MANITOBA-MINNESOTA TRANSMISSION PROJECT

BIRD-WIRE COLLISION MONITORING 2020 - 2022

Prepared for

Manitoba Hydro

By

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December 2022

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. This was done to 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, at 16 sites during the spring, summer, and fall periods of 2021, and at 12 sites during the spring and summer of 2022. 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 as control sites. Each survey site was visited twice during each survey period (fall 2020/21, spring 2021/22, and summer 2021/22). A bird movement survey was conducted at each site prior to the collision survey to help evaluate of the effectiveness of the bird diverters.

Evidence of 108 bird collisions were found at the survey sites from 2020-2022. Most collisions (72) were found during the spring period, followed by the fall period (25 collisions), with the least in the summer period (11 collisions). Of the total collisions found, 70 were observed at sites with bird diverters and 38 were observed at control sites.

The estimated weekly bird mortality per km was not significantly different between sites with bird diverters and control sites during the spring, summer, or fall. This supports the null hypothesis that 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. Average bird collision mortality estimates were highest in the spring period for both sites with bird diverters and control sites. Average estimated seasonal bird mortality per km ranged from 30.6 to 478.6 mortalities/km at sites with bird diverters and 48.3 to 209.1 mortalities/km at control sites.

The collision mortality estimates observed in this study were higher than the range of other collision mortality studies that have occurred within the province due to high scavenger rates and the relatively high number of collisions found at some sites. Further mitigation measures should be considered at several sites to reduce the number of bird collisions.

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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 an 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.

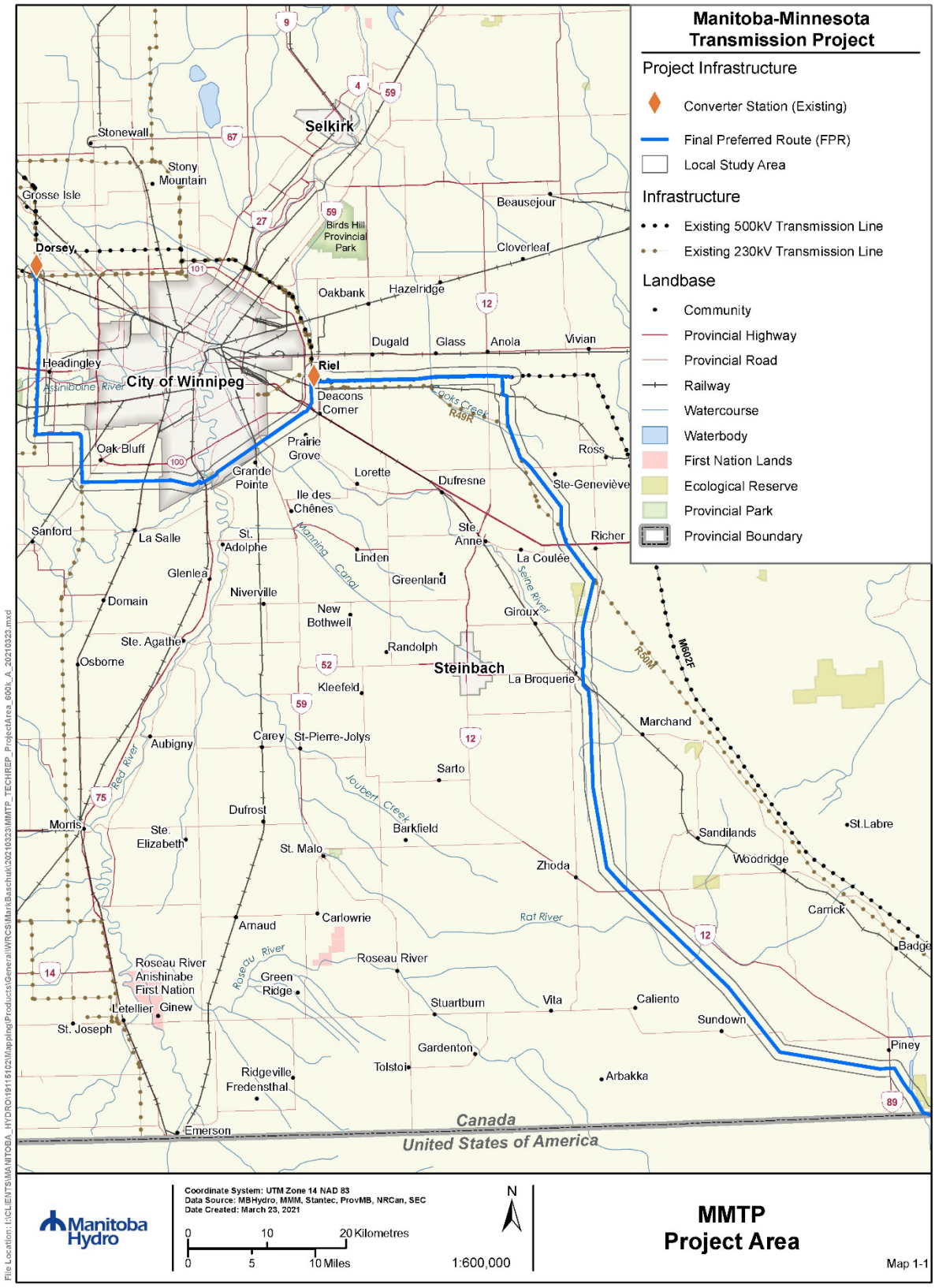
Additionally, bird-wire collision monitoring was conducted in the fall of 2014 along the existing M602F transmission line and other transmission lines that crossed the Assiniboine River to act as a proxy for the MMTP (Stantec 2015; Manitoba Hydro 2015). Survey sites were classified into collision risk 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 2020-2022 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, the spring, summer, and fall of 2021, and the spring and summer of 2022.



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)

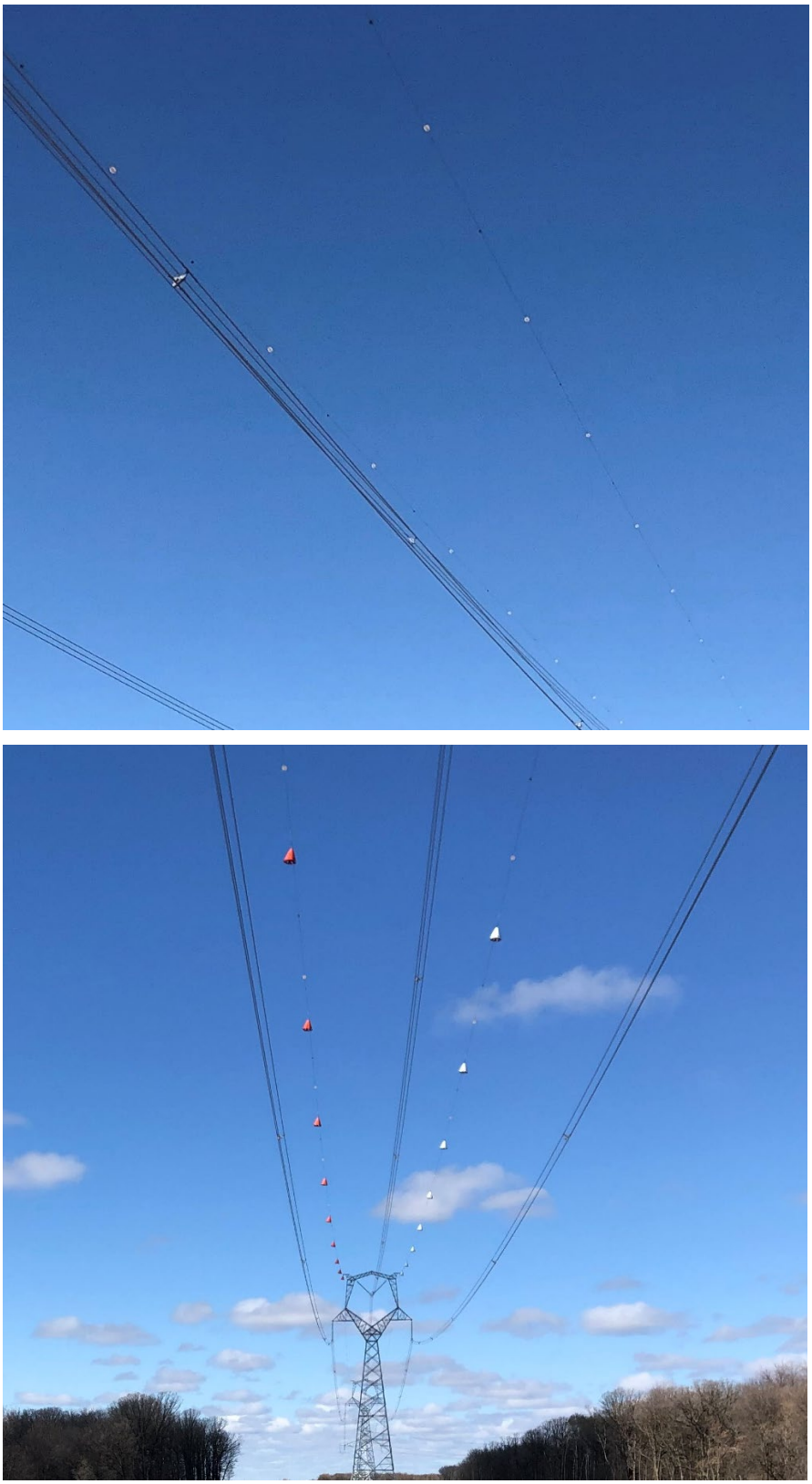


Photo 2. Alternating Swan-Flight Bird Diverters and Bird Flight Bird Diverters (top), and additional aircraft cone markers (bottom) on the Manitoba-Minnesota Transmission Project

2.0 METHODS

2.1 BIRD-WIRE COLLISION MONITORING

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:

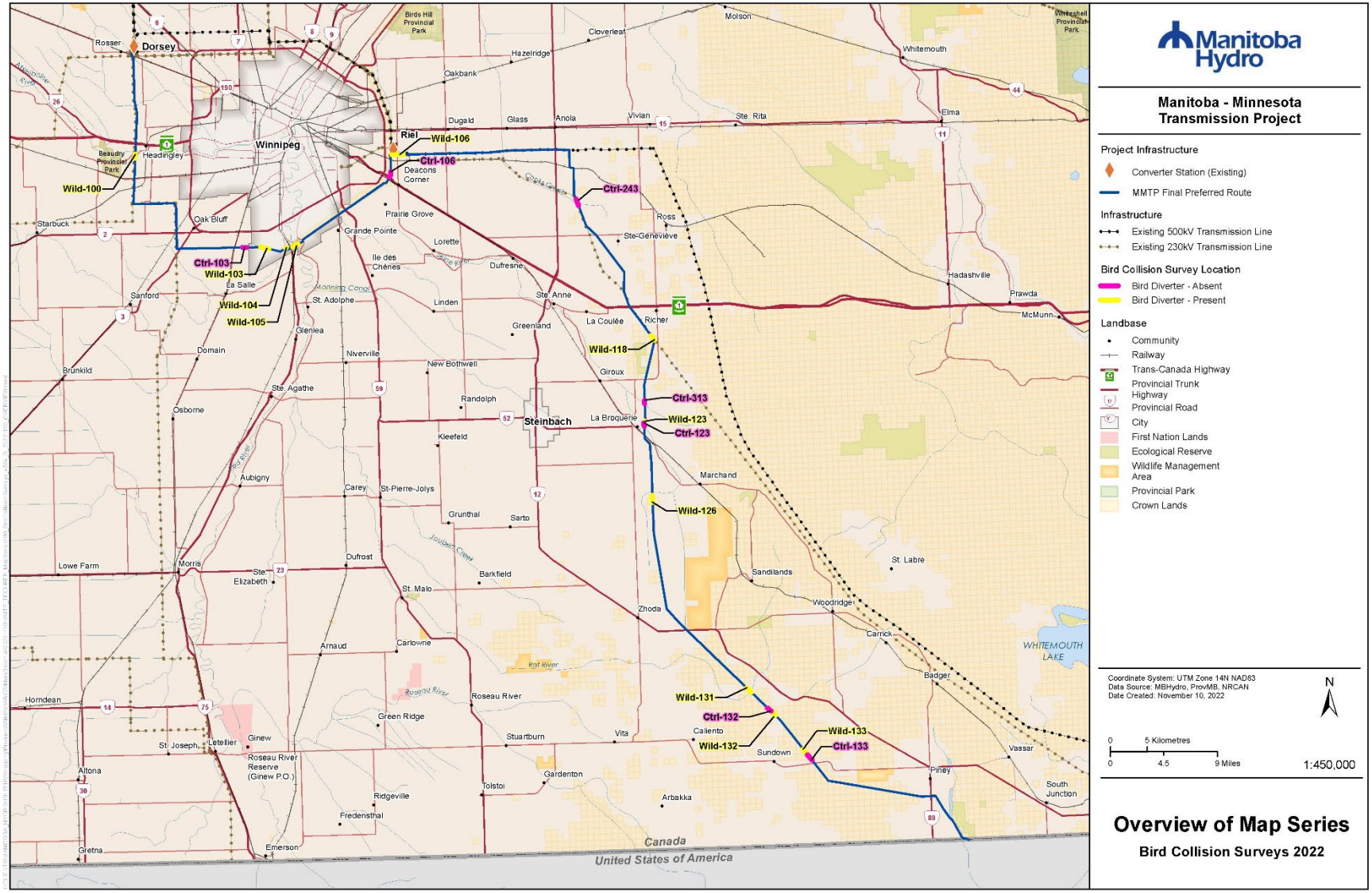
• H_0 (null): The mortality of birds at high-risk areas with bird diverters will not be different than the mortality of birds at low-risk areas without bird diverters.

• 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).

Bird-wire collision monitoring occurred twice during the spring, summer, and fall periods from 2020-2022. In the fall of 2020, all 18 sites were surveyed, in the spring, summer, and fall of 2021, 16 sites were surveyed, and in the spring and summer of 2022, 12 sites were surveyed (Table 1). In 2021, the conditions at two sites, Ctrl-133 and Wild-133, were too wet to allow for collision monitoring and were not searched. In 2022, due to overland flooding throughout the southern portion of the province, six sites (Wild-104, Wild-105, Wild-126, Wild-131, Wild-133, Ctrl-133) were not searched.

Surveys for bird-wire collisions were conducted at each site by four to six personnel. Each site was visited twice, with 5-7 days between visits. Personnel 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 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) and collision evidence was identified to species where possible and photographed.



