sections of retaining wall are required.

Purchasing property for a proposed freeway will create remnant parcels of land that are excess to what is required for the freeway. These remnant parcels can be sold and consolidated into other existing adjacent parcels or, if there are ancillary needs, the excess property may be used for detention areas, borrow sources or utility corridors.

All remnant parcels created through the purchase and dedication of land to road right of way must have legal access to road right of way. Parcels can not exist without access. During negotiations with landowners, consideration should be given to acquiring land that creates parcels of land without legal access. The cost of providing legal access should be considered when preparing legal plans. It may be more efficient to consolidate remnant parcels with adjacent parcels or road right oy way to eliminate the need to provide legal access.

9.8.2 Drainage

For most of Phase 1 the increased peak runoff can be detained within interchanges and the freeway ditch using appropriately sized culverts to throttle flow out of these areas. Borrow pits developed during construction may also be used for detention. However, flow entering the Hudson Bay swale along Drainage Path 3 has fewer detention opportunities. The natural detention capacity of the Hudson Bay swale can be increased by expanding it into undeveloped parcels of land that will be cut off or altered by construction of the Saskatoon Freeway. Following are potential locations detention areas:

- Between the CN right-of-way and north west of the proposed Highway 11 interchange;
- Triangle between the old Penner Road, farm access, and east of the proposed Highway 11; and

› At approximately 19+460 the proposed freeway grades up to the Highway 11 interchange. At this point, the ditch will need to continue grading down to the Hudson Bay swale. These locations may be expanded for borrow and detention.

9.9 Intelligent Transportation Systems (ITS)

A high-level concept plan was developed for Phase 1 of the study as illustrated in **Figure 8.1**. This plan represents a plausible layout of ITS devices; however, it is recognized that consultation will be needed with key stakeholders before finalizing. The final ITS Plan will be completed in conjunction with the final project report.

10 Environmental Summary

10.1 General Environmental Recommendations

10.1.1 Wildlife and Species of Conservation Concern

A large diversity of wildlife, including Species of Conservation Concern (SOCC) and Species at Risk (SAR), were identified within the proposed freeway corridor. Additional species and occurrences of SOCC and SAR are likely to be identified as more surveys are completed. The majority of wildlife and bird species in Saskatchewan are protected by provincial and federal legislation, hence, where possible, routing aims to minimize effects to areas of important wildlife habitat. There are additional legal protections for wildlife SOCC and SAR. Where routing cannot avoid crossing into habitat utilized by wildlife and SOCC/SAR, the following mitigations should be considered to reduce impacts:

- Consider the Environment and Climate Change Canada (ECCC) avoidance guidelines for breeding birds when scheduling construction activities;
- Conduct breeding bird surveys prior to and during construction during the general nesting period;
- Consider design measures that employ strategies to preserve wildlife movement corridors;
- Acquire permits for relocation or removal of wild species, if appropriate;
- Construction activities should consider the restricted activity timing windows for the protection of fish and fish habitat outlined by Fisheries and Oceans Canada (DFO 2013).
- Conduct pre-construction surveys in areas where SOCC/SAR have potential to be found;
- Establish setbacks around wildlife and plant SOCC occurrences prior to construction in accordance with the Saskatchewan ARGs. Contact ENV or ECCC if project activities fall within listed setback distances;
- Implement construction options that minimize loss of SOCC/SAR habitat, such as bridging over sensitive habitat;
- Consider intelligent transportation system measures such as animal detection systems (animal deterrent systems and/or driver advisory systems.
- Implement wildlife crossings to maintain a naturalized connection between habitat on either side of the proposed freeway; and
- Consider implementing design options that reduce sensory impacts to wildlife (noise, light pollution), such as reduce lighting, dark-sky compliant lighting, sound barriers, etc.

Future Wildlife Studies

SNC-Lavalin will complete additional wildlife surveys during the spring and summer of 2020 in selected areas which likely have high value wildlife habitat. In Phase 1, these areas include the South Saskatchewan River Valley, the Hudson Bay Swale, and quarters with extensive native prairie vegetation and wetlands.

In addition, species-specific detection surveys will be required as the project approaches construction. It is recommended that a species-detection survey is completed in an area if the target species has potential habitat. At the time of writing this report, it is recommended that the following surveys take place in suitable locations within Phase 1:

- Auditory amphibian surveys;
- Grassland bird surveys;
- Yellow rail surveys;
- Common nighthawk surveys;
- Short-eared owl surveys;
- Prairie raptor surveys;
- Burrowing owl surveys;
- Sharp-tailed grouse surveys; and
- Additional snow track surveys.

Additional surveys may be required as potential habitat is identified.

