

MANITOBA-MINNESOTA TRANSMISSION PROJECT

BIRD-WIRE COLLISION MONITORING 2020



Prepared for

Manitoba Hydro

By

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May 2021

SUMMARY

As part of the Environmental Monitoring Plan for the Manitoba-Minnesota Transmission Project, studies were conducted to monitor avian mortality caused by transmission line infrastructure using a control-impact study design and determine the effectiveness of mitigation measures and, if appropriate, propose revisions to the existing plans or develop new mitigation options should high levels of avian mortality occur as a result of the transmission line. Bird-wire collision mortality monitoring, using standardized methods, occurred at 18 sites along the transmission line in the fall of 2020. Eleven of the sites were Environmentally Sensitive Sites that had been fitted with bird diverters and seven sites located nearby, without bird diverters, were selected to act as control sites. Each survey site was visited twice from September 10 – 21, 2020, with each survey separated by five to seven days. Evidence of 16 bird collisions were observed at nine sites during the surveys. Ten bird collisions were observed at sites with bird diverters and six bird collisions were observed at sites without bird diverters. No collision evidence from species listed as Threatened or Endangered by the federal *Species at Risk Act* or the provincial *The Endangered Species and Ecosystems Act* were observed during the surveys. Bird carcasses were planted at survey sites to allow the calculation of searcher bias and scavenger bias in the study. These values were used to estimate the collision mortality rates and compare the values between sites with and without bird diverters present. The estimated collision mortality during the six-week fall migration period was 99.9 mortalities/km at sites with bird diverters and 109.6 mortalities/km at sites without bird diverters. These values are higher than the range of other collision mortality studies that have occurred within the Province and may be due to low searcher efficiency and relatively small sample sizes.

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1.0 INTRODUCTION

The Manitoba-Minnesota Transmission Project (MMTP) is a 500 kilovolt, alternating current transmission line that originates at the Dorsey Converter Station on the northwest side of Winnipeg, and ends at the United States border near Piney, Manitoba (Map 1). During the environmental assessment process, a potential increase of bird mortalities was identified due to bird-wire collisions. Section 4.5.3 in the MMTP Environmental Monitoring Plan outlined the monitoring approach for bird-wire collisions (Manitoba Hydro 2019).

Transmission lines pose a collision risk to birds and can cause fatalities or injuries that can be a significant source of mortality for some species (APLIC 2012; Loss *et al.* 2014). Birds that are most vulnerable to wire collisions often include long-distance migrants, nocturnal migrants, and species with high wing-loading (small wings relative to body size) (Bevanger 1994; Rioux *et al.* 2013). Other factors that also can affect bird collision risk, include the local habitat, environmental conditions, and the design of the transmission line (Bevanger 1994; Bevanger and Broseth 2001). Generally, birds are able to avoid colliding with transmission lines if they are able to see the obstacle early enough (APLIC 2012). Commercially available products can be installed on transmission lines to increase their visibility to birds and have been proven to reduce bird collisions (Barrientos *et al.* 2012; Brown and Drewien 1995; Morkill and Anderson 1991).

To mitigate some risk of bird-wire collisions posed by the MMTP, Environmentally Sensitive Sites (ESS's) were identified during pre-construction surveys and fitted with bird diverters during construction. Bird diverters were installed on the ground conductor wires, including an alternating sequence of Swan-Flight™ Bird Diverters and Bird Flight Diverters, and in some areas additional aircraft cone line markers, that also served to make the transmission line visible to aircraft (Photo 1; Photo 2).

Several studies were conducted during the pre-construction period to identify ESS's where there was a potential for a high number of bird-wire collisions, including bird migration studies, bird movement studies, and bird collision monitoring at nearby, proxy transmission lines.

Bird migration studies were conducted in the spring and fall of 2014 to provide and understanding of bird use near the MMTP and identify important stopover or staging sites in the region (Stantec 2015; Manitoba Hydro 2015). The data collected was used to help identify ESS's and determine the placement of bird diverters.

Bird movement studies were conducted at major waterbodies near the MMTP route in the spring and fall of 2014. The objectives of this study were to gather data on the number, distribution, and flight patterns of birds near major waterbodies, including Richer Lake, Lonesand Lake, Sundown Lake, Red River, Assiniboine River, and Deacons Reservoir (Stantec 2015; Manitoba Hydro 2015) (Map 1). The data collected was also used to help identify ESS's and determine the placement of bird diverters.

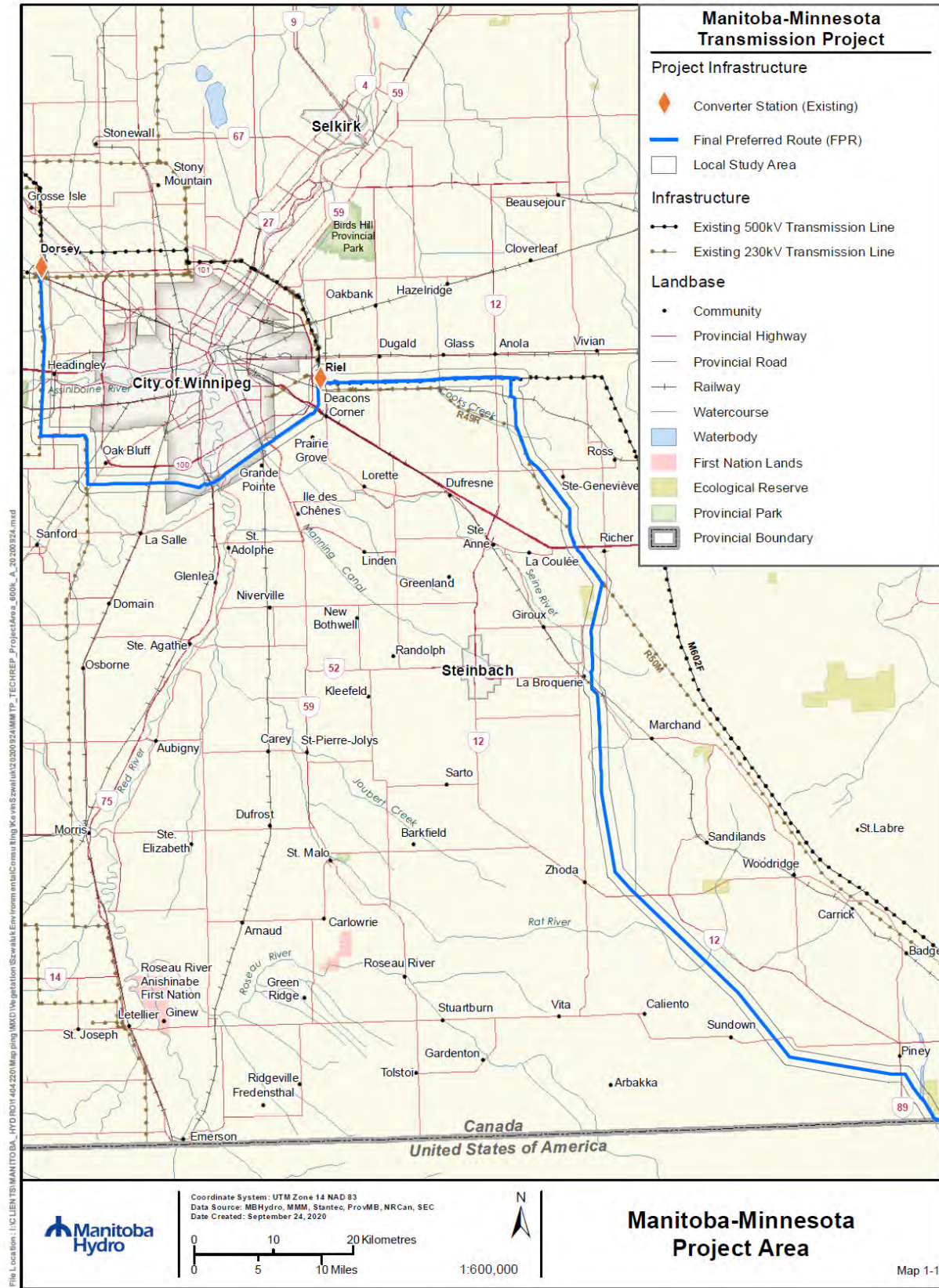
Additionally, bird-wire collision monitoring was conducted in the fall of 2014 along the existing M602F transmission line and other transmission lines that crossed the Assiniboine River to act as a proxy for the MMTP (Stantec 2015; Manitoba Hydro 2015). Survey sites were classified into collision risk categories

