KEEYASK TRANSMISSION PROJECT

ENVIRONMENTAL EFFECTS MONITORING PLAN

ECOSYSTEM DIVERSITY, PRIORITY PLANT AND INVASIVE PLANT MONITORING FROM 2016 TO 2019

Prepared for

Manitoba Hydro

By

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May 2020

This report should be cited as follows:

ECOSTEM Ltd. 2020. Keeyask Transmission Project: Environmental Effects Monitoring – Ecosystem Diversity, Priority Plant and Invasive Plant Monitoring from 2016 to 2019. A report prepared for Manitoba Hydro by ECOSTEM Ltd., May 2020.

SUMMARY

In 2014, Manitoba Hydro received an Environment Act Licence for the construction, operation and maintenance of the Keeyask Transmission Project (the Project). The Project consists of a Construction Power line and Station; four Unit lines originating at the Keeyask Generating Station, and terminating at the Keeyask Switching Station; and three Generation Outlet Transmission (GOT) lines link the Keeyask Switching Station to the northern collector system, terminating at the Radisson Converter Station.

Licence requirements include monitoring the environmental effects of the Project as outlined in the licence conditions and the Project Environmental Assessment (EA) Report (Manitoba Hydro 2012). The Keeyask Transmission Project Environmental Effects Monitoring Plan (Manitoba Hydro 2015) describes how this monitoring will be undertaken.

The Environmental Effects Monitoring Plan includes monitoring effects on terrestrial ecosystems and vegetation, focusing on intactness, ecosystem diversity, priority plants and invasive plants.

This report presents the findings from the ecosystem diversity, priority plant and invasive plant monitoring conducted from 2016 to 2019.

Ecosystem Diversity

Ecosystem diversity is a type of biodiversity that essentially refers to the variety of ecosystem types. Maintaining native ecosystem diversity is fundamental to maintaining terrestrial ecosystem health. The ecosystem diversity monitoring uses stand level habitat composition and priority habitat types as the indicators for ecosystem diversity. Priority habitat types are those native habitat types that are regionally rare or uncommon, highly diverse (i.e., species rich and/or structurally complex), highly sensitive to disturbance or have high potential to support rare plants.

The EA Report predicted that, before considering additional mitigation measures, the Project was expected to affect 32 of the 46 priority habitat types, and the effects would be relatively small. Even with the very small Project effects, the EA Report concluded that cumulative effects on ecosystem diversity from past and current projects and activities were already in the moderate magnitude range. On this basis, mitigation included avoiding all of the priority habitat types to the extent practicable during final routing of the transmission lines. Additionally, the Project's Environmental Protection Plans (EnvPPs) include measures to minimize the risk that accidental fires and accidental spills will affect priority habitat, and measures to minimize the risk that invasive plants will affect terrestrial habitat and plants.

Project effects on ecosystem diversity were evaluated based on the degree to which the priority habitat identified for avoidance was not disturbed, and on changes to ecosystem diversity metrics.

Habitat mapping completed for the EA report showed that 125 patches of priority habitat existed along the Construction Power, Generation Outlet Transmission and Unit Line rights-of-way

(ROWs) prior to construction. Project impacts (i.e., clearing or physical disturbance) and indirect effects on the priority habitat patches along the ROWs were documented through aerial and ground surveys. The extent of Project clearing in priority habitat was mapped using high resolution digital ortho-imagery.

The monitoring found that actual Project effects on ecosystem diversity were less than predicted in the EA Report. Additionally, there were no unanticipated Project effects.

Monitoring showed that Project clearing in priority habitat as of September 2019 was 7% less than predicted. Due to a smaller footprint, estimated long-term indirect Project effects on priority habitat were 17% less than predicted.

As expected, 47 of the 125 priority habitat patches that existed along the Project footprint prior to construction were entirely or almost entirely removed by Project clearing. In contrast, there were only minor Project effects on the portions of priority habitat patches that were outside of the standard cleared ROW corridor width. Only one of the effects was large enough to be seen during low-altitude aerial surveys. All of the remaining effects were localized, small in area and never extending more than 20 meters from the edge of ROW clearing. The types of effects included tree damage, tree collapse, tree mortality, understorey vegetation mortality and understorey vegetation loss.