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

Site ID	UTM Start	UTM End	Bird Diverters	Environmentally Sensitive Site	Site Length (m)	Fall 2020		Spring 2021		Summer 2021		Fall 2021		Spring 2022		Summer 2022	
						Visit 1 Date	Visit 2 Date	Visit 1 Date	Visit 2 Date	Visit 1 Date	Visit 2 Date	Visit 1 Date	Visit 2 Date	Visit 1 Date	Visit 2 Date	Visit 1 Date	Visit 2 Date
Wild-100	14N 612852 5524260	14N 612874 5524824	Present	Assiniboine River	565	10-Sep	15-Sep	04-May	11-May	01-Jun	08-Jun	24-Aug	31-Aug	11-May	18-May	01-Jun	08-Jun
Wild-103	14N 631009 5511990	14N 629896 5512242	Present	Brady Landfill	1141	10-Sep	16-Sep	04-May	11-May	01-Jun	08-Jun	24-Aug	31-Aug	11-May	18-May	01-Jun	08-Jun
Wild-104	14N 633256 5512083	14N 633375 5512151	Present	La Salle River	136	10-Sep	16-Sep	04-May	11-May	01-Jun	08-Jun	24-Aug	31-Aug	NA	NA	NA	NA
Wild-105	14N 634221 5512238	14N 634926 5512641	Present	Red River	647	10-Sep	16-Sep	04-May	11-May	01-Jun	08-Jun	24-Aug	31-Aug	NA	NA	NA	NA
Wild-106	14N 647686 5524747	14N 647892 5524753	Present	Deacon Reservoir	1501	11-Sep	16-Sep	04-May	11-May	01-Jun	08-Jun	24-Aug	31-Aug	11-May	18-May	01-Jun	08-Jun
Wild-118	14N 682799 5500258	14N 683261 5499642	Present	Richer Lake (Waterfowl Sensitivity Area)	770	11-Sep	17-Sep	05-May	12-May	02-Jun	09-Jun	25-Aug	01-Sep	12-May	19-May	02-Jun	09-Jun
Wild-123	14N 682009 5488650	14N 681841 5488433	Present	Seine River	275	14-Sep	21-Sep	05-May	12-May	02-Jun	08-Jun	25-Aug	01-Sep	12-May	19-May	02-Jun	09-Jun
Wild-126	14N 682967 5478612	14N 682999 5477647	Present	Breeding Habitat Sensitive Area	965	14-Sep	21-Sep	05-May	12-May	02-Jun	09-Jun	25-Aug	01-Sep	NA	NA	NA	NA
Wild-131	14N 696364 5451953	14N 695776 5452518	Present	Rat River	816	15-Sep	21-Sep	06-May	13-May	03-Jun	10-Jun	26-Aug	02-Sep	NA	NA	NA	NA
Wild-132	14N 699047 5449373	14N 699635 5448809	Present	Lonesand Lake (Waterfowl Sensitivity Area)	814	15-Sep	21-Sep	06-May	12-May	03-Jun	10-Jun	26-Aug	02-Sep	12-May	19-May	02-Jun	09-Jun
Wild-133	14N 703436 5444197	14N 704026 5443449	Present	Sundown Lake and Wetland Sensitive Area	952	11-Sep	17-Sep	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ctrl-103	14N 627981 5512213	14N 627408 5512198	Absent	Brady Landfill	573	10-Sep	16-Sep	04-May	11-May	01-Jun	08-Jun	24-Aug	31-Aug	11-May	18-May	01-Jun	08-Jun
Ctrl-106	14N 647519 5522464	14N 647351 5521749	Absent	Deacon Reservoir	761	10-Sep	16-Sep	04-May	11-May	01-Jun	09-Jun	25-Aug	31-Aug	11-May	18-May	01-Jun	08-Jun
Ctrl-123	14N 681842 5488432	14N 681863 5487958	Absent	Seine River	388	14-Sep	21-Sep	05-May	12-May	02-Jun	09-Jun	25-Aug	01-Sep	12-May	19-May	02-Jun	09-Jun
Ctrl-132	14N 698589 5449814	14N 699047 5449373	Absent	Lonesand Lake (Waterfowl Sensitivity Area)	636	15-Sep	21-Sep	06-May	13-May	03-Jun	10-Jun	26-Aug	02-Sep	12-May	19-May	02-Jun	09-Jun
Ctrl-133	14N 704027 5443448	14N 704580 5442747	Absent	Sundown Lake and Wetland Sensitive Area	893	11-Sep	17-Sep	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ctrl-243	14N 672961 5517848	14N 672621 5518744	Absent	Cook's Creek	959	11-Sep	16-Sep	05-May	12-May	02-Jun	09-Jun	25-Aug	01-Sep	11-May	18-May	01-Jun	08-Jun
Ctrl-313	14N 681909 5491500	14N 681923 5491016	Absent	Unnamed Creek	485	14-Sep	21-Sep	05-May	12-May	02-Jun	09-Jun	25-Aug	01-Sep	12-May	19-May	02-Jun	09-Jun

Photo 3. Personnel Conducting a Bird-mortality Collision Survey along the MMTP right-of-way, June 2022

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 quail (*Coturnix sp.*) carcasses, sourced from a commercial supplier, within search areas in locations unknown to the searchers prior to searches commencing (California Energy Commission 2003; APLIC 2012). In 2020, one quail was planted at 14 sites, in 2021 two quail were planted at 15 sites during each survey period (spring, summer, fall), and in 2022 two quail were planted at 11 sites during each survey period 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 for sites with bird diverters and control sites for each survey period. The overall searcher efficiency for each survey period, including both sites with bird diverters and control sites, was used in final calculations as it provided a larger sample size and better estimation of searcher efficiency.

Searcher efficiency was calculated as:

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

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. The scavenger bias for sites with bird diverters and control sites for each survey period was used in final calculations to account for differences in scavenger presence between the site types.

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 estimated weekly mortality per km between control sites and sites with bird diverters for each survey period (spring, summer, and fall) was compared using a Wilcoxon Rank Sum test ($\alpha = 0.05$).

2.2 BIRD MOVEMENT SURVEYS

To provide a comparison of bird activity between the sites with bird diverters to the control sites, a bird movement survey was conducted in 2021 and 2022. As sites fitted with bird diverters were chosen because they were shown to have high numbers of bird movements observed prior to construction (Stantec 2015; Manitoba Hydro 2015), a comparison of bird movements with control sites is useful in helping to determine if bird diverters are working successfully. Bird movement surveys were conducted at all sites, except for site Wild-123, prior to searching for bird carcasses. All personnel were involved monitoring bird activity across and around the ROW for 15 minutes at each bird wire collision site. The number, species (where possible), approximate flight height in relation to tower height, and general cardinal direction of birds crossing the ROW was recorded. A Wilcoxon Rank Sum test ($\alpha = 0.05$) was used to test for a difference of bird movements observed during 2021 and 2022 between sites with bird diverters and control sites.

Photo 4. Personnel Conducting a Bird Movement Survey Along the MMTP Right-of-way, May 2022

3.0 RESULTS

3.1 BIRD-WIRE COLLISION SURVEYS

Evidence of 108 bird collisions were found at the survey sites from 2020-2022. Most collisions (72) were found during the spring period, followed by the fall period (25 collisions), with the least in the summer period (11 collisions). Of the total collisions found, 70 were observed at sites with bird diverters and 38 were observed at control sites (Table 2).

The Wild-106 site, at the Deacon Reservoir, had the greatest number of collisions found (37), with 22 of these occurring in the spring 2022 period (Table 2). Sites, Wild-103 and Ctrl-103 also had relatively high numbers of collisions compared to other sites (Table 2).

Collision mortality estimates were greatest during the spring period and lowest during the summer period, for both sites with bird diverts and control sites (Table 3). Mortality estimates were greater at sites with bird diverters compared to control sites in the spring period, relatively equal during the fall, and lower in the summer (Table 3). The estimated weekly mortality per km was not significantly different between sites with bird diverters and control sites during the spring ($p=0.93$), summer ($p=0.93$), or fall ($p=0.43$).

Waterfowl (family Anatidae) were the most common group of birds found during the surveys and consisted of 28 of the total mortalities observed from 2020-2022 (Appendix 1). Warblers (family Parulidae) and sparrows (family Passerellidae) were also common mortalities, consisting of 13 and 12 of the total mortalities observed, respectively. The most common species observed during the surveys were sora (*Porzana carolina*), which consisted of nine of the total mortalities observed from 2020-2022 (Appendix 1).

In 2020 and 2022, no species listed under of the federal Species at Risk Act (SARA) or Manitoba Species at Risk Act were found (Appendix 1). In 2021, evidence from two species listed under the Species at Risk Act (SARA) were found. Evidence of a western grebe (*Aechmophorus occidentalis*) and a rusty blackbird (*Euphagus carolinus*), both listed as a species of Special Concern under Schedule 1, were found at two different sites (Appendix 1).

Searcher efficiency ranged from a low of 0.14 (14%) in fall 2020, to a high of 0.67 (67%) in spring 2021 (Appendix 2). Scavenging biases ranged low of 0.67 (33%) in the fall of 2020 to a high of 0.06 (94%) in the spring of 2021 (Appendix 2). Scavenging biases were particularly high in the spring and summer periods, compared to the fall periods.

Table 2. Bird Collision Evidence Observed Along the MMTP from 2020-2022

Site	Bird Diverters	Total Collisions	Average Weekly Mortality/km
Wild-100	Present	3	16.6
Wild-103	Present	13	27.4
Wild-104	Present	1	45.6
Wild-105	Present	7	52.8
Wild-106	Present	37	69.4
Wild-118	Present	2	8.5
Wild-123	Present	2	32.6
Wild-126	Present	1	3.7
Wild-131	Present	2	15.2
Wild-132	Present	2	5.5
Wild-133*	Present	0	0
Ctrl-103	Absent	12	40.5
Ctrl-106	Absent	9	18.9
Ctrl-123	Absent	9	43.5
Ctrl-132	Absent	0	0
Ctrl-133*	Absent	0	0
Ctrl-243	Absent	3	6.2
Ctrl-313	Absent	5	36.1
Total		108	

* Surveyed in Fall 2020 only

Table 3. Average Bird Collision Mortality Estimates for Each Survey Period from 2020-2022

Survey Period	Bird Diverters	Est. Weekly Mortality	Est. Weekly Mortality/km	Est. Seasonal Mortality/km*
Spring	Absent (Control)	138.1	36.4	209.1
	Present	501.1	79.8	478.6
Summer	Absent (Control)	30.6	8.0	48.3
	Present	36.5	5.1	30.6
Fall	Absent (Control)	50.6	11.2	67.1
	Present	93.3	11.2	67.0
All	Absent (Control)	73.1	18.5	108.2
	Present	210.3	32.0	192.1

* Multiplied by a factor of six weeks

3.2 BIRD MOVEMENT SURVEYS

Bird movements appeared to be higher at sites with bird diverters during all periods in 2020 and 2021 (Table 4; Table 5). However, bird movements were not significantly different compared to control sites ($p = 0.12$). Several sites, including Wild-100, Wild-103, and Wild-106 had relatively high numbers of bird movements in comparison to other sites. Most movements at these sites were from blackbirds, gulls, and Canada geese (*Branta canadensis*) crossing over the ROW (Appendix 1). Several species listed under the federal SARA and Manitoba's Species at Risk Act were also observed during the surveys, including barn swallow (*Hirundo rustica*), golden-winged warbler (*Vermivora chrysoptera*), trumpeter swan (*Cygnus buccinator*), and peregrine falcon (*Falco peregrinus*) (Appendix 1).

Table 4. Bird Movement Numbers and Site Type Average During Each Survey Period in 2022

Site	Bird Diverters	Spring 2022	Spring 2022 Average	Summer 2022	Summer 2022 Average
Wild-100	Present	128	57	341	170
Wild-103		28		96	
Wild-106		62		305	
Wild-118		51		84	
Wild-132		14		24	
Ctrl-103	Absent	46	32	80	61
Ctrl-106		4		30	
Ctrl-123		66		154	
Ctrl-132		8		33	
Ctrl-243		26		21	
Ctrl-313		44		49	

Table 5. Bird Movement Numbers and Site Type Average During Each Survey Period in 2021

Site	Bird Diverters	Spring 2021	Spring 2021 Average	Summer 2021	Summer 2021 Average	Fall 2021	Fall 2021 Average
Wild-100	Present	63	20	59	50	90	145
Wild-103		22		282		1,045	
Wild-104		21		28		23	
Wild-105		1		20		16	
Wild-106		16		25		46	
Wild-118		30		12		72	
Wild-126		5		8		1	
Wild-131		25		11		1	
Wild-132		1		5		10	
Ctrl-103	Absent	1	21	7	11	11	8
Ctrl-106		4		8		17	
Ctrl-123		80		20		6	
Ctrl-132		6		13		1	
Ctrl-243		15		5		10	
Ctrl-313		18		10		3	

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. Bird movement data from 2021 and 2022 did not show a significant difference in bird movements between sites with bird diverters and control sites. However, data from 2021 did show a significant difference, and the sites fitted with bird diverters were chosen based on bird movement data collected in 2014. This suggests that bird movements are likely variable and may need a more extensive study to accurately determine any significant differences.

It is unknown how the overland flooding observed in southern Manitoba in 2022 affected the bird communities, movements, and subsequent bird-collision mortalities in this study. Overland flooding can reduce the amount of nesting and foraging habitat available for some species of birds, while increasing the amount of these habitats for other species (Knutson and Klaas 1997). The relatively high number of collisions observed in the spring of 2022 may have been influenced by birds concentrating in non-flooded sites, where the survey occurred, and poor weather conditions (*i.e.,* excessive precipitation) that resulted in overland flooding.

The estimated collision mortality rates observed during this study 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 6). By adding the average estimated seasonal mortality per km for the spring and fall periods, for a comparison of annual mortality produced in 2014, in this study at bird diverter sites there is an estimated 545.6 mortalities/km annually and 276.2 mortalities/km annually at control sites. For both site types this is greater than the 120.8 mortalities/km annually at high-risk sites in 2014 (Stantec 2015). Some of the difference in annual mortality observed in this study compared to the studies listed in Table 6 may be due to differences in bird abundance and diversity due to latitude of the study sites. This study was conducted in southern Manitoba, where bird diversity and abundance tend to be higher compared to the other studies that were conducted in more northern locations. A greater abundance and diversity of birds could result in greater numbers of collisions.

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 6. 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 apparent high rates of bird collision mortality along the MMTP, particularly at sites with bird diverters in the spring period, may be attributed to the high scavenger rates observed and the relatively high number of collisions observed at some sites. At sites with bird diverters in spring, scavengers took 90-94% of all the planted bird carcasses, which amplified the collision mortality estimates.

The groups of birds and species observed as collision mortalities in this study were consistent with other studies. Common groups of birds that are collision fatalities include, waterfowl, grebes, shorebirds, and cranes (Bevanger 1998; Rioux *et al.* 2013; Bernardino *et al.* 2018), generally due to their relatively large body size and small wings. In this study, various species of waterfowl and sora (included in the crane grouping) were some of the most common collision fatalities observed. Warblers and sparrows were also common groups of birds observed as mortalities in this study and may be attributed to their relative abundance, particularly during the spring migration period.

Despite the presence of bird diverters, some sites, including Wild-105 and Wild-106, had relatively high bird mortality estimates in comparison to other sites. Most bird collisions observed at these sites occurred in the spring. It is possible that the waterbodies at sites Wild-105 and Wild-106, the Red River and Deacon Reservoir, respectively, may provide some of the earliest open water habitat in spring due to the presence of flowing or circulating water. Open water habitat is attractive to species groups such as waterfowl and gulls, which are commonly found during collision surveys.

