Birtle Transmission Project

Appendix A

Transmission Line Routing

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Licensing & Environmental Assessment

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A.Transmission line routing

A.1 Overview

This appendix provides details on the transmission line routing process used to determine the location of the final preferred route for the Manitoba portion of the Birtle Transmission Project (B71T), in support of chapter 6 of the environmental assessment report. Manitoba Hydro has developed a transmission line routing process involving a multi-phase decision-making approach that incorporates feedback from internal discipline experts and external (public, Indigenous and regulatory) stakeholders at key milestones. It incorporates the consideration of the environment, opportunities and constraints for transmission line development, and the interests and concerns that influence the use of the land or could be affected by the route. The primary goal is to limit the overall effect of the transmission line by considering and balancing the effect across various key perspectives.

The routing methods used for this Project are based on those developed by the Electric Power Research Institute (EPRI) and Georgia Transmission Corporation (GTC) for overhead electric transmission line siting (EPRI-GTC 2006). Manitoba Hydro selected the EPRI-GTC methodology for the St. Vital to Letellier and Manitoba-Minnesota Transmission Projects because it has been successfully applied to more than 200 linear projects across North America, and because the tools used in the methodology provide a structured and transparent way to represent the trade-offs between competing stakeholder interests and land uses, along with the decisions made in a transmission line routing process.

The EPRI-GTC methodology is a quantitative, computer-based methodology for use as a tool in evaluating the suitability of an area for locating new overhead transmission lines. It is informed by geospatial information (where features and activities occur on the landscape) and, with the help of models at each step through the process, considers three broadly conceived perspectives that apply to land use. The three perspectives are as follows:

- **Built environment perspective**, concerned with limiting the effect on the socio-economic environment
- **Natural environment perspective**, concerned with limiting the effect on the biophysical environment
- **Engineering environment perspective**, concerned with cost, system reliability, constructability and other technical constraints

The methodology involves the following general steps, which are described in further detail in the sections below:

- Characterizing the project region
- Establishing the border crossing zones
- Establishing the route planning area
- Developing alternate corridors
- Determining a preferred route
- Developing a final route

A.2 Characterizing the Project Region

Once the system planning studies had determined that Birtle South Station was the most appropriate terminus for the new line to Saskatchewan, the next step was to characterize the suitability of the region (e.g., southwestern Manitoba) for routing transmission line. This involved compiling and sourcing existing desktop data such as satellite imagery, land use/ownership, buildings and protected areas, and existing infrastructure. It involved reconnaissance field trips, initial public and Indigenous engagement, including the identification of Indigenous communities in the region and potential stakeholders and very preliminary contact to gather initial information about the region (detailed in chapters 3 and 4).

Perspectives and priorities were reviewed and verified during an April 7, 2016 workshop with provincial staff representing Lands, Forestry, Parks, Wildlife, Fisheries, Mineral Resources, Agriculture, Infrastructure and Transportation, Heritage Resources and Enforcement. Manitoba Hydro also contacted other representatives individually. The workshop determined the most current and appropriate data sets to use for the Project.

A.3 Establishing the Border Crossing Zones

As Manitoba Hydro is responsible for the Manitoba portion of the transmission line and SaskPower is responsible for the Saskatchewan portion, it was necessary to have a coordinated decision-making process to determine potential border crossing zones where the transmission line could feasibly connect at the border. Initial phases in this step occurred concurrently with work to establish the route planning area (described in the next section). In order to coordinate the process several meetings and workshops between Manitoba Hydro and SaskPower were used to discuss the respective routing process methods and key routing criteria, and then share outputs of preliminary constraint mapping and potential border crossing zones, with rationale. The following potential border crossing zones were jointly evaluated (Map A-1):

- A 4 km North Zone with its northern boundary being Highway 478
- A 5.2 km Centre 1 Zone (SaskPower Centre A) north of the Qu’Appelle River
- A 5 km Centre 2 Zone (SaskPower Centre B) south of the Qu’Appelle River
- A 4.6 km SaskPower South Zone
- A 2.4 km Manitoba Hydro South Zone further south than the above

The North Zone was selected as a candidate because it allowed the development of routes that could avoid the Spy Hill - Ellice Community Pasture, containing important prairie species. However, concerns for Manitoba Hydro for the North Zone focused on costs associated with length of the Manitoba Hydro side of the line (approximately 57 km) compared to other zones, as well as the presence of several steep slopes and associated soil stability issues in the ravines that would need to be crossed. SaskPower had a preference for this zone as it resulted in a shorter line length on the Saskatchewan side; however, SaskPower noted some concerns with this option, such as some land ownership issues and the amount of tree clearing that may be needed, as well as more wetlands (sloughs, drainage courses) than lines to other zones.

The two Centre Zones offered a more direct route between the two stations; however, concerns for Manitoba Hydro for the Center 1/A Zone focused on the presence of important native prairie in the Spy Hill - Ellice Community Pasture, and proximity to a railway, gravel pits, and the community of St. Lazare. The land on the Saskatchewan side of the pasture was more wooded with less prairie areas, but the SaskPower routes would require crossing a ravine with known slope stability concerns. A benefit to SaskPower was that it is the shortest route from station to station and could also take advantage of an existing transmission corridor for approximately half its length.

Concerns for Manitoba Hydro for the Center 2/B Zone included the potential for several sites of historical value and that routes would be within community pasture, and likely create stakeholder concerns. SaskPower also had concerns with this zone, in terms of geotechnical, environmental and heritage issues with crossing the Qu’Appelle River Valley, encroachment on existing aggregate extraction areas and known deposits, proximity to a National Historic Site and existing potash mine, proximity to residences near the potash mine, and salt from the mine contaminating conductors causing an increase in maintenance costs.

Manitoba Hydro had concerns with the line lengths associated with both south zones, which ranged from 50 - 67 km. On the Manitoba side, routes would also be constrained by a proposed Protected Area to the south and First Nations land, requiring considerable backtracking of routes. SaskPower also had concerns with the lengths of routes to this zone, as well as construction issues associated with it being on an undulating morainal plain with many creeks and associated flooding issues.

After sharing perspectives, Manitoba Hydro and SaskPower agreed to eliminate their most southern border crossing options due to the length of line and high costs. Both parties also agreed to eliminate non-overlapping areas of the north crossing area, and reduce the size of the Center 1/A border crossing to better reflect how a transmission line may actually be routed in the area (i.e., south of an existing road). SaskPower formally requested removing the center 2/B Zone due to constraints related to construction, operation and maintenance, and environment. The output of this process resulted in the establishment of two alternate border crossing zones (North and Centre 1/A; Map A-1).

A.4 Establishing the route planning area

With the border crossing zones established the next step was to define the outer boundaries of the area that encompasses the start and end points of the transmission line. A route planning area was established through the development of “macro corridors” from Birtle South Station to each border crossing.

This stage of the process involved the use of 30 m Landsat imagery from 2004 that was classified into various land cover classes including agriculture, forest, wetlands, open land (including grasslands), open water, transmission corridors, other utility corridors, primary/secondary roads, and urban areas. Using the macro corridor model (discussed below), each 30 x 30 m satellite image cell could be assessed in terms of suitability for transmission line development. This resulted in the development of a “composite suitability surface” for the entire study area, with each grid cell assigned a ranking associated with its underlying land cover/surface type. The model identified corridors that limit effects on built and natural environments (EPRI-GTC 2006).

The macro corridor model is based on general preferences to parallel roads and transmission lines across various land use categories. In many cases, paralleling existing transmission lines or existing road rights-of-way can limit effects on these environments; therefore these criteria make up the model. Three macro corridors were developed using the macro corridor model (Table A-1). Separate suitability surfaces were developed for each of the three types of routes, and then they were over overlain to form the composite surface. Each corridor corresponds to a set of weights designed to emphasize certain parameters that are often used to delineate a planning area for a new transmission line project. Conceptual routes ("optimal paths[1]") were generated with the model, running from Birtle South Station to each of the two border crossings. These optimal paths incorporated the following broad routing options:

- Paralleling roads
- Paralleling transmission lines
- Cross country (i.e., without targeting paralleling opportunities)

The macro corridors (Map A-2) developed from the model represented the top 5% (i.e., the most suitable 5%) of "optimal paths" between the start and end points. The outside limits of the combined macro corridors were used to guide the creation of the route planning area.

The macro corridors developed by the model are intended to give a starting place for the routing team to make informed decisions with respect to the development of the route planning area. The routing team then used experience combined with knowledge of technical, environmental and built considerations to make decisions about the boundaries of the route planning area.

Table A-1: Macro corridor model[1]

Land-cover Type	Cross Country	Roads	Transmission Line
Agricultural Forage Field	6	6	6
Agricultural Forage Field	6	6	6
Agricultural Field	6	6	6
Coniferous Forest	3	3	3
Cultural Features	9	9	9
Deciduous Forest	3	3	3
Forest Cut Blocks	2	2	2
Forest Fire - Burnt Area	3	3	3
Mixedwood Forest	3	3	3
Open Decidious Forest	3	3	3
Range and Grassland	3	3	3
Roads Trails Rail Lines	5	1	5
Sand and Gravel	1	2	2
Slope >15%	9	9	9
Transmission Corridor	5	5	1

[1] The "Optimal Path" is the most suitable route because it receives the lowest score, representing the route with the least impact considering that perspective (EPRI-GTC).

Treed Rock	2	2	2
Water	7	7	7
Water Bodies	7	7	7
Wetland - Bogs	6	6	6
Wetland - Marsh	6	6	6

[1]Higher numbers mean less preferred for routing a transmission line.

Finalizing the route planning area (Map A-2) from the macro corridors involved making adjustments to the macro corridors using knowledge and experience relating to the various input criteria as follows:

- Eastern boundary was delineated by:
    - avoidance of oil and gas development
    - consideration of steep terrain
    - avoidance of prairie potholes northeast of Birtle
    - consideration of aesthetic value near Birtle
    - consideration of routing opportunities near Binscarth
    - consideration of river valleys
    - avoidance of wildlife habitat
- Southern boundary was delineated by:
    - avoidance of a runway / glide path (travelling south of the glide path it would be very difficult to head back north based on the community pastures and First Nations Land)
- Northern boundary was delineated by:
    - Consideration of the location of SaskPower's Tantallon Station (limits the extent we would consider heading north / backtracking)
    - Avoidance of two protected areas (Areas of Least Preference)

A.5 Developing alternate corridors

A.5.1 Overview

In the next phase of the routing process, several alternate corridors were developed within the route planning area using GIS modelling. Alternate corridors map the suitability of areas within the route planning area, with a greater level of resolution, for locating a transmission line and further narrow the geographic area under consideration for route development.

Separate corridors were developed to represent the three perspectives discussed previously, including the Built Environment Perspective (protecting people, places and cultural resources), the Natural Environment Perspective (protecting water resources, plants and animals) and the Engineering Perspective (minimizing costs and schedule delays). Each of the three perspectives included all criteria, but additional weighting was applied to emphasise Built, Natural, or Engineering criteria, respectively. In addition, a simple average perspective was developed, where each of the three Perspectives was weighted equally, and finally all four perspectives were combined into a composite corridor.

In this phase more detailed spatial data was used than previous steps, including more fine-scale, detailed digital data for the various characteristics of each relevant feature (e.g. for wetlands, floodplains, and land use/land cover) from the GIS database. In some cases additional field data was gathered, such as building type/purpose, or specific agricultural land use (e.g. crop vs. forage). The composite corridor formed the overall guidance for routing from this point forward.

Creating the alternate corridors involved the following:

- Developing the alternate corridor evaluation model
- Organizing data
- Creating geospatial data layers
- Creating suitability surfaces
- Implementing least cost path analysis

Each of these steps is discussed briefly below.

A.5.2 Developing the alternate corridor evaluation model

The alternate corridor evaluation model (Table A-2), based on stakeholder preferences, was initially developed in 2013 to represent the suitability of features on the landscape in southern Manitoba for transmission line routing.

The research on stakeholders involved gathering and organizing information from key data-holders responsible for managing mapping information in the region.

On May 6-8 2013, Manitoba Hydro invited key data holders to workshops to participate in a process of determining what factors, and features within each factor, are important to consider when routing a transmission line in Southern Manitoba. During the process, participants were grouped into each of the three perspectives:

- The Engineering Environment perspective was represented by Manitoba Hydro and Manitoba Infrastructure and Transportation.
- The Natural Environment perspective was represented by Fisheries and Oceans Canada, Ducks Unlimited Canada, Nature Conservancy of Canada, Manitoba Lodge and Outfitters Association, Manitoba Trappers Association, Manitoba Woodlot Association, and Provincial representatives including Parks and Natural Areas, Wildlife, Forestry, the Seine River Conservation District, Bird Atlas, and the Protected Areas Initiative.
- The Built Environment perspective was represented by the Keystone Agricultural producers, University of Manitoba, Manitoba Aerial Applicators Association, Manitoba Trappers Association, City of Winnipeg Planning Department, Local Government Planners, and Provincial representatives that included Aboriginal and Northern Affairs, Agriculture, Food and Rural Initiatives, and Culture, Heritage and Tourism.

For each of the three groups or perspectives the first step involved reviewing and modifying an initial long list of standard landscape features (gained from previous projects and experience) to facilitate the identification of the key factors within each group that influence transmission line suitability for the general region. The following is the list of most appropriate factors selected by each participant group for the Project:

- Engineering:
    - Linear infrastructure
    - Spannable waterbodies
    - Geotechnical considerations (e.g., floodplains/wetlands)
    - Mining operations/quarries
    - Slope
    - Proximity to future wind farms
- Natural:
    - Aquatics
    - Special features (e.g., managed woodlots, conservation lands)
    - Land cover (e.g., agriculture, grassland, forests)
    - Wildlife habitat (e.g., waterfowl, ungulates)
- Built:
    - Proximity to buildings
    - Building density
    - Proposed development
    - Soil capability/agricultural use

- Land use (e.g., livestock, crops)
- National, Provincial, and Municipal Historic Sites
- Proximity to heritage, archaeological sites and centennial farms
- Landscape character (e.g., residential, campgrounds)
- Edge of field (e.g., road allowances, quarter sections)

Definitions for each factor / feature in the alternate corridor evaluation model are provided in Table A-3.

The list of factors was then assigned weights based on relative suitability in siting a transmission line, accomplished by conducting pair-wise comparisons employing the Analytic Hierarchy Process[2]. This was done separately for each of the three groups (built, natural and engineering). The result was a percentage weighting for each factor, with all factors within each perspective totalling 100 percent.

A final step involved developing suitability values for each feature (e.g., slope class, distance to residences, building density class, wildlife habitat type, etc.). For each feature, numbers between 1 and 9 were used to represent degrees of suitability for routing a transmission line across (or in proximity to) this feature, with 1 being most suitable and 9 being least suitable. Within each factor (e.g. building density) there needs to be a feature with a suitability value of 1 (i.e., <1 building per acre) and one with a 9 (i.e., > 10 buildings per acre). The other features are scored between 1 and 9.

Based on the EPRI-GTC Methodology (2006) output of the modelling process resulted in three suitability groupings (high, moderate or low) for an overhead electric transmission line. Areas that have high suitability (ranked 1, 2, or 3) do not contain known sensitive resources or physical constraints, and therefore should be considered as suitable areas for the development of corridors. Areas with moderate suitability (ranked 4, 5, or 6) contain resources or land uses that are moderately sensitive to disturbance or that present a moderate physical constraint to overhead electric transmission line construction and operation. Resource conflicts or physical constraints in these areas can generally be reduced or avoided using standard mitigation measures. Areas with low suitability (ranked 7, 8, or 9) contain resources or land uses that present a potential for significant impacts that may not be readily mitigated.

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[2] The Analytic Hierarchy Process is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. It was developed by Tomas Saaty in the 1970s. ATP has a particular application in group decision making. AHP users first decompose their decision to a series of pair-wise comparisons of each subcomponent of the problem. In the case of the routing model, these subcomponents are features within each layer. A numerical weight is derived for each element, resulting in the weight of the layer within its perspective these subcomponents are features within each layer. A numerical weight is derived for each element, resulting in the weight of the layer within its perspective.

Locating a transmission line in these areas would require careful routing or special design measures. While these areas can be crossed, it is not desirable to do so if other, more suitable alternatives are available.

The resulting model includes (see Figure A-1 for details):

- factors (e.g. building density)
    - factor weight (e.g. 17.8% for building density)
- features (e.g. <1 building / acre (rural agriculture))
    - suitability values (e.g. 1 for < 1 building / acre (rural agriculture))

Factor

Factor weight

Features

Suitability Values

Building Density	17.8%
< 1 Building / Acre (Rural Agricultural)	1
1 Building per 1-5 acres	3.3
1-3 Buildings/Acre (Rural/Residential)	4.5
3-10 Buildings / Acre (Suburban)	7.2
>10 Buildings / acre	9

Figure A-1: Example factor layer with labels

The next step in the process was to identify areas where avoidance was of particular concern as there may be no viable options for building a transmission line. These "Areas of Least Preference" included locations where routing may not be feasible due to physical barriers, administrative regulations, and/or locations where substantial regulatory approvals issues/delays would be expected. Examples include national/provincial parks, active mines and quarries, and historic sites. These Areas of Least Preference were removed from the transmission corridor selection process, and would only be brought back in during development of alternate routes, under special circumstances (e.g., when the only option for a route is through one of these areas and there is mitigation available to deal with the effects).