The number of affected priority habitat types was the same as predicted. While some types had lower effects than predicted, others had higher effects. Three of the priority habitat types with higher than predicted effects were of potential concern because they already had relatively high regional cumulative effects without the Project. The increases for all three types were substantially less than needed to reach the cumulative effects benchmark that would flag them for potential further mitigation.

Further substantive increases in long-term Project effects are not expected because additional clearing or physical disturbance is not planned, and because ROW maintenance activities are expected to be confined to the existing cleared ROW. Even if unanticipated additional clearing or physical disturbance occurs in the future, the amount of area that would be required to change the conclusions regarding effects significance are much too high except for extremely rare habitat types (which should be protected by EnvPPs).

There are no recommendations for revisions to the EnvPPs. Monitoring indicated that EnvPP measures were implemented well during Project construction.

There are no recommendations for further mitigation given that estimated long-term effects are substantially less than predicted and substantial future increases are not expected.

It is recommended that ecosystem diversity monitoring be discontinued given that long-term Project effects are expected to be substantially less than predicted and the risk of unanticipated future effects is low.

Priority Plants

Priority plants are defined as those plants that are particularly important for ecological and/or social reasons. Priority plants are the native plant species that are highly sensitive to Project features, make high contributions to ecosystem function and/or are of particular interest to the KCNs. Based on the findings compiled for the EA Report and from previous extensive research in the study region, the environmental assessment and monitoring focused on the known locations of regionally rare plants, and on changes in the amount of priority plant habitat.

The EA Report predicted that Project effects on priority plant species were expected to be low. The rarest species were not known to occur in the Project footprint, or in the vicinity of it. For the remaining species, Project effects were expected to be nil or low, depending on the species. The reasons for this were that less than 1% of their known sites and less than 1% of their habitat would be affected by the Project.

Field surveys to document effects on the known priority plant sites were conducted in August, 2016 (all ROW clearing had been completed at the time of the surveys). The post-Project terrestrial habitat mapping was used to estimate the amounts of affected priority plant habitat.

Monitoring found that actual Project effects on priority plants were low, as predicted. There were no unanticipated Project effects.

There were virtually no Project effects on the known priority plant sites. Also, Project clearing, physical disturbance and indirect effects in priority plant habitat were low.

Project effects on priority plants are not expected to increase substantially in the future as further clearing or physical disturbance outside of the ROWs is not planned, and because ROW maintenance activities are expected to be confined to the existing cleared ROW.

There are no recommendations for revisions to the Environmental Protection Plans.

There are no recommendations for further mitigation given that estimated long-term effects are substantially less than predicted and substantial future increases are not expected.

It is recommended that priority plant monitoring be discontinued. The plants at the known sites appeared to be healthy, and it is unlikely that there will be substantive future Project effects on the known priority plant sites or on priority plant habitat. Additionally, other Project monitoring has indicated that the Project is not substantially increasing the risk that invasive plants will adversely affect priority plant species or their habitat.

Invasive Plants

Non-native plants are those plants that are growing outside of their country or region of origin. Invasive plants are those non-native plants that can outcompete or even replace native plants. Invasive plants are of concern because they can materially affect rare plant species, alter soil conditions and, in extreme cases, change vegetation composition or other ecosystem attributes.

Other non-native plant species are also of interest because they may become invasive under some local conditions, or may become invasive in the future due to changing climate.

The EA Report predicted that the Project was not expected to substantially increase the rate at which invasive plants would be introduced and/or spread in the Project area. The vast majority of clearing is in undisturbed native habitat (i.e., places where invasive plants are typically absent). Also, the EnvPPs include measures to minimize the risk that Project equipment and activities would transport invasive plants into the Project area.

Invasive plant monitoring documented the degree of non-native plant introduction and spread in the ROWs and recommended control measures, if needed. Non-native plant distribution and abundance were documented through ground surveys conducted along permanent transects, meandering surveys in the cleared ROW and incidental observations from the other terrestrial habitat and ecosystems monitoring. Surveys were conducted in every year from 2016 to 2019. A total of 11.1 km of permanent transects were sampled in every year except in 2016 when 8.1 km were sampled.

Invasive plant monitoring to date has found that there has been limited introduction and spreading of non-native plant in the cleared ROWs. Non-native plants were found at one site in 2016 and at four sites in 2017. Relatively large increases in the number of sites and total non-native plant cover did not occur until 2018. However, total non-native cover remained low, and distribution remained limited to a few locations in 2019.