based on landcover types. High risk sites were adjacent to a permanent waterbody (*e.g.*, Assiniboine River, Deacon Reservoir), moderate risk sites were adjacent to a wetland or riparian area (*e.g.*, stream, marsh), and low risk sites were located in upland habitat (Stantec 2015). The observed mortalities along with habitat bias, searcher bias, and scavenger bias were used to calculate the estimated collision mortality for each collision risk category. The estimated collision mortality in the study was found to be 120.8 mortalities/km/year at high risk sites, which was based on the number of collisions observed at a single site adjacent to the Assiniboine River (Stantec 2015). Moderate risk sites were found to have 69.3 mortalities/km/year, and low-risk sites had 16.5 mortalities/km/year (Stantec 2015).

These mortality estimations were used to help identify ESS's and the placement of bird diverters on the MMTP. The mortality estimations identified in 2015 can also be compared to the numbers observed in 2020 to help determine the effectiveness of bird diverters and examine if further mitigation may be required.

Specifically, the objectives of this study are to 1) monitor avian mortality caused by transmission line infrastructure using a control-impact study design; and 2) determine the effectiveness of mitigation measures and, if appropriate, propose revisions to the existing plans or develop new mitigation options should high levels of avian mortality occur as a result of the transmission line (Manitoba Hydro 2019).

This report examines the results of bird-wire collision surveys conducted in the fall of 2020.



Map 1. Manitoba-Minnesota Transmission Project



Photo 1. Swan-Flight Bird Diverter (top) and Bird Flight Diverter (bottom) (Linestar Utility Supply 2021; Preformed Line Products 2021)



Photo 2. Alternating Swan-Flight Bird Diverters and Bird Flight Bird Diverters (top), and additional aircraft cone markers (bottom) on the Manitoba-Minnesota Transmission Project

2.0 METHODS

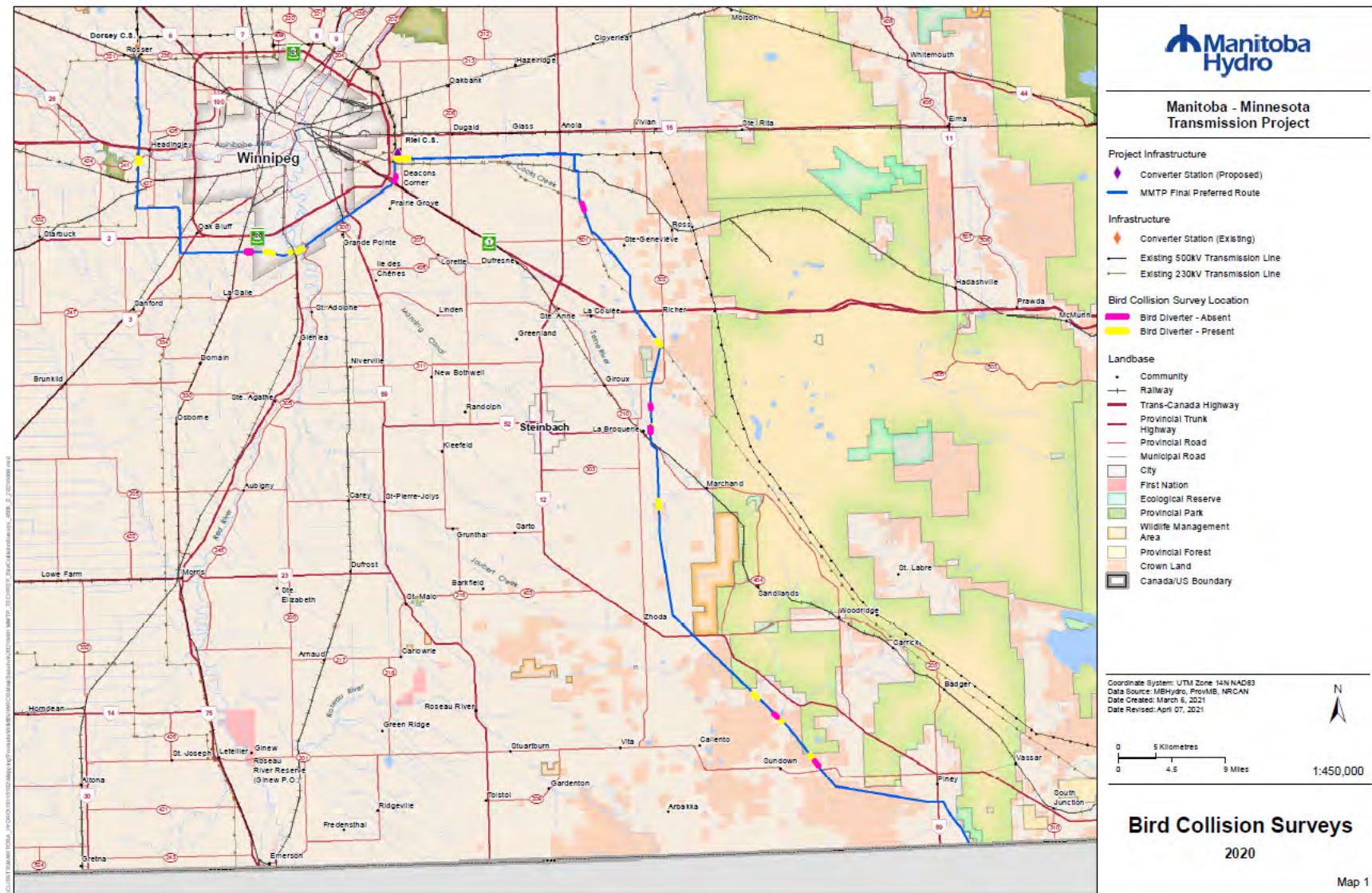
Bird-wire collision monitoring was designed to test the hypothesis that bird diverters are sufficient in reducing mortality of birds due to collisions with the transmission line to a level that is negligible in areas determined to have a high risk of a collision. As such, the null and alternate hypotheses state:

- H_0 (null): The mortality of birds at high-risk areas with bird diverters will not be different than the mortality of birds at low-risk areas without bird diverters.
- H_1 (alternate): The mortality of birds at high-risk areas with bird diverters will be greater than the mortality of birds at low-risk areas without bird diverters.

As outlined in the Section 4.5.3 and 7.3.2 of the MMTP Environmental Monitoring Plan, 18 sites were selected for bird-wire collision mortality monitoring along the Manitoba-Minnesota Transmission Project in a control-impact study design (Map 2). Eleven of the sites were identified as ESS's that were fitted with bird diverters. Seven control sites, that were not fitted with bird diverters, but were expected to have above average bird activity due to waterbody crossings or were nearby ESS's were also selected. Sites ranged in length from 136 to 1,501 m in length (Table 1).