Table A-2: Alternate Corridor Evaluation Model

Engineering

Linear Infrastructure	**37.6%**
Parallel Roads ROW	1
Municipal Road Allowances	3.1
Parallel Provincial Highways ROW	3.4
Parallel Existing Transmission Lines (<300kV)	3.8
No Linear Infrastructure	4.4
Parallel Oil / Gas Transmission Pipeline	5.6
Parallel Railway ROW	5.6
Within Road, Railroad, or Utility ROW	9

Spannable Waterbodies	**11.0%**
No Waterbody	1
Non-navigable / spannable waterbody	2.8
Navigable / spannable waterbody	4.3
Non navigable spannable waterbody (specialty structures – 300-450m)	9

Geotechnical Considerations	**31.8%**
No Special Geotechnical Considerations	1
Floodplain	6.6
Wetland / Peatlands	9

Mining Operations / Quarries	**13.9%**
No Mining Operation	1
Abandoned / Inactive Mines	9

Slope	**5.7%**
Slope 0-15%	1
Slope 15-30%	3.1
Slope >30%	9

Natural

Aquatics	**10.0%**
No Aquatic Feature	1
Ephemeral Streams (Non-Fish Bearing)	4.9
Spannable Waterbodies (Lakes & Ponds)	6.1
Permanent Stream	7.5
Bogs	7.7
Marsh	8.2
Permanent Stream (CRA Fish Bearing)	9

Special Features	**42.4%**
No Special Land	1
Managed Woodlots	5.4
Crown Land With Special Code	7
Community Pastures	7.3
Conservation Easement	8.0
Proposed Protected Areas	8.6
Conservation Lands	9

Land Cover	**10.2%**
Exposed / Urbanized / Open Land	1
Agricultural (Forage)	2.5
Agricultural (Crops)	2.8
Grassland	5
Deciduous Forest	5.5
Coniferous Forest	5.7
Mixed Forest	6
Non-developed sandhills	8.1
Native Grassland	9

Wildlife Habitat	**37.4%**
Other	1
Ungulate Habitat	6.1
Waterfowl Habitat	6.3
Waterfowl Hotspots	7.0
Grouse Lek Area	7.7
Rare Species Habitat	8.0
Endangered Species Habitat	9

Built

Proximity to Buildings	**11.9%**
> 800 m	1
400 - 800 m	2.7
100 - 400 m	6.5
ROW - 100 m	9

Building Density	**17.8%**
< 1 Building / Acre (Rural Agricultural)	1
1 Building per 1-5 acres	3.3
1-3 Buildings/Acre (Rural/Residential)	4.5
3-10 Buildings / Acre (Suburban)	7.2
>10 Buildings / acre	9

Soil Capability / Agricultural Use	**14.3%**
Other	1
Class 6 & 7 (Low Productivity)	3.3
Organic Soils / Peat Bogs / Sod Production	3.9
Class 4 & 5 (Forages, Transitional)	5.9
Class 1- 3 (Prime Ag./Cultivated Land)	9

Land Use	**18.9%**
Other	1
Open Land (Sand & Gravel)	1.7
Agricultural (Forage)	4.9
Listed Trails (Existing & Planned)	5.9
WMA (unprotected)	5.8
Agricultural (Crops)	6.6
Intense Development & Use	6.6
Intensive Livestock	9

Proximity to Heritage Sites	**14.3%**
> 300 m	1
200 - 300 m	9

Landscape Character	**9.1%**
Other	1
Recreational Trails	4.1
Escarpments (timeless topography)	7.5
Resort Lodges/ Campgrounds	8.6
Designated Historic Sites	9

Edge of Field	**13.9%**
Road Allowances	1
Quarter Section / Half-Mile Lines	1.9
Parallel/Adjacent To Road Allowances	2.9
Other (None of the Above)	9

Areas of Least Preference
Wastewater Treatment Areas
Buildings
Oil Well Heads
Towers and Antennae
Waste disposal sites
Non-Spannable Waterbodies (>450 m)
Mines and Quarries (Active)
Contaminated sites
Wildlife Management Area (Protected Portions)
Campgrounds & Picnic Areas
Indian Reserves / TLE Selections
Airports/Aircraft Landing Areas (glide path)
Recreational Centers (Golf, Skiing, etc.)
Heritage Plaques
Schools / daycare parcels
Cemeteries / Burial Grounds
Known Archaeological Sites
Religious / Worship Site Parcels

Table A-3: Alternate Corridor Model Criteria Definitions	
CRITERIA	**DESCRIPTION**
ENGINEERING	
Linear Infrastructure	
No Linear Infrastructure	All areas not covered by one of the criteria below.
Parallel Roads ROW	Buffers were placed on road, Provincial Highway, Existing Transmission Line (<300 kV), Pipeline and Railway Rights-of-Way. Areas within these buffers would constitute paralleling.
Parallel Provincial Highways ROW	
Parallel Existing Transmission Lines (<300kV)	
Parallel Oil / Gas Transmission Pipeline	
Parallel Railway ROW	
Municipal Road Allowances	Road allowances where no roads exist
Within Road, Railroad, or Utility ROW	Existing Road, Railway and utility ROWs
Spannable Waterbodies	
No Waterbody	All areas not covered by one of the criteria below.
Non-navigable / spannable waterbody	All waterbodies greater than 300m across and less than 450m across that cannot be spanned with a standard structure
Navigable / spannable waterbody	
Spannable Waterbody (Standard Structures)	All waterbodies less than 300 m across.
Geotechnical Considerations	
No Special Geotechnical Considerations	All areas not covered by one of the other criteria
Floodplain	Based on 2014 flood and contour interpretation
Wetland / Peatlands	Land cover class - Wetland / Peatland.
Mining Operations / Quarries	
No Mining Operation	All areas not covered by one of the criteria below.
Abandoned / Inactive Mines	All areas where an abandoned or inactive mine is present.
Slope	
Slope 0 - 15%	Areas with a slope less than 15%
Slope 15 - 30%	Areas with a slope between 15 to 30%
Slope > 30%	Areas with a slope greater than 15%
NATURAL	
Aquatics	
No Aquatic Feature	All areas not covered by one of the criteria below.
Ephemeral Streams (Non-Fish Bearing)	All streams classified Type E based on Fisheries and Oceans Canada habitat classification
Spannable Waterbodies (Lakes & Ponds)	All waterbodies less than 300 m across.
Marsh	Wetland classification based on the Forest Resource Inventory
Bogs	All wetland Bog classified features from the LCC
Permanent Stream	All permanent streams not classified Type A or B streams based on Fisheries and Oceans Canada habitat classification
Permanent Stream (CRA Fish Bearing)	All Type A and B streams based on Fisheries and Oceans Canada habitat classification
Special Features	
No Special Land	All areas not covered by one of the criteria below.
Managed Woodlots	Areas of land designated as Manitoba Forestry Association Woodlot Locations
Crown Land With Special Code	Land that is Crown-owned with a special code
Community Pasture	Community pasture boundaries designated by the Province of Manitoba
Conservation Easement	All Conservation easements designated by various Non-Government Organizations.
Proposed Protected Areas	Areas that are being proposed as protected areas within the region.
Conservation Lands	All locations off NCC property interests.
Land Cover	
Exposed / Urbanized / Open Land	Land cover features as compiled by Landsat Thematic Mapper imagery. Data was collected in 2005-2006.
Agricultural (Forage)	
Agricultural (Crops)	
Non-developed sandhills	
Grassland	
Deciduous Forest	
Coniferous Forest	
Mixed Forest	
Native Grassland	
Wildlife Habitat	
Other	All areas not covered by one of the criteria below.
Ungulate Habitat	Canada land inventory - Areas identified as ungulate wildlife habitat
Waterfowl habitat	Canada land inventory – waterfowl habitat classified as high
Waterfowl hot spots	Ducks unlimited – waterfowl hotspots
Grouse lek habitat	Manitoba Conservation Data Center information
Rare species habitat	Manitoba Conservation Data Center information – rare species occurrence data
Endangered Species Habitat	Manitoba Conservation Data Center information – endangered species occurrence data
BUILT	
Proximity to Buildings	
> 800 m	Areas that are farther than 800 meters from buildings.
400 - 800 m	Areas that are between 400 and 800 meters from buildings.
100 - 400 m	Areas that are between 100 and 400 meters from buildings.
ROW - 100 m	Areas that are between the right-of-way and 100 meters from buildings.
Building Density	
< 1 Building / Acre (Rural Agricultural)	Areas that have a building density of less than 1 building per acre.
1 Building per 1-5 acres	Areas that have a building density of 1 building per 1 to 5 acres.
1-3 Buildings / Acre (Rural Residential)	Areas that have a building density of 1 to 3 buildings per acre.

3-10 Buildings / Acre (Suburban Density)	Areas that have a building density of 3 to 10 buildings per acre.
Soil Capability & Agricultural Use	
Other	All areas not covered by one of the criteria below.
Class 6 & 7 (Low Productivity)	Soils classified from the MB Soils Database from a combination of all the digital RM soils data available on the MLI website.
Organic Soils / Peat Bogs / Sod Production	
Class 4 & 5 (Forages, Transitional)	
Class 1- 3 (Prime Agricultural & Cultivated Land)	
Land Use	
Other	All areas not covered by one of the criteria below
Open land	Land use features as compiled by Landsat Thematic Mapper imagery. Data were collected in 2005-2006
Wildlife management area (unprotected)	Wildlife Management Area Boundaries (unprotected portions)
Listed Trails (Existing & Planned)	Trails that are listed as snowmobile trails within Manitoba.
Agricultural (Forage)	Land use features as compiled by Landsat Thematic Mapper imagery. Data was collected in 2005-2006.
Intense Development & Use	
Agricultural (Crops)	
Intensive Livestock	All Hog Operation Farms within the region.
Proximity to Heritage Sites	
> 300 m	Areas that are greater than 300 meters from various heritage sites.
200 - 300 m	Areas that are between 200 and 300 meters from various heritage sites.
Landscape Character (Viewsheds)	
Other	All areas not covered by one of the criteria below
Recreational Trails	All areas within the viewshed of trails that are listed as snowmobile trails within Manitoba
Escarpments (timeless topography)	Timeless topography including escarpments and enduring features, derived from 1:50K canvec contours
Resort Lodges & Campgrounds	All areas within the viewshed of these various layers
Designated Historic Sites	All areas within the viewshed of designated historic sites
Edge of Field	
Road Allowances	Areas between sections provided for roads, where no roads have been built.
Quarter Section Lines / Half-Mile Section Lines	All quarter and half-mile section lines
Parallel Or Adjacent To Road Allowances	Areas between sections provided for roads, where no roads have been built, that are parallel or adjacent.
Other (None of the Above)	All areas not covered by one of the criteria above.

A.5.3 Organizing data

The next step in the creation of alternate corridors was to organize the geospatial data to effectively represent each factor in the alternate corridor evaluation model. Sources of data included aerial photography, geographic information system databases, publicly available data sets, windshield and field surveys and other sources. Each factor in the alternate corridor evaluation model must be represented by a geospatial data layer. The geospatial data layer divides the route planning area into grid cells (5 m x 5 m). Each cell is assigned a suitability value (between 1 and 9) based on the alternate route evaluation model.

Using the special features factor in the natural environment sub-model (Figure A-2) as an example, there are 10 features within the layer, each given a suitability value from 1 to 9 (e.g. managed woodlots is 5.4). Figure A-3 shows a portion of the special features data layer. Each 5x5 m grid cell within that layer is given a value based on the corresponding suitability value in Figure A-2.

Special Features	42.4%
No Special Land	1
Managed Woodlots	5.4
Crown Land With Special Code	7
Community Pastures	7.3
Areas of Special Interest (ASI)	7.8
Recreation Provincial Park (Non-Protected Portions)	8
Proposed Protected Areas	8.6
Heritage Rivers	8.7
Heritage Marshes	9
Conservation Lands	9

Figure A-2: Alternate corridor model evaluation example

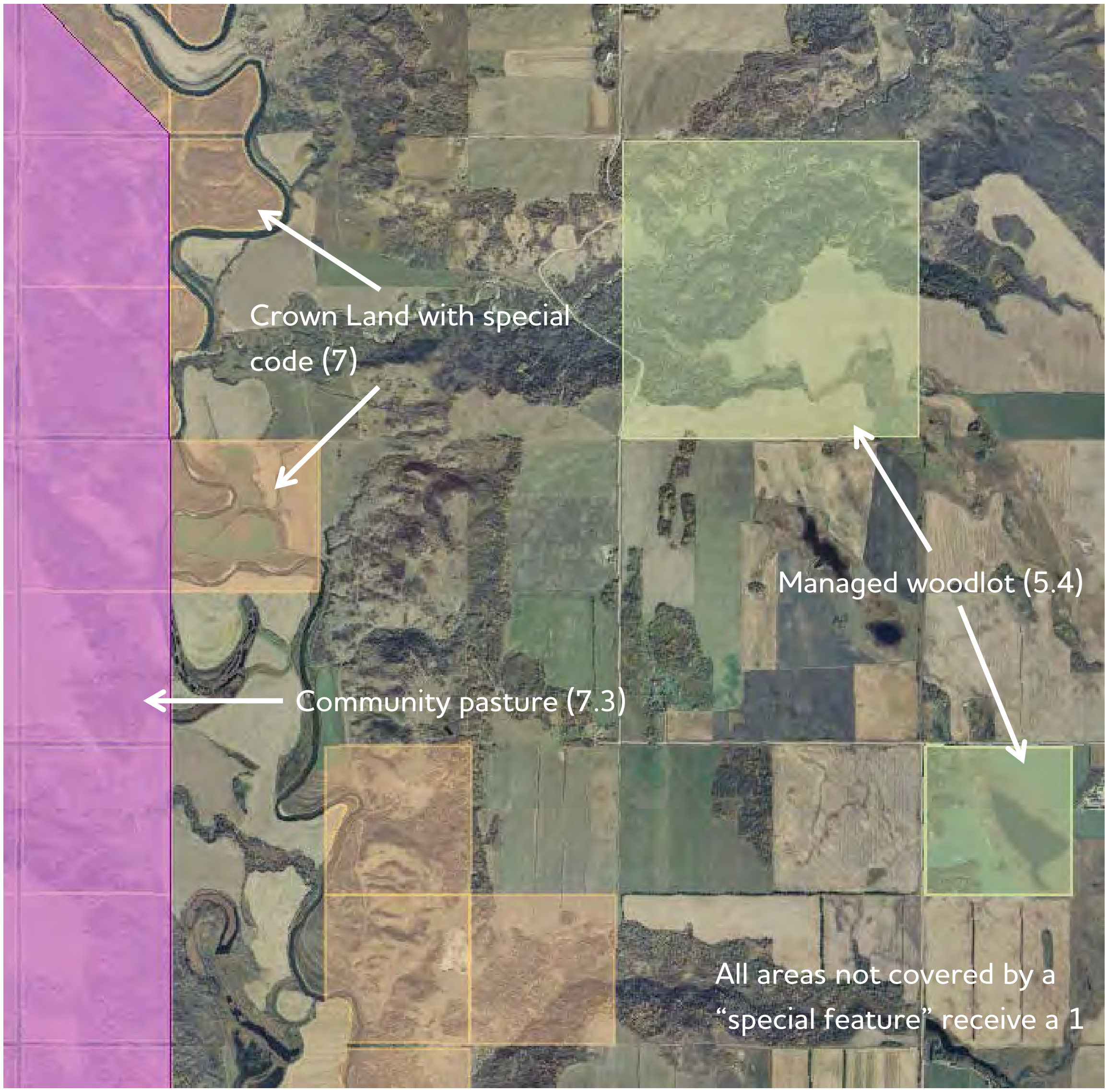

Figure A-3: Portion of the special features geospatial data Layer

A.5.4 Establishing suitability surfaces

The next step in the creation of alternate corridors was to establish suitability surfaces. A suitability surface was created by combining the individual geospatial data layers (factors and areas of least preference) into one layer using overlay analysis (Figure A-4). Overlay Analysis involved each geospatial data layer being:

- Multiplied by an assigned weight
- Summed and averaged as a continuous surface
- Masked by the areas of least preference layer (all areas of least preference receive a 0, therefore the model will not route there)

The overlay analysis process produced a suitability surface that is represented by a map in which each grid cell is given a value that defines the suitability of that area for routing a transmission line.

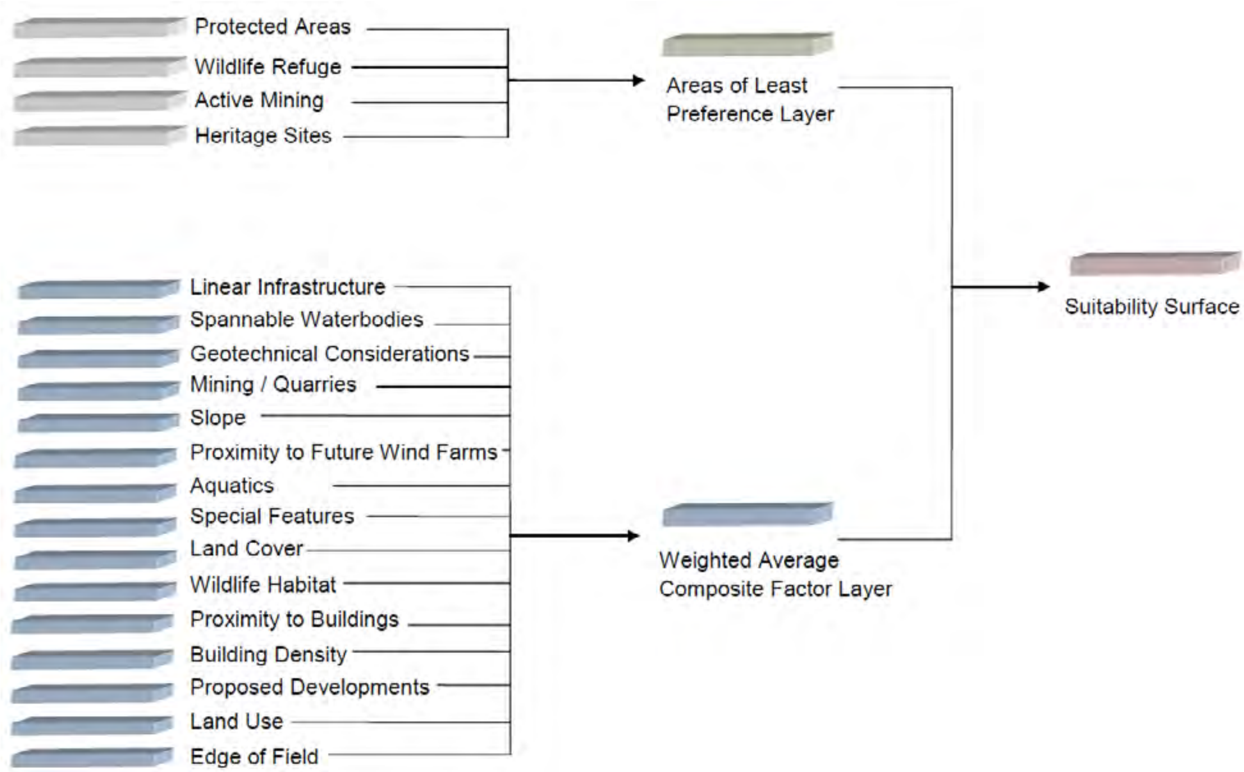

Figure A-4: Combining the Factor Layers and Areas of Least Preference Layer into the Suitability Surface

Suitability surfaces were created for each of the three perspectives: engineering environment, natural environment, and built environment, as well as one for the simple average. Each suitability surface represents a weighted combination of the three perspectives. Four scenarios were created by distributing the weight of each environment as follows:

- Engineering environment suitability surface (Map A-3): The data layers from the engineering environment perspective are given five times (72%) the emphasis of the built environment (14%) and natural environment (14%) perspectives.
- Natural environment suitability surface (Map A-4): The data layers from the natural environment perspective are given five times (72%) the emphasis of the built environment (14%) and engineering environment (14%) perspectives.
- Built environment suitability surface (Map A-5): The data layers from the built environment perspective are given five times (72%) the emphasis of the natural environment (14%) and engineering environment (14%) perspectives.
- Simple average suitability surface (Map A-6): The data layers for the simple average suitability surface are given equal emphasis (33.3% applied to all three perspectives).

A.5.5 Establishing alternate corridors

The next step in the process was to create a series of corridors using least cost path analysis on the suitability surfaces created in the previous step. An algorithm was used to find the "cost" of every possible path between the two end points. The "cost" in this case is the accrual of values of those grid cells, not monetary in nature. A path is any continuous string of grid cells connecting the start and end points input into the system. Lower summed values indicate relatively suitable paths, whereas higher summed values indicate relatively less suitable paths.

Figure A-5 demonstrates the development of a sample "optimal path" using information from a hypothetical situation. Figure A-5 (A) displays an example area that has four components in the special features data layer (a managed woodlot, a conservation easement, conservation lands and a proposed protected area) and several components within the land cover layer. In Figure A-5(B), grid cells are overlaid and assigned suitability values based on the components present and the suitability values from the model. Finally, Figure A-5(C) shows in dark green the most suitable path (corridor) through the area for locating a transmission line (the sum of each cell along the path will be less than the sum of any other combination of cells). The alternate corridors developed from the model represent the top three percent[3] (the most suitable three percent) of “optimal paths” within the route planning area.

For the development of the alternate corridors, one start point, Birtle South Station was used. Least cost path analysis was run from the first start point to each of the 2 border crossing areas.

Alternate corridors were generated for each of the three perspectives (built environment, natural environment, and engineering environment) as well as the simple average (an average of the three perspectives). Alternate corridor analysis was performed on weighted suitability surfaces for each of these for groups to produce alternate corridors for each. The analysis of the engineering environment weighted suitability surface (Map A-3), produced the engineering environment alternate corridors (Map A-7), the analysis of the natural environment weighted suitability surface (Map A-4), produced the natural environment alternate corridors (Map A-7), the analysis of the built environment weighted suitability surface (Map A-5), produced the built environment alternate corridors (Map A-7), and the analysis of the simple average suitability surface (Map A-6), produced the simple average alternate corridors (Map A-7).

The combination of the four alternate corridors resulted in the development of a composite corridor. The composite corridor depicts the most suitable areas (considering all four perspectives), based on the criteria used in the model, in which to plan potential routes for the transmission line. Map A-8 shows the composite corridor for each of the two border crossing areas.

The area represented by the composite corridor also serves as the base for the next phase of data collection. Up to this phase, the route planning area has been examined almost exclusively by aerial photography and existing geospatial data. Subsequently, the features in the composite corridor were verified by the routing team through both ground and aerial based field surveys. During these field surveys, project staff documented landscape features (such as new buildings, building types) and used this information to update geospatial data. This level of verification provided the routing team with the most up to date data needed to develop alternate routes.

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[3] When the EPRI-GTC Siting Methodology was first created, it was validated against recent electric transmission line siting projects. It was discovered that the routes selected for these projects typically fell within corridors created at 3% of all potential routes. For this reason, 3% has become widely used by utilities implementing this methodology to create Alternate Corridors.