The likely explanation for why non-native plant cover remained very low in the cleared portions of the ROW was a combination of: (i) a very low proportion of the ROW area having exposed mineral substrates; the relatively short time since ROW clearing; limitations on potential seed input; and, increasing native plant cover. The large increase in the number of sites with non-native plants between 2017 and 2018 was linked to the construction of the South Access Road for the Keeyask Generation Project and to Project spreading of plants that were long-established in the Radisson Converter Station footprint.

Only two species, field sow-thistle and white sweet clover, were classified as being of relatively high invasive concern for the Project area. Small patches or individual field sow-thistle plants found during the surveys were immediately removed by ECOSTEM staff due to their relatively high level of concern and the small number of plants. White sweet clover plants, which were found at two sites, were not removed by ECOSTEM staff because they had already become established along the South Access Road.

There are no definite recommendations regarding modifications to the EnvPPs. To the extent we are aware of how the EnvPP measures were implemented, they appeared to have been effective in limiting the introduction and spreading of invasive plants.

Control recommendations are not provided at this time for the same reasons as during the monitoring. Promoting the expansion of native herbaceous and low shrub vegetation in the ROW and, where allowable, in the SAR corridor is expected to be the best way to limit the expansion of non-native plants in the ROW.

It is recommended that invasive plant monitoring be discontinued for several reasons. Project effects are consistent with predictions, the two recorded species of invasive concern are either close to or part of much larger patches in the South Access Road corridor, the ongoing regeneration of native plants will likely control these species and the risk of unanticipated future effects is low.

ACKNOWLEDGEMENTS

ECOSTEM Ltd. would like to thank Manitoba Hydro for sponsoring this monitoring. Particular thanks go to Jonathan Wiens for coordinating the terrestrial monitoring studies, to Trevor Barker for managing fieldwork logistics, David Block, and to on-site Manitoba Hydro staff, including Megan Anger, Rachelle Budge, Kim Bryson, Caroline Walmsley, Gord Macdonald, Michele Nicholson, Tanner Booth, Brian Fournier and Linda Campbell for their support and assistance in planning field activities and access to the sites.

Chiefs and Councils of Tataskweyak Cree Nation (TCN), War Lake First Nation (WLCN), York Factory First Nation (YFFN) and Fox Lake Cree Nation (FLCN) are gratefully acknowledged for their support of this program. We would also like to thank Clayton Flett and Terry Kitchekeesik of TCN for arranging logistic support and providing field staff for studies.

We would also like to thank North/South Consultants Inc., in particular Ron Bretecher, Shari Fournier, Regan Caskey and Mary Lang for their guidance, logistical support and other resources that made these studies possible. Additionally, we thank Wildlife Resource Consulting Services field staff for cooperating on fieldwork logistics.

Custom Helicopters and its pilots are gratefully acknowledged for providing transportation during fieldwork and Nicole Pokornowska and Ben Hofer for coordinating the logistics.

STUDY TEAM

Dr. James Ehnes was the project manager and study designer.

Fieldwork was conducted by Brock Epp, Nathan Ricard, Alex Snitowski and Alanna Sutton of ECOSTEM Ltd.; and Barry Flett from TCN.

Data analysis and report writing were completed by Brock Epp and James Ehnes. GIS analysis and cartography were completed by Alex Snitowski, Nathan Ricard and James Ehnes.

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1.0 INTRODUCTION

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2.0 ECOSYSTEM DIVERSITY

2.1 INTRODUCTION

Ecosystem diversity refers to the number of different ecosystem types and their areal distribution at various ecosystem levels. Maintaining native ecosystem diversity is fundamental to maintaining terrestrial ecosystem functions and overall ecosystem health.

The indicators for ecosystem diversity are stand level habitat composition and priority habitat types. Priority habitat types are those native habitat types are regionally rare or uncommon, highly diverse (i.e., species rich and/or structurally complex), highly sensitive to disturbance or have high potential to support rare plants.

The EA Report (Manitoba Hydro 2012) predicted that, before considering additional mitigation measures, Project construction is expected to affect 32 of the 46 priority habitat types, and the effects would be relatively small. Project construction will not change the total number of native broad habitat types in the region, and changes in the regional representation of the affected regionally common or uncommon native habitat types is expected to be very small (<=0.01%).