Each site was surveyed twice during the 2020 fall migration season with each survey separated by five to seven days (Table 1). Surveys for bird-wire collisions were conducted at each site by four personnel that walked parallel lines spaced 5-10 m apart, for the entire length of the site, below the cleared right-of-way (ROW) (CWSEC 2007; Photo 3). The spacing of personnel varied slightly depending on the relative density of vegetation and terrain. Personnel visually inspected the search area for signs of bird collisions (*i.e.*, carcasses and clusters of feathers). Collisions were recorded when the remains found consisted of more than five feathers in a square meter (Barrientos *et al.* 2012). The location of the collision was recorded using a handheld global positioning system (GPS), collision evidence was identified to species where possible and photographed.

Bird flight activity surveys were not conducted in 2020 due to study practicalities and statistical design concerns. Study methods such as the frequency of passage studies are being reconsidered as bird movements reported in other studies in Manitoba (Wood 2019), which had a high monitoring effort, still resulted in high variability. Data with high variability rarely result in a statistically meaningful measurable difference.



Map 2. Location of Bird-collision Survey Sites Along the Manitoba-Minnesota Transmission Project

Table 1. Survey Dates and Site Characteristics for Bird-wire Collision Monitoring, September 2020

Site ID	UTM Start	UTM End	Bird Diverters	Environmentally Sensitive Site	Site Length (m)	Visit 1 Date (2020)	Visit 2 Date (2020)
Wild-100	14N 612852 5524260	14N 612874 5524824	Present	Assiniboine River	565	Sep-10	Sep-15
Wild-103	14N 631009 5511990	14N 629896 5512242	Present	Brady Landfill	1141	Sep-10	Sep-16
Wild-104	14N 633256 5512083	14N 633375 5512151	Present	La Salle River	136	Sep-10	Sep-16
Wild-105	14N 634221 5512238	14N 634926 5512641	Present	Red River	647	Sep-10	Sep-16
Wild-106	14N 647686 5524747	14N 647892 5524753	Present	Deacon Reservoir	1501	Sep-11	Sep-16
Wild-118	14N 682799 5500258	14N 683261 5499642	Present	Richer Lake (Waterfowl Sensitivity Area)	770	Sep-11	Sep-17
Wild-123	14N 682009 5488650	14N 681841 5488433	Present	Seine River	275	Sep-14	Sep-21
Wild-126	14N 682967 5478612	14N 682999 5477647	Present	Breeding Habitat Sensitive Area	965	Sep-14	Sep-21
Wild-131	14N 696364 5451953	14N 695776 5452518	Present	Rat River	816	Sep-15	Sep-21
Wild-132	14N 699047 5449373	14N 699635 5448809	Present	Lonesand Lake (Waterfowl Sensitivity Area)	814	Sep-15	Sep-21
Wild-133	14N 703436 5444197	14N 704026 5443449	Present	Sundown Lake and Wetland Sensitive Area	952	Sep-11	Sep-17
Ctrl-103	14N 627981 5512213	14N 627408 5512198	Absent	Brady Landfill	573	Sep-10	Sep-16
Ctrl-106	14N 647519 5522464	14N 647351 5521749	Absent	Deacon Reservoir	761	Sep-10	Sep-16
Ctrl-123	14N 681842 5488432	14N 681863 5487958	Absent	Seine River	388	Sep-14	Sep-21
Ctrl-132	14N 698589 5449814	14N 699047 5449373	Absent	Lonesand Lake (Waterfowl Sensitivity Area)	636	Sep-15	Sep-21
Ctrl-133	14N 704027 5443448	14N 704580 5442747	Absent	Sundown Lake and Wetland Sensitive Area	893	Sep-11	Sep-17
Ctrl-243	14N 672961 5517848	14N 672621 5518744	Absent	Cook's Creek	959	Sep-11	Sep-16
Ctrl-313	14N 681909 5491500	14N 681923 5491016	Absent	Unnamed Creek	485	Sep-14	Sep-21



Photo 3. Personnel Conducting a Bird-mortality Collision Survey along the MMTP right-of-way, September 2020. Note: the R49R transmission line in the background.

Sources of bias, including searcher efficiency bias and scavenger bias, can influence the estimations of bird collisions. Searcher efficiency bias is important to include in mortality estimates as dead or injured birds may be overlooked during a survey, particularly when vegetation is present. Additionally, scavenger bias is important to include as both mammalian and avian scavengers may remove carcasses before they are located. By placing (planting) dead birds on the survey sites, these sources of biases can be considered, and a more accurate estimate of bird mortality can be produced.

Searcher efficiency bias was estimated by planting one quail (*Coturnix sp.*) carcass, sourced from a commercial supplier, within search areas in locations unknown to the searchers prior to searches commencing (California Energy Commission 2003; APLIC 2012). Fourteen quail were planted at fourteen sites in 2020 for the searcher efficiency trials. The proportion of the planted birds found is then used in the estimation of total collision mortality.

Searcher efficiency was calculated as:

$$\text{Searcher Efficiency} = \frac{\text{Number of planted birds found}}{\text{Number of birds planted}}$$

The planted birds used in the searcher efficiency trials were also used to estimate the scavenger removal bias. Search periods were separated by five to seven days to allow time for potential scavengers to locate planted bird carcasses. Carcasses were considered scavenged if they were missing, or partially consumed. The proportion of planted birds remaining after the specified time period was used to determine the scavenger bias.

Scavenger bias was calculated as:

$$\text{Scavenger Bias} = \frac{\text{Number of planted birds remaining}}{\text{Number of birds planted}}$$

Habitat bias effects were also calculated to account for unsearchable portions of the formal search areas (*i.e.*, marshes, ponds, thick standing crops). Unsearchable areas were delineated in the field with a handheld GPS and its size was subtracted from the formal search area.

Habitat bias was calculated as:

$$\text{Habitat Bias} = \frac{\text{Actual area searched}}{\text{Formal search area}}$$

Estimated collision mortality (collisions/site/week) was calculated using searcher efficiency, scavenger, and habitat bias at all surveyed sites. The following assumptions were made during calculations:

- Due to logistical restraints, weather conditions, etc., site revisits were conducted from five to seven days after the initial visit. Despite these differences in duration, it was assumed that collision mortalities and scavenging results are representative of a seven-day period.
- The observed level of mortality was consistent throughout the six-week spring and six-week fall migration periods.
- Bird mortality is negligible outside these six-week migration periods.
- The sites surveyed have representative levels of mortality in comparison to other areas of the transmission line.

Estimated weekly mortality was calculated as:

$$\text{Estimated Weekly Mortality} = \frac{\text{Number of bird carcasses found}}{\text{Searcher Efficiency} * \text{Scavenger Bias} * \text{Habitat Bias}}$$

The estimated weekly mortality was then standardized per kilometer of transmission line searched to obtain the estimated weekly mortality/km. To estimate seasonal collision mortality (spring or fall), weekly collision mortality estimates were multiplied by a factor of six weeks (42 days). Annual collision mortality can be calculated by adding the spring and fall collision mortality estimates together.

To examine the effectiveness of bird diverters, the average estimated weekly mortality per km from was compared between sites with diverters to those without diverters using a two-tailed t-test was conducted ($\alpha = 0.05$).

3.0 RESULTS

Evidence of 16 bird collisions were found during the 2020 surveys. Ten bird collisions were located at seven sites with bird diverters present and six bird collisions were located at two sites without bird diverters (Table 2). The average estimated weekly mortality per km was not significantly different between sites with bird diverters and without ($p = 0.58$). No species listed under the federal *Species at Risk Act* or the provincial *Endangered Species and Ecosystems Act* were found during the surveys. One injured or exhausted Vesper sparrow (*Pooecetes gramineus*), that was unable to fly, was observed at the base of a tower at site Wild-103 and was included as a collision.