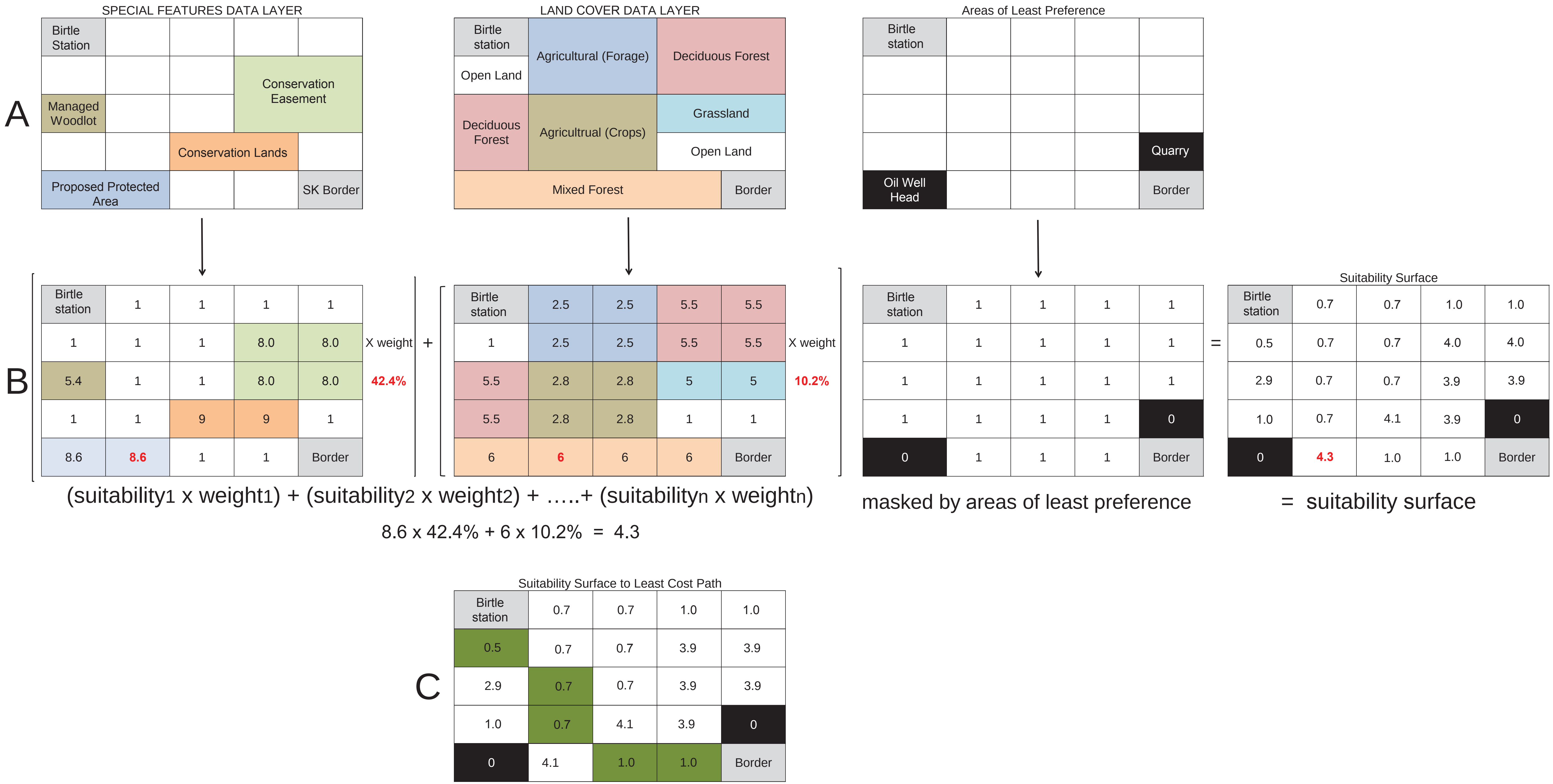


Figure A-5: Diagram of the aggregation process for combining factor layers into the suitability surface

A.6 Determining the preferred route

A.6.1 Overview

After the first round of public and Indigenous engagement process was concluded in the fall of 2016 the input was brought into the final step in the evaluation process. The routing team applied expert judgment to this information for ranking the top alternate routes and selecting a preferred route. While computation models generate useful data, these data must be considered by individuals with experience and expertise in the process of route selection. Information pertaining to features, land uses and perspectives, more difficult to quantify geospatially, must also be considered. As indicated previously, Manitoba Hydro and SaskPower had agreed to develop preferred routes to each of the two border crossing zones, and then meet to get consensus on the preferred border crossing.

A.6.2 Alternate route evaluation model

The alternate route evaluation model (AREM) as shown in Table A-4, built on the types of criteria developed previously for the three perspectives (engineering, natural, and built), but focused on those criteria that can discriminate among route options within a corridor, such as distance to buildings or livestock operations, percent length in floodplains or steep slopes, or intactness of natural habitat. Criteria were assigned weights based on their relative importance, again building on the work done in the previous stakeholder process, but incorporating feedback from the public and Indigenous engagement processes. Definitions for each of the model criteria are provided in Table A-4.

Table A-4: Alternate route evaluation model

Criteria	Weight
Built	
Relocated residences – within ROW	30%
Potential relocated residences (100 m) – Edge of ROW	18%
Proximity to residences (100-400 m) – Edge of ROW	6%
Proposed developments – Within ROW	17%
Current agricultural land use – ROW (value)	4%
Land capability for agriculture– ROW (value)	2%
Diagonal crossings of agriculture crop land ROW – (acres)	11%
Proximity to buildings and structures (100 m) – EOROW	3%
Public use areas (250m) – EOROW	7%
Historic / cultural resources (250 m) – edge of ROW	2%
Natural	
Intactness – ROW (acres)	39%
Native grassland areas (acres) – ROW	31%
Wetland areas (acres) – ROW	24%
Natural forests (acres) – ROW	3%
Stream crossings – centerline	3%
Engineering	
Total project costs (value)	34%
Position preference (value)	6%
Seasonal construction and maintenance restrictions (value)	20%
Accessibility (value)	20%
%length on slopes 30% or greater (value)	7%
Major ravines >350m (count)	7%
% length in Qu'Appelle / Assiniboine floodplains	6%

Table A-5: Model criteria definitions

Criteria	Measurement	Criteria Description
Built		
Relocated Residences – Within ROW	Count	Occupied Residence categorized in buildings layer and windshield surveys
Proximity to Residences (edge of ROW to 100 m)	Count	
Proximity to Residences (100-400 m from Edge of ROW)	Count	
Proposed Residential Developments - Within ROW	Count	Quarter section of land within which there is an approved residential subdivision
Current Agricultural Land Use (Acres) – ROW	Acres	Apply weighting based on production values to annual crop (2.7x) and hayland (1x) land cover classes
Land Capability for Agriculture (Acres) – ROW	Acres	Apply weighting to agricultural capability classes - Classes 1-3 (2x) and Classes 4-5 (1x)
Diagonal crossing of Agriculture Crop Land (Acres) – ROW	Acres	Diagonal crossings of land to be annually cropped land (MH LCC)
Proximity to Buildings and Structures(100 m) – EROW	Count	All buildings and structures excluding occupied and unoccupied residences, churches, schools, daycare, unobservable or unused buildings
Public Use areas) (250 m) – Edge of ROW	Count	Schools, Churches, Park Parcels, Recreational Trails, Campgrounds, Resorts and Lodges, Woodlots
Historic/Cultural Resources (250 m) – Edge of ROW	Count	Designated and known heritage sites
Natural		
Intactness (Acres) – ROW	Acres	Intact natural habitat polygons >200 ha in size (MH LCC; excluding agriculture areas and other disturbed/built-up areas) buffered by existing linear disturbances (high-use – 400-m buffer and low-use 200 m buffer)
Native grassland	Acres	Grassland cover class (MH LCC) - on crown land.
Wetland Areas (Acres) – ROW	Acres	All wetland cover classes (MH LCC)
Natural Forests (Acres) – ROW	Acres	All forested (*i.e.*, productive and non-productive) cover classes (MH LCC)
Stream/River Crossings	Count	Type A, B, C, Fish Habitat streams based on Fisheries and Oceans Canada
Engineering		
Total Project Costs	Cost	Estimated cost of the Project including construction material costs, including estimates of tower type based on terrain, additional costs for angle structures and clearing costs
Position preference	Value	Position Preference is a value, between 1 and 6 placed on a section of the route based on the potential impact to agricultural operations. The lengths of each value (1 to 6) are multiplied by the value and totalled for the entire route. Factor 1 - Edge of Road Allowance (km) – least impact to farming Factor 2 - Mid Field (km) – >40m from edge of field allowing farming operation to navigate around the structure. Factor 3 - Quarter section Line (km) – on quarter section line impacting as little of the farming operation in either adjacent field Factor 4 - Edge of Quarter Section Line (km) – offset from a quarter section line impacting as little of the farming operation in a single field Factor 5 - Within 40m of Edge of Parcel Line (km) – within 40m of the edge of a parcel impact the farming operation more significantly Factor 6 - Diagonal (km) – most disruption to a farming operation
Seasonal Construction and Maintenance Restrictions ROW	Value	A value determined by the presence of wetland, forest, and agricultural land use/land cover patterns within the ROW
Accessibility	Value	A value determined by the ROW's proximity to the nearest public roadway (improving accessibility), and any wetland locations within the ROW (reducing accessibility)
% Length on Slopes >30%	Value	% Length of line along slopes greater than 30%
Major Ravines > 350m	Count	Count of crossings of a ravine > 350 m across.
% Length in Qu'appelle and Assiniboine floodplains	Value	% Length of line in the delineated flood plains

A.6.3 Preference determination model

In order to provide guidance to the decision-making process, prior to the development and evaluation of route segments, the Transmission Senior Management Team developed a list of key considerations and assigned each a weight based on relative importance for this Project. This formed the basis of the preference determination model (PDM). Weights were based on technical experience and familiarity with the key issues in the Project area related to its geographical and sociological makeup and input from the engagement process. The team determined the criteria in the model as well as the relative weights of each criterion (Table A-6).

Table A-6: Preference determination model

Criteria	Percent	Description
Cost	40%	Cost was based on high-level construction cost estimates used for relative comparison, defined in the alternate route evaluation criteria (values do not represent actual cost estimates for the project).
Community	35%	Input received from the public and Indigenous engagement processes.
Schedule Risks	5%	Includes consideration of the need for additional regulatory approvals, seasonality of construction, overall level of complication expected that could result in delays.
Environment (Natural)	7.5%	Consideration of the natural-based statistics from the alternate route evaluation criteria, further interpretation by the Project team, and additional information not captured by the criteria that can inform the relative potential effect on the natural environment of different route alternatives.
Environment (Built)	7.5%	Consideration of the built statistics from the alternate route evaluation criteria, further interpretation by the Project team and additional information not captured by the criteria that can inform the relative potential effect on the built environment of different route alternatives.
System Reliability	5%	Consideration of transmission line crossings and line length (longer lines have more exposure to extreme weather events).

A.6.4 Developing alternate routes

Once alternate corridors are identified (as described above), the routing team identifies alternate routes within those corridors. The alternate routes are potential, preliminary centerline routes for the proposed transmission line that can be evaluated and analyzed by the Project team and presented to the public for feedback. The routes are composed of individually numbered route segments that connect to form contiguous routes from the start to end point.

Once the various segments for alternate routes were developed sufficiently a map of the output (Map A-9) was posted to the Project website and it was used during Round 1 of the public and Indigenous engagement process initiated in November 2016 (described in chapters 3 and 4 of the Environmental Assessment Report). Input was collected on route/segment preferences, issues and concerns, including any potential new segments proposed during the engagement process to avoid areas of concern not previously identified.

The alternate route evaluation model was used to develop segment/route statistics to assist in making decisions regarding any proposed adjustments to routes or line segments gathered through the stakeholder engagement process. The routing team used the statistics developed for the new proposed segments to assess their viability and effect on the various routing options. The screening output was then brought into the alternate route evaluation step at the conclusion of the engagement round. Map A-10 shows the evaluation routes used in the next step of the process, selecting the preferred route and border crossing.

A.6.5 Overview of analysis

In the preference determination step, the “finalists” from the AREM alternate route analysis step were considered in a comparative fashion by the Project team, including the design and construction engineers, biophysical and socio-economic specialists, and engagement team in a route evaluation workshop. Including this diverse group in the process ensured that this step incorporated feedback received in the public (Chapter 3) and Indigenous engagement (Chapter 4) processes together with route statistics, and additional research and analysis by discipline specialists, to provide input into the selection of a preferred route.

Prior to reviewing the alternate route evaluation statistics, the number of possible routes (millions of segment-to-segment route combinations) was reduced to a manageable size for evaluation. This reduction was accomplished in a two-step process using GIS.

The initial step screened down to approximately 24,278 route combinations by eliminating from further analysis all routes that are greater than 120% longer than the shortest route between the start and each border crossing, and routes that backtrack by more than 1,000 m. The decision to remove all routes greater than 120% of the total length of the shortest route was based on the logic of minimizing overall impact - longer routes are generally less favorable, as the greater distance increases potential impacts (e.g., the route will cross more total land area creating, in most cases, increased costs, land effects, and impacted number of individuals). Backtracking segments are those that cause the route to turn in a direction opposite to moving towards the end point.

Considerable research and data analysis occurred in preparation for a route evaluation workshop to enable Project team members to be in a position to discuss, debate and evaluate the information collectively, and arrive at a group decision regarding the selection of the preferred route. The first step in analysis involved establishing discipline-specific working groups to evaluate and rank each route using the relevant PDM criterion. The cost criteria scoring and system reliability scoring were determined by technical staff and engineers from System Planning, Project Management, Transmission Line Design, and Civil Design and construction. The community criterion rankings were developed by the public and Indigenous engagement teams (Manitoba Hydro staff and supporting consulting staff). The environment (natural) criteria scoring was determined by the specialist consultants on the Project team that conducted the assessment on the biophysical and physical components of the Project that could be affected, together with Manitoba Hydro Licensing and Environmental Assessment staff. The environment (built) criteria scoring was determined by the specialist consultants on the Project team that conducted the assessment on the components of the socio-economic environment that could be affected by the Project (e.g., land use, agriculture, and heritage) and Manitoba Hydro Licensing and Environmental Assessment staff. Finally, the schedule risks criterion scoring was developed through consideration by the entire Project team as elements of each consideration (built, natural, technical) can contribute to schedule risks.

Each discipline-specific working group used the segment statistics, technical experience and feedback from engagement to score each route within the preference determination framework from 1 (most preferred) to 3 (least preferred). For each alternate route, the statistical output, in the form of a histogram, depicted the overall scores from each perspective (Engineering, Natural, Built, and Simple Average). Using this histogram, it was possible to visually consider the strengths and weaknesses of each route and determine the top scoring routes. Lower scores indicated relatively more suitable routes, and higher scores indicated relatively less suitable routes. Routes with a less favorable score in most categories could be screened out, and rationale was available for including routes, which included information obtained through public engagement, review of the statistical analysis and the histogram outputs.

After the discipline-specific working groups had ranked the options for each criterion independently, they participated in a workshop (January 2017) to collectively evaluate alternate routes. The workshop facilitated discussion and examination of the statistical results of the alternate route evaluation model, and consensus-building on results.

The first step in the workshop was to reduce the number of alternate routes to a set of finalists. Each discipline-specific work group presented their nominations for route finalists, based on their analysis and perspective. The overall team discussed and debated these recommended finalists, facilitated through discussion and examination of the statistical results of the alternate route evaluation model and consideration of additional information (field work, analysis, feedback through engagement processes). Ultimately a subset of finalists were selected and carried forward for further evaluation in the preference determination phase, which is discussed further in paragraphs that follow.

The next step of the workshop was to run the finalists from each border crossing through the preference determination process, in order to determine a relative preference between the two border crossing options. Figure A-6 depicts the alternate route evaluation process and preference determination for each individual border crossing. Using the steps of the methodology to guide the decision-making, a preferred crossing point was selected by first selecting a preferred route to each possible crossing point, and then comparing the strongest routes to each crossing against each other.

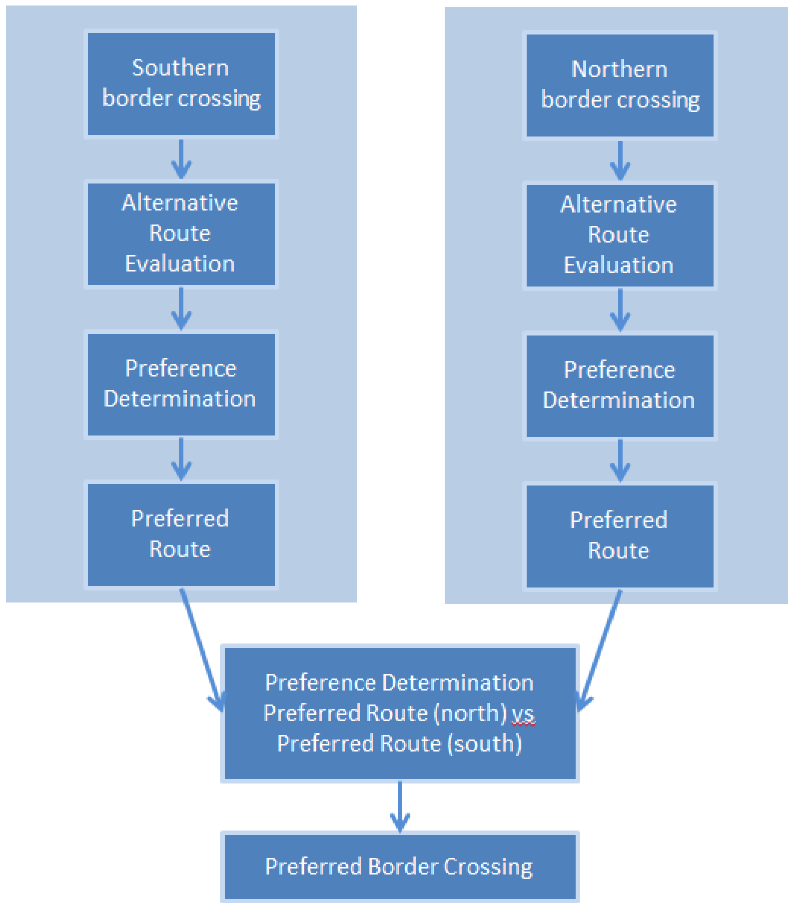


Figure A-6: Alternate route evaluation flow chart

A.6.6 Southern border crossing

The first step in examining routes to the southern border crossing was to reduce the number of routes / options by conducting a pairwise comparison of similar segments. Table A-7 provides details on the segments compared, the decision made and the rationale for the decision.

Table A-7: Segment comparisons		
Segments	**Decision**	**Rationale**
36E vs 35E/39 (Figure A-7)	Keep 35E/39, remove 36E	Segment 35E/39 skirts the edge of the community pasture, minimizes impact to intactness and native grassland which are key in this area, avoids listed species habitats, has a better Assiniboine River crossing angle, stays out of the low oxbow area, provides more flexibility for angle tower placement further away from the water, and is better from and agriculture perspective.
101 vs 26A/26B (Figure A-8)	Keep 101, remove 26A/26B	Segment 101 was a mitigative segment developed to minimize impacts to homes in the area.

Figure A-7: Segment 36E – 39/35E comparison

Figure A-8: Segment 101 – 26A/26B comparison.

The next step was to review the route statistics and top scoring routes remaining to select the top 3-5 routes to proceed to preference determination. Table A-8 provides details on the routes selected and the rationale (Map A-11).

Table A-8: Routes selected for preference determination (south)

Route	Rationale
S1-337	Top scoring simple average route
S2-27	Best scoring engineering route within the top ten natural routes
S2-28	Top scoring engineering route
S1-385	Top scoring built route
S1-387	High scoring built route, better (than S1-385) from the other perspectives.

Table A-9 outlines the preference determination scores for each criteria and the considerations for that score.