Even with the very small Project effects, the EA Report concluded that cumulative effects on ecosystem diversity from past and current projects and activities were already in the moderate magnitude range for all of the affected priority habitat types. On this basis, mitigation included avoiding all of the priority habitat types to the extent practicable during final routing of the transmission lines. Also, the EnvPPs include measures to minimize the risk that accidental fires and accidental spills will affect priority habitat. The EnvPPs will include measures to minimize the risk that invasive plants will affect terrestrial habitat.

The objectives of the ecosystem diversity monitoring (Manitoba Hydro 2015) are to:

- Determine the degree that priority habitat patches identified for avoidance where practical, are not disturbed; and,
- Confirm actual project effects on ecosystem diversity during construction.

2.2 METHODS

Section 4.2.3 of the Project's monitoring plan (Manitoba Hydro 2015) outlines the methods for the ecosystem diversity monitoring. The following summarizes the methods for the activities conducted during 2016 and 2018.

Habitat mapping completed for the Project environmental impact assessment studies was used to identify priority habitat patches intersecting or within 20 m of Project ROW clearing. This identified 15 patches for the Construction Power ROW (Table 2-1) and 110 patches for the GOT and Unit Line ROWs (Table 2-2).

Aerial surveys of the ROWs were conducted by two qualified surveyors in a Bell Jet Ranger helicopter. During these surveys, one person noted any disturbances that could potentially affect the mapped priority habitat patches adjacent to the ROW as the helicopter flew along each side of the ROW. That person also identified any additional priority habitat patches that were not present in the mapping. Meanwhile, the second surveyor acquired low-level oblique photography of the entire cleared ROW. These photos were reviewed in the office for any evidence that a priority habitat patch had been missed. The photos and aerial survey notes were used to further document effects on the known priority habitat patches.

Ground surveys were then conducted by a terrestrial ecologist in selected priority habitat patches identified by the mapping and aerial survey. At each of these patches, the surveyor noted any disturbances, including clearing within the patch that was outside of the standard ROW corridor width, understory impacts and unusual impacts within the adjacent transmission ROW (e.g. deep rutting). The standard cleared ROW widths are 60 m for Construction Power, 200 m for GOT and 265 m for Unit Lines. The location of any encountered impact was recorded with a handheld GPS unit, and photos were acquired.

Rutting or excavation in the ROW was recorded because these impacts could potentially have indirect effects on soils or vegetation in the physically undisturbed portion of the priority habitat patch. Examples of potential sources of indirect effects from these impacts include tree root damage or alterations to surface or ground water.

An observed change was described in terms of the relevant Project impacts at that location and the associated direct and indirect effects on priority habitat. In this report, an impact is what the Project did in terms of the ecosystem component of interest (e.g. vegetation clearing). An effect is any direct or indirect consequence of the source impact (e.g. habitat loss).

Field surveys in 2016 were conducted along the Construction Power ROW and the western portion of the Generation Outlet Transmission (GOT) ROW (Map 2-1) on July 7, 2016. Ground surveys of the 15 priority habitat patches along the Project ROW were conducted on August 20 and 21, 2016.

Field surveys in 2018 were conducted along the GOT and Unit Line ROWs. Forty-seven of the 110 priority habitat patches were not surveyed because they fell either entirely or almost entirely within the cleared ROW. The remaining 63 priority habitat patches were surveyed by air on July 6, 2018 (Map 2-1). The 23 patches that were within walking distance of a road were ground surveyed on July 7 to 9, 2018.

Following the field surveys, available information was reviewed for the possible causes of any changes observed in the priority habitat patches. Included in this review was an evaluation as to whether or not the change was caused by the Project.

Table 2-1: Number of priority habitat patches adjacent to or overlapping the Construction Power ROW, by habitat and their survey type