Several of the sites had evidence of multiple collisions. One site, Ctrl-103, had evidence of four collisions. The site Wild-103 had evidence of three collisions, and three other sites, Ctrl-123, Wild-106, and Wild-106, had evidence of two collisions.

Table 2. Bird Collision Evidence Observed Along the MMTP in Fall 2020

Site	Bird Diverters	Date	Visit No.	Species	UTM Coordinate
Wild-100	Present	Sep 15 2020	2	Nashville warbler	14 U 612875 5524591
Wild-103	Present	Sep 10 2020	1	Mallard	14 U 631000 5511988
Wild-103	Present	Sep 16 2020	2	Vesper sparrow	14 U 629994 5512220
Wild-103	Present	Sep 16 2020	2	Unknown waterfowl species	14 U 630780 5512069
Wild-106	Present	Sep 16 2020	2	Unknown species	14 U 649178 5524784
Wild-106	Present	Sep 16 2020	2	Gull species	14 U 648329 5524766
Wild-118	Present	Sep 17 2020	2	Black and white warbler	14 U 682886 5500146
Wild-123	Present	Sep 21 2020	2	Vesper sparrow	14 U 682001 5488644
Wild-126	Present	Sep 14 2020	1	Sora	14 U 682987 5478433
Wild-132	Present	Sep 15 2020	1	Unknown species	14 U 699563 5448878
Ctrl-103	Absent	Sep 10 2020	1	Canada goose	14 U 627907 5512177
Ctrl-103	Absent	Sep 10 2020	1	Gull species	14 U 627896 5512231
Ctrl-103	Absent	Sep 10 2020	1	Mallard	14 U 627684 5512220
Ctrl-103	Absent	Sep 16 2020	2	Canada goose	14 U 627629 5512197
Ctrl-123	Absent	Sep 21 2020	2	Sora	14 U 681865 5488312
Ctrl-123	Absent	Sep 21 2020	2	Magnolia warbler	14 U 681846 5488031

Searcher efficiency was estimated to be 14%, with only two of 14 planted carcasses being found by search personnel (Table 3). Half of the planted carcasses were predated by the second search, resulting in a scavenger bias of 50% (Table 3).

Estimated weekly mortality ranged from 0 to 52.0 mortalities/km at sites with bird diverters present (Appendix 1). Only two sites without bird diverters (control sites) had evidence of bird collisions, Ctrl-103, near the Brady Landfill and Ctrl-123 at the Seine River; the estimated weekly mortality at these two sites was 99.7 mortalities/km and 73.7 mortalities/km, respectively (Appendix 1).

The estimated weekly mortality per km was 16.6 mortalities/km at sites with bird diverters, and 18.3 mortalities/km at sites without bird diverters (Table 3). During the six-week fall migration period, this corresponds to 99.9 mortalities/km at sites with bird diverters and 109.6 mortalities/km at sites without bird diverters (Table 3).

Table 3. Bird Collision Survey Results and Estimated Mortalities along the Manitoba-Minnesota Transmission Project in Fall 2020

Site Type	Total Length (km)	No. Collisions	No. Birds Planted	No. Birds Scavenged	No. Planted Birds Found	Searcher Efficiency (%)	Scavenger Bias (%)	Habitat Bias	Est. Weekly Mortality	Est. Weekly Mortality/km	Est. Seasonal Mortality/km*
Bird Diverters Present	8.58	10	8	5	0	14	50	1.0	142.9	16.6	99.9
Bird Diverters Absent (Control)	4.69	6	6	2	2			1.0	85.7	18.3	109.6
All Sites	13.28	16	14	7	2			1.0	228.6	17.2	103.3

*Multiplied by a factor of six weeks

4.0 DISCUSSION

Bird diverters appear to be effective at reducing the number of collisions along the MMTP and the null hypothesis of no mortality difference between sites with and without bird diverters appears to be supported. There appears to be a lower number of bird mortalities at sites with bird diverters present than at sites without bird diverters, even though the difference is not significant. The lack of a significant difference may be due to bird diverter sites supporting greater numbers of birds. These sites were chosen systematically based on bird observations and movements and would presumably have greater numbers of mortalities if bird diverters were not present. The estimated collision mortalities for sites near the Brady Landfill (Ctrl-103 and Wild-103), as well as sites near the Seine River (Ctrl-123 and Wild-123) support this conclusion as the control sites with no bird diverters have higher collision mortalities. However, sites near the Deacon Reservoir (Ctrl-106 and Wild-106) and sites near Lonesand Lake (Ctrl-132 and Wild-132) show the opposite pattern, with bird diverter sites having higher collision mortalities than those without. These estimates are based on relatively small numbers of observed mortalities, two collisions at site Wild-106 and one at site Wild-132, which may not reflect the effectiveness of bird diverters. Additional data from future surveys will help distinguish and support patterns of bird collision mortalities along the MMTP and the effectiveness of bird diverters.

Sites near the Brady Landfill had some of the highest mortality estimates out of all the sites. The Brady Landfill was not anticipated to be an issue for gulls due to being sufficiently far away from the MMTP and not intersecting with gull flight paths (Manitoba Hydro 2015). However, during the surveys in 2020, large numbers of Canada geese (*Branta canadensis*) and ring-billed gulls (*Larus delawarensis*) were observed crossing directly overhead of the MMTP. Habitat differences, such as agricultural crop locations around the Brady Landfill may have influenced bird movements in 2020 in comparison to those observed in 2014. Presumably, the number of bird collisions near the Brady Landfill would be higher if sections of the MMTP nearby were not fitted with bird diverters, which is supported by the greater number of collisions observed at the control site (Ctrl-103) compared to the bird diverter site (Wild-103).

Sites near Sundown Lake (Ctrl-133 and Wild-133) were predicted to have a moderate collision risk for sandhill cranes (*Grus canadensis*) (Manitoba Hydro 2015). During surveys in September 2020, numerous sandhill cranes were observed, but no bird mortalities were found at either site.

The estimated collision mortality rates observed in the fall of 2020 are higher than those observed during the pre-construction studies conducted along the proxy transmission lines in 2014, and those observed at other transmission lines in the province (Table 4). At proxy sites in 2014, high risk sites were estimated to have 120.8 mortalities/km annually. In 2020, estimated collision mortalities were only calculated for the fall period but can be multiplied by two to provide an estimate of annual mortality. In fall 2020, seasonal estimated collision mortalities at sites with bird diverters were 99.9 mortalities/km, or 199.8 mortalities/km annually. At sites without bird diverters, estimated collision mortality was 109.6 mortalities/km in the fall, or 219.2 mortalities/km annually. Both annual estimates of collision mortality

for sites with and without bird diverters are much higher than those for the high risk sites observed during the pre-construction surveys.

The bird mortality rates observed in this study are also higher in comparison to the rates observed in other published studies. Faanes (1987) estimated bird collision mortality rate of 69 birds/km and Rioux *et al.* (2013) found average mortality rates of 42.3 ± 17.1 birds/km/year. However, comparisons of mortality rates between studies may be misleading as sources of bias (searcher efficiency, scavenger bias, habitat bias) can vary substantially between study locations (Morrison 2002; APLIC 2006).

Table 4. Estimated Seasonal Collision Mortality (mortalities/km/6 weeks) from Other Studies Conducted in Manitoba (WRCS 2017; WRCS 2018a; WRCS 2018b; WRCS 2018c; WRCS 2021).