Table A-9: Preference determination scores and considerations (south)			
Criteria	Route	Score	Considerations
Cost	S2-28	1	Scores for cost included total length, number of angles, ease of construction and number and distance of ravine crossings.
	S2-27	1.5	
	S1-337	2	
	S1-385	2.25	
	S1-387	2.25	
System Reliability	S2-28	1	System reliability was based primarily on length. Shorter lines have less overall exposure to extreme weather events.
	S2-27	1.5	
	S1-337	2	
	S1-385	3	
	S1-387	2.25	
Risk to Schedule	S2-28	1	Risk to schedule was based on proportion of crown land (requires more approvals), challenges in land acquisition, concerns of regulators for routing through the community pastures.
	S2-27	1	
	S1-337	3	
	S1-385	2	
	S1-387	3	
Environment (Natural)	S2-28	1	Natural environment scores were based entirely on the community pastures. Routes through the community pastures potentially affect intactness of rare native grassland habitat, risks to listed species and several species of concern.
	S2-27	1	
	S1-337	3	
	S1-385	3	
	S1-387	3	
Environment (Built)	S2-28	2	All routes are generally very good from a built perspective because of the overall avoidance of residences and buildings. For that reason the agricultural differences were key in differentiating between the routes.
	S2-27	2	
	S1-337	1.5	
	S1-385	1	
	S1-387	1	
Community	S2-28	3	Community scores considered proximity to residents and heritage sites, segments that follow roads and half-mile alignments (preferred over cross country alignment).
	S2-27	2.5	
	S1-337	2.5	
	S1-385	1	
	S1-387	2	

Table A-10 provides the results of the preference determination for the southern border crossing.

Table A-10: Preference determination (south)

Criteria	%	S2-28	S2-27	S1-337	S1-385	S1-387
Cost	40	1	1.5	2	2.25	2.25
Weighted		0.4	0.6	0.8	0.9	0.9
System Reliability	5	1	1.5	2	3	2.25
Weighted		0.05	0.075	0.1	0.15	0.1125
Risk To Schedule	5	1	1	3	2	3
Weighted		0.05	0.05	0.15	0.1	0.15
Environment (Natural)	7.5	1	1	3	3	3
Weighted		0.075	0.075	0.225	0.225	0.225
Environment (Built)	7.5	2	2	1.5	1	1
Weighted		0.15	0.15	0.1125	0.075	0.075
Community	35	3	2.5	2.5	1	2
Weighted		1.05	0.875	0.875	0.35	0.7
TOTAL	100	1.78	1.83	2.26	1.80	2.16
RANK		1	3	5	2	4

When the weighted scores were considered, the result was the selection of Route S2-28 as the preferred route to the southern border crossing. The total score for route S1-385 was only 0.02 more than the top route (1.78 – 1.80) so it was also screened forward. Based on the above routes S2-28 and S1-385 proceeded to the final preference determination along with the preferred route to the northern border, discussed below.

A.6.7 Northern border crossing

The first step in examining the routes to the northern border was to review the route statistics and the top scoring routes to select the top 3-5 routes to proceed to preference determination. Table A-11 provides details on the routes selected and the rationale (Map A-12).

Table A-11: Routes selected for preference determination (north)	
Route	Rationale
N2-4185	Top scoring simple average and engineering route.
N2-9208	Top scoring built route.
N2-4147	Top scoring engineering route within the top ten natural routes.
N2-4146	Top scoring simple average route that uses segments 44B and 52 (important segments based on engagement feedback, not included in the other routes).

Table A-12 outlines the preference determination scores for each criterion and the considerations for that score.

<table>
<tr><th colspan="4">Table A-12: Preference determination scores and considerations (north)</th></tr>
<tr><th>Criterion</th><th>Route</th><th>Score</th><th>Considerations</th></tr>
<tr><td rowspan="4">Cost</td><td>N2-4158</td><td>1</td><td rowspan="4">Cost considered ease of construction, length, number of angle towers and ravine crossings (specialty towers).</td></tr>
<tr><td>N-9208</td><td>3</td></tr>
<tr><td>N2-4147</td><td>1.1</td></tr>
<tr><td>N2-4146</td><td>1.1</td></tr>
<tr><td rowspan="4">System Reliability</td><td>N2-4158</td><td>1</td><td rowspan="4">System reliability was based on length. Shorter lines have less overall exposure to extreme weather events.</td></tr>
<tr><td>N-9208</td><td>3</td></tr>
<tr><td>N2-4147</td><td>1</td></tr>
<tr><td>N2-4146</td><td>1</td></tr>
<tr><td rowspan="4">Risk to Schedule</td><td>N2-4158</td><td>1</td><td rowspan="4">Risk to schedule scores were based on proportion of Crown land (routes that have more Crown land can trigger interests from a variety of different departments in the government and increase the need for other approvals or influence the duration and level of effort required in those processes have a greater risk to schedule.)</td></tr>
<tr><td>N-9208</td><td>1</td></tr>
<tr><td>N2-4147</td><td>1</td></tr>
<tr><td>N2-4146</td><td>1</td></tr>
<tr><td rowspan="4">Environment (Natural)</td><td>N2-4158</td><td>1.5</td><td rowspan="4">Natural scores were based on the amount of wetlands and grasslands crossed, species at risk habitat crossed and potential effects on habitat intactness.</td></tr>
<tr><td>N-9208</td><td>3</td></tr>
<tr><td>N2-4147</td><td>1</td></tr>
<tr><td>N2-4146</td><td>1</td></tr>
<tr><td rowspan="4">Environment (Built)</td><td>N2-4158</td><td>2</td><td rowspan="4">Built scores were based on agricultural considerations, proximity to homes, and potential effects on future development.</td></tr>
<tr><td>N-9208</td><td>1.5</td></tr>
<tr><td>N2-4147</td><td>1.6</td></tr>
<tr><td>N2-4146</td><td>1</td></tr>
<tr><td rowspan="4">Community</td><td>N2-4158</td><td>2</td><td rowspan="4">Community scores were based on proximity to homes and heritage sites and paralleling of roads and mile alignments.</td></tr>
<tr><td>N-9208</td><td>2</td></tr>
<tr><td>N2-4147</td><td>1</td></tr>
<tr><td>N2-4146</td><td>2</td></tr>
</table>

Table A-13 provides the results of the preference determination for the northern border crossing. When the weighted scores were considered, the result was the selection of Route N2-4147 as the preferred route to the northern border crossing.

Table A-13: Preference determination (north)

Criteria	%	N2-4158	N-9208	N2-4147	N2_4146
Cost	40	1	3	1.1	1.1
Weighted		0.4	1.2	0.44	0.44
System Reliability	5	1	3	1	1
Weighted		0.05	0.15	0.05	0.05
Risk To Schedule	5	1	1	1	1
Weighted		0.05	0.05	0.05	0.05
Environment (Natural)	7.5	1.5	3	1	1
Weighted		0.1125	0.225	0.075	0.075
Environment (Built)	7.5	2	1.5	1.6	1
Weighted		0.15	0.1125	0.12	0.075
Community	35	2	2	1	2
Weighted		0.7	0.7	0.35	0.7
TOTAL	100	1.46	2.44	1.09	1.39
RANK		3	4	1	2

A.6.8 Final preference determination

As indicated, after the routes for each border crossing had been assessed the next step was to compare the highest ranking routes from each border crossing against each other to determine overall route preferences and from that the preferred border crossing.

Routes S2-28, S1-385. And N2-4147 (Map A-13) were selected for the final preference determination as described above. The statistics generated by the models (alternate route evaluation and preference determination) provided a clear understanding of the strengths and weaknesses associated with each border crossing and the routes used to connect the crossing to the project start point. The highest ranking routes from each border crossing were then compared against each other to determine overall route preferences and from that the preferred border crossing. The top route(s) from each border crossing then moved into a final preference determination step to flesh out the strengths and weaknesses of the border crossings as illustrated by alternate routes deemed most ideal to reach these crossings. Table A-14 summarizes the comparisons.

Table A-14: Preference determination scores and considerations (north/south)			
Criterion	Route	Score	Rationale
Cost	N2-4147	3	Cost scores were based on length, number of angles and ravine crossings.
	S1-385	1.1	
	S2-28	1	
System Reliability	N2-4147	3	System reliability scores were based on length and ravine crossings.
	S1-385	1.5	
	S2-28	1	
Risk to Schedule	N2-4147	1	Risk to schedule was based on proportion of crown land, risk of land expropriation, routing through the community pasture which could require time for addressing environmental issues.
	S1-385	3	
	S2-28	2.5	
Environment (Natural)	N2-4147	1	Natural scores were based on potential effects to species at risk habitat, native grassland habitat and habitat intactness,
	S1-385	3	
	S2-28	3	
Environment (Built)	N2-4147	3	Built scores were based on proximity to homes and future development and potential effects on agriculture.
	S1-385	1	
	S2-28	2	
Community	N2-4147	1	Community scores were based on proximity to homes and heritage sites, paralleling mile alignments and roads. More weight was given to concerns that were not as easily mitigated.
	S1-385	1.5	
	S2-28	3	

In terms of cost, both southern routes were substantially preferred over the northern route for this criterion. Almost 70 % of the Project costs are related to construction and line length, and the northern route is substantially (20-30%) longer than the routes to the southern crossing (northern route = 59.4 km; southern routes = 46.2 km/41.7 km). The northern route introduces additional construction risk associated with ravine crossings and increased foundation installation challenges. While there was limited geotechnical information available it appears that there is a risk of encountering the presence of boulders/cobbles and low tills, creating challenges for drilling. Costs for S1 (385) and S2 (28) would be very similar to one another (within hundreds of thousands), but considerably less than the northern route.

In terms of system reliability, both southern routes were preferred to the northern route in terms of this criterion. Length was the main driver due to the risk of damage to the line from adverse weather– more length results in more towers and more exposure to extreme events (wind/ice/tornados, etc.). In terms of risk to schedule, the northern route was somewhat preferred, although there are several technical issues, and uncertainties with land acquisition. Risk to schedule scores were based on proportion of crown land (routes that have more Crown land can trigger interests from a variety of different departments in the government and increase the need for other approvals or influence the duration and level of effort required in those processes have a greater risk to schedule.

In terms of natural environment, the northern route was substantially preferred over the southern routes based on natural environment issues. The southern routes cross the community pasture, a region with national profile as prairie grassland, supporting several rare grassland bird species. While the north route is longer than the south routes the natural environment effects should all be readily mitigatable and it avoids issues associated with the community pasture, based on conversations with subject matter experts from Manitoba Sustainable Development. During the public engagement process (section 3.4.5), several stakeholders expressed concerns about routes through the pasture. The southern routes would also cross similar important habitat in Saskatchewan. As S2 skirts the edge of the pasture in Manitoba it ranks slightly higher than S1, which does not, in terms of natural environment issues. The pasture is intact native grassland and provides large areas of intact habitat for at risk grassland birds.

In terms of built environment, the southern routes were slightly preferred over the northern route based on this criterion. All routes were generally very good from a built perspective because of the overall avoidance of residences and buildings. Agricultural differences were the main factor in differentiating between the routes. The north route was the least preferred of the three routes simply because as the longest route it crosses the greatest amount of agricultural lands, and through more developed area (an additional three residences within 100 m, 12 residences within 100-400 m, and one proposed development). The S1 was ranked higher as it mostly avoids residences, building and development permits. It was the most compatible of the three routes from the built perspective as it crosses the least amount of agricultural lands. S2 was the second most compatible of the three routes from the built perspective as it crosses more agricultural lands than the S1 but is still less than the north route. Agriculture impacts were less on S2 but that was overridden by the residential implications.

In terms of community, the northern route was somewhat preferred than the southern routes, but the Community category represents competing views from interest groups, landowners, members of the public and Indigenous communities. These included opposing views related to the potential for the transmission line to affect natural landscapes versus agricultural land and/or crown land versus private land, and which should be avoided. The scores aimed to balance the differing interests through understanding how individual concerns/ impacts can or cannot be mitigated or whether the concern is tangible or a perceived impact. The northern route avoids community pastures, follows mile lines and existing roadways and would affect fewer private landholdings and agricultural management units. During the public engagement process (section 3.4.5) several landowners and agricultural organizations expressed concerns that routing should be through pastures to avoid private agricultural land, whereas concerns that were raised through the Indigenous engagement process (sections 4.4.7.2 and 4.4.8.3) focused more on concerns within the pasture.

In conclusion, the southern routes through the community pasture were preferred to the northern route, primarily driven by the difference in line length (13-18 km) and substantial associated costs associated with the northern route. Landowners and agricultural groups had voiced strong opposition to impacting prime agricultural land along the northern route and urged routing through the pastures, and there are risks to schedule through the land acquisition process. ENGOs and Manitoba Department of Sustainable Development’s Wildlife and Fisheries Branch had expressed strong concerns about the southern routes and potential impacts to rare and endangered grassland/species in the pasture. Indigenous groups had expressed concerns about important areas in the pasture. While this is a very important consideration, Manitoba Hydro was of the opinion that additional studies to identify and characterize the area, combined with monitoring, mitigation and adaptive management measures, could address risks of impacts in the pasture. Therefore, the primary driver was the high cost difference between the routes.

Table A-15 outlines the preference determination scores for each criteria and the considerations for that score. Based on this analyses and discussions the output of the January 2017 workshop was a preferred route (S1-385) and therefore the southern border crossings as the preferred crossing. The preferred route (Map A-14) was posted to the Project web site and used for the next round of engagement.

Table A-15: Preference determination (north / south)				
Criteria	%	NS-4147	S1-385	S2-28
Cost	40	3	2	1
Weighted		1.2	0.8	0.4
System Reliability	5	3	1.5	1
Weighted		0.15	0.075	0.05
Risk To Schedule	5	1	3	2.5
Weighted		0.05	0.15	0.125
Environment (Natural)	7.5	1	3	3
Weighted		0.075	0.225	0.225
Environment (Built)	7.5	3	1	2
Weighted		0.225	0.075	0.15
Community	35	1	1.5	3
Weighted		0.35	0.525	1.05
TOTAL	100	2.05	1.85	2.00
RANK		3	1	2

A.6.9 SaskPower Routing Process

Like Manitoba Hydro, SaskPower completed its own routing and engagement processes to determine preference related to border crossing locations. SaskPower summarized the advantages and challenges of the best route to the north crossing compared to the best route to the south crossing.

Advantages in a route to the north crossing were primarily a shorter line length (2.4 km), with associated savings on capital costs. In addition, the north route does not run parallel to a CN rail line as the south route does, and thus avoids potential rail induction effects and associated mitigation costs. This route also has fewer farmyards with less cultivated land impacted, versus the south option, as well as slightly less native prairie and associated environmental issues. It also reduces potential impacts to the Spy Hill – Ellice Community Pasture (1/3 as much construction compared to south option); crosses community pasture in the area preferred by the current lease of the community pasture.

Challenges in a route to the north crossing include a requirement for a crossing of Deerhorn Creek and extensive seasonally flooded area around it (crossing width approximately 560 m, so at least one structure will have to be in flooded zone); also wetter conditions would be encountered at the north end of the community pasture. In addition, the north crossing would require nearly twice as much tree clearing as the south option, which adds cost to ROW preparation as well as requiring permits / timing restrictions due to environmental concerns. The north option would also result in a lower percentage of the route being adjacent to existing road or transmission infrastructure (59% versus 87% for south options) resulting in reduced accessibility to the line for construction and maintenance. There would also be impacts to more private landowners (24 versus 19 for the south option). SaskPower also recognized that the north option would add substantially more construction length for Manitoba Hydro on their side of border, increasing overall transmission line length.

In assessing the route to the south crossing SaskPower determined that advantages would include a requirement for substantially less tree clearing on the ROW, compared to the north option, and there were also fewer waterbodies and seasonally flooded areas crossed, resulting in slightly less 'native environment' impacted overall. The greater use of community pasture for the south option would result in fewer private landowners being impacted (19 versus 24 for the north option), and it would avoid the crossing of Deerhorn Creek and the extensive seasonal flooding area around it; overall fewer issues with water (surface and groundwater) and seasonal flooding compared to the north option. The south option also had substantially greater length of route being adjacent to existing road or transmission infrastructure (87% versus 59% for the north option) resulting in much better access to structure sites for construction and maintenance. Finally, as indicated previously, SaskPower also recognized that the south border option results in a much shorter route for Manitoba Hydro, significantly reducing overall transmission line length.

SaskPower described the challenges with the south option as including a requirement for an additional 2.4 km of construction (Tantallon station to SK-MB Border), with associated additional capital costs. In addition, the south route would require paralleling an existing CN Rail line for approximately 7.7 km, resulting in additional costs for AC mitigation studies and potential mitigation measures. The south route would also have a greater impact on the Spy Hill – Ellice community pasture, including the location in an area of the pasture strongly opposed by the current leasee of the community pasture.

SaskPower's process resulted in a preference for the north border crossing, primarily due to costs associated with additional transmission line length and rail line mitigation work, estimated to be approximately 29% more for a south border crossing.

A.6.1 Selecting a Common Border Crossing

On January 18 and 20, 2017 SaskPower and Manitoba Hydro met to share details describing the rationale for their respective preferences, with the objective of determining a mutually acceptable border crossing location that would serve the needs of both parties. As described above, both parties listed cost as the primary factor, but SaskPower selected the north border and Manitoba Hydro selected the south border. The difference was that the Manitoba Hydro costs for the north crossing were several times greater than the SaskPower cost savings for the south route, based primarily on line length. The process required compromises by both parties but through discussion there was consensus on a selection of a south border crossing.

A.7 Developing a Final Route

With the south border crossing selected there was a need to finalize the Manitoba route to this crossing. A February 6 workshop was held to discuss the output of the discussions with SaskPower and determine if any modifications were required, through understanding the issues they had addressed. The only outstanding issue was to finalize the route through the pasture that best dealt with sensitivities related to native prairie and associated wildlife species. On February 10 2017, prior to developing the materials for the second round of public and Indigenous engagement, Manitoba Hydro met with representatives of Manitoba Department of Sustainable Development's Wildlife and Fisheries Branch to discuss issues associated with the route through the pasture. Based on the first round of engagement the Branch had expressing concerns about a transmission line corridor intersecting Spy Hill Community Pasture due to large tracts of intact mixed-grass prairie and populations of prairie songbird species protected under *The Endangered Species and Ecosystems Act*. During the meeting Manitoba Hydro presented the output of the routing process and the substantial difference in line length and the rationale for routing through the pasture. Several alternative segments in the pasture were discussed that would route away from prairie areas and associated songbird habitat.

The preferred route was presented in a second round of public and Indigenous engagement (sections 3.4.4 and 4.3) in April 2017 to solicit feedback and make any further refinements. In order to provide flexibility in discussing specific route segments within the pasture, the second round of public/Indigenous engagement included a map of the preferred route with a generalized rectangular Ongoing Route Discussion Area identified within the pasture (Figure A-9).

Manitoba Hydro met with the Wildlife and Fisheries Branch again to discuss a biophysical field program to gather detailed information in the vicinity of the proposed pasture route segments and provided a summary report to them at the end of the spring/summer field program. The Branch provided a letter response acknowledging Manitoba Hydro's efforts to lessen the Project effects on grassland habitat and recommending a series of mitigation and monitoring requirements. Based on this information the Final Preferred Route was established (Map A-15). The Final Preferred Route selected therefore represents a consideration of multiple perspectives and inputs accounting for diverse interests and objectives. Criteria representing the natural, built and technical perspectives were used for route comparisons to arrive at a balanced decision on routing.