Another factor that may have influenced the collision mortality at site Wild-106 could be the presence of several other transmission lines adjacent to the MMTP that lack bird diverters. There are three other transmission lines parallel to the MMTP, along the Deacon Reservoir, two of which do not have bird diverters. These transmission lines could contribute to bird mortalities in the area and along the MMTP ROW if crippled birds end up at site Wild-106.

Additional mitigation may be beneficial at several sites to reduce bird collisions. Site Wild-106, which is already fitted with bird diverters still had a relatively high number of mortalities, presumably due to the

proximity of open water habitat created by the Deacon Reservoir and potentially the nearby, unmarked transmission lines. Bird diverters could be installed on the nearby transmission lines along the Deacon Reservoir to reduce the number of bird collisions caused by these lines.

If possible, to reduce the suitability of the Deacon Reservoir to birds, particularly in the spring, bird deterrent measures, including propane cannons or predator effigies could be installed at the reservoir in collaboration with the City of Winnipeg. Bird hazing could also be attempted to reduce habitat suitability of the reservoir but may be problematic due to being labour intensive. Other sites, including Ctrl-103 near the Brady Landfill and Ctrl-123 near the Seine River, which also had relatively high mortality rates could be suitable candidates for the installation of bird diverters to reduce collisions.

This was the final year of bird collision monitoring for MMTP operation. No further monitoring is scheduled at this time.

5.0 CONCLUSIONS

Bird-wire diverters along the MMTP appear to be effective at reducing the number of bird-wire collision mortalities. Estimated collision mortality rates along the MMTP appear to be higher in comparison to other studies in Manitoba and in North America. Several sites could be improved with additional mitigation measures. This was the final year of bird collision monitoring, and no further monitoring is planned.

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Appendix 1

Bird Collision Survey Results 2020-2022

Table 1. Bird Collision Survey Results 2020-2022

Site	Bird Diverters	Date	Period	Species	UTM	Total Collisions
Wild-100	Present	September 15, 2020	Fall 2020	Nashville Warbler	14 U 612875 5524591	3
		May 4, 2021	Spring 2021	Common Goldeneye	14 U 612883 5524776	
		August 24, 2021	Fall 2021	Unknown Gull Species	14 U 612858 5524359	
Wild-103		September 10, 2020	Fall 2021	Mallard	14 U 631000 5511988	13
		September 16, 2020	Fall 2021	Vesper Sparrow	14 U 629994 5512220	
		September 16, 2020	Fall 2021	Unknown Waterfowl Species	14 U 630780 5512069	
		May 11, 2021	Spring 2021	Unknown Waterfowl Species	14 U 630864 5512006	
		May 11, 2021	Spring 2021	Least Flycatcher	14 U 630605 5512109	
		June 8, 2021	Summer 2021	Alder Flycatcher	14 U 630019 5512216	
		August 24, 2021	Fall 2021	Western Grebe	14 U 630473 5512123	
		August 24, 2021	Fall 2021	Unknown Gull Species	14 U 630474 5512090	
		May 11, 2022	Spring 2022	Unknown Passerine Species	14 U 630980 5512038	
		May 18, 2022	Spring 2022	Canada Goose	14 U 630139 5512194	
		May 18, 2022	Spring 2022	Canada Goose	14 U 630292 5512145	
		May 18, 2022	Spring 2022	Unknown Gull Species	14 U 630389 5512114	
		June 1, 2022	Summer 2022	Sora	14 U 630331 5512153	
Wild-104		May 11, 2021	Spring 2021	Unknown Waterfowl Species	14 U 634314 5512299	1
Wild-105		May 4, 2021	Spring 2021	Unknown Gull Species	14 U 634274 5512251	7
		May 4, 2021	Spring 2021	Unknown Species	14 U 634248 5512274	
		May 4, 2021	Spring 2021	Rusty Blackbird	14 U 634260 5512302	
		May 4, 2021	Spring 2021	Unknown Gull Species	14 U 634925 5512606	
		May 4, 2021	Spring 2021	Savannah Sparrow	14 U 672314 5520469	
		June 1, 2021	Summer 2021	Mallard	14 U 634746 5512516	
Wild-106		September 16, 2020	Fall 2020	Unknown Species	14 U 649178 5524784	37
		September 16, 2020	Fall 2020	Unknown Gull Species	14 U 648329 5524766	
		May 4, 2021	Spring 2021	Canada Goose	14 U 648329 5524766	
		May 4, 2021	Spring 2021	Unknown Species	14 U 648555 5524784	
		May 4, 2021	Spring 2021	Harris's Sparrow	14 U 648981 5524782	
		May 4, 2021	Spring 2021	Unknown Passerine	14 U 672318 5520277	
		May 4, 2021	Spring 2021	Swamp Sparrow	14 U 649010 5524783	

Site	Bird Diverters	Date	Period	Species	UTM	Total Collisions
		May 4, 2021	Spring 2021	Sharp-tailed Grouse	14 U 648007 5524739	
		May 4, 2021	Spring 2021	Common Loon	14 U 647729 5524781	
		May 4, 2021	Spring 2021	Unknown Waterfowl Species	14 U 648036 5524785	
		May 11, 2021	Spring 2021	Marsh Wren	14 U 649044 5524786	
		May 11, 2021	Spring 2021	Yellow-rumped Warbler	14 U 648932 5524793	
		June 8, 2021	Summer 2021	Northern Shoveler	14 U 647746 5524779	
		June 8, 2021	Summer 2021	Canada Goose	14 U 647909 5524755	
		August 24, 2021	Fall 2021	Double-crested Cormorant	14 U 647882 5524743	
		May 11, 2022	Spring 2022	Ring-billed Gull	14 U 648612 5524782	
		May 11, 2022	Spring 2022	Song Sparrow	14 U 649081 5524807	
		May 11, 2022	Spring 2022	American Coot	14 U 648584 5524781	
		May 11, 2022	Spring 2022	Black-capped Chickadee	14 U 648576 5524798	
		May 11, 2022	Spring 2022	Canada Goose	14 U 648443 5524770	
		May 11, 2022	Spring 2022	Ovenbird	14 U 648444 5524770	
		May 11, 2022	Spring 2022	Black and White Warbler	14 U 648383 5524781	
		May 11, 2022	Spring 2022	Yellow-rumped Warbler	14 U 648254 5524774	
		May 11, 2022	Spring 2022	Blackpoll Warbler	14 U 648151 5524760	
		May 11, 2022	Spring 2022	Black and White Warbler	14 U 648068 5524782	
		May 11, 2022	Spring 2022	Yellow Warbler	14 U 647958 5524771	
		May 11, 2022	Spring 2022	Black and White Warbler	14 U 647877 5524768	
		May 11, 2022	Spring 2022	Unknown Sparrow Species	14 U 647877 5524768	
		May 11, 2022	Spring 2022	Sora	14 U 647753 5524778	
		May 11, 2022	Spring 2022	Savannah Sparrow	14 U 647731 5524768	
		May 11, 2022	Spring 2022	Unknown Corvid Species	14 U 647878 5524740	
		May 18, 2022	Spring 2022	Unknown Thrush Species	14 U 648548 5524761	
		May 18, 2022	Spring 2022	Unknown Species	14 U 648679 5524777	
		May 18, 2022	Spring 2022	Unknown Species	14 U 649181 5524780	
		May 18, 2022	Spring 2022	Ring-billed Gull	14 U 649184 5524791	
		May 18, 2022	Spring 2022	Unknown Woodpecker Species	14 U 648607 5524787	
		May 18, 2022	Spring 2022	Chipping Sparrow	14 U 648289 5524776	
Wild-118		September 17, 2020	Fall 2020	Black and White Warbler	14 U 682886 5500146	2
		May 12, 2021	Spring 2021	Orange-crowned Warbler	14 U 683043 5499948	

Site	Bird Diverters	Date	Period	Species	UTM	Total Collisions
Wild-123		September 21, 2020	Fall 2020	Vesper Sparrow	14 U 682001 5488644	2
		May 12, 2022	Spring 2022	Unknown Species	14 U 681890 5488515	
Wild-126		September 14, 2020	Fall 2020	Sora	14 U 682987 5478433	1
Wild-131		May 6, 2021	Spring 2021	Unknown Waterfowl Species	14 U 696148 5452194	2
		May 13, 2021	Spring 2021	Unknown Waterfowl Species	14 U 698902 5449514	
Wild-132		June 3, 2021	Summer 2021	Canada Goose	14 U 699590 5448857	2
		Sep 15 2020	Fall 2020	Unknown Species	14 U 699563 5448878	
Wild-133		NA	NA	NA	NA	0
Ctrl-103	Absent	September 10, 2020	Fall 2020	Canada Goose	14 U 627907 5512177	12
		September 10, 2020	Fall 2020	Unknown Gull Species	14 U 627896 5512231	
		September 10, 2020	Fall 2020	Mallard	14 U 627684 5512220	
		September 16, 2020	Fall 2020	Canada goose	14 U 627629 5512197	
		May 4, 2021	Spring 2021	Mallard	14 U 627557 5512249	
		May 4, 2021	Spring 2021	Sora	14 U 627705 5512225	
		May 4, 2021	Spring 2021	Savannah Sparrow	14 U 627711 5512218	
		May 11, 2021	Spring 2021	Dark-eyed Junco	14 U 627813 5512194	
		August 24, 2021	Fall 2021	Wood Duck	14 U 627819 5512204	
		May 11, 2022	Spring 2022	Unknown Passerine Species	14 U 627865 5512237	
		May 11, 2022	Spring 2022	Lapland Longspur	14 U 627788 5512232	
		May 11, 2022	Spring 2022	Unknown Species	14 U 627731 5512225	
Ctrl-106		May 4, 2021	Spring 2021	Sharp-tailed Grouse	14 U 647425 5521897	9
		June 1, 2021	Summer 2021	Unknown Species	14 U 647412 5521914	
		June 1, 2021	Summer 2021	Sharp-tailed Grouse	14 U 647520 5522468	
		June 9, 2021	Summer 2021	American Crow	14 U 672952 5517865	
		August 25, 2021	Fall 2021	Unknown Species	14 U 647541 5522251	
		August 25, 2021	Fall 2021	Northern Shoveler	14 U 647522 5522284	
		August 31, 2021	Fall 2021	Sora	14 U 647437 5521883	
		May 11, 2022	Spring 2022	Sora	14 U 647501 5522011	
		May 11, 2022	Spring 2022	Unknown Sparrow Species	14 U 647491 5522011	
Ctrl-123		September 21, 2020	Fall 2020	Sora	14 U 681865 5488312	9
		September 21, 2020	Fall 2020	Magnolia Warbler	14 U 681846 5488031	

Site	Bird Diverters	Date	Period	Species	UTM	Total Collisions
		May 5, 2021	Spring 2021	Red-breasted Merganser	14 U 681870 5488219	
		May 5, 2021	Spring 2021	Green-winged Teal	14 U 681844 5487987	
		May 5, 2021	Spring 2021	Unknown Blackbird Species	14 U 681835 5488259	
		May 12, 2021	Spring 2021	Northern Pintail	14 U 681852 5488375	
		May 12, 2021	Spring 2021	Sharp-tailed Grouse	14 U 681859 5488366	
		May 12, 2022	Spring 2022	Blue-winged Teal	14 U 681851 5488187	
		May 12, 2022	Spring 2022	Mallard	14 U 681869 5488228	
Ctrl-132		NA	NA	NA	NA	0
Ctrl-133		NA	NA	NA	NA	0
Ctrl-243		May 5, 2021	Spring 2021	Unknown Waterfowl Species	14 U 672770 5518381	3
		June 2, 2021	Summer 2021	Bald Eagle	14 U 672879 5518001	
		May 11, 2022	Spring 2022	Yellow-rumped Warbler	14 U 672645 5518657	
Ctrl-313		May 12, 2021	Spring 2021	Marsh Wren	14 U 681907 5491240	5
		May 12, 2022	Spring 2022	Sora	14 U 681917 5491190	
		May 19, 2022	Spring 2022	Sora	14 U 681912 5491237	
		May 19, 2022	Spring 2022	Unknown Species	14 U 681904 5491208	
		June 9, 2023	Summer 2022	Unknown Species	14 U 681935 5491261	

Appendix 2

Bird Collision Survey Results and Estimated Mortalities 2020-2022

Table 1. Bird Collision Survey Results and Estimated Mortalities along the Manitoba-Minnesota Transmission Project in Fall 2020

Site Type	Total Length (km)	Searched Length (km)	No. Collisions	No. Birds Planted	No. Birds Not Scavenged	No. Planted Birds Found	Searcher Efficiency	Scavenger Bias	Habitat Bias	Est. Weekly Mortality*	Est. Weekly Mortality/km	Est. Seasonal Mortality/km**
Bird Diverters Absent (Control)	4.69	4.69	6	6	4	2	0.33	0.67	1	85.7	18.3	109.6
Bird Diverters Present	8.58	8.58	10	8	3	0	0	0.38	1	142.9	16.6	99.9
Total	13.28	13.28	16	14	7	2	0.14	0.5	1	228.6	17.2	103.3

* Calculations used the total scavenger bias due to larger sample size

**Multiplied by a factor of six weeks

Table 2. Bird Collision Survey Results and Estimated Mortalities along the Manitoba-Minnesota Transmission Project in Spring 2021

Site Type	Total Length (km)	Searched Length (km)	No. Collisions	No. Birds Planted	No. Birds Not Scavenged	No. Planted Birds Found	Searcher Efficiency	Scavenger Bias	Habitat Bias	Est. Weekly Mortality	Est. Weekly Mortality/km	Est. Seasonal Mortality/km*
Bird Diverters Absent (Control)	3.80	3.68	12	12	2	9	0.75	0.17	0.97	108.6	28.6	153.5
Bird Diverters Present	7.63	7.24	22	18	1	11	0.61	0.06	0.95	576.1	75.5	453.0
Total	11.43	10.92	34	30	3	20	0.67	0.1	0.96	528.6	46.3	277.5

*Multiplied by a factor of six weeks

Table 3. Bird Collision Survey Results and Estimated Mortalities along the Manitoba-Minnesota Transmission Project in Summer 2021

Site Type	Total Length (km)	Searched Length (km)	No. Collisions	No. Birds Planted	No. Birds Not Scavenged	No. Planted Birds Found	Searcher Efficiency	Scavenger Bias	Habitat Bias	Est. Weekly Mortality	Est. Weekly Mortality/km	Est. Seasonal Mortality/km*
Bird Diverters Absent (Control)	3.80	3.68	4	12	2	6	0.5	0.17	0.97	51.6	13.6	81.6
Bird Diverters Present	7.63	7.49	5	18	3	8	0.44	0.17	0.98	63.9	8.4	50.4
Total	11.43	11.17	9	30	5	14	0.47	0.17	0.98	114.9	10.1	60.6