Study and Year(s)	Estimated Collision Mortality (mortalities/km/6 weeks)					
	Spring Migration Diverters Present	Spring Migration Diverters Absent	Breeding Bird Diverters Present	Breeding Bird Diverters Absent	Fall Migration Diverters Present	Fall Migration Diverters Absent
Keeyask Transmission Project 2016	NA	NA	10.8	0	10.32	0
Keeyask Transmission Project 2017	469.09*	1130.88*	0	54.91	14.54	27.49
Lake Winnipeg East 2018	NA	NA	NA	NA	5.98	NA
Wuskwatim Outlet Transmission Line 2014, 2016-2018	NA	NA	NA	27.34	NA	27.34
Bipole III Transmission Line 2018-2020	35.10	29.64	NA	NA	19.68	19.38

* The estimated collision mortality was inflated due to efficient scavengers.

The reason estimated collision mortalities in 2020 along the MMTP were higher than in 2014 at the proxy transmission lines and in other studies may be due to several reasons. Bird movements and numbers can be highly variable and may account for some of the differences observed. The timing of migration, species presence, and local weather conditions can affect bird movements, which will influence the number of bird collisions at sites. Additional data collected along the MMTP will help distinguish and support patterns of bird collision mortalities along the MMTP.

Differences in estimated mortality may also be attributed to the relatively low searcher efficiency of personnel in 2020, which amplifies the number of potential collisions. Searcher efficiency is related to vegetation density (Philibert *et al.* 1993) and searcher efficiency was likely reduced at sites where dense vegetation was present. Site selection is limited to sections of the transmission line with bird diverters and vegetation density cannot be controlled for. As shown, two sites Ctrl-103 and Wild-103 were found to have relatively high numbers of collisions, three and four, respectively. It should be noted that both

these sites consisted of tilled agriculture where observability of collision evidence was greater than other sites that may have had relatively dense vegetation.

The use of quail, with their cryptic colouration may also affect observability of planted birds, but are a good representation of many wild bird species. In 2020, a variety sizes, from smaller than a typical songbird, to robin-sized quail were used as planted birds. The use of very small quail will try to be avoided as they may not accurately reflect wild birds species and may inflate observer bias. Future surveys may incorporate a greater number of observers, or a larger sample size of planted birds to increase searcher efficiency and accurately determine bias.

Future surveys conducted during the spring, summer, and fall of 2021 will help to distinguish and support patterns of bird collision mortalities along the MMTP. If these surveys consistently identify high number of bird-wire collision mortalities further mitigation may be required at select sites. At this time no further mitigation is recommended along the MMTP.

5.0 CONCLUSIONS

Bird-wire diverters along the MMTP appear to be effective at reducing the number of bird-wire collision mortalities. No Threatened or Endangered species were observed during the fall 2020 survey. Estimated collision mortality rates appear to be higher in comparison to other studies but may be a result of vegetation conditions and relatively low searcher efficiency in 2020. Future surveys will help to discern collision patterns and identify problematic areas if they occur. At this time, no further mitigative measures are recommended. Additional bird-wire collision mortality surveys will be conducted in the spring, summer, and fall of 2021 as part of operation monitoring.

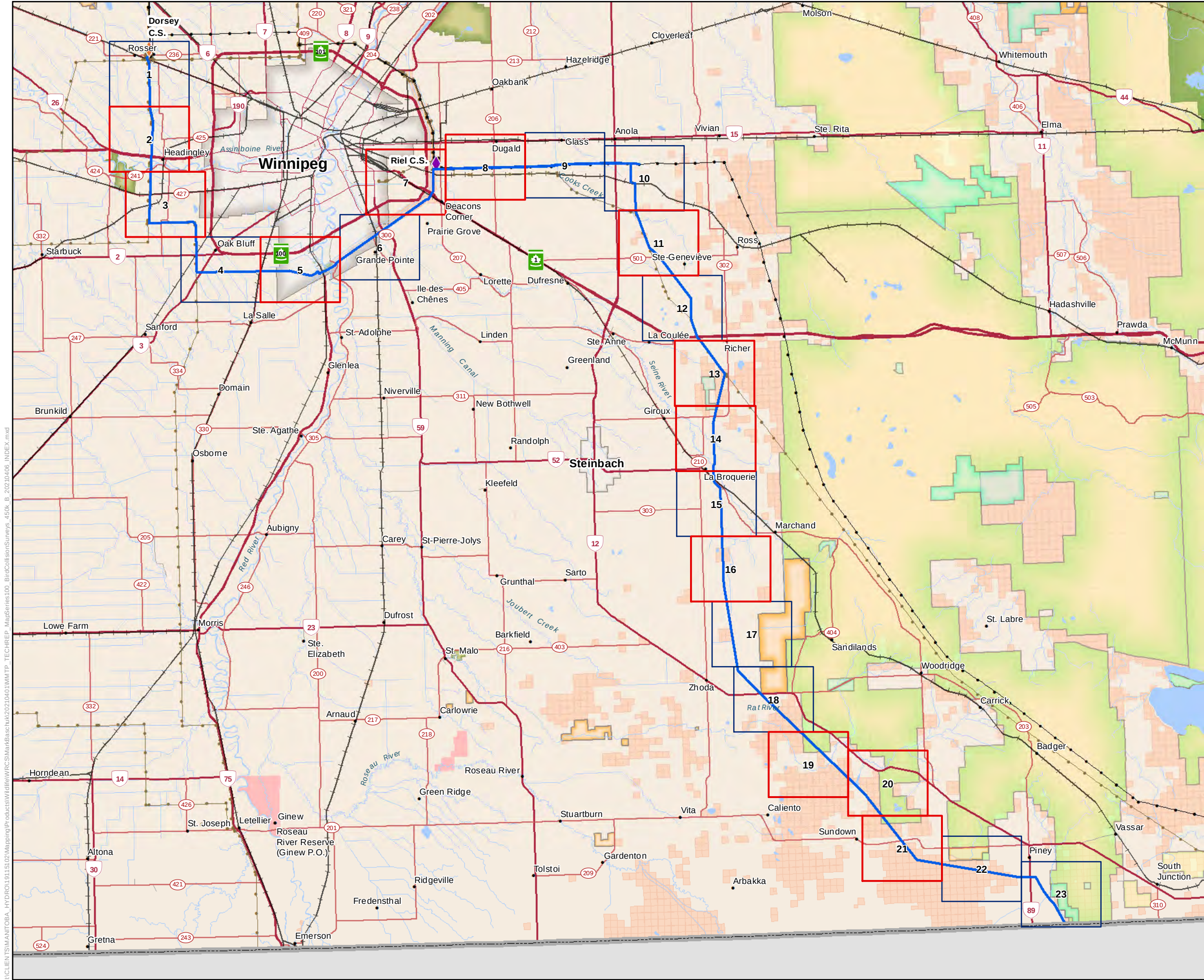
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Appendix 1

Bird Collision Map Series



Manitoba - Minnesota Transmission Project

- Project Infrastructure**
- ◆ Converter Station (Proposed)
 - MMTP Final Preferred Route
- Infrastructure**
- ◆ Converter Station (Existing)
 - Existing 500kV Transmission Line
 - Existing 230kV Transmission Line

- Map Tile Index - 1:30,000**
- Map Series Tile
 - Map Tile

- Landbase**
- Community
 - Railway
 - Trans-Canada Highway
 - Provincial Trunk Highway
 - Provincial Road
 - Municipal Road
 - City
 - First Nation
 - Ecological Reserve
 - Provincial Park
 - Wildlife Management Area
 - Provincial Forest
 - Crown Land
 - Canada/US Boundary

Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date Created: March 6, 2021
Date Revised: April 07, 2021