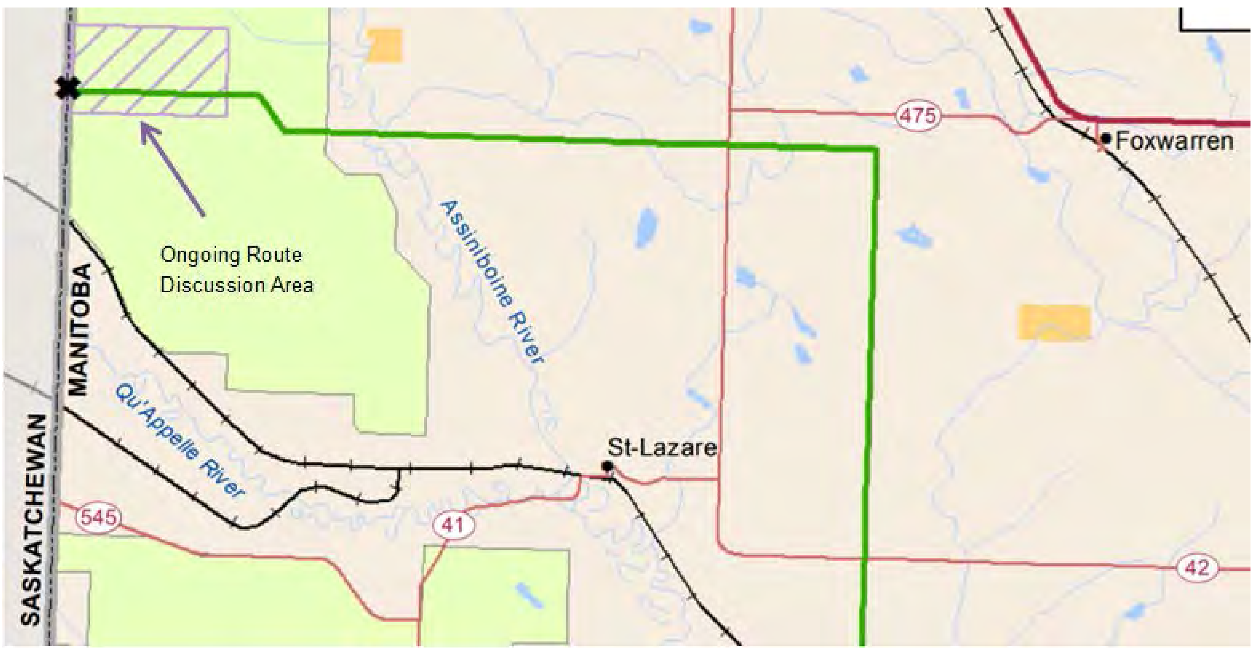


Figure A-9: Ongoing Route Discussion Area

Manitoba Hydro used a transparent and comprehensive routing process, based on the EPRI-GTC methodology that used criteria based models to evaluate and compare route alternatives and explicitly support decision-making. The result of the transmission line routing process is the selection of a final preferred route based on a robust and transparent methodology that included extensive engagement through the public and Indigenous engagement processes. The route selection process considered a broad range of environmental, socio-economic, technical, and stakeholder information and feedback from the public and Indigenous engagement processes in stepping through the stages listed above to determine a route that balanced these factors. The objective of the process was to determine the location of a route that limits overall effect through the balancing of perspectives categorized as built, natural and environmental, as described above.

The data collected from a variety of sources, to inform routing decisions was used in the comparative evaluation of route alternatives, alongside qualitative, yet critical feedback from engagement processes. Throughout the process, decision-making was undertaken by the Project team representing all key perspectives (natural, built, technical). The team considered route statistics as well as insights gained from field study and qualitative information that was difficult to measure on land but important to examine. The resulting 46 km long final preferred route represents a reasonable balance of perspectives and values, incorporating mitigation proposed during the public and First Nations and Metis engagement processes.

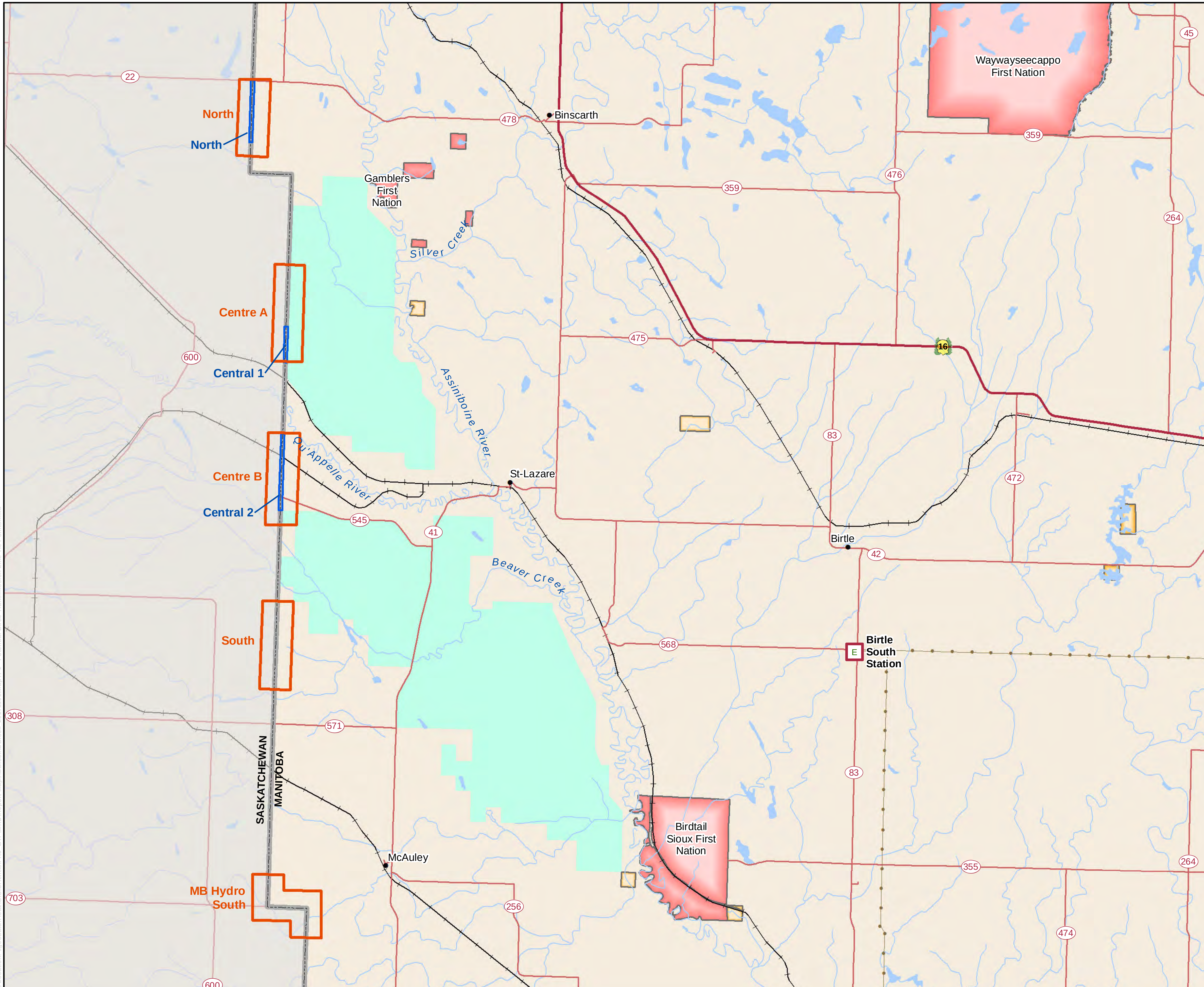
The assessment of potential effects (chapter 7) was based on this route. Table A-17 presents the statistics for the final preferred route, as calculated by the criteria from the alternate route evaluation model.

Table A-16: Final preferred route statistics

Feature	FPR
Built	
Relocated Residences – Within ROW (count)	0
Potential Relocated Residences - EOROW to 100m (count)	1
Proximity to Residences - 100-400m from Edge of ROW (count)	7
Proposed Developments - Within ROW (count)	1
Current Agricultural Land Use - ROW (value)	176
Land Capability for Agriculture – ROW (value)	224
Diagonal crossing of Agriculture Crop Land – ROW (acres)	19
Proximity to Buildings and Structures - EOROW to 100m (count)	10
Special Features - EOROW to 250m (count)	1
Historic/Cultural Resources - EOROW to 250m (count)	3
Natural	
Natural Forests - ROW (acres)	86
Intactness - ROW (acres)	103
Stream / River Crossings - Centerline (count)	3
Wetlands - ROW (acres)	10
Native Grassland - ROW (acres)	54
Engineering	
Length (km)	46
Seasonal Construction + Maintenance Restrictions - ROW (value)	89
% Length on Slopes 30% or greater (value)	0.5
Major Ravines > 350m (count)	2
% Length in Qu'appelle and Assiniboine floodplains (value)	3
Accessibility (value)	21,676,958
Construction/Design Costs ($)	$8,724,608
Position Preference (value)	50

A.8 References

EPRI-GTC. 2006. EPRI-GTC Overhead Electric Transmission Line Siting Methodology. EPRI, Palo Alto, CA, and Georgia Transmission Corporation, Tucker, GA: 2006. 1013080.



Manitoba Hydro

Birtle Transmission Project

Project Infrastructure
- Birtle South Station

Infrastructure
- Transmission Line

Planning Area
- Potential Transmission Tie-Points
- Border Crossing Area

Landbase
- Community
- Yellowhead Highway
- Road
- Railway Line
- First Nation
- Community Pasture
- Wildlife Management Area
- Province of Manitoba Boundary

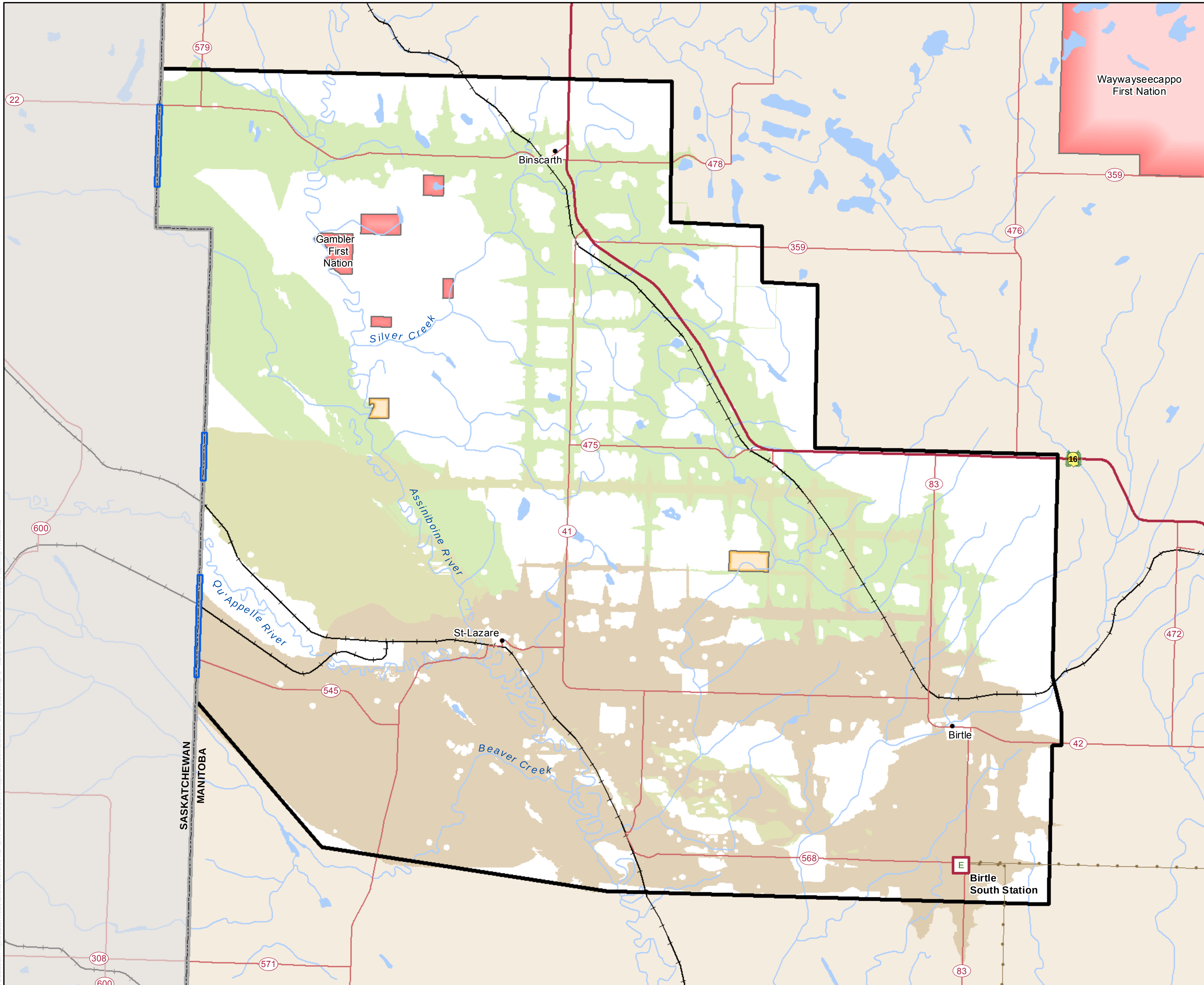
Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 13, 2017
Available in accessible formats upon request.

0 4 8 Kilometres
0 2 4 Miles
1:200,000

N

Potential Border Crossing Zones

Map A-1



Manitoba Hydro

Birtle Transmission Project

Project Infrastructure

E Birtle South Station

Infrastructure

Transmission Line

Planning Area

Border Crossing Area

Route Planning Area

Macro Corridors

North

Central 1

Central 2

Landbase

Community

Yellowhead Highway

Road

Railway Line

First Nation

Wildlife Management Area

Province of Manitoba Boundary

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 11, 2017
Available in accessible formats upon request.

0 4 8 Kilometres

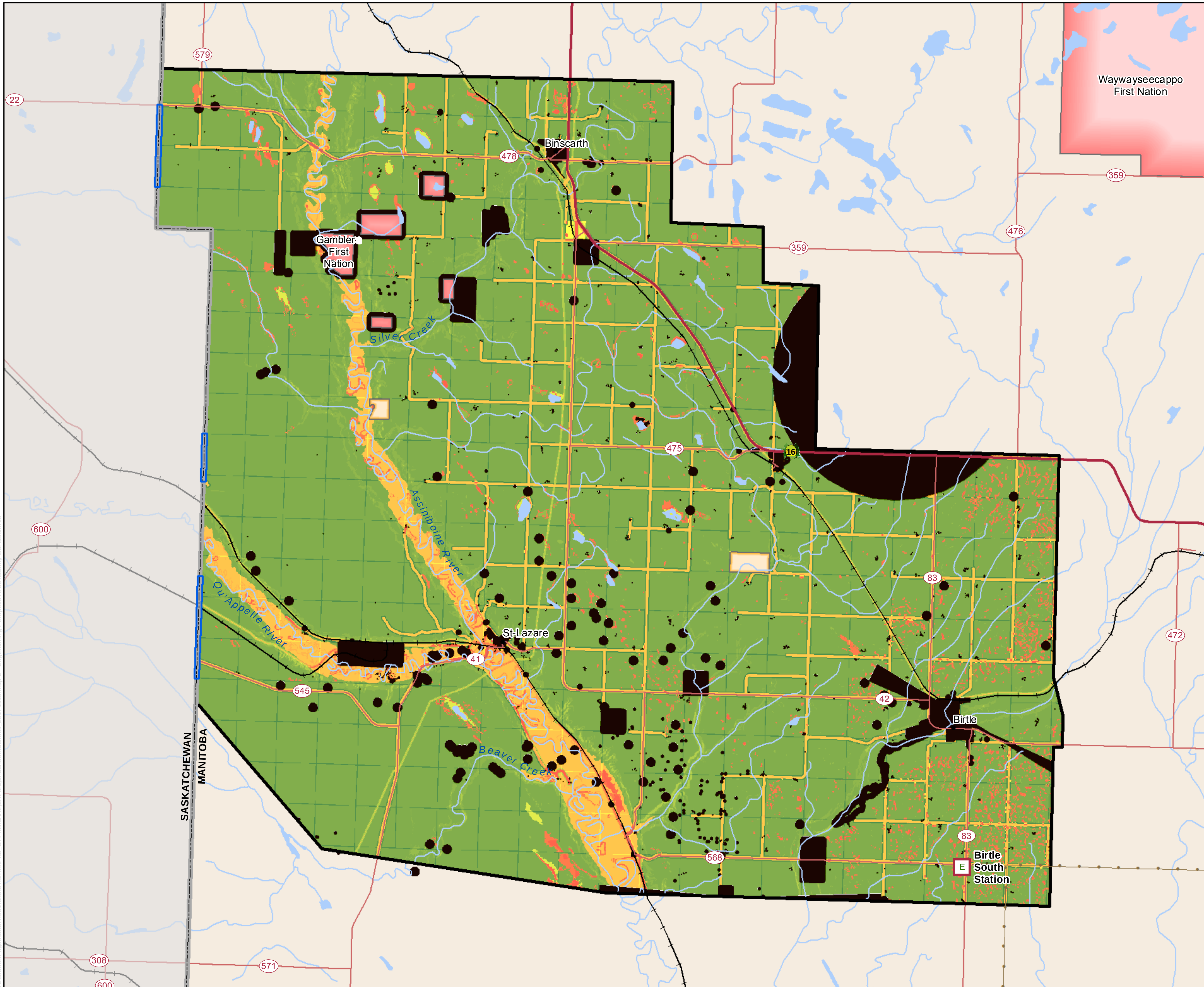
0 2 4 Miles

1:150,000

N

Macro Corridors and Route Planning Area

Map A-2



Manitoba Hydro

Birtle Transmission Project

Project Infrastructure

- Birtle South Station

Infrastructure

- Transmission Line

Suitability Surface

- Area of Least Preference

Engineering Environment

- Less Suitable: 7.2
- More Suitable: 1.0
- Border Crossing Area
- Route Planning Area

Landbase

- Community
- Yellowhead Highway
- Road
- Railway Line
- First Nation
- Wildlife Management Area
- Province of Manitoba Boundary

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 11, 2017
Available in accessible formats upon request.

N

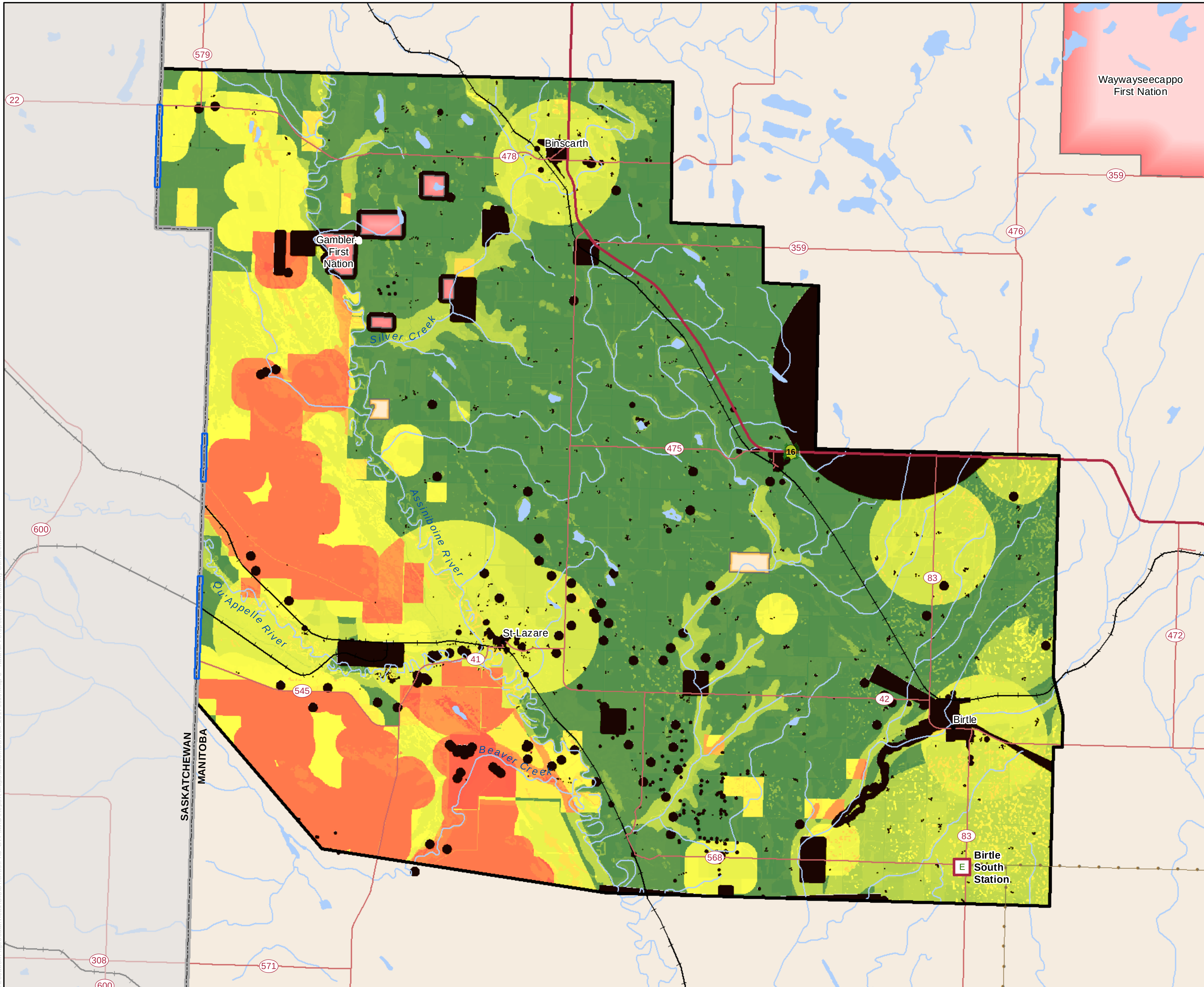
0 4 8 Kilometres

0 2 4 Miles

1:150,000

Engineering Perspective Suitability Surface

Map A-3



Manitoba Hydro

Birtle Transmission Project

Project Infrastructure

E Birtle South Station

Infrastructure

Transmission Line

Suitability Surface

Area of Least Preference

Natural Perspective

Less Suitable: 9.0

More Suitable: 1.0

Border Crossing Area

Route Planning Area

Landbase

Community

Yellowhead Highway

Road

Railway Line

First Nation

Wildlife Management Area

Province of Manitoba Boundary

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 11, 2017
Available in accessible formats upon request.