*Multiplied by a factor of six weeks

Table 4. Bird Collision Survey Results and Estimated Mortalities along the Manitoba-Minnesota Transmission Project in Fall 2021

Site Type	Total Length (km)	Searched Length (km)	No. Collisions	No. Birds Planted	No. Birds Not Scavenged	No. Planted Birds Found	Searcher Efficiency	Scavenger Bias	Habitat Bias	Est. Weekly Mortality	Est. Weekly Mortality/km	Est. Seasonal Mortality/km*
Bird Diverters Absent (Control)	3.80	3.68	4	12	6	5	0.42	0.5	0.97	15.6	4.1	24.6
Bird Diverters Present	7.63	7.49	5	18	4	11	0.61	0.22	0.98	43.8	5.7	34.2
Total	11.43	11.17	9	30	10	16	0.53	0.33	0.98	52.5	4.6	27.6

*Multiplied by a factor of six weeks

Table 5. Bird Collision Survey Results and Estimated Mortalities along the Manitoba-Minnesota Transmission Project in Spring 2022

Site Type	Total Length (km)	Searched Length (km)	No. Collisions	No. Birds Planted	No. Birds Not Scavenged	No. Planted Birds Found	Searcher Efficiency	Scavenger Bias	Habitat Bias	Est. Weekly Mortality	Est. Weekly Mortality/ km	Est. Seasonal Mortality/km*
Bird Diverters Absent (Control)	3.8	3.59	11	12	2	5	0.42	0.17	0.94	167.67	44.12	264.74
Bird Diverters Present	5.07	4.59	27	10	1	7	0.70	0.10	0.91	426.05	84.03	504.20
Total	8.87	8.18	38	22	3	12	0.55	0.14	0.92	553.98	62.46	374.74

*Multiplied by a factor of six weeks

Table 6. Bird Collision Survey Results and Estimated Mortalities along the Manitoba-Minnesota Transmission Project in Summer 2022

Site Type	Total Length (km)	Searched Length (km)	No. Collisions	No. Birds Planted	No. Birds Not Scavenged	No. Planted Birds Found	Searcher Efficiency	Scavenger Bias	Habitat Bias	Est. Weekly Mortality	Est. Weekly Mortality/km	Est. Seasonal Mortality/km*
Bird Diverters Absent (Control)	3.8	3.59	1	12	2	8	0.67	0.17	0.94	9.53	2.51	15.04
Bird Diverters Present	5.07	4.59	1	10	3	4	0.40	0.30	0.91	9.20	1.82	10.89
Total	8.87	8.18	2	22	5	12	0.55	0.23	0.92	17.49	1.97	11.83

*Multiplied by a factor of six weeks

Appendix 3

Bird Movement Observations 2021-2022

Table 1. Number of Bird Movements Observed at Sites During Each Survey Period in 2021

Site	Bird Diverters	Species	Spring 2021	Summer 2021	Fall 2021	Total	Grand Total
Wild-100	Present	American Crow	2	4	20	26	212
		American Robin	4	1	2	7	
		Bald Eagle	0	0	2	2	
		Blackbird Spp.	6	0	0	6	
		Black-capped Chickadee	0	0	2	2	
		Brewer's Blackbird	5	0	0	5	
		Canada Goose	2	0	18	20	
		Cedar Waxwing	0	29	0	29	
		Clay-coloured Sparrow	0	1	0	1	
		Duck Spp.	7	1	1	9	
		Eastern Kingbird	0	2	0	2	
		Franklin's Gull	10	0	0	10	
		Gull Spp.	3	0	32	35	
		Mallard	4	1	0	5	
		Merlin	1	2	1	4	
		Northern Flicker	0	2	1	3	
		Red-tailed Hawk	0	1	0	1	
		Red-winged Blackbird	13	13	0	26	
		Ring-billed Gull	3	0	0	3	
		Ruby-throated Hummingbird	0	0	1	1	
		Sandhill Crane	1	0	0	1	
		Savannah Sparrow	0	2	0	2	
		Song Sparrow	1	0	0	1	
		Sparrow Spp.	0	0	7	7	
		Unknown Sp..	0	0	1	1	
		White-breasted Nuthatch	1	0	2	3	
Wild-103	Present	American Robin	4	0	0	4	1349
		Brewer's Blackbird	5	0	0	5	
		Canada Goose	6	277	2	285	
		Duck Spp.	2	0	30	32	
		Gull Spp.	0	0	1012	1012	
		Peregrine Falcon*	3	0	0	3	
		Red-winged Blackbird	1	5	0	6	
		Ring-billed Gull	0	0	1	1	
		Swainson's Hawk	1	0	0	1	
Wild-104	Present	American Crow	0	1	0	1	72
		American Goldfinch	0	4	0	4	
		American Robin	0	0	1	1	
		American White Pelican	0	3	2	5	

Site	Bird Diverters	Species	Spring 2021	Summer 2021	Fall 2021	Total	Grand Total
		Blackbird Spp.	4	0	6	10	
		Black-capped Chickadee	0	0	1	1	
		Blue Jay	0	1	11	12	
		Brown-headed Cowbird	0	1	0	1	
		Canada Goose	3	0	0	3	
		Downy Woodpecker	0	0	1	1	
		Duck Spp.	4	0	0	4	
		Franklin's Gull	2	0	0	2	
		Gull Spp.	1	0	0	1	
		Mallard	0	2	0	2	
		Red-tailed Hawk	1	2	1	4	
		Red-winged Blackbird	0	12	0	12	
		Western Kingbird	0	1	0	1	
		White-breasted Nuthatch	5	1	0	6	
		Yellow Warbler	1	0	0	1	
Wild-105	Present	American Goldfinch	0	0	2	2	37
		American White Pelican	0	0	6	6	
		Black-billed Magpie	1	0	0	1	
		Blackbird Spp.	0	3	0	3	
		Blue Jay	0	1	0	1	
		Cooper's Hawk	0	1	0	1	
		Franklin's Gull	0	0	2	2	
		Gull Spp.	0	0	3	3	
		Mallard	0	2	0	2	
		Mourning Dove	0	2	0	2	
		Red-tailed Hawk	0	3	1	4	
		Red-winged Blackbird	0	2	0	2	
		Ring-billed Gull	0	0	2	2	
		Western Kingbird	0	1	0	1	
		Western Meadowlark	0	3	0	3	
		Woodpecker Spp.	0	1	0	1	
		Yellow Warbler	0	1	0	1	
Wild-106	Present	American White Pelican	0	0	1	1	87
		Baltimore Oriole	0	1	0	1	
		Blackbird Spp.	5	0	0	5	
		Common Grackle	1	0	0	1	
		Franklin's Gull	7	0	0	7	
		Killdeer	1	2	0	3	
		Mourning Dove	0	3	19	22	
		Orchard Oriole	0	1	0	1	
		Red-winged Blackbird	0	14	24	38	

Site	Bird Diverters	Species	Spring 2021	Summer 2021	Fall 2021	Total	Grand Total
		Song Sparrow	2	0	0	2	
		Swainson's Hawk	0	0	2	2	
		Tree Swallow	0	1	0	1	
		Western Kingbird	0	3	0	3	
Wild-118	Present	American Crow	1	0	0	1	114
		American Robin	12	0	0	12	
		Blue Jay	1	0	0	1	
		Brewer's Blackbird	8	0	0	8	
		Common Raven	0	10	0	10	
		Franklin's Gull	0	0	70	70	
		Great-crested Flycatcher	0	2	0	2	
		Red-winged Blackbird	7	0	0	7	
		Sandhill Crane	0	0	2	2	
		Yellow Warbler	1	0	0	1	
Wild-123	Present	Downy Woodpecker	1	0	0	1	2
		Pileated Woodpecker	1	0	0	1	
Wild-126	Present	American Goldfinch	0	4	0	4	14
		American Robin	0	1	0	1	
		Baltimore Oriole	0	1	0	1	
		Blackbird Spp.	3	0	0	3	
		Blue Jay	0	0	1	1	
		Northern Flicker	2	0	0	2	
		Red-tailed Hawk	0	1	0	1	
		Ruby-throated Hummingbird	0	1	0	1	
Wild-131	Present	Blackbird Spp.	5	3	0	8	37
		Brewer's Blackbird	1	1	0	2	
		Canada Goose	2	0	0	2	
		Cedar Waxwing	0	3	0	3	
		Common Grackle	1	0	0	1	
		Common Yellowthroat	0	2	0	2	
		Duck Spp.	1	0	0	1	
		Killdeer	2	0	0	2	
		Merlin	0	0	1	1	
		Mourning Dove	2	0	0	2	
		Red-winged Blackbird	10	2	0	12	
		Trumpeter Swan*	1	0	0	1	
Wild-132	Present	American Crow	0	2	10	12	16
		Mourning Dove	0	2	0	2	
		None	0	0	0	0	
		Ruby-throated Hummingbird	0	1	0	1	

Site	Bird Diverters	Species	Spring 2021	Summer 2021	Fall 2021	Total	Grand Total
		Sandhill Crane	1	0	0	1	
Ctrl-103	Absent	American Crow	0	0	1	1	19
		Canada Goose	0	0	3	3	
		Duck Spp.	0	1	0	1	
		Hawk Spp.	0	1	0	1	
		Lincoln Sparrow	1	0	0	1	
		Northern Harrier	0	1	0	1	
		Red-winged Blackbird	0	4	0	4	
		Sparrow Spp.	0	0	7	7	
Ctrl-106	Absent	Barn Swallow*	0	0	3	3	29
		Blackbird Spp.	0	3	0	3	
		Canada Goose	0	0	10	10	
		Duck Spp.	1	0	0	1	
		Hawk Spp.	1	0	0	1	
		Northern Harrier	0	0	1	1	
		Red-tailed Hawk	0	2	3	5	
		Red-winged Blackbird	0	3	0	3	
		Sharp-tailed Grouse	2	0	0	2	
Ctrl-123	Absent	American Crow	0	1	0	1	106
		American Robin	1	2	0	3	
		Bald Eagle	0	0	4	4	
		Blue Jay	2	0	0	2	
		Brown-headed Cowbird	0	1	0	1	
		Canada Goose	2	0	0	2	
		Common Grackle	0	2	0	2	
		Common Raven	1	0	0	1	
		Eastern Kingbird	0	2	0	2	
		Killdeer	0	1	0	1	
		Mallard	2	0	0	2	
		Mourning Dove	0	2	0	2	
		Red-tailed Hawk	0	0	1	1	
		Red-winged Blackbird	64	9	0	73	
		Rock Pigeon	3	0	0	3	
		Turkey Vulture	1	0	1	2	
		Western Kingbird	1	0	0	1	
		Western Meadowlark	2	0	0	2	
		Yellow-headed Blackbird	1	0	0	1	
Ctrl-132	Absent	American Crow	2	1	0	3	20
		Blackbird Spp.	0	1	0	1	
		Canada Goose	1	0	0	1	
		Chipping Sparrow	1	0	0	1	

Site	Bird Diverters	Species	Spring 2021	Summer 2021	Fall 2021	Total	Grand Total
		Killdeer	2	0	0	2	
		Mallard	0	9	0	9	
		Northern Flicker	0	0	1	1	
		Warbler Spp.	0	2	0	2	
Ctrl-243	Absent	American Crow	1	0	4	5	30
		American Robin	1	0	2	3	
		Bald Eagle	0	0	2	2	
		Black-billed Magpie	2	3	0	5	
		Blackbird Spp.	2	0	0	2	
		Blue Jay	3	0	0	3	
		Brewer's Blackbird	5	0	0	5	
		Canada Goose	0	0	1	1	
		Common Grackle	1	0	0	1	
		Merlin	0	0	1	1	
		Red-winged Blackbird	0	2	0	2	
Ctrl-313	Absent	American Crow	0	1	0	1	31
		American Robin	0	1	0	1	
		Black-billed Magpie	0	1	0	1	
		Brewer's Blackbird	2	0	0	2	
		Common Grackle	0	3	0	3	
		Common Raven	1	4	2	7	
		Mallard	10	0	0	10	
		Red-winged Blackbird	3	0	0	3	
		Turkey Vulture	2	0	1	3	
Total			310	513	1352	2175	2175

*Listed under Schedule 1 of the federal Species at Risk Act or Under Manitoba's Species at Risk Act

Table 2. Number of Bird Movements Observed at Sites During Each Survey Period in 2022

Site	Species	Spring 2022	Summer 2022	Total	Grand Total
Wild-100	American Crow	9	6	15	469
	American Goldfinch	0	3	3	
	American Robin	1	4	5	
	Bald Eagle	2	0	2	
	Baltimore Oriole	1	0	1	
	Barn Swallow	2	30	32	
	Blackbird Spp.	38	79	117	
	Black-capped Chickadee	4	0	4	
	Blue Jay	1	10	11	
	Common Starling	0	28	28	
	Duck Spp.	0	12	12	
	Eastern Kingbird	0	4	4	
	Mallard	5	0	5	
	Passerine Spp.	34	148	182	
	Red-winged Blackbird	0	8	8	
	Rock Pigeon	2	0	2	
	Savannah Sparrow	3	0	3	
	Sparrow Spp.	19	0	19	
	Swallow Spp.	2	0	2	
	White-breasted Nuthatch	5	0	5	
	Yellow Warbler	0	9	9	
Wild-103	American Crow	0	3	3	124
	American White Pelican	0	33	33	
	Barn Swallow*	0	4	4	
	Blackbird Spp.	15	7	22	
	Canada Goose	0	36	36	
	Duck Spp.	10	0	10	
	Lesser Yellowlegs	1	0	1	
	Mallard	2	10	12	
	Sparrow Spp.	0	3	3	
Wild-106	American Crow	0	4	4	367
	Blackbird Spp.	26	119	145	
	Brewer's Blackbird	0	16	16	
	Canada Goose	2	0	2	
	Common Grackle	0	4	4	
	Common Starling	0	8	8	
	Mourning Dove	0	23	23	
	Passerine Spp.	24	68	92	
	Red-tailed Hawk	1	0	1	
	Red-winged Blackbird	9	17	26	