Surface Water and Wetlands

Wetlands are abundant throughout the project corridor and serve as important habitat for wildlife and vegetation. Wetlands are protected in Saskatchewan and proponents are required to compensate for the loss of wetland habitat. Hence, where possible, routing aims to minimize the total area of wetland habitat affected. For areas where impacts to wetlands are unavoidable, the following mitigations should be considered to reduce impacts:

- A drainage plan should be developed to preserve drainage and minimize potential impacts to the surrounding surface water system. For example, surface water inputs into adjacent wetlands should not cause adverse impacts to the ecological function of undisturbed areas;
- Ancillary roads and laydown areas should avoid wetland habitat where possible;
- An Aquatic Habitat Protection Permit (AHPP) in accordance with *The Environmental Management and Protection Act, 2010* should be obtained for works within the bed, bank, or boundary of a waterbody / wetland, or discharge with adverse effects on water;
- Wetland classification surveys should be completed where disturbance to wetlands cannot be avoided;
- A Drainage Permit may be required for effects to drainage;
- Erosion and sediment control measures should be implemented to protect adjacent wetland areas and the river valley;
- Pre-construction species detection surveys for SOCC (e.g. northern leopard frog and rare plant surveys) should be conducted in wetlands with the potential to support SOCC, followed by suitable mitigation where required; and
- Proponents are required by federal and provincial regulations to compensate for the loss of wetland habitat where it can not be avoided.

Native Grasslands

Unseeded grassland is present within Phase 1 and provides important habitat for a variety of wildlife species. Proponents in Saskatchewan may be required to compensate for the loss of grassland habitat (i.e. compensation has been a condition in some recent ministerial decisions), hence, where possible, routing aims to minimize the total area of grassland habitat affected. For areas where impacts to grasslands are unavoidable, the following mitigations should be considered to reduce impacts:

- Ancillary and/or temporary construction roads and laydown areas should avoid grassland habitat where possible;
- Disturbed areas should be restored to grassland habitat using native species and following Saskatchewan Ministry of Highways (Ministry) and the Ministry of Environment policies on revegetation and seeding; and
- Pre-construction species detections surveys for SOCC (rare plant surveys) should be conducted in native prairie/pasture areas with the potential to support SOCC, followed by suitable mitigation where required.

Heritage Resources

The proposed freeway corridor passes through areas that have the potential to contain heritage resources, ranging from the earliest occupations to more recent homestead sites. The presence of a concentration of important heritage resources at Wanuskewin Heritage Park highlights the potential of some portions of the proposed freeway route to encounter heritage resources. Some of these heritage resources may be sufficiently significant to require extensive mitigation, which can affect both the project detailed design and timetable. A referral to the Heritage Conservation Board will be required prior to construction, and it is likely that a Heritage Resources Impact Assessment will be required.

10.1.2 Phase 1 Specific Environmental Recommendations

South Saskatchewan River Crossing

The South Saskatchewan River valley is an ecologically important feature, serves as a natural corridor for wildlife movement, habitat for fish species, and has a high potential for archaeological finds. As such, the location of the crossing has been chosen to minimize disturbance to the channel and banks as much as possible. The following mitigations should be employed for the river crossing:

- Bridge elevation should ensure that wildlife movement through the river valley is preserved;
- Placement and size of bridge abutments should be considered and minimized as much as practical so that disturbance to the banks is reduced;
- Placement and size of the piers should be minimized as much as practical to limit impacts to fish habitat within the river channel. Compensation for disturbance to fish habitat will likely be required once the final design of the piers and construction plans are known;
- Measures to protect the water quality in the river (i.e. as a result of spills and/or road salt/gravel application) should be considered in bridge designs;
- Species specific surveys for SOCC should be conducted in the river valley prior to disturbance and suitable mitigation measures should be developed based on the results; and
- Construction activities should consider the restricted activity timing windows for the protection of fish and fish habitat outlined by Fisheries and Oceans Canada (DFO 2013).

Hudson Bay Swale

The Hudson Bay swale is an ecologically sensitive feature and is being considered for future inclusion into the City's natural area protection plan (pers. comm. Genevieve Russell). Based on this, project designs should consider minimizing direct impacts to the Hudson Bay swale where possible. Should impacts to the Hudson Bay swale be unavoidable the following mitigations should be employed:

- Measures to preserve drainage in unimpacted areas of the swale should be taken;
- If the swale forms part of the road drainage network, measures should be taken to ensure that surface water inputs into the swale do not cause adverse impacts to the ecological function. This could include pre-treatment of road runoff using forebay systems and installation of permanent erosion and sediment control measures;
- Implement wildlife crossings to maintain a naturalized connection between habitat on either side of the proposed freeway;
- Consider implementing design options that reduce sensory impacts to wildlife (e.g. noise, light pollution), such as reduce lighting, dark-sky compliant lighting, sound barriers, etc.;
- Depending on the regulatory regime in place at the time of construction, compensation for impacts to this feature may be required; and
- Species specific surveys for SOCC should be conducted in the swale prior to disturbance and suitable mitigation measures should be developed based on the results.

Wanuskewin Heritage Park

Wanuskewin Heritage Park is located northeast of the proposed freeway corridor and is classified as a provincial heritage site. An on-ramp onto Hwy 11 briefly intersects the 1.8 km buffer surrounding the park. The area in and adjacent to the park has a high potential to contain heritage resources. Additionally, Wanuskewin is seeking UNESCO World Heritage status which requires natural landscapes adjacent to the park to be preserved. The following mitigations are recommended in areas adjacent to Wanuskewin Heritage Park:

- Heritage assessment of the proposed right of way should be undertaken early in the planning and design process and a suitable mitigation plan should be developed;
- Freeway designs in the vicinity of Wanuskewin should include considerations for viewscape to preserve views from the west edge of Park; and
- Freeway designs in the vicinity of Wanuskewin should include considerations for noise mitigation to preserve sound levels in the Park. A noise study should be conducted in future planning stages to better understand the potential for noise impacts.

11 References

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