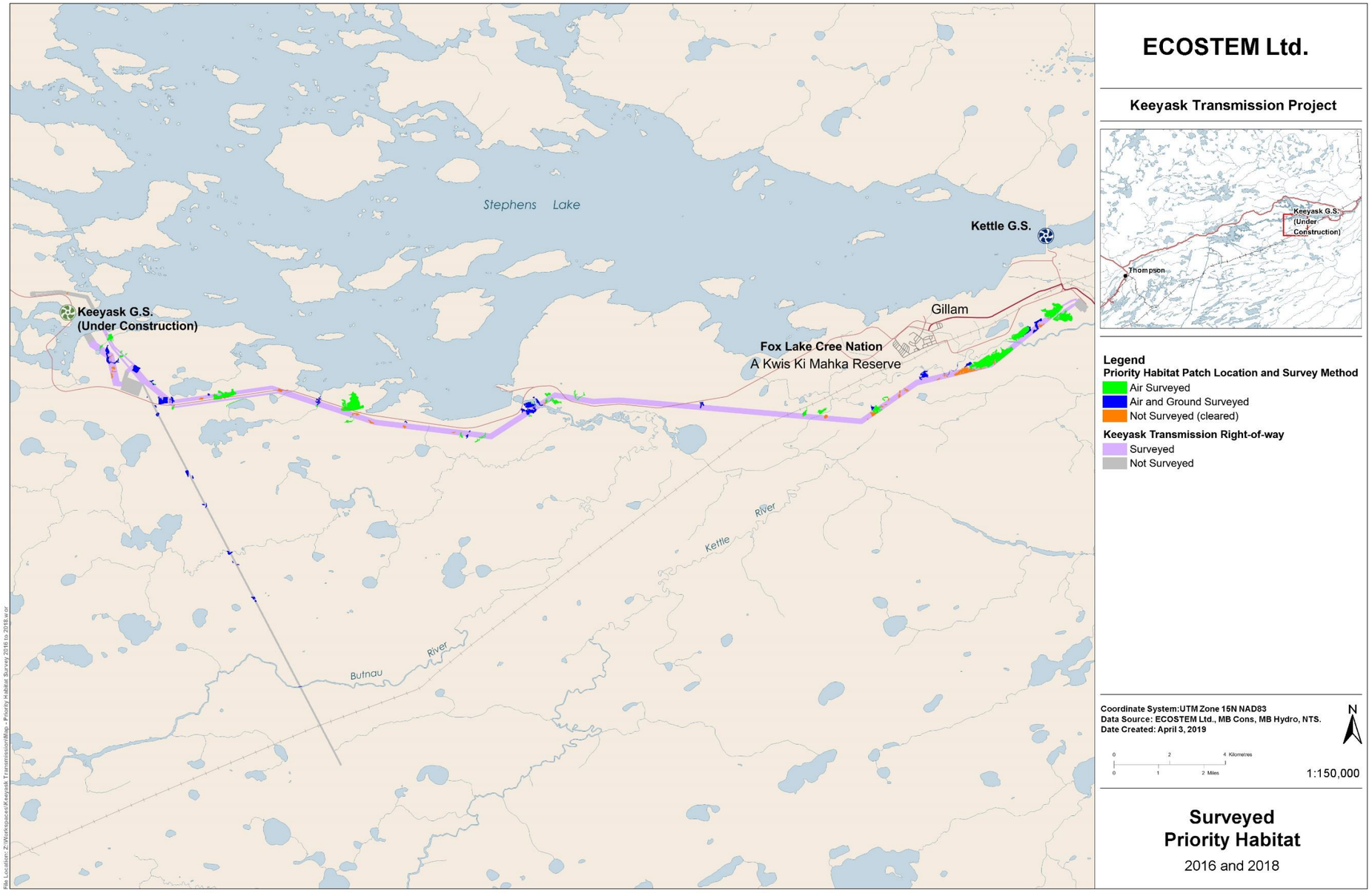
Priority Habitat Type	EnvPP Sensitivity Type	Total Number of Patches	Surveyed by Air and Ground
Black spruce mixture on shallow peatland	Rare forest/woodland on peatland	2	2
Tall shrub on thin peatland	Rare tall shrub on peatland	1	1
Tamarack mixture on mineral	Rare, highly affected upland forest/woodland	4	4
Tamarack mixture on shallow peatland	Rare, highly affected forest/woodland on peatland	2	2
Tamarack mixture on thin peatland	Rare, highly affected forest/woodland on peatland	2	2
Low vegetation on riparian peatland	Riparian wetland	1	1
-	Rare Plant Habitat	3	3
All Patches		15	15

Table 2-2: Number of priority habitat patches adjacent to or overlapping the GOT and Unit Line ROWs, by habitat and type.