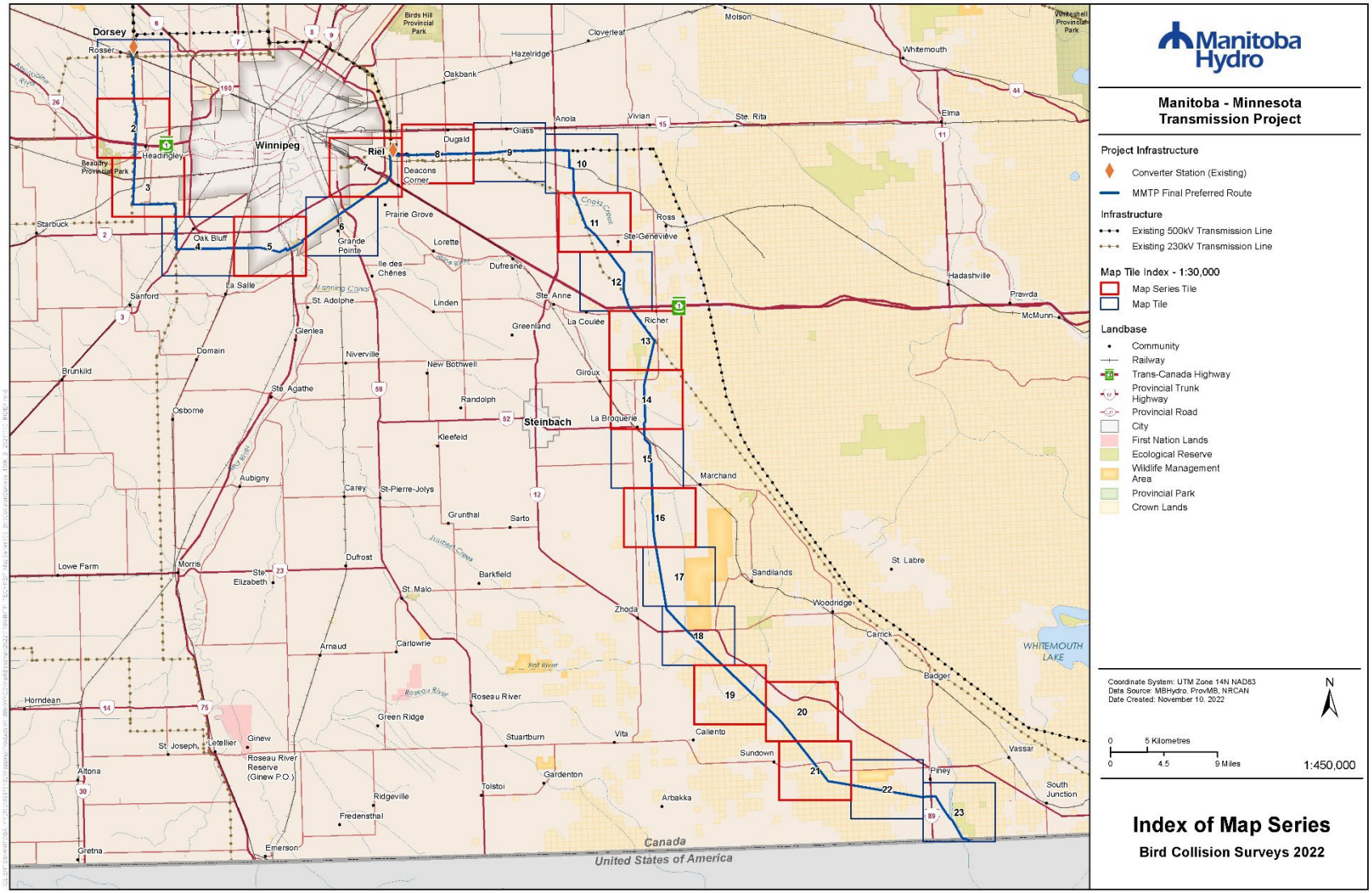
Site	Species	Spring 2022	Summer 2022	Total	Grand Total
	Swallow Spp.	0	38	38	
	Tree Swallow	0	8	8	
Wild-118	American Crow	2	0	2	135
	American Robin	3	11	14	
	Baltimore Oriole	0	4	4	
	Blackbird Spp.	19	32	51	
	Brewer's Blackbird	0	4	4	
	Common Raven	0	3	3	
	Downy Woodpecker	1	0	1	
	Duck Spp.	0	3	3	
	Passerine Spp.	26	27	53	
Wild-132	American Robin	2	3	5	38
	Blackbird Spp.	7	0	7	
	Duck Spp.	0	3	3	
	Golden-winged Warbler*	0	3	3	
	Mallard	0	9	9	
	Passerine Spp.	5	3	8	
	Swallow Spp.	0	3	3	
Ctrl-103	Blackbird Spp.	36	35	71	126
	Brewer's Blackbird	0	39	39	
	Canada Goose	8	0	8	
	Mallard	1	0	1	
	Northern Harrier	0	3	3	
	Passerine Spp.	0	3	3	
	Trumpeter Swan*	1	0	1	
Ctrl-106	Barn Swallow	0	14	14	34
	Blackbird Spp.	0	4	4	
	Red-tailed Hawk	3	0	3	
	Red-winged Blackbird	1	0	1	
	Swallow Spp.	0	9	9	
	Western Meadowlark	0	3	3	
Ctrl-106	American Crow	5	6	11	220
	American Robin	0	3	3	
	Barn Swallow	0	3	3	
	Blackbird Spp.	27	63	90	
	Brewer's Blackbird	2	0	2	
	Buteo Spp.	0	4	4	
	Canada Goose	0	8	8	
	Cliff Swallow	12	0	12	
	Duck Spp.	0	3	3	
	Eastern Kingbird	0	3	3	
	Passerine Spp.	9	34	43	

Site	Species	Spring 2022	Summer 2022	Total	Grand Total
	Red-winged Blackbird	8	4	12	
	Rock Pigeon	2	0	2	
	Swallow Spp.	0	8	8	
	Tree Swallow	0	8	8	
	Waterfowl Spp.	1	0	1	
	Western Meadowlark	0	3	3	
	Yellow Warbler	0	4	4	
Ctrl-132	American Crow	0	7	7	41
	American Robin	0	4	4	
	Blue Jay	0	8	8	
	Crane Spp.	0	8	8	
	Passerine Spp.	8	6	14	
Ctrl-243	American Crow	9	4	13	47
	Black-billed Magpie	2	0	2	
	Blackbird Spp.	2	0	2	
	Black-capped Chickadee	2	0	2	
	Canada Goose	4	0	4	
	Duck Spp.	4	0	4	
	Passerine Spp.	3	4	7	
	Swallow Spp.	0	4	4	
	Turkey Vulture	0	6	6	
	Western Meadowlark	0	3	3	
Ctrl-313	American Crow	7	4	11	93
	Barn Swallow*	2	0	2	
	Black-billed Magpie	0	4	4	
	Blackbird Spp.	15	3	18	
	Blue Jay	0	4	4	
	Eastern Kingbird	2	0	2	
	Great Blue Heron	1	0	1	
	Mallard	2	0	2	
	Passerine Spp.	15	23	38	
	Red-tailed Hawk	0	4	4	
	Red-winged Blackbird	0	7	7	
Total		477	1,217	1,694	1,694

*Listed under Schedule 1 of the federal Species at Risk Act or Under Manitoba's Species at Risk Act

Appendix 4

Bird Collision Map Series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Manitoba - Minnesota Transmission Project
Project Infrastructure
Converter Station (Existing)
MMTP Final Preferred Route
Infrastructure
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
City
First Nation Lands
Ecological Reserve
Wildlife Management Area
Provincial Park
Crown Lands
Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date Created: November 10, 2022
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0 4.5 9 Miles
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Bird Collision Surveys 2022
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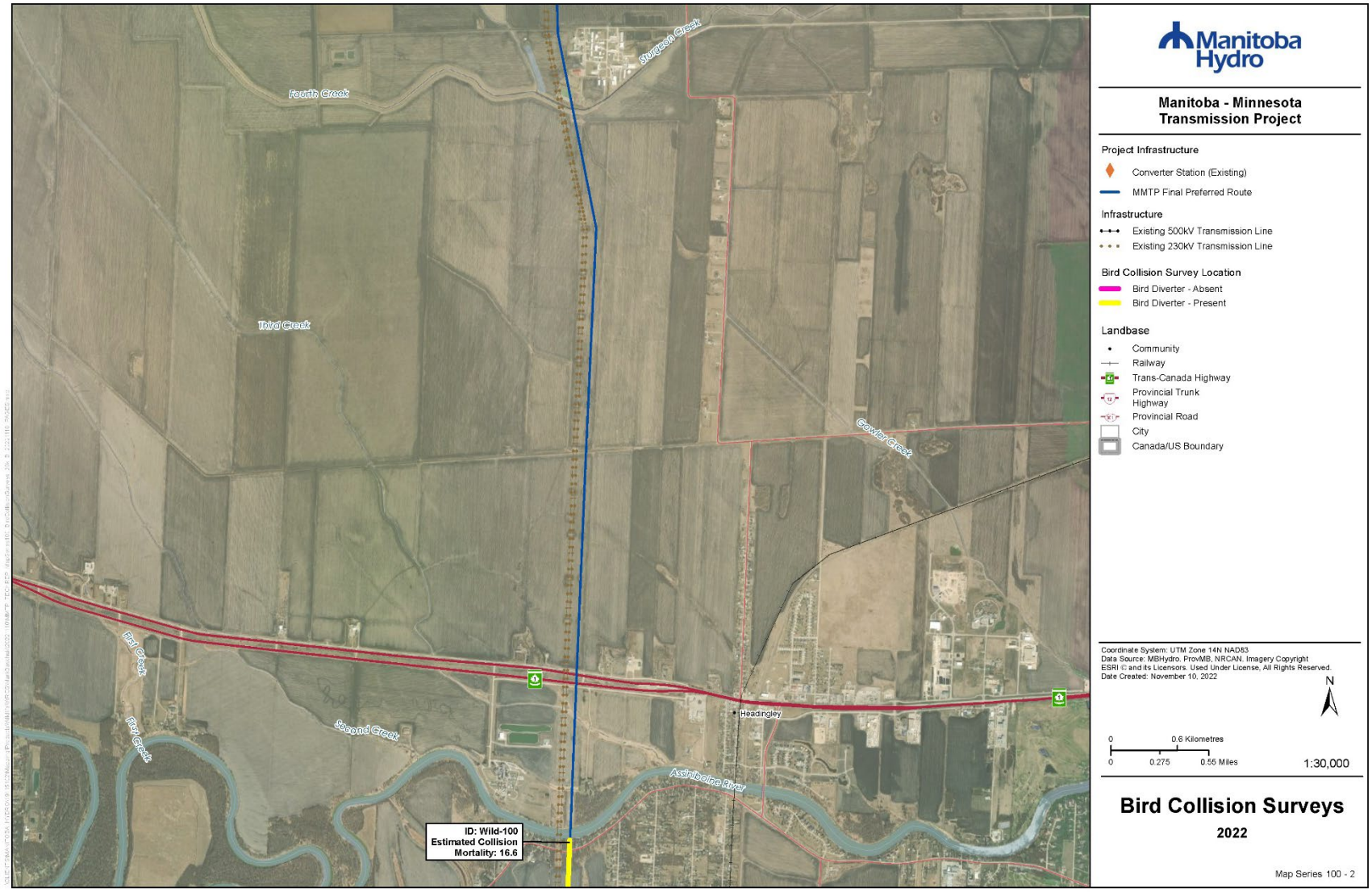
Winnipeg
Riel
Steinbach
Canada
United States of America
WHITEMOUTH LAKE


Fourth Creek
Sturgeon Creek
Third Creek
Cowley Creek
First Creek
Second Creek
River Creek
Headingley
Assiniboine River
ID: Wild-100
Estimated Collision
Mortality: 16.6
Manitoba Hydro
Manitoba - Minnesota
Transmission Project
Project Infrastructure
Converter Station (Existing)
MMTP Final Preferred Route
Infrastructure
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
City
Canada/US Boundary
Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN, Imagery Copyright ESRI © and its Licensors. Used Under License, All Rights Reserved.
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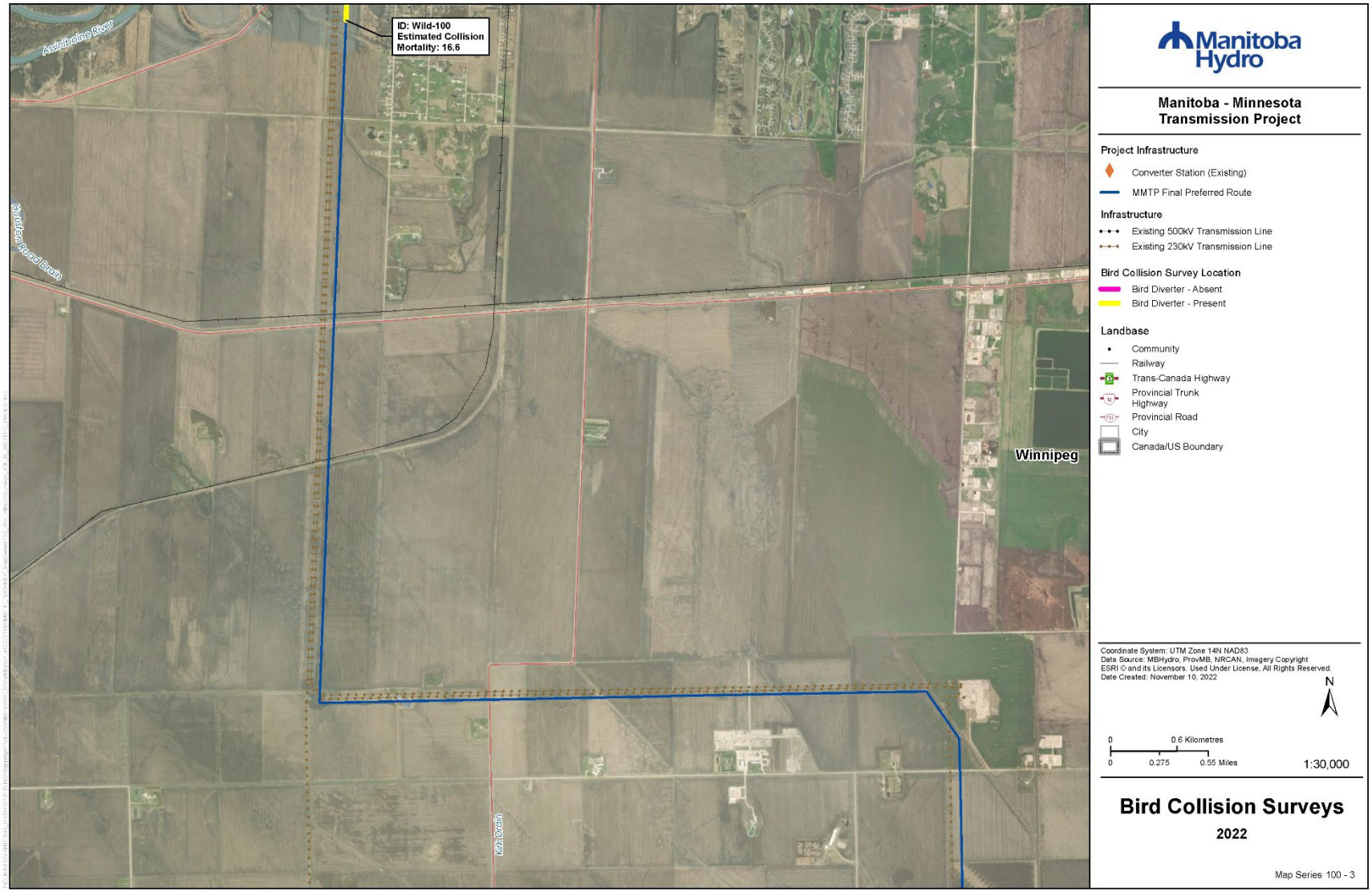
Bird Collision Surveys
2022
Map Series 100 - 2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Estimated Collision
Mortality: 16.6
Assiniboine River
Hudson Road Drain
Kirk Drain
Winnipeg
Manitoba Hydro
Manitoba - Minnesota
Transmission Project
Project Infrastructure
Converter Station (Existing)
MMTP Final Preferred Route
Infrastructure
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
City
Canada/US Boundary
Coordinate System: UTM Zone 14N NAD83
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Date Created: November 10, 2022
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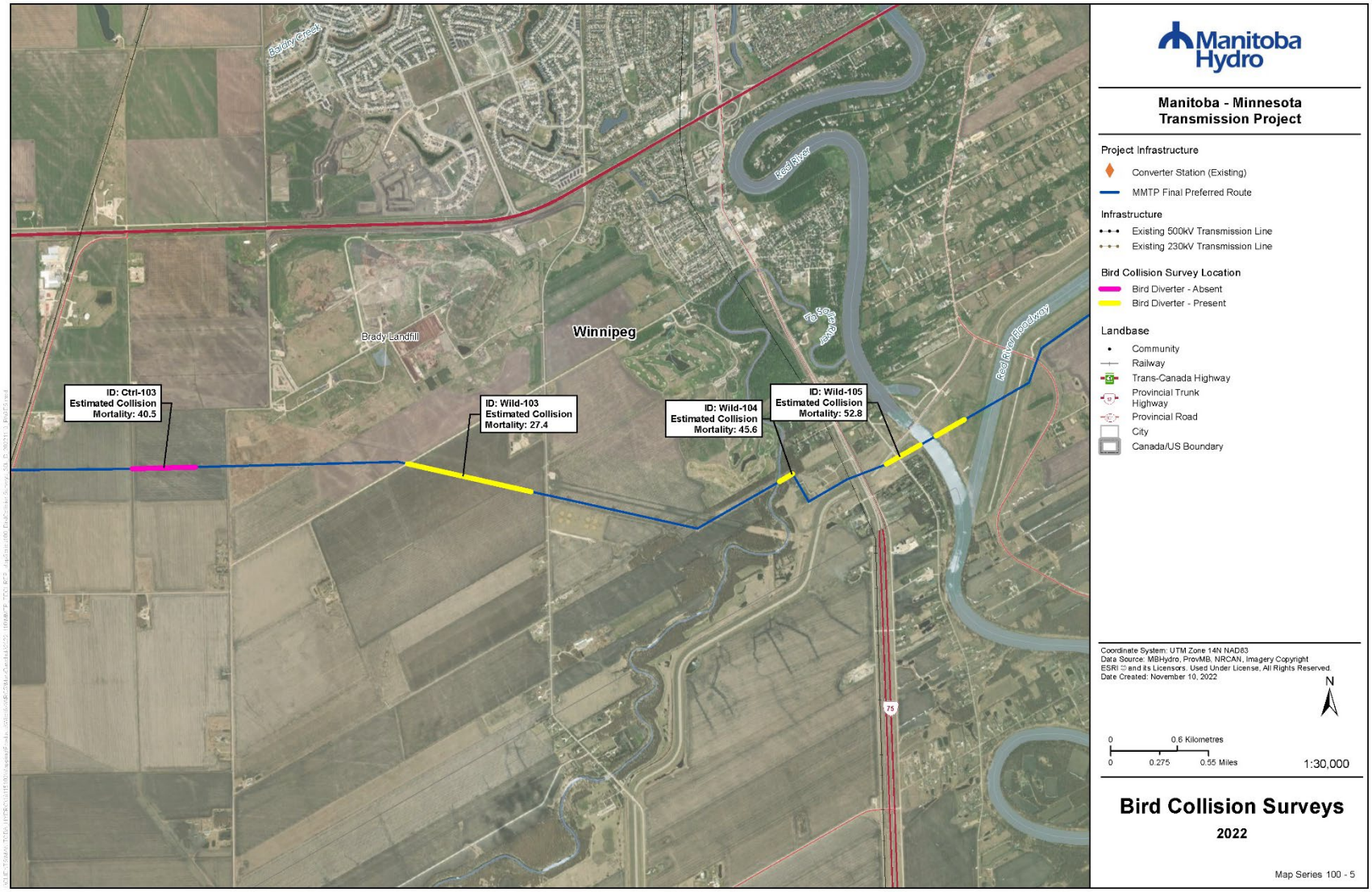
Bird Collision Surveys
2022
Map Series 100 - 3