N

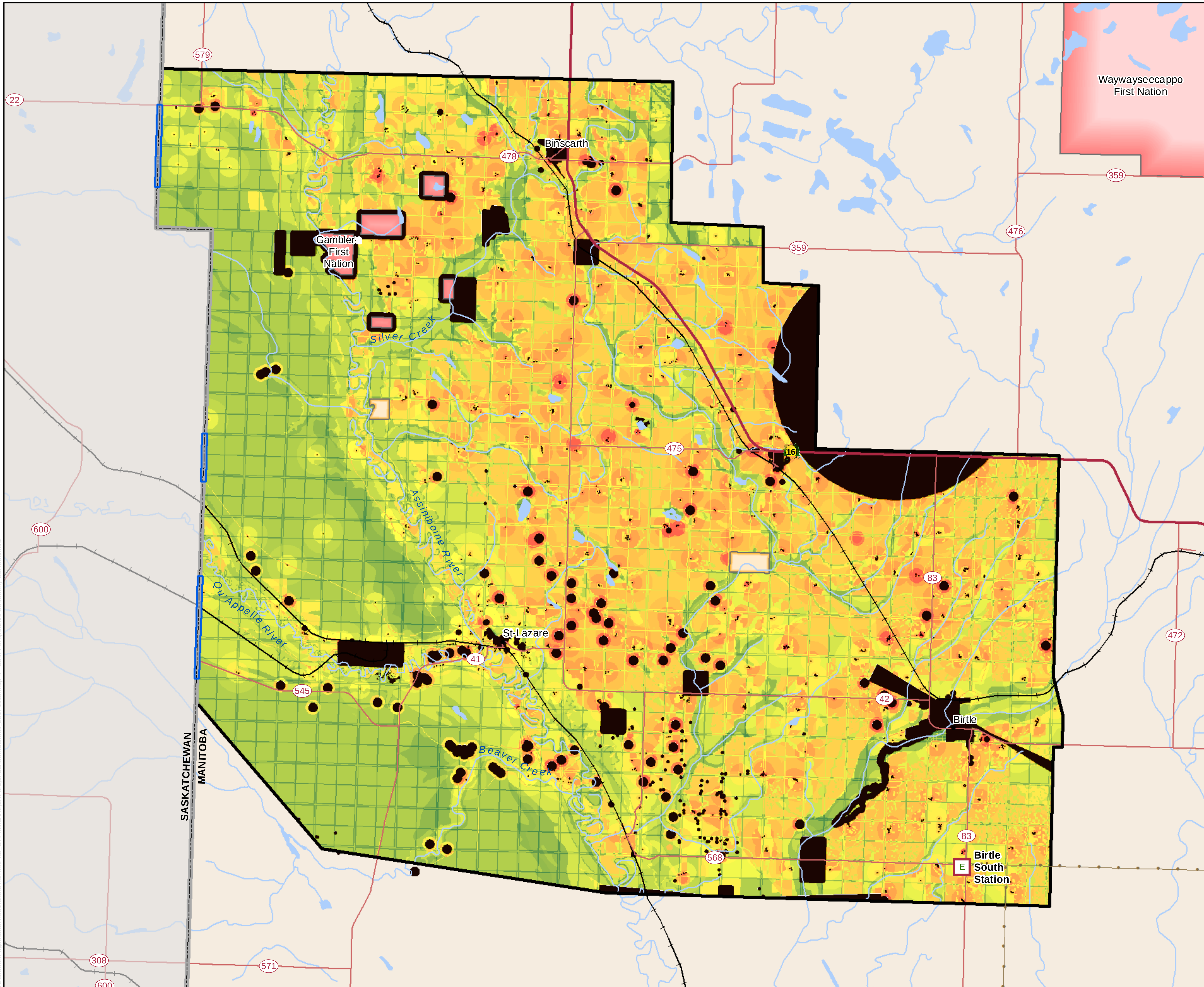
0 4 8 Kilometres

0 2 4 Miles

1:150,000

Natural Perspective Suitability Surface

Map A-4



Manitoba Hydro

Birtle Transmission Project

Project Infrastructure

Birtle South Station

Infrastructure

Transmission Line

Suitability Surface

Area of Least Preference

Built Perspective

Less Suitable: 7.8

Low : 1.0

Border Crossing Area

Route Planning Area

Landbase

Community

Yellowhead Highway

Road

Railway Line

First Nation

Wildlife Management Area

Province of Manitoba Boundary

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 11, 2017
Available in accessible formats upon request.

N

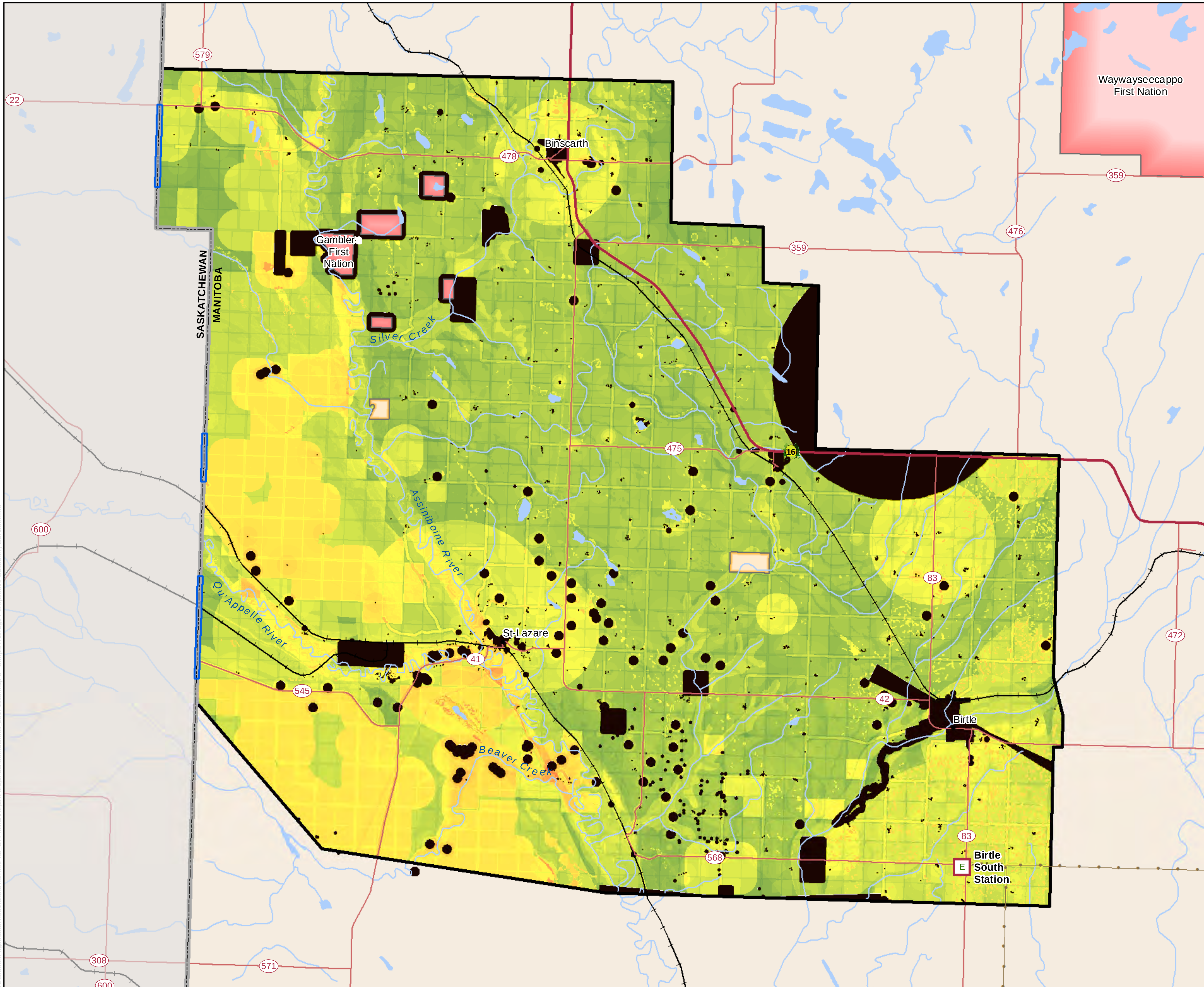
0 4 8 Kilometres

0 2 4 Miles

1:150,000

Built Perspective Suitability Surface

Map A-5



Manitoba Hydro

Birtle Transmission Project

Project Infrastructure

Birtle South Station

Infrastructure

Transmission Line

Suitability Surface

Area of Least Preference

Less Suitable: 6.4

More Suitable: 1.1

Border Crossing Area

Route Planning Area

Landbase

Community

Yellowhead Highway

Road

Railway Line

First Nation

Wildlife Management Area

Province of Manitoba Boundary

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 11, 2017
Available in accessible formats upon request.

0 4 8 Kilometres

0 2 4 Miles

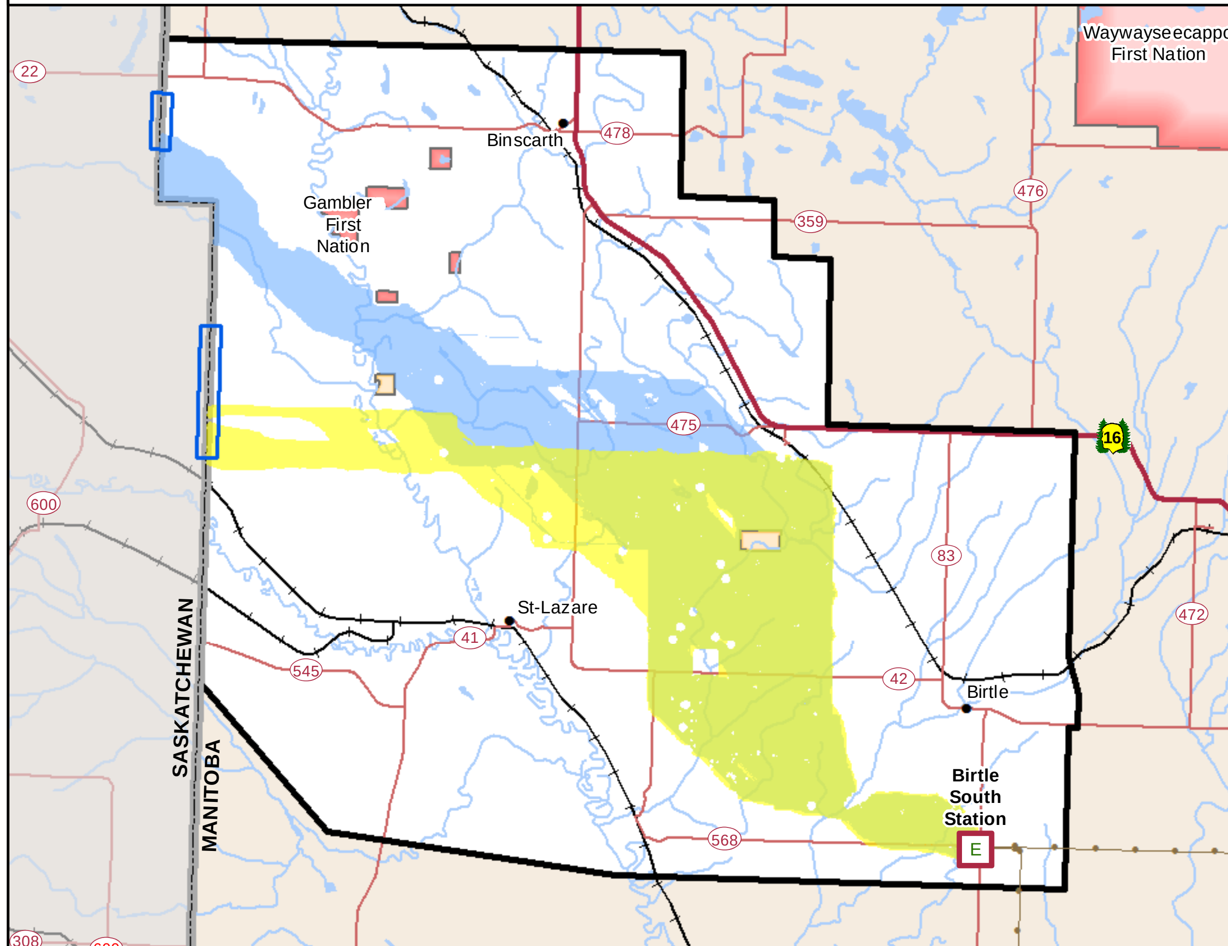
1:150,000

N

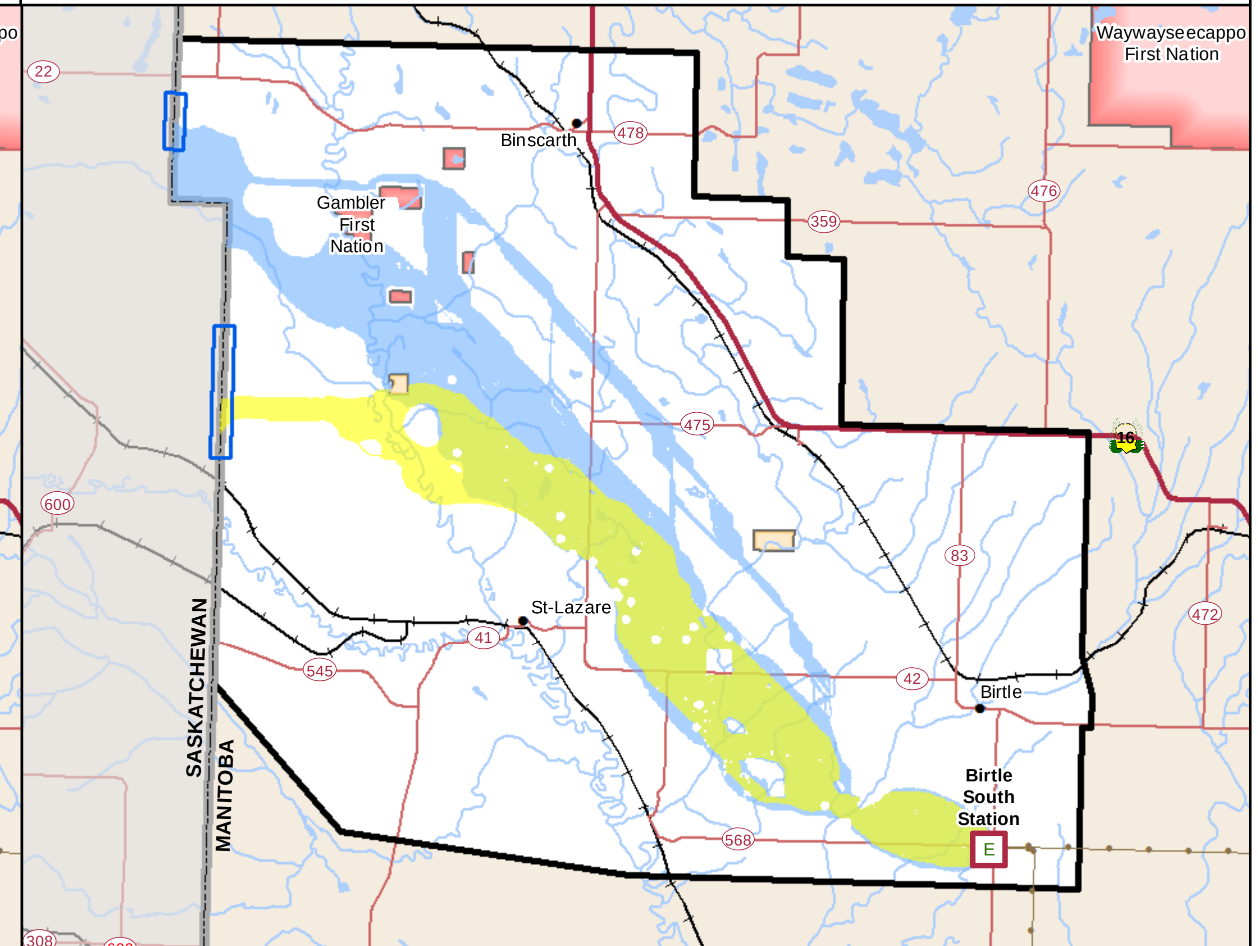
Simple Average Perspective Suitability Surface