Priority Habitat Type	EnvPP Sensitivity Type	Total Number of Patches	Not Surveyed[1]	Surveyed by Air Only	Surveyed by Air and Ground
Black spruce dominant on riparian peatland	Riparian wetland	6	1	5	-
Black spruce mixedwood on mineral	Rare upland forest/woodland	3	3	-	-
Black spruce mixedwood on thin peatland	Rare, highly affected upland forest/woodland	2	2	-	-
Black spruce mixture on mineral	Rare, highly affected upland forest/woodland	6	3	2	1
Black spruce mixture on shallow peatland	Rare forest/woodland on peatland	9	4	5	-
Black spruce mixture on thin peatland	Uncommon forest/woodland on peatland	20	7	1	12
Jack pine dominant on mineral	Rare, highly affected upland forest/woodland	9	3	6	-
Jack pine mixedwood on mineral	Rare, highly affected upland forest/woodland	1	-	1	-
Jack pine mixture on thin peatland	Rare, highly affected upland forest/woodland	5	3	-	2
Tall shrub on riparian peatland	Riparian wetland	4	1	1	2
Tall shrub on shallow peatland	Rare tall shrub on peatland	1	-	1	-
Tall shrub on thin peatland	Rare tall shrub on peatland	5	2	1	2
Tall shrub on wet peatland	Uncommon tall shrub peatland	1	-	1	-
Tamarack dominant on mineral	Rare, highly affected upland forest/woodland	2	1	1	-
Tamarack dominant on shallow peatland	Rare forest/woodland on peatland	1	1	-	-
Tamarack dominant on wet peatland	Uncommon forest/woodland on wet peatland	1	-	1	-
Tamarack mixture on mineral	Rare, highly affected upland forest/woodland	1	1	-	-
Tamarack mixture on shallow peatland	Rare, highly affected forest/woodland on peatland	12	5	6	1
Tamarack mixture on thin peatland	Rare, highly affected forest/woodland on peatland	14	8	3	3
Trembling aspen dominant on all ecosites	Rare, rich, highly affected upland forest/woodland	5	2	3	-
Trembling aspen mixedwood on all ecosites	Rare, rich, highly affected upland forest/woodland	1	-	1	-
Tamarack- black spruce mixture on riparian peatland	Riparian wetland	1	-	1	-
All patches		110	47	40	23

Notes: [1] Not surveyed because they were either entirely or mostly cleared.

2.2.1 MAPS



Map 2-1: Priority habitat patches surveyed by method in 2016 and 2018

2.3 RESULTS

2.3.1 PRIORITY HABITAT PATCHES

The following summarizes key monitoring results for the priority habitat patches within or adjacent to the Project Footprint. For further details, see the annual reports (ECOSTEM 2017a and 2019b).

2.3.1.1 CONSTRUCTION POWER ROW

Habitat mapping completed for the Project environmental impact assessment studies identified 15 priority habitat patches along the Construction Power ROW (Map 2-1). Twelve of the habitat patches were included due to their regional rarity, degree of past cumulative effects, or being riparian habitat (Table 2-4). The remaining three priority habitat patches were included because they were a terrestrial habitat type that may support rare plant species.

Priority habitat patches that were not already shown in the habitat mapping were not identified from the aerial survey of the Construction Power ROW conducted in 2016 and the subsequent review of the oblique aerial photos acquired during this survey.

Clearing or disturbance (e.g., trails, machine disturbance) of the priority habitat patches outside of the ROW were not detected from the aerial survey and the subsequent review of the oblique aerial photos acquired during this survey.

Relative to their pre-Project boundaries, impacts on the 15 priority habitat patches were generally limited (Table 2-4). Map 2-2 shows the status of the priority habitat patches, including any impacts at each patch.

Ten of the priority habitat patches had some clearing where they overlapped the ROW. The remaining five patches had no clearing either because they were separated from the cleared ROW by undisturbed vegetation, or because clearing within the ROW was unnecessary (the native vegetation was already short and clearing occurred in the winter).

In four of the ten patches with some ROW clearing, the clearing was limited to either a narrow band or clearing of larger trees. The substrate and low vegetation were not disturbed (Photo 2-6). These situations occurred in wetlands with low vegetation or very sparse tree cover.

One priority habitat patch (PH0938) had clearing that extended into the patch beyond the standard ROW clearing width. The additional impact was an approximately 20 m^2 area that included cleared trees, mechanical damage to the surrounding trees and mechanical disturbance of the substrate (Photo 2-2).