Manitoba Hydro
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Project Infrastructure
Converter Station (Existing)
MMTP Final Preferred Route
Infrastructure
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
City
Canada/US Boundary
ID: Ctrl-103
Estimated Collision Mortality: 40.5
ID: Wild-103
Estimated Collision Mortality: 27.4
ID: Wild-104
Estimated Collision Mortality: 45.6
ID: Wild-105
Estimated Collision Mortality: 52.8
Brady Landfill
Winnipeg
Red River
Red River Floodway
Coordinate System: UTM Zone 14N NAD83
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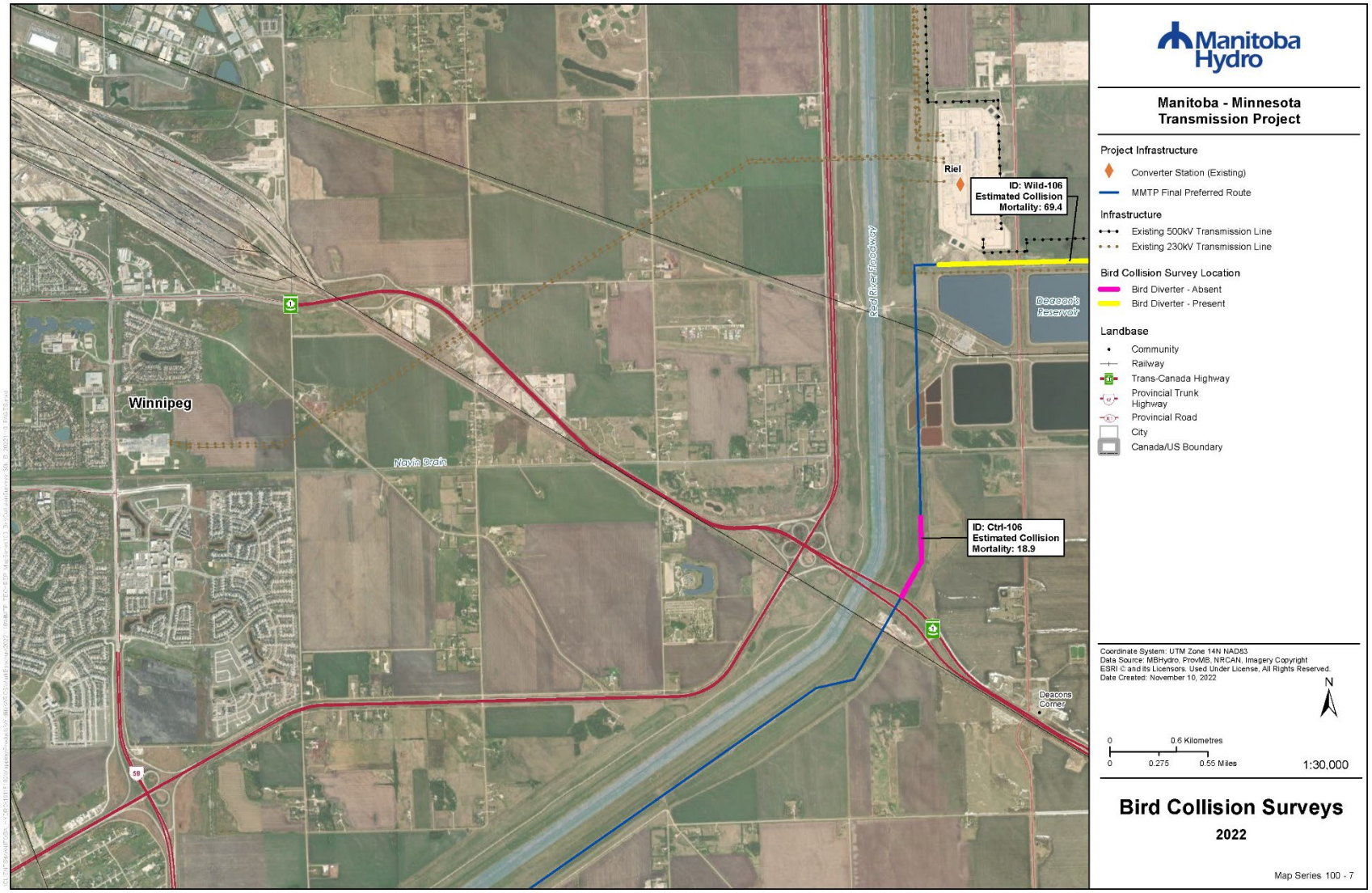
Bird Collision Surveys
2022
Map Series 100 - 5


Manitoba Hydro
Manitoba - Minnesota Transmission Project
Project Infrastructure
Converter Station (Existing)
MMTP Final Preferred Route
Infrastructure
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
City
Canada/US Boundary
Riel
ID: Wild-106
Estimated Collision Mortality: 69.4
ID: Ctrl-106
Estimated Collision Mortality: 18.9
Winnipeg
Mavin Drain
Red River Floodway
Deacon's Reservoir
Deacons Corner
59
Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN, Imagery Copyright ESRI © and its Licensors. Used Under License, All Rights Reserved.
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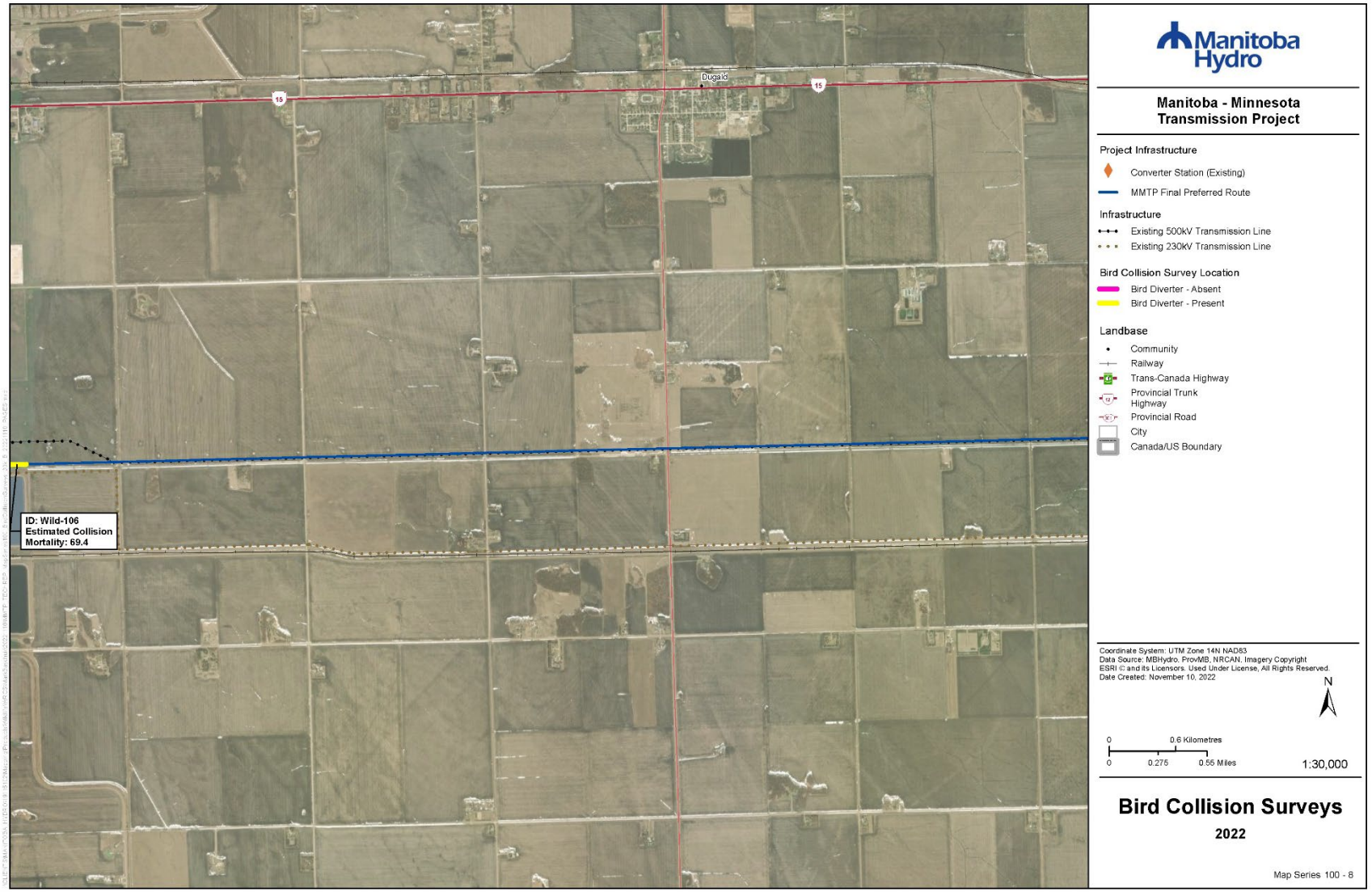
Bird Collision Surveys
2022
Map Series 100 - 7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15
15
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Estimated Collision
Mortality: 69.4
Manitoba Hydro
Manitoba - Minnesota
Transmission Project
Project Infrastructure
Converter Station (Existing)
MMTP Final Preferred Route
Infrastructure
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
City
Canada/US Boundary
Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN, Imagery Copyright
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Date Created: November 10, 2022
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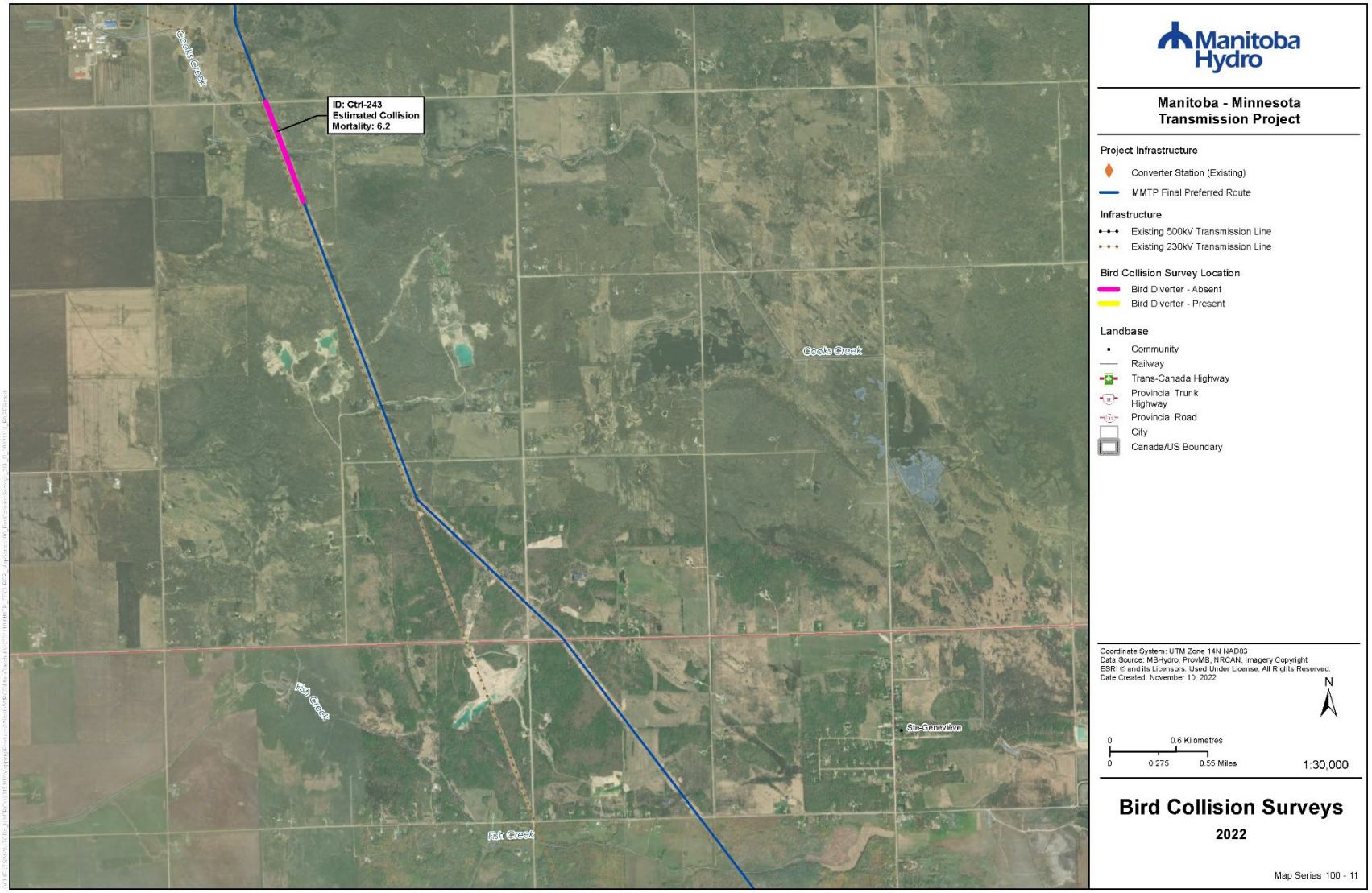
Bird Collision Surveys
2022
Map Series 100 - 8