Map A-6

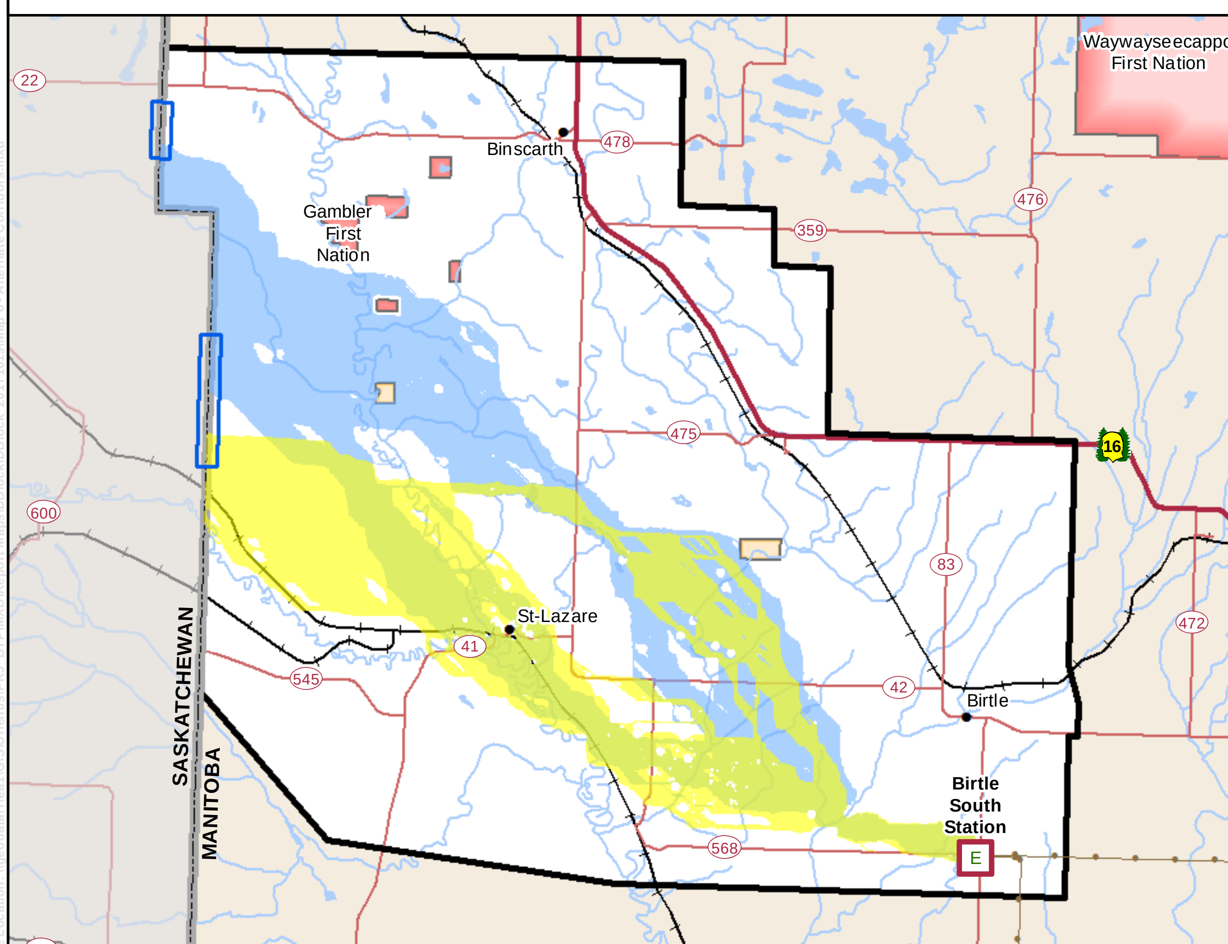
ENGINEERING ENVIRONMENT CORRIDOR



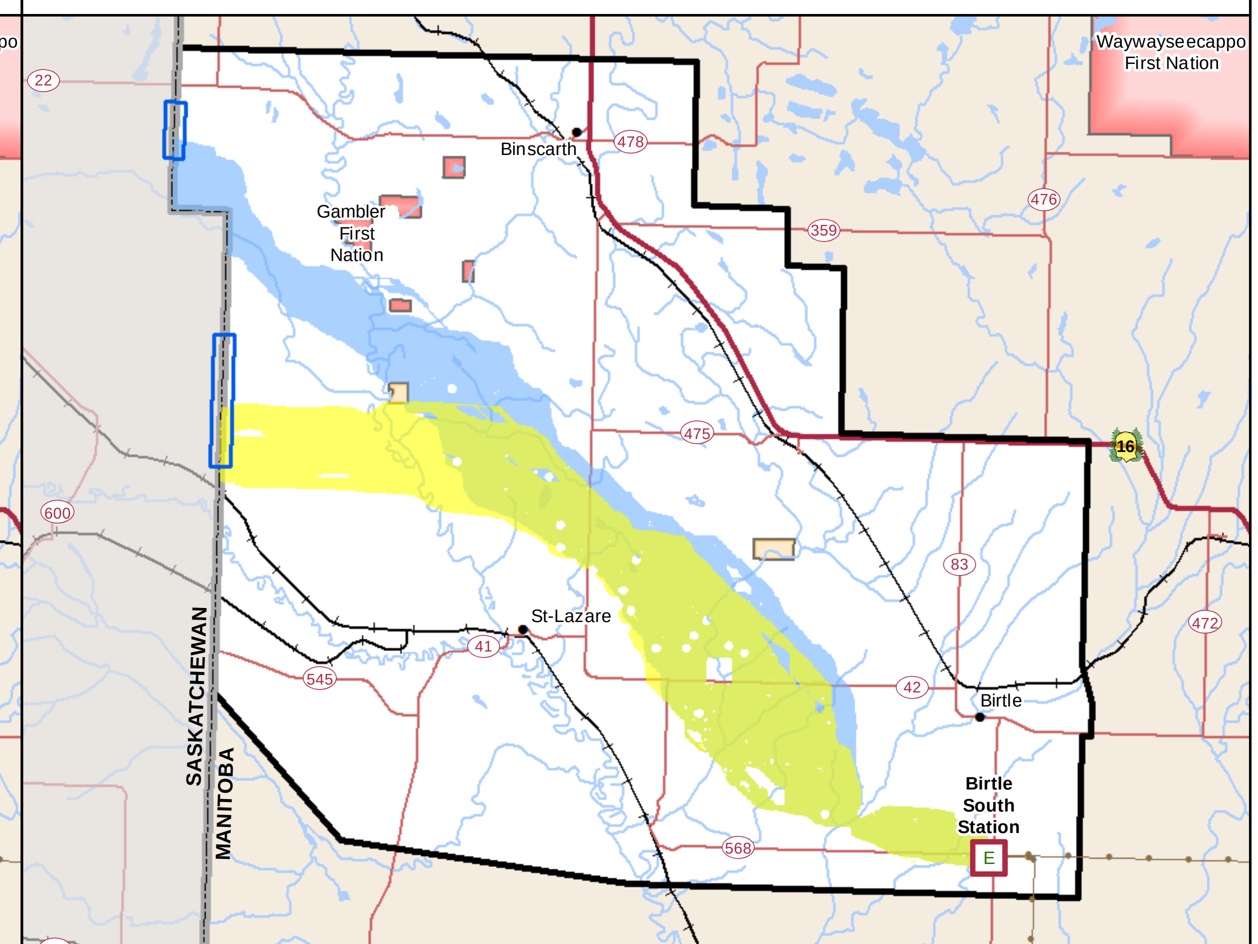
NATURAL ENVIRONMENT CORRIDOR



BUILT ENVIRONMENT CORRIDOR



SIMPLE AVERAGE CORRIDOR



Manitoba Hydro

Birtle Transmission Project

Project Infrastructure

- E Birtle South Station

Infrastructure

- Transmission Line

Alternate Corridors

- North
- Central 1

Route Planning Area

- Route Planning Area
- Border Crossing Area

Landbase

- Community
- Yellowhead Highway
- Road
- Railway Line
- First Nation
- Wildlife Management Area
- Province of Manitoba Boundary

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 11, 2017
Available in accessible formats upon request.

N

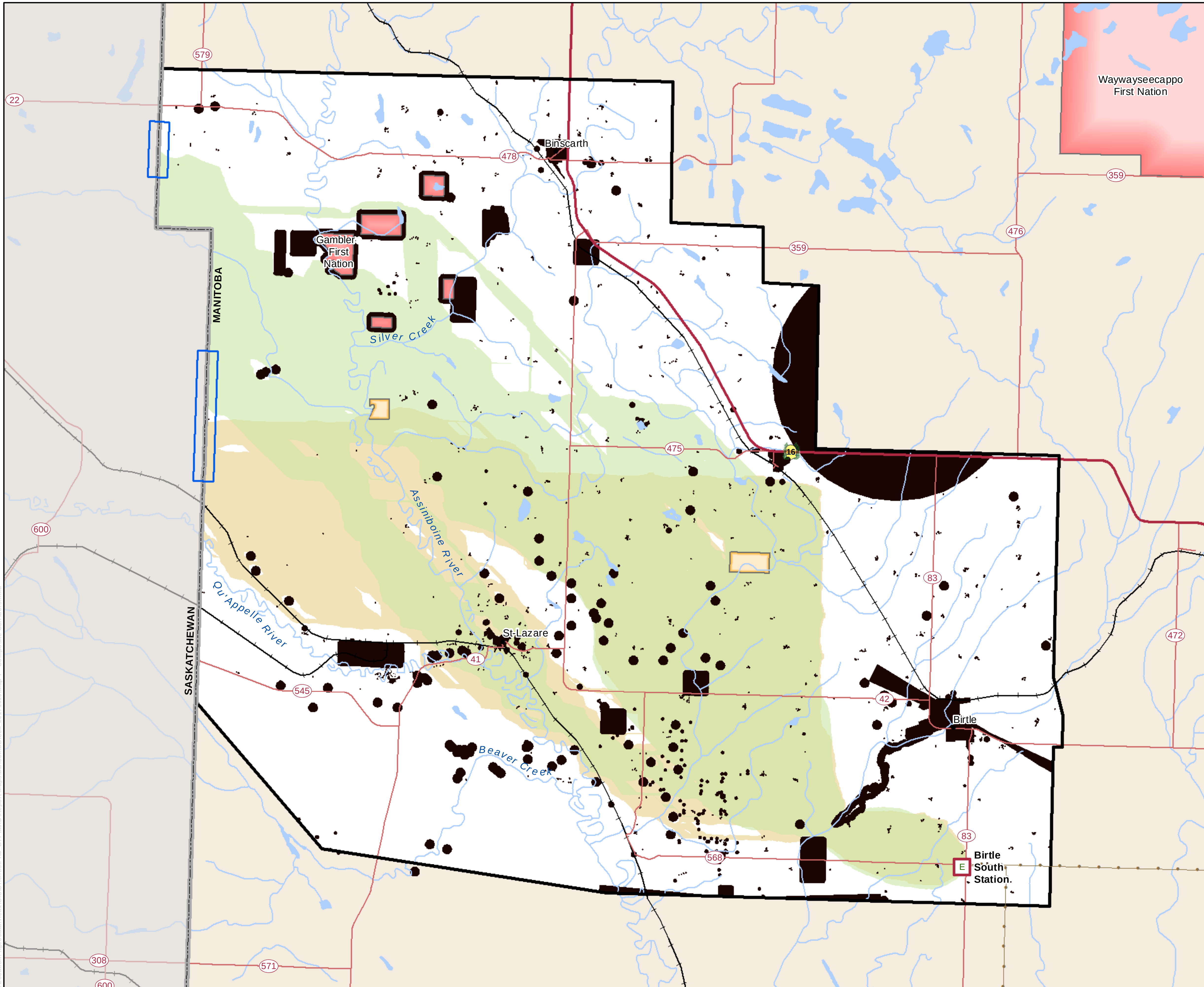
0 5 10 Kilometres

0 2 4 Miles

1:300,000

Alternate Corridors

Map A-7



Manitoba Hydro

Birtle Transmission Project

Project Infrastructure

E Birtle South Station

Infrastructure

Transmission Line

Composite Corridors

North

Centre

Planning Area

Area of Least Preference

Border Crossing Area

Route Planning Area

Landbase

Community

Yellowhead Highway

Road

Railway Line

First Nation

Wildlife Management Area

Province of Manitoba Boundary

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 11, 2017
Available in accessible formats upon request.

N

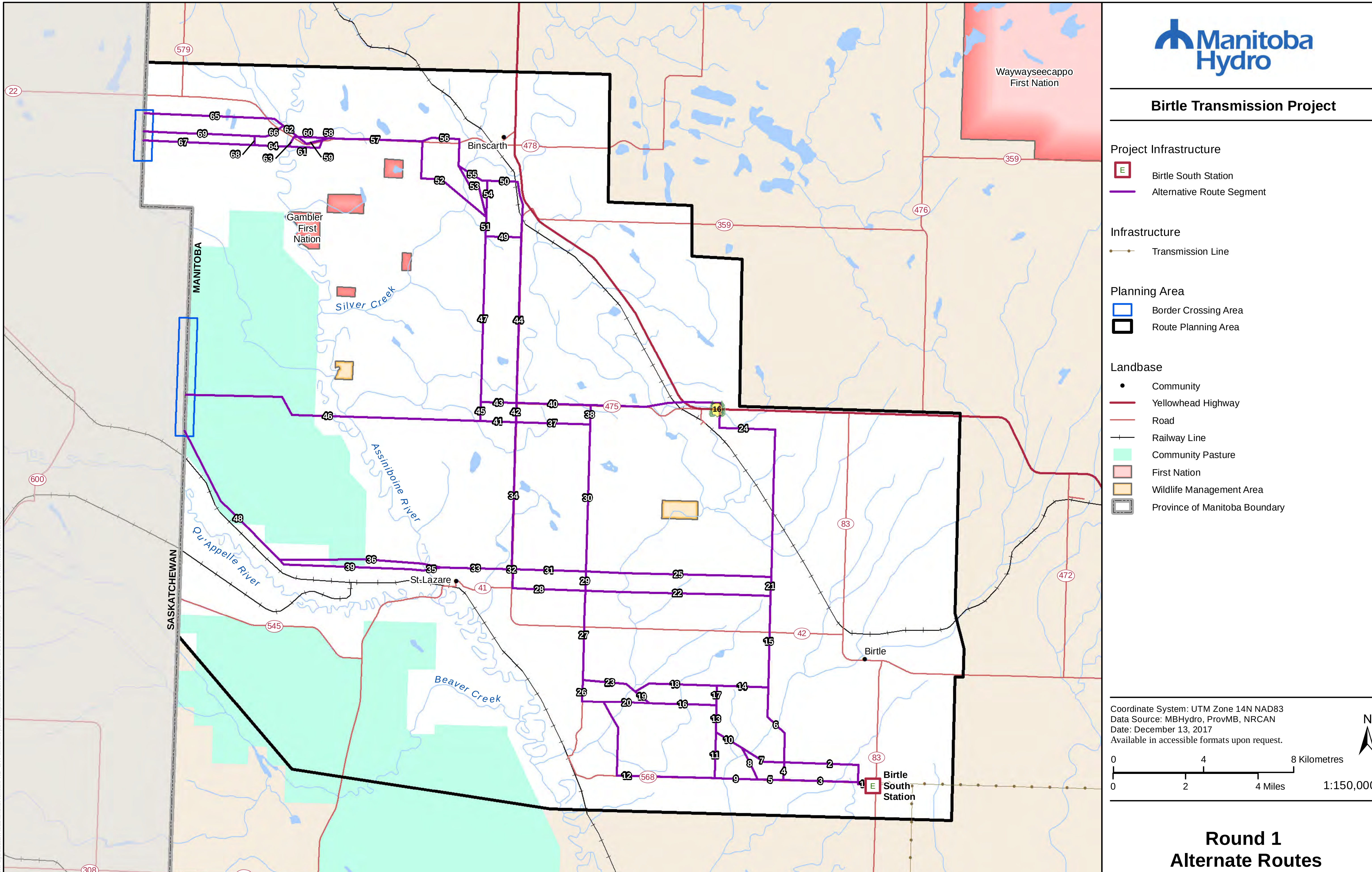
0 4 8 Kilometres

0 2 4 Miles

1:150,000

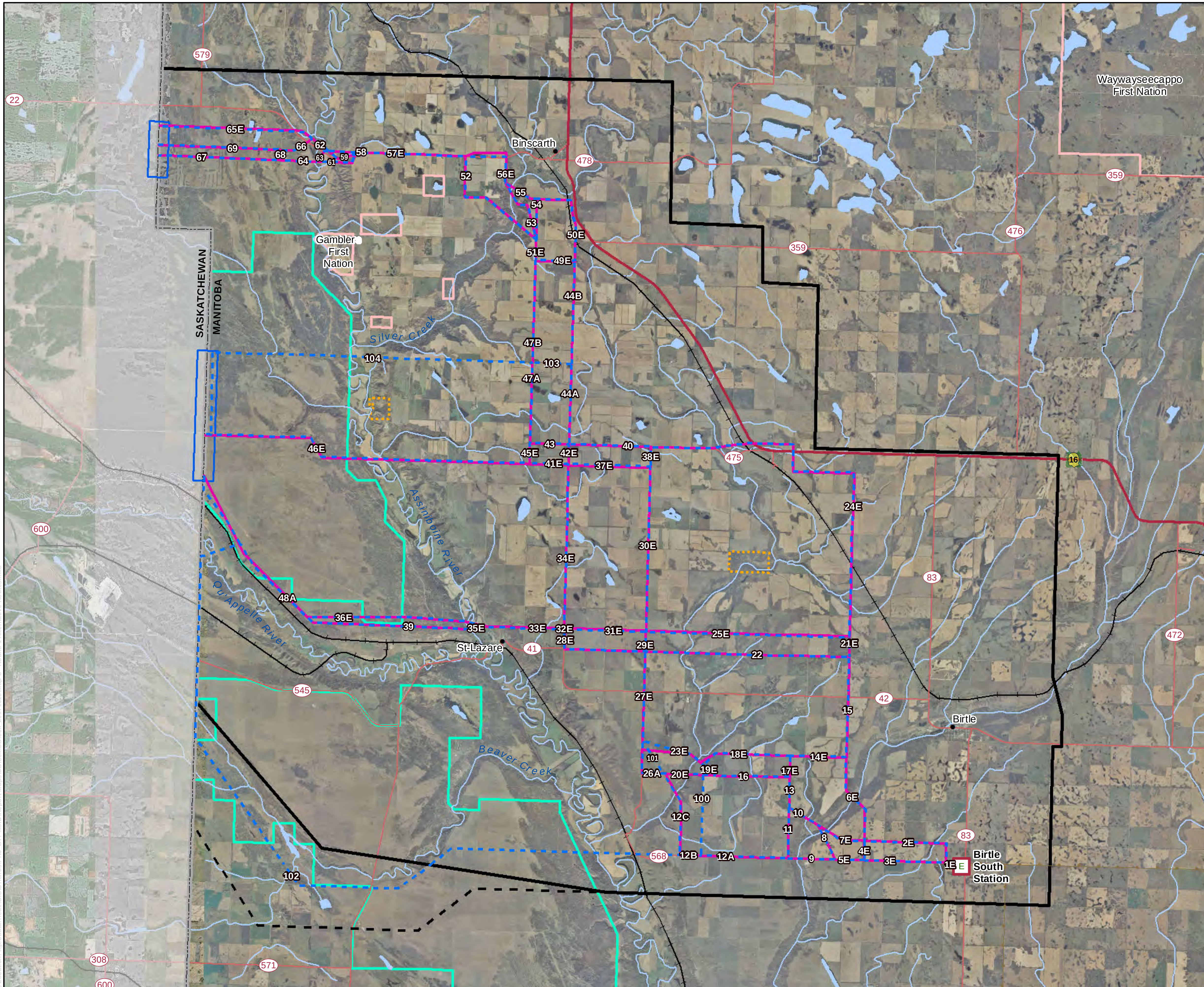
Composite Corridors

Map A-8



Round 1 Alternate Routes

Map A-9



Manitoba Hydro

Birtle Transmission Project

Project Infrastructure

- Birtle South Station
- Round 1 Evaluation Routes & Segment Number
- Round 1 Alternative Routes

Infrastructure

- Transmission Line

Planning Area

- Border Crossing Area
- Route Planning Area
- AREM Extenstion to Route Planning Area

Landbase

- Community
- Yellowhead Highway
- Road
- Railway Line
- First Nation
- Wildlife Management Area
- Community Pasture
- Province of Manitoba Boundary

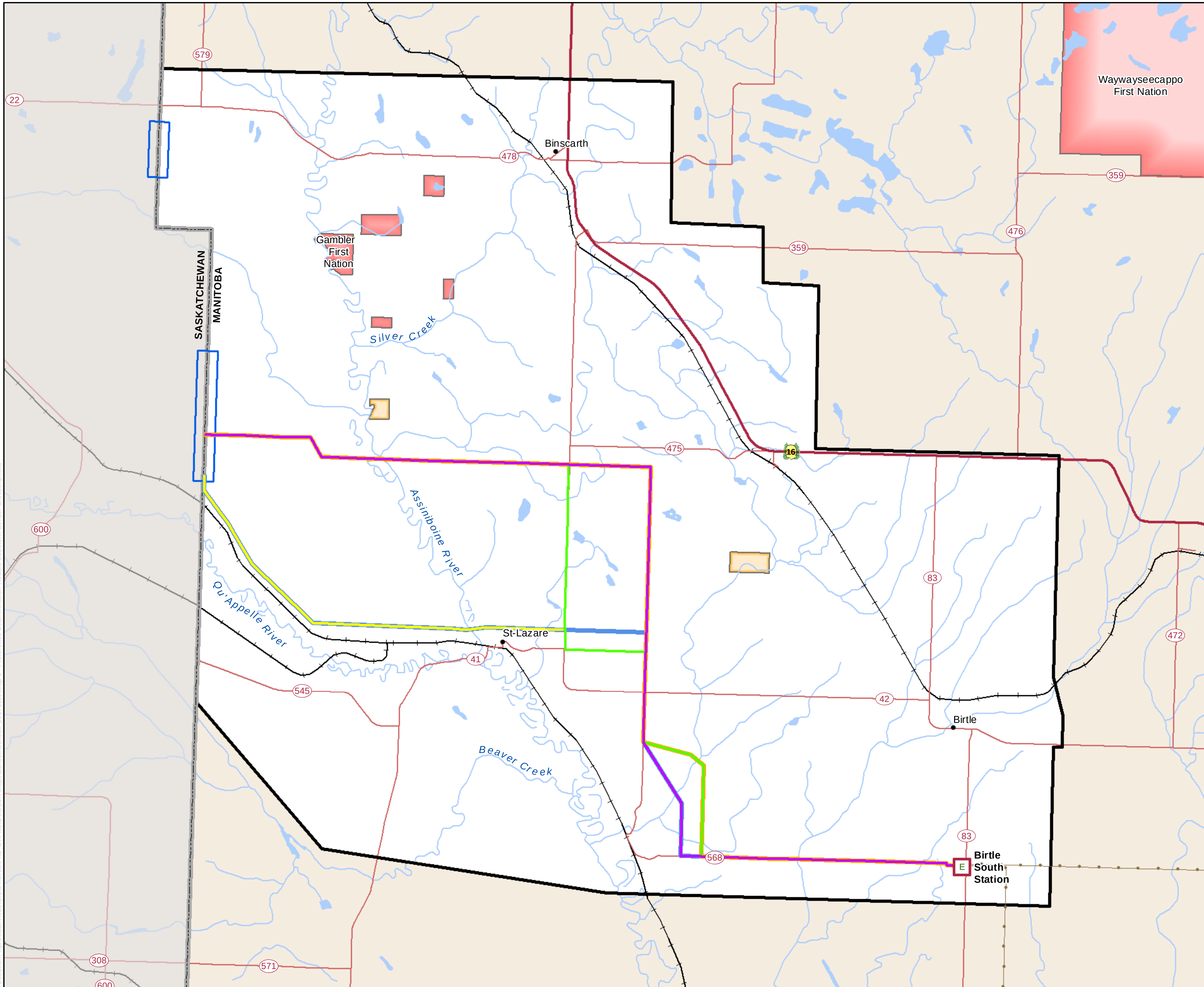
Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 11, 2017
Available in accessible formats upon request.