Three other priority habitat patches (PH1271, PH0910 and PH0001) had tree mortality in the undisturbed forest adjacent to the ROW (Photo 2-7). At these patches, all of the dead trees were tamaracks (*Larix laricina*). The mortality was limited to areas adjacent to the ROW, extending

from a few metres, up to 20 metres into the undisturbed forest. Tamarack trees further from the ROW appeared healthy.

Deep rutting from two sets of vehicle tracks was present within the ROW adjacent to patch PH9998 (Photo 2-8). At other locations within the ROW with shallow organic substrates, deep excavations were also present. These excavations were deep enough to collect water, and potentially affect local drainage. While these usually appeared to be places where material for transmission tower foundation construction was excavated, these excavations or disturbances were at least 80 m from towers at locations near priority habitat patches PH9998 and PH0001 (Photo 2-5).

Table 2-3: Status of priority habitat patches adjacent to the Construction Power ROW in 2016.

Patch ID	Reason Included as a Priority Habitat Patch	Clearing Inside[1]	Clearing Outside[2]	Effect	Impact or Effect Description
PH0820	Rare, highly affected forest/woodland on peatland	No	None	None	None.
PH0754	Rare, highly affected forest/woodland on peatland	No	None	None	None.
PH9999	Riparian wetland	No	None	None	None
PH0001	Rare forest/woodland on peatland	No	None	Tree Mortality	Dead or dying tamarack extending several metres from the ROW edge into the patch; Filled mineral pit at patch boundary. Deeper excavation in adjacent ROW distant from towers.
PH0910	Rare, highly affected upland forest/woodland	No	None	Tree Mortality	Dead or dying tamarack extending into forest up to 20 m.
PH9998	Rare Plant Habitat	Yes	None	None	5-6 m wide vehicle track with ruts. Deeper excavation in adjacent area.
PH0563	Rare forest/woodland on peatland	Yes	None	None	ROW clearing adjacent to patch only.
PH9997	Rare Plant Habitat	Yes	None	None	Impacts limited to narrow trail in ROW and clearing of larger trees only.
PH9996	Rare Plant Habitat	Yes	None	None	Impacts limited to narrow trail in ROW and clearing of larger trees only.
PH0044	Rare tall shrub on peatland	Yes	None	None	Impacts limited to 5m wide path through patch. Willow beginning to regenerate.
PH0698	Rare, highly affected forest/woodland on peatland	Yes	None	None	ROW clearing adjacent to patch only.
PH0109	Rare, highly affected forest/woodland on peatland	Yes	None	None	ROW clearing adjacent to patch only.
PH1298	Rare, highly affected upland forest/woodland	Yes	None	None	None.
PH1271	Rare, highly affected upland forest/woodland	Yes	None	Tree Mortality	Approximately 5 m x 25 m dugout in adjacent ROW with excavated material placed near treeline; Dead or dying tamarack extending into forest up to 10 m.
PH0938	Rare, highly affected upland forest/woodland	Yes	Clearing	None	4 m x 5 m cleared area into habitat patch, mechanical tree and ground disturbance. Deeper excavation in ROW.

[1] Clearing was observed within the Pre-Project patch boundaries. [2] Clearing outside of ROW but within the remaining portion of the patch.