Cooks Creek
ID: Ctrl-243
Estimated Collision
Mortality: 6.2
Cooks Creek
Fish Creek
Ste-Genevieve
Fish Creek
Manitoba Hydro
Manitoba - Minnesota
Transmission Project
Project Infrastructure
Converter Station (Existing)
MMTP Final Preferred Route
Infrastructure
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
City
Canada/US Boundary
Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN, Imagery Copyright ESRI © and its Licensors. Used Under License, All Rights Reserved.
Date Created: November 10, 2022
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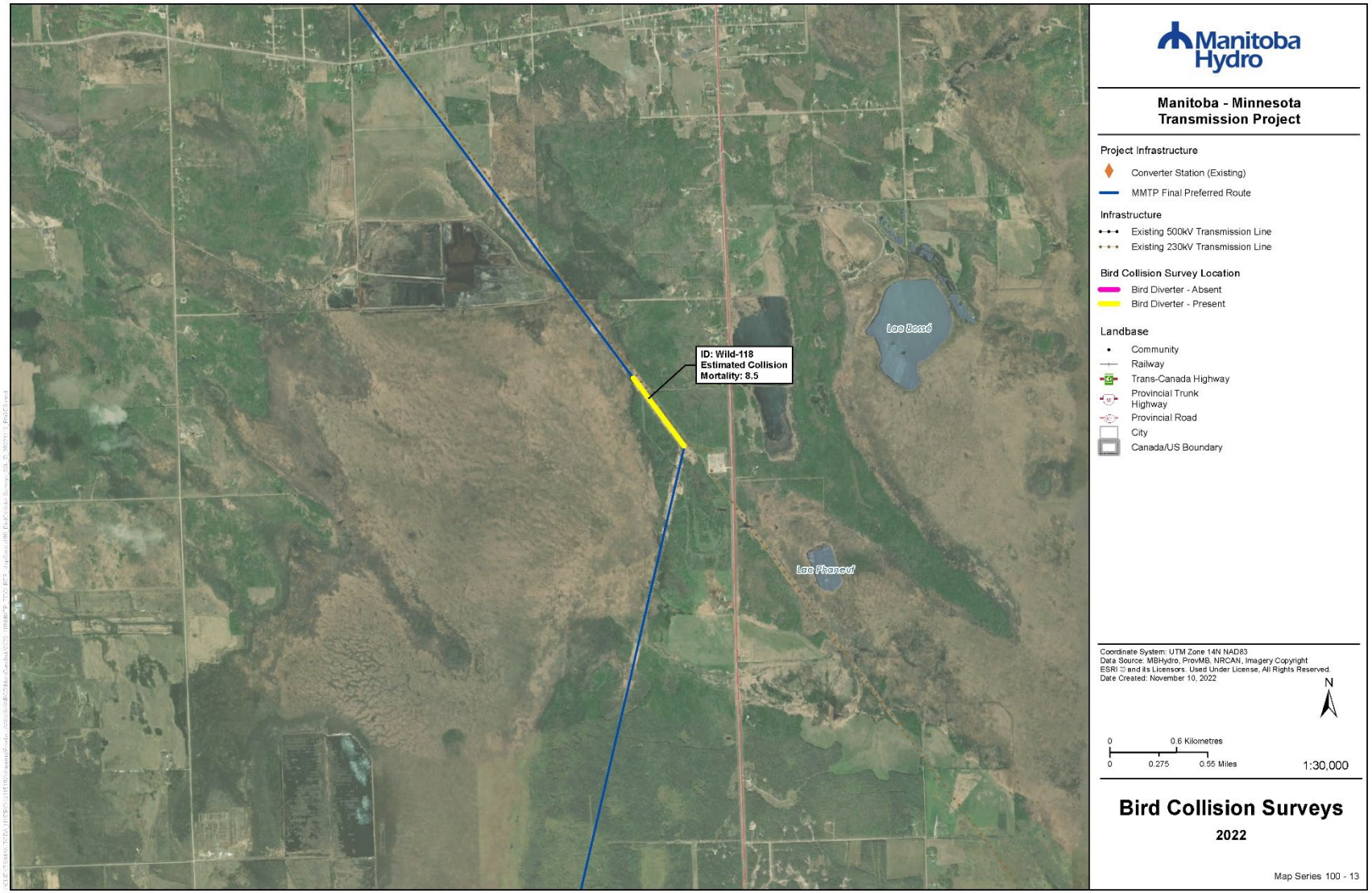
Bird Collision Surveys
2022
Map Series 100 - 11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Estimated Collision Mortality: 8.5
Lac Bossé
Lac Fhaneuf
Manitoba Hydro
Manitoba - Minnesota Transmission Project
Project Infrastructure
Converter Station (Existing)
MMTP Final Preferred Route
Infrastructure
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
City
Canada/US Boundary
Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN, Imagery Copyright ESRI and its Licensors. Used Under License, All Rights Reserved.
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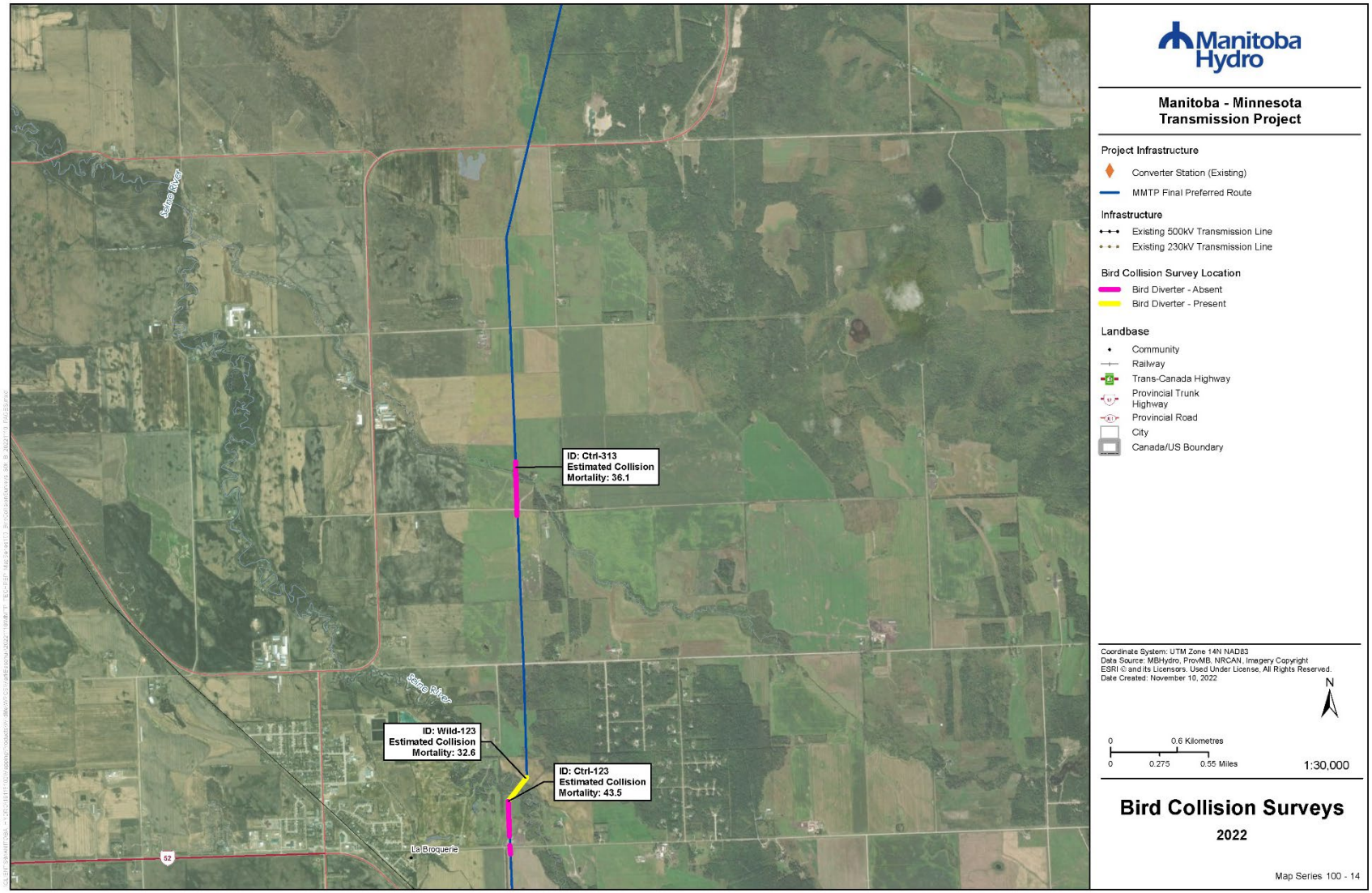
Bird Collision Surveys
2022
Map Series 100 - 13