0 5 Kilometres
0 4.5 9 Miles
1:450,000

Index of Map Series Bird Collision Surveys 2020

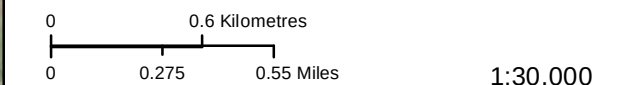
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Manitoba - Minnesota Transmission Project

- Project Infrastructure**
- MMTP Final Preferred Route
 - Converter Station (Proposed)
- Infrastructure**
- Converter Station (Existing)
 - Existing 500kV Transmission Line
 - Existing 230kV Transmission Line
- Bird Collision Survey Location**
- Bird Diverter - Absent
 - Bird Diverter - Present
- Landbase**
- Community
 - Railway
 - Trans-Canada Highway
 - Provincial Trunk Highway
 - Provincial Road
 - Municipal Road
 - City
 - Canada/US Boundary

Coordinate System: UTM Zone 14N NAD83
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Bird Collision Surveys 2020



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Manitoba - Minnesota Transmission Project

Project Infrastructure

- MMTP Final Preferred Route
- Converter Station (Proposed)

Infrastructure

- Converter Station (Existing)
- Existing 500kV Transmission Line
- Existing 230kV Transmission Line

Bird Collision Survey Location

- Bird Diverter - Absent
- Bird Diverter - Present

Landbase

- Community
- Railway
- Trans-Canada Highway
- Provincial Trunk Highway
- Provincial Road
- Municipal Road
- City
- Canada/US Boundary

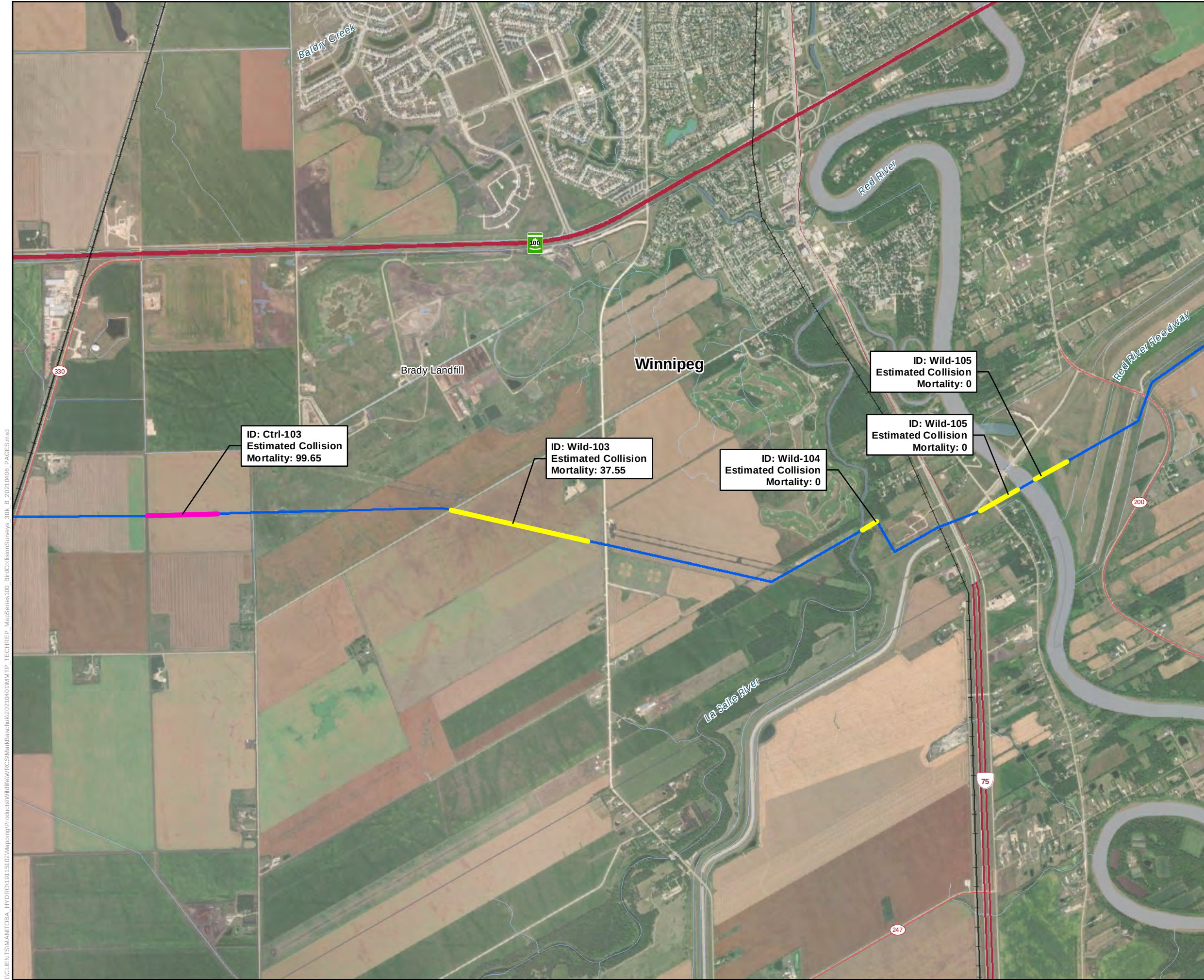
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0 0.6 Kilometres
0 0.275 0.55 Miles

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Bird Collision Surveys 2020



Manitoba - Minnesota Transmission Project

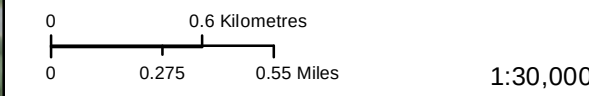
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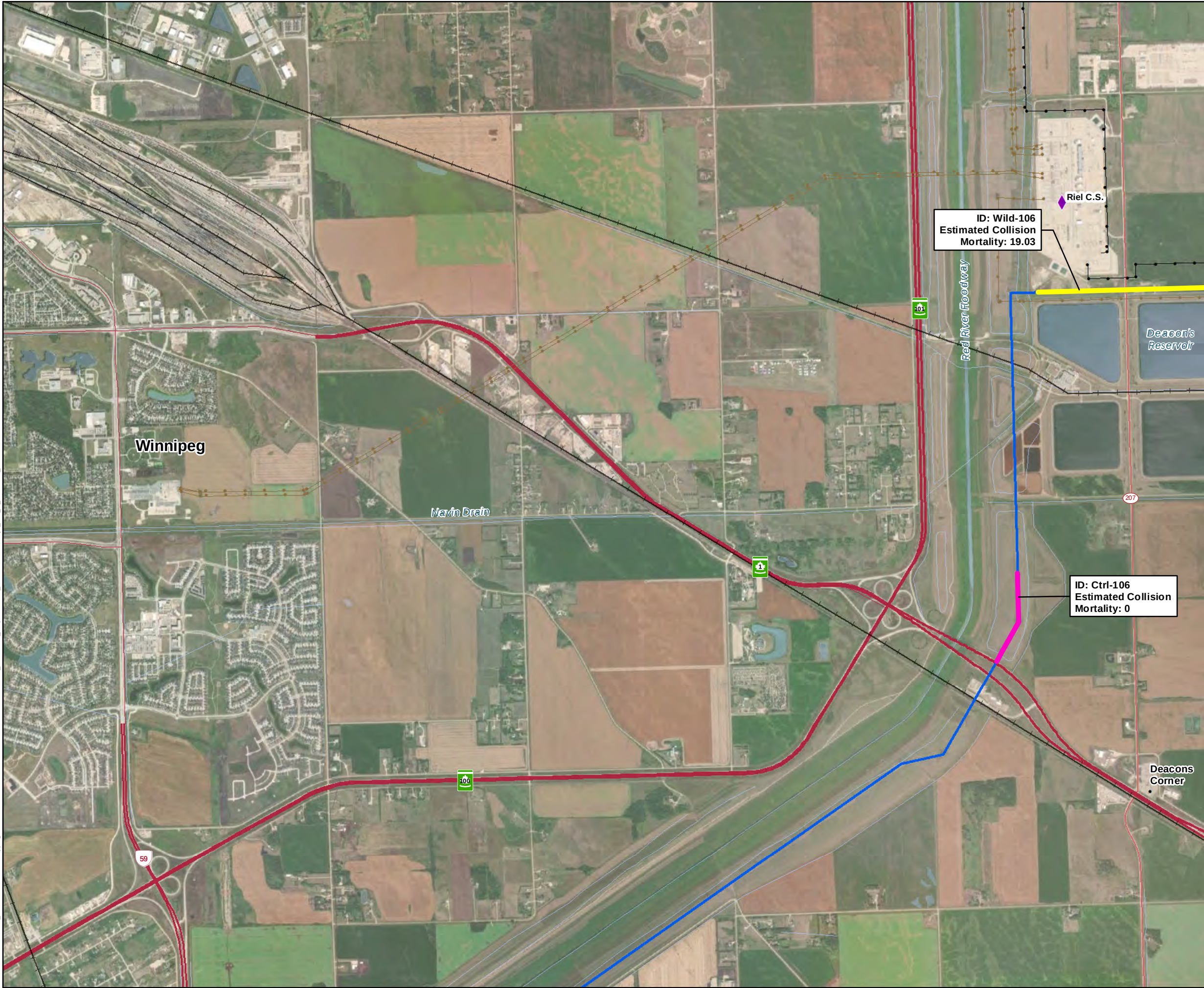
- Landbase
- Community
 - Railway
 - Trans-Canada Highway
 - Provincial Trunk Highway
 - Provincial Road
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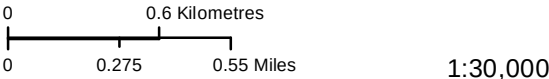