PH9998

PH9997

Source: ECOSTEM Ltd. 2016

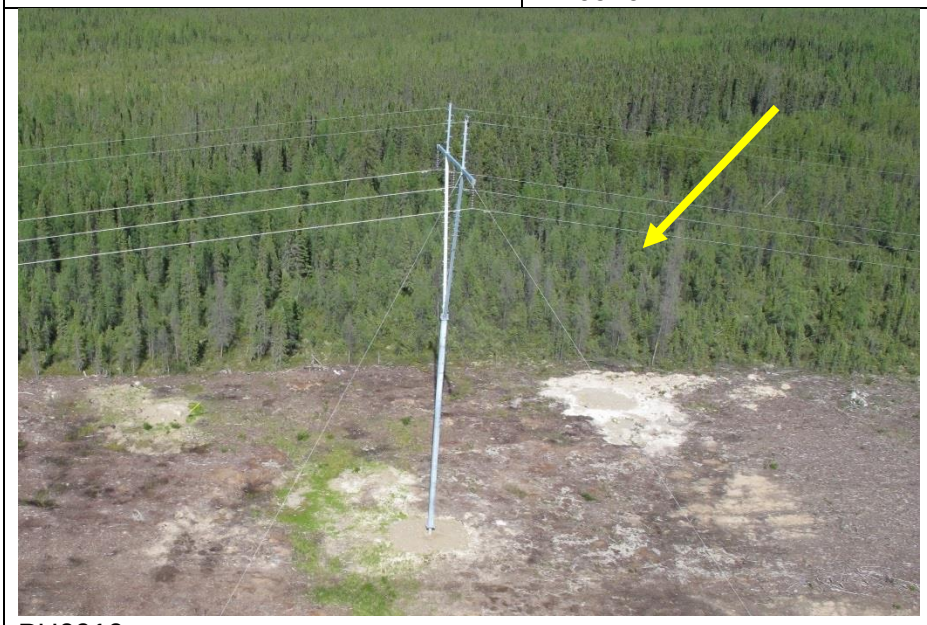
Photo 2-1: Two priority habitat patches adjacent to a ROW segment having a reduced cleared width or minimal clearing.

Source: ECOSTEM Ltd. 2016

Photo 2-2: Clearing and disturbance adjacent to the ROW in priority habitat patch PH0938.

PH1271

PH0910



PH0910

Source: ECOSTEM Ltd. 2016

Photo 2-3: Tamarack mortality in two priority habitat patches adjacent to the ROW.

Source: ECOSTEM Ltd. 2016

Photo 2-4: Deep Rutting in ROW adjacent to priority habitat patch PH9998.

Source: ECOSTEM Ltd. 2016

Photo 2-5: Excavation in ROW near priority habitat patch PH0001.

2.3.1.2 GOT AND UNIT LINE ROWS

Priority habitat patches that were not already shown in the habitat mapping were not identified from the aerial survey of the GOT and Unit Line ROWs conducted in 2018 and the subsequent review of the oblique aerial photos acquired during this survey.

The aerial survey (Map 2-1) and the subsequent review of the oblique aerial photos acquired during this survey, found only one location (Patch PH1874) with effects on priority habitat (including indirect effects) that could be due to the Project. This location was included in the subsequent ground surveys.

The ground surveys at 23 patches (Map 2-3) recorded 14 minor effects outside of the cleared ROW (Table 2-4). All of these effects were localized, small in area and not extending more than a few meters from the edge of ROW clearing. Map 2-3 shows the status of the priority habitat patches as observed during the aerial and ground surveys, including the type of effect at each patch.

Available information was reviewed for the possible causes of the 15 observed effects recorded during the aerial and ground surveys. Table 2-4 summarizes impacts, direct effects and indirect effects for each while Photo 2-6 to Photo 2-10 illustrate them. In each case, the effect on priority habitat was either a direct effect or a mixture of direct and indirect effects (see below).

Natural processes were determined to be the cause for one of the 15 observed effects. At the edge of patch PH1840 (adjacent to a pre-existing deep, wet peatland), tree mortality and collapse extended into the patch for approximately 10 m from the cleared ROW edge (Photo 2-9). While some of the tree collapse closest to the ROW and further away from the wet peatland was likely due to the Project (see below), photography of this particular location from 2009 showed that the tree mortality and collapse adjacent to the wet peatland was already underway before the Project. That habitat change appeared to be caused by natural permafrost melting.

The largest effect by far was the one observed in patch PH1874 during aerial surveys. In this patch, collapsing and dying trees extended for approximately 70 m along a pre-existing runnel. Also, runoff from the ROW was flowing in this runnel and depositing sediment into the patch. Examination of aerial photos of the area taken in 2015 showed that the majority of the tree collapse and mortality that was near the ROW edge occurred after clearing. It is uncertain how much of the total observed tree collapse was due to Project effects. At minimum, some of the effects at the ROW edge were definitely Project-related while the rest was likely accelerated by indirect Project effects.

Of the remaining 14 effects, five were definitely due to ROW clearing or transmission tower installation during construction, and six were evaluated as being likely due to the Project, and three as being possibly due to the Project (Table 2-4).

The five definite Project effects were very minor, and affected trees or understorey vegetation (Table 2-4). At one patch (PH1834) the bark and trunk of a tree adjacent to