N

0 4 8 Kilometres
0 2 4 Miles
1:150,000

Round 1 Alternative Routes

Map A-10



Birtle Transmission Project

Project Infrastructure

- Birtle South Station

Southern Route Finalists

- S1_337
- S1_385
- S1_387
- S2_27
- S2_28

Infrastructure

- Transmission Line

Planning Area

- Border Crossing Area
- Route Planning Area

Landbase

- Community
- Yellowhead Highway
- Road
- Railway Line
- First Nation
- Wildlife Management Area
- Province of Manitoba Boundary

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 11, 2017
Available in accessible formats upon request.

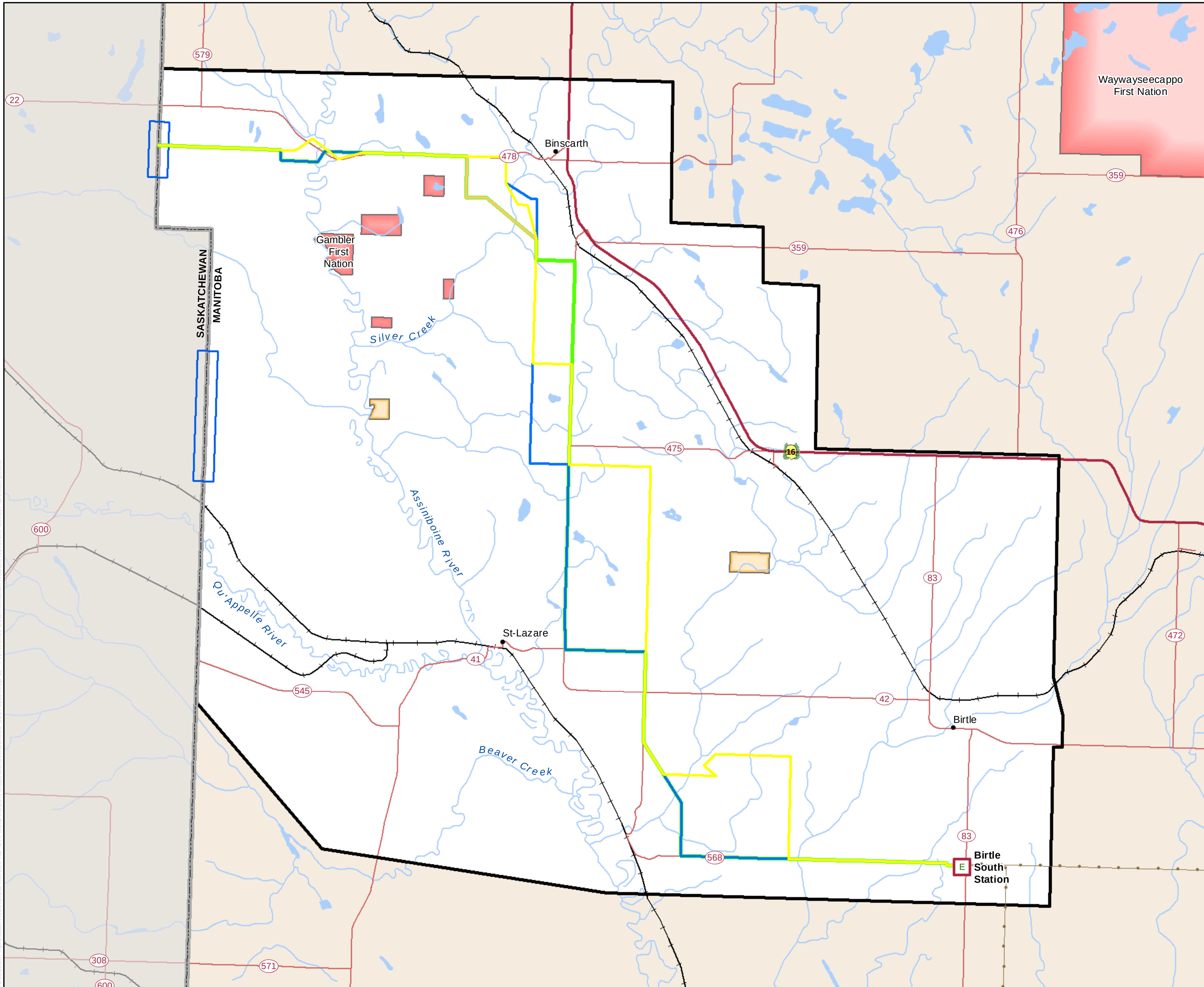
N

0 4 8 Kilometres
0 2 4 Miles
1:150,000

Preference Determination Routes

Southern Border Crossing

Map A-11



Manitoba Hydro

Birtle Transmission Project

Project Infrastructure

- Birtle South Station

Northern Route Finalists

- N2_4146
- N2_4147
- N2_41851
- N2_9208

Infrastructure

- Transmission Line

Planning Area

- Border Crossing Area
- Route Planning Area

Landbase

- Community
- Yellowhead Highway
- Road
- Railway Line
- First Nation
- Wildlife Management Area
- Province of Manitoba Boundary

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 11, 2017
Available in accessible formats upon request.

N

0 4 8 Kilometres

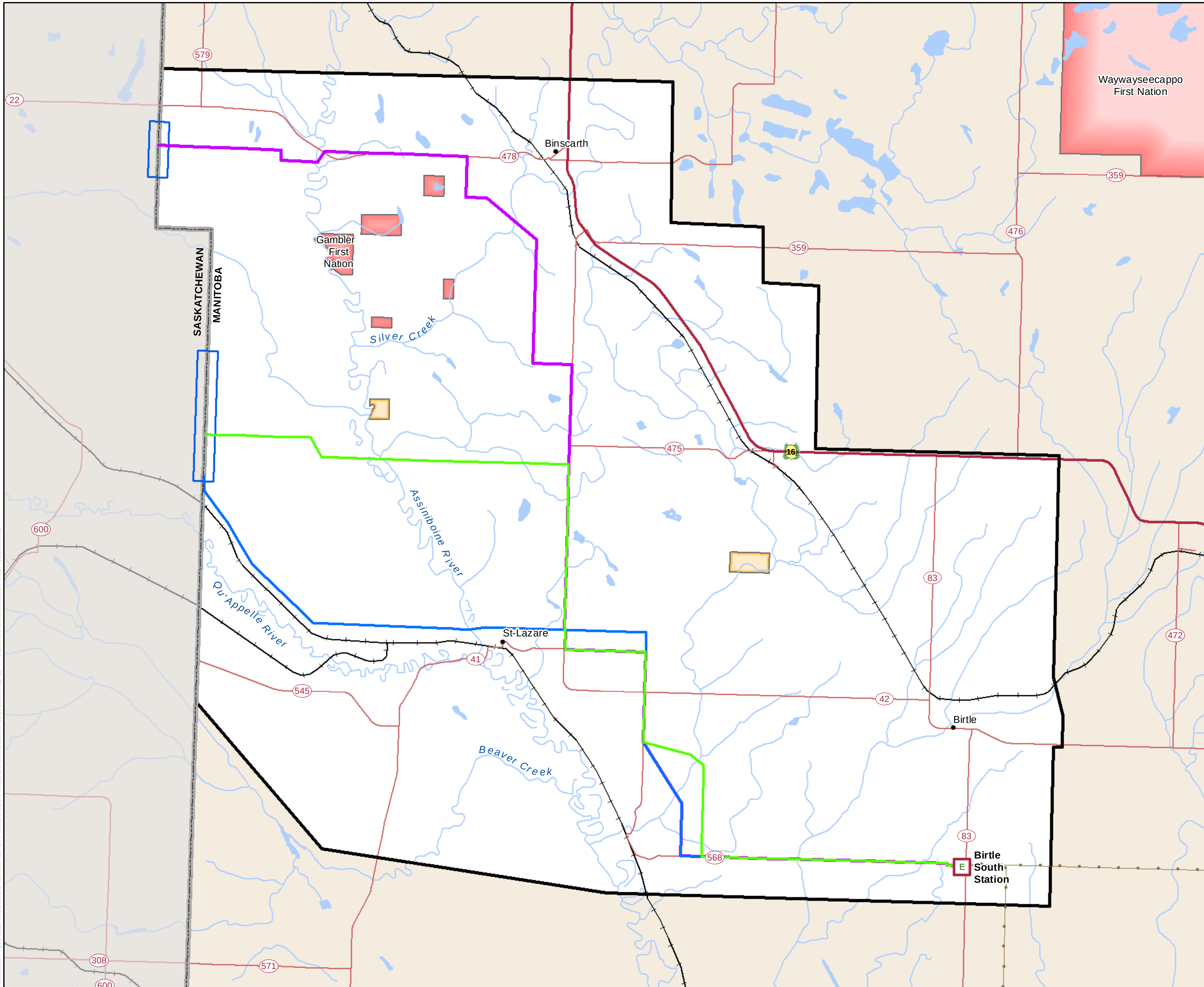
0 2 4 Miles

1:150,000

Preference Determination Routes

Northern Border Crossing

Map A-12



Manitoba Hydro

Birtle Transmission Project

Project Infrastructure

Birtle South Station

RouteID

N2_4147

S1_385

S2_28

Infrastructure

Transmission Line

Planning Area

Border Crossing Area

Route Planning Area

Landbase

Community

Yellowhead Highway

Road

Railway Line

First Nation

Wildlife Management Area

Province of Manitoba Boundary

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 11, 2017
Available in accessible formats upon request.

0 4 8 Kilometres

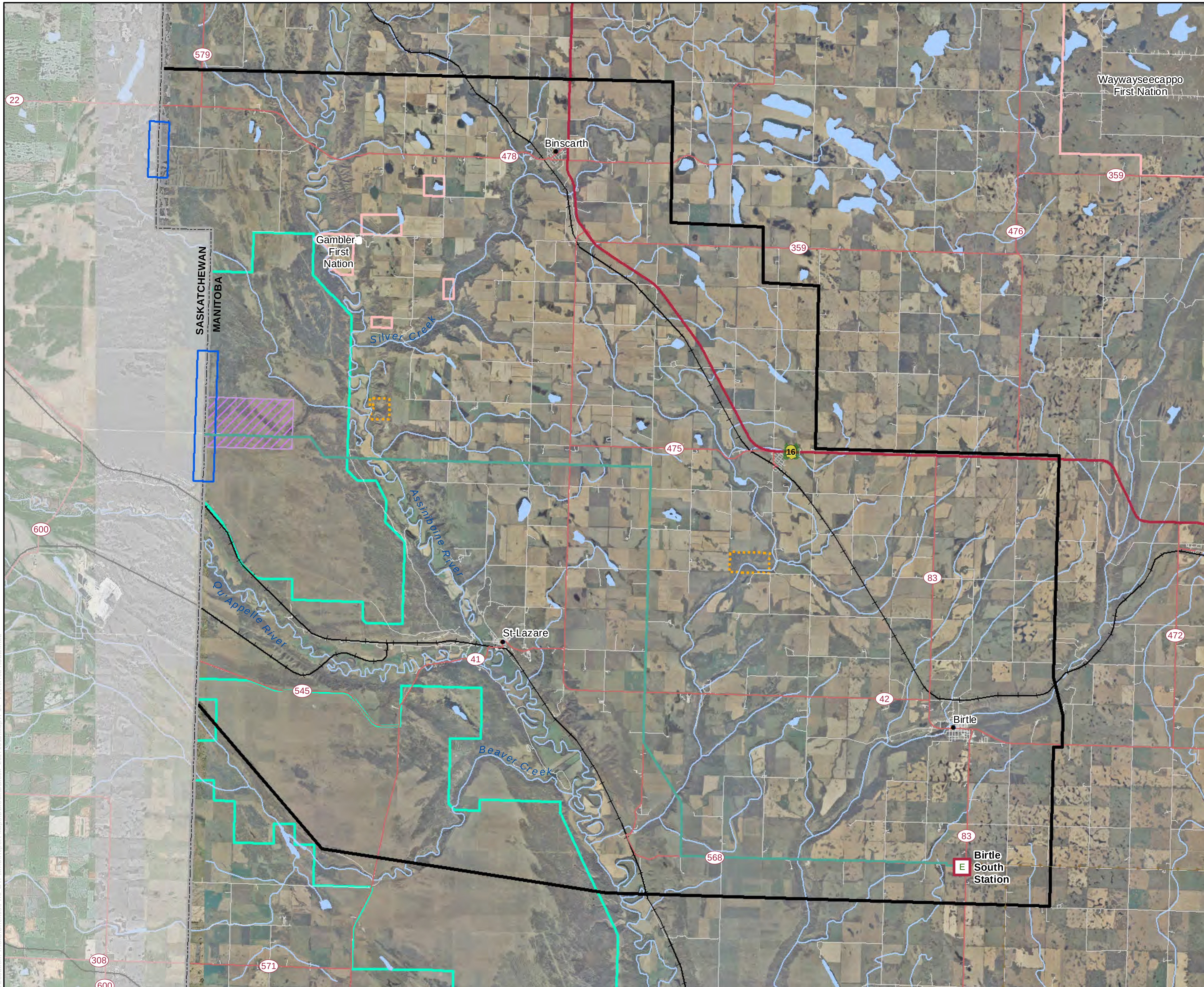
0 2 4 Miles

1:150,000

N

Preference Determination Final Routes

Map A-13



Manitoba Hydro

Birtle Transmission Project

Project Infrastructure

- Birtle South Station
- Preferred Route

Infrastructure

- Transmission Line

Planning Area

- Border Crossing Area
- Route Planning Area
- Ongoing Route Discussion Area

Landbase

- Community
- Yellowhead Highway
- Road
- Municipal Road
- Railway Line
- First Nation
- Wildlife Management Area
- Community Pasture
- Province of Manitoba Boundary

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 11, 2017
Available in accessible formats upon request.

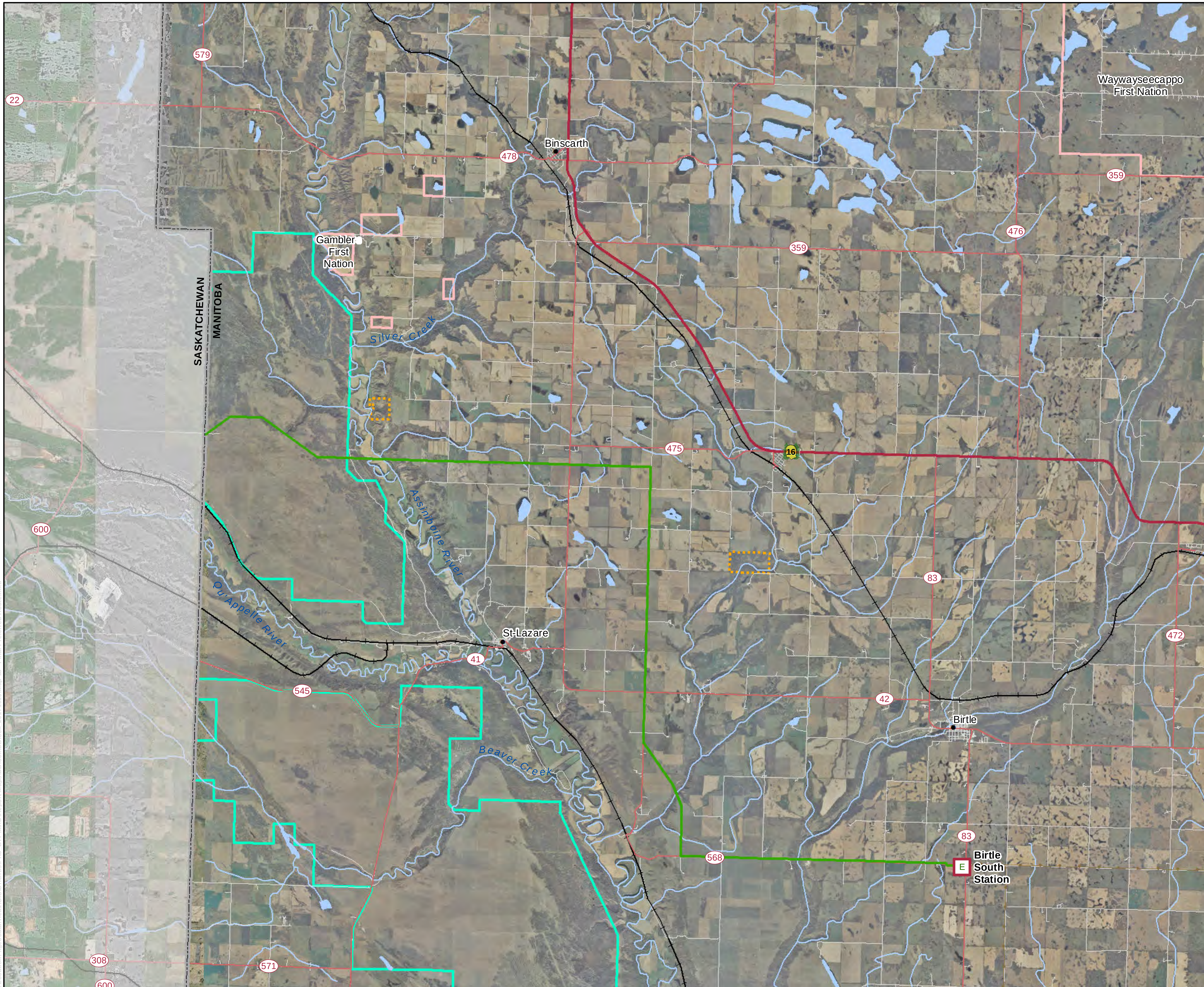
N

0 4 8 Kilometres
0 2 4 Miles

1:150,000

Preferred Route

Map A-14



Manitoba Hydro

Birtle Transmission Project

Project Infrastructure

- Birtle South Station
- Final Preferred Route

Infrastructure

- Transmission Line

Landbase

- Community
- Yellowhead Highway
- Road
- Municipal Road
- Railway Line
- First Nation
- Wildlife Management Area
- Community Pasture
- Province of Manitoba Boundary

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date: December 11, 2017
Available in accessible formats upon request.

N

0 4 8 Kilometres
0 2 4 Miles

1:150,000

Final Preferred Route

Map A-15