Manitoba - Minnesota
Transmission Project

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Manitoba - Minnesota Transmission Project

Project Infrastructure

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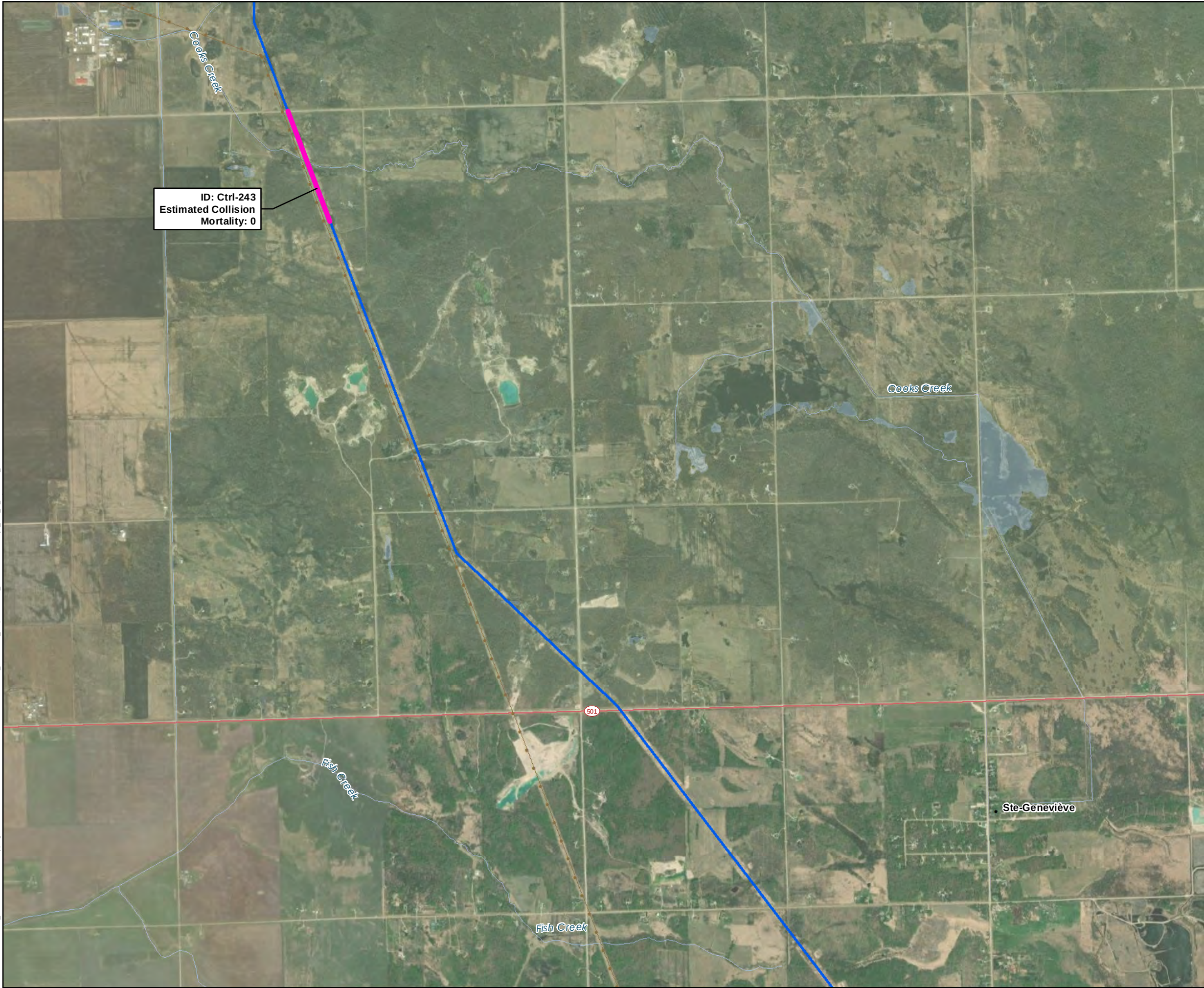
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Bird Collision Surveys 2020

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Manitoba - Minnesota
Transmission Project

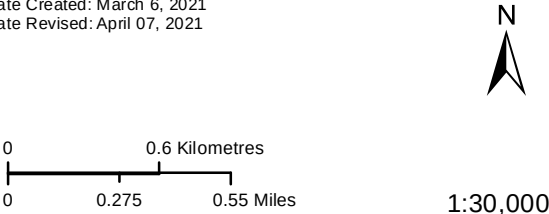
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Manitoba - Minnesota Transmission Project