Manitoba Hydro
Manitoba - Minnesota Transmission Project
Project Infrastructure
Converter Station (Existing)
MMTP Final Preferred Route
Infrastructure
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
City
Canada/US Boundary
Coordinate System: UTM Zone 14N NAD83
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Date Created: November 10, 2022
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Bird Collision Surveys
2022
Map Series 100 - 14
ID: Ctrl-313 Estimated Collision Mortality: 36.1
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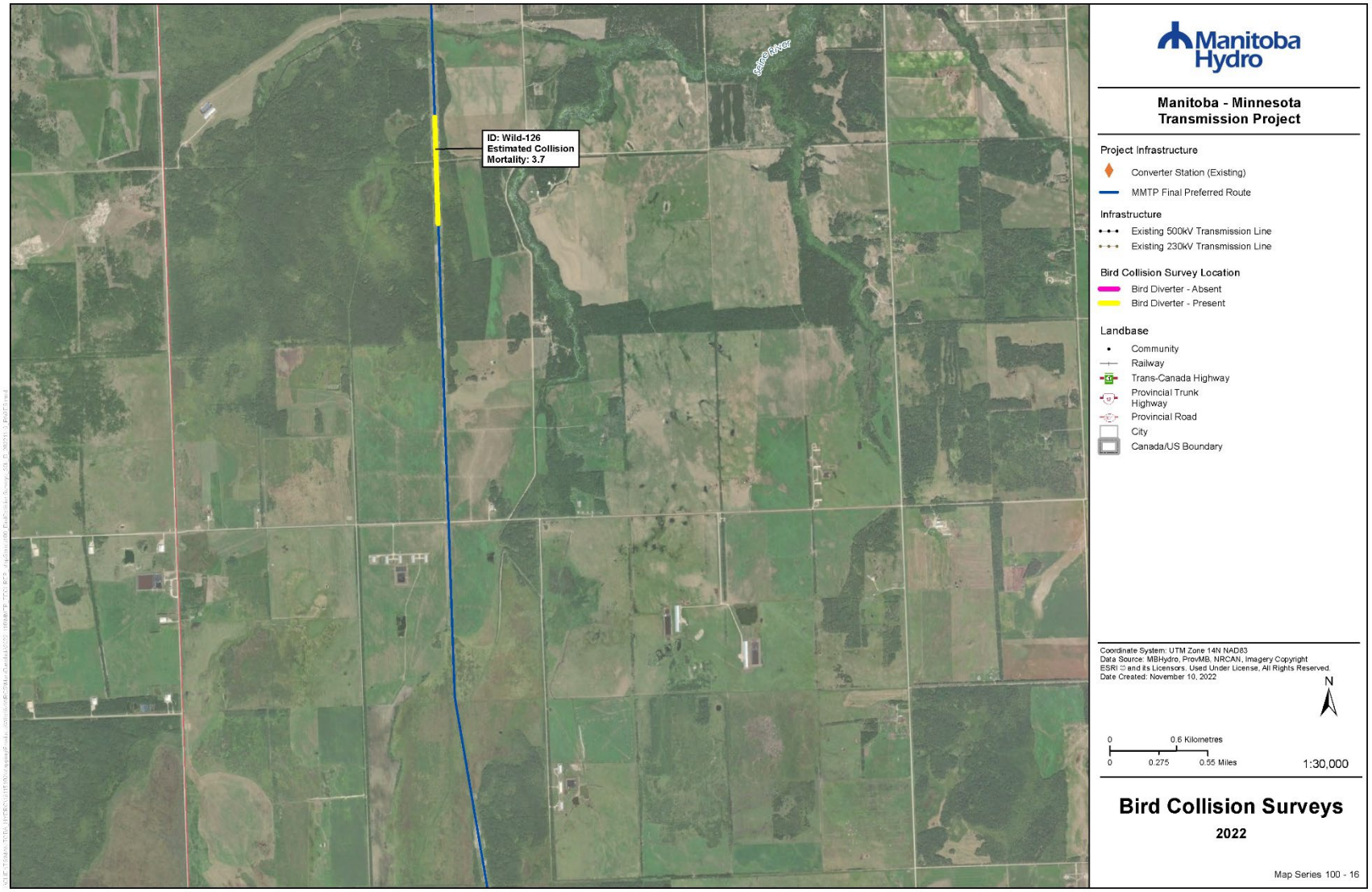
Sturgeon River
Sturgeon River
La Broquerie
52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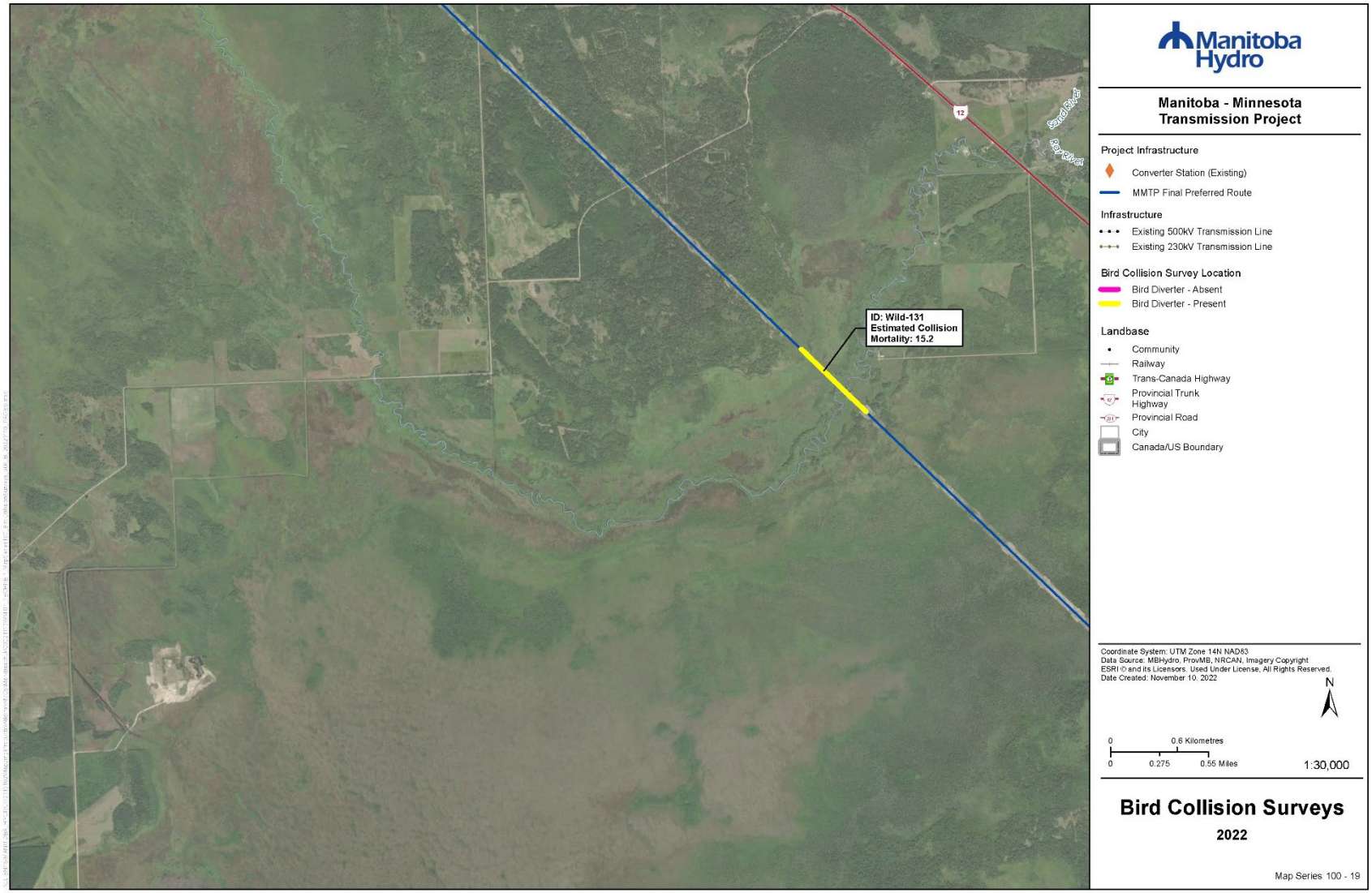
Manitoba Hydro
Manitoba - Minnesota Transmission Project
Project Infrastructure
Converter Station (Existing)
MMTP Final Preferred Route
Infrastructure
Existing 500kV Transmission Line
Existing 230kV Transmission Line
Bird Collision Survey Location
Bird Diverter - Absent
Bird Diverter - Present
Landbase
Community
Railway
Trans-Canada Highway
Provincial Trunk Highway
Provincial Road
City
Canada/US Boundary
Coordinate System: UTM Zone 14N NAD83
Data Source: MBHydro, ProvMB, NRCAN, Imagery Copyright ESRI © and its Licensors. Used Under License, All Rights Reserved.
Date Created: November 10, 2022
N
0 0.6 Kilometres
0 0.275 0.55 Miles
1:30,000
Bird Collision Surveys
2022
Map Series 100 - 16


ID: Wild-131
Estimated Collision
Mortality: 15.2
12
Sand River
Manitoba Hydro
Manitoba - Minnesota
Transmission Project
Project Infrastructure
Converter Station (Existing)
MMTP Final Preferred Route
Infrastructure
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
City
Canada/US Boundary
Coordinate System: UTM Zone 14N NAD83
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Date Created: November 10, 2022
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0.55 Miles
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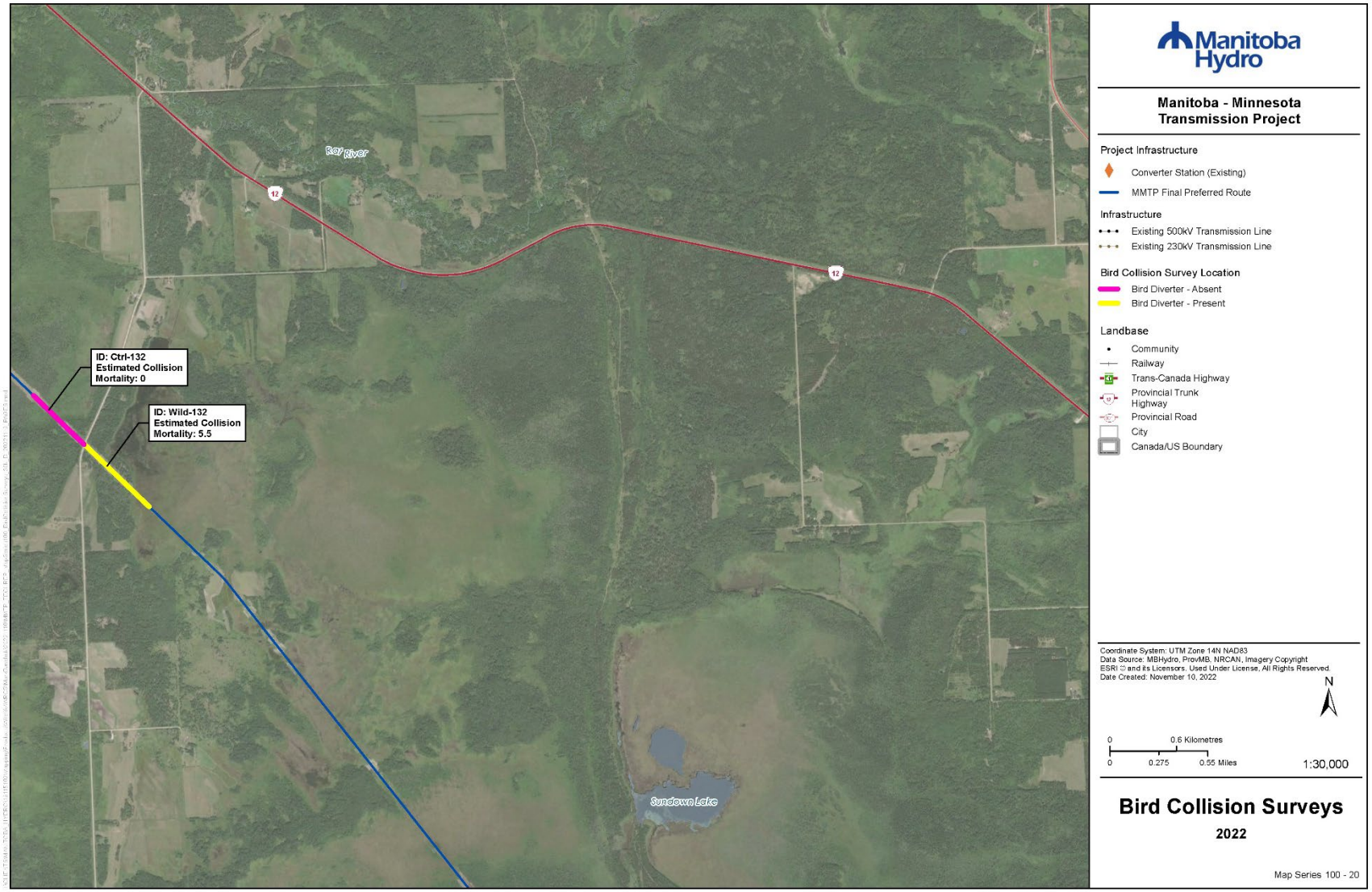
Bird Collision Surveys
2022
Map Series 100 - 19


Roseau River
12
12
ID: Ctrl-132
Estimated Collision
Mortality: 0
ID: Wild-132
Estimated Collision
Mortality: 5.5
Sundown Lake
Manitoba Hydro
Manitoba - Minnesota
Transmission Project
Project Infrastructure
Converter Station (Existing)
MMTP Final Preferred Route
Infrastructure
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
City
Canada/US Boundary
Coordinate System: UTM Zone 14N NAD83
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Date Created: November 10, 2022
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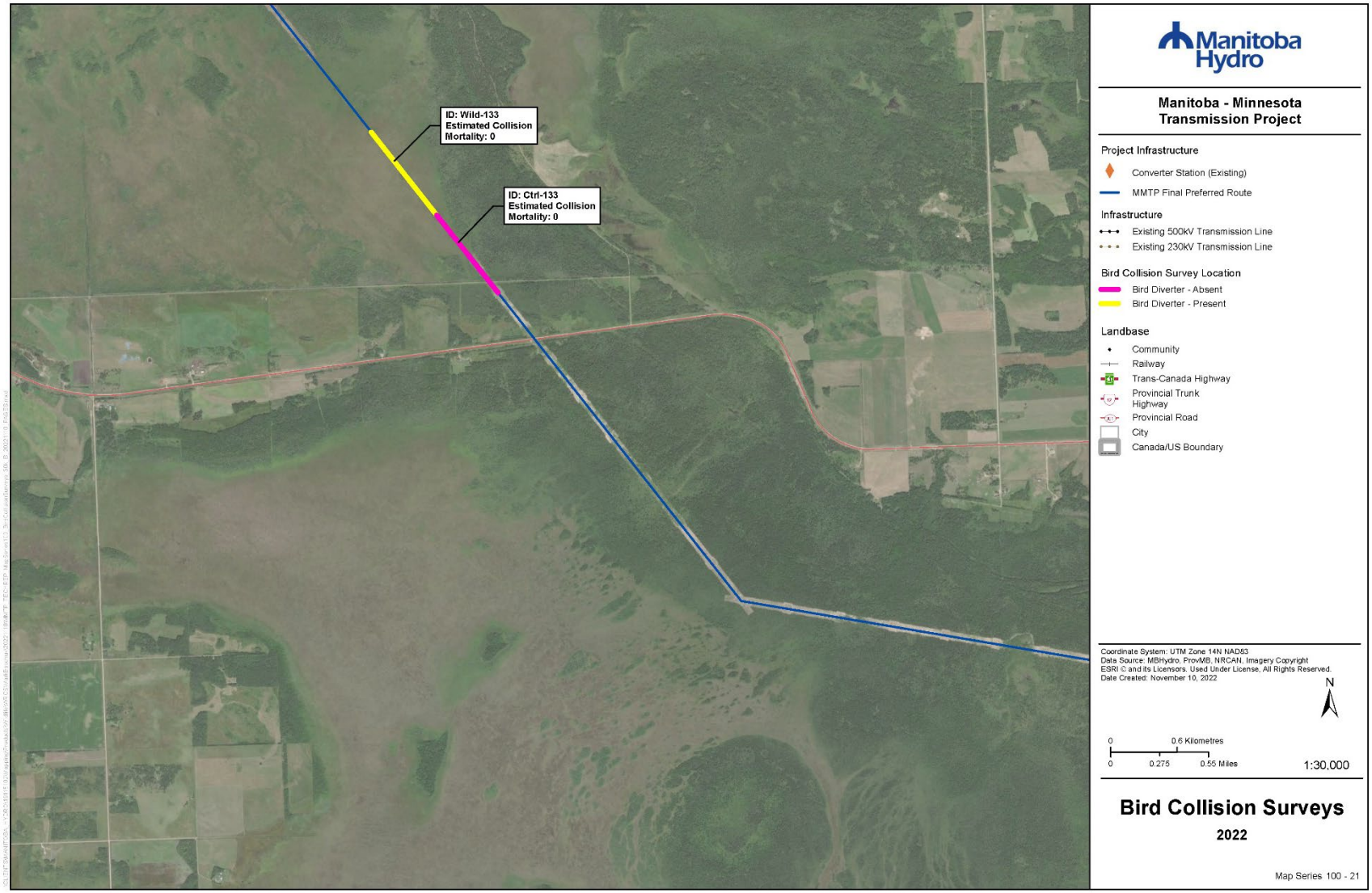
0.275
0.55 Miles
1:30,000
Bird Collision Surveys
2022
Map Series 100 - 20


ID: Wild-133
Estimated Collision
Mortality: 0
ID: Ctrl-133
Estimated Collision
Mortality: 0
Manitoba Hydro
Manitoba - Minnesota
Transmission Project
Project Infrastructure
Converter Station (Existing)
MMTP Final Preferred Route
Infrastructure
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
City
Canada/US Boundary
Coordinate System: UTM Zone 14N NAD83
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Date Created: November 10, 2022
N
0
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0.55 Miles
1:30,000
Bird Collision Surveys
2022
Map Series 100 - 21

Appendix 5

Photos

Photo 1. Song Sparrow Carcass Observed at Site Wild-106, May 2022

Photo 2. Ovenbird Carcass Observed at Site Wild-106, May 2022

Photo 3. Blackpoll Warbler Carcass Observed at Site Wild-106, May 2022

Photo 4. Black and White Warbler Carcass Observed at Site Wild-106, May 2022

Photo 5. Yellow Warbler Carcass Observed at Site Wild-106, May 2022

Photo 6. Yellow-rumped Warbler Carcass Observed at Site Ctrl-243, May 2022

Photo 7. Sora Carcass Observed at Site Wild-103, June 2022

Available in accessible formats upon request