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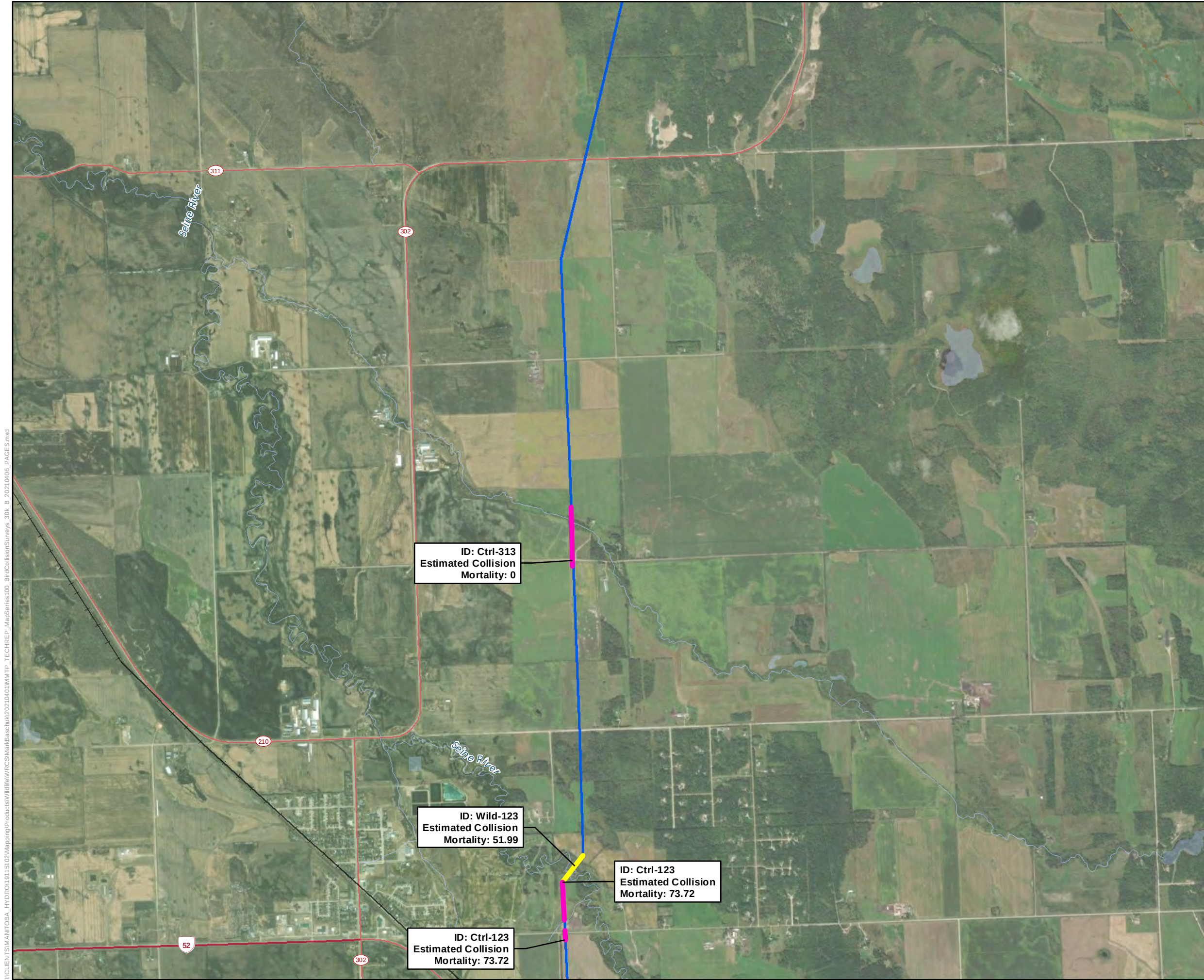
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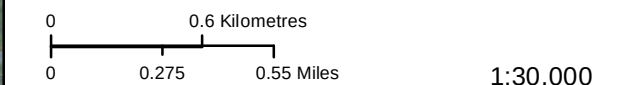
Bird Collision Surveys 2020



Manitoba - Minnesota Transmission Project

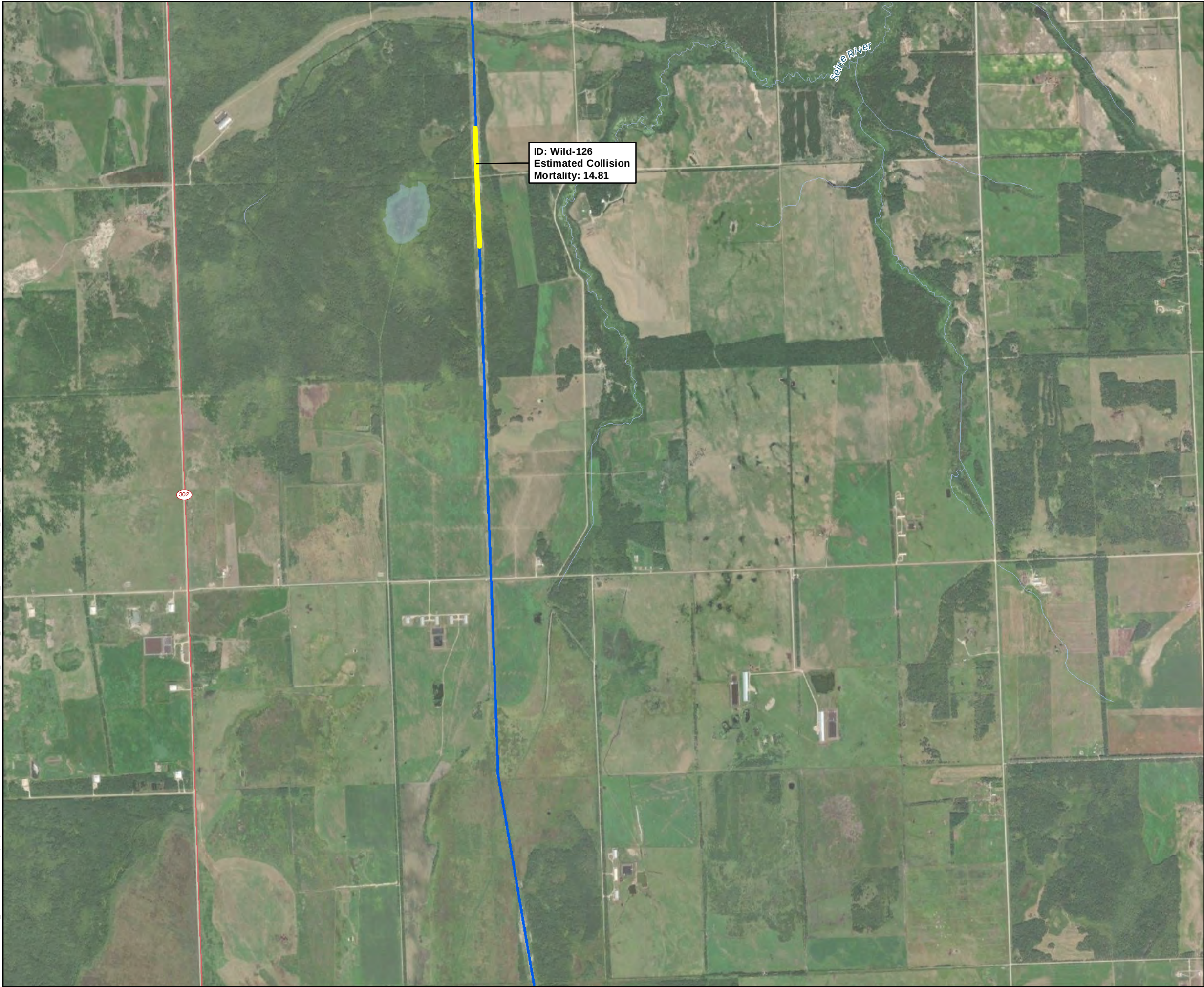
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Bird Collision Surveys 2020



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Bird Collision Surveys 2020

Appendix 2

Photos



Photo 1. Canada Geese Crossing over the MMTP near Brady Landfill, September 2020



Photo 2. Sora Carcass Observed at Site Ctrl-123, September 2020



Photo 3. Nashville Warbler Carcass Observed at Site Wild-100, September 2020



Photo 4. Vesper Sparrow Carcass Observed at Site Wild-103, September 2020



Photo 5. Black and White Warbler Carcass Observed at Site Wild-118, September 2020



Photo 6. Mallard Partial Carcass Observed at Site Wild-103, September 2020



Photo 7. Remnants of a Quail Carcass Following a Scavenger Bias Period of Seven Days, September 2020. Note: nearly all soft tissue was removed by insects during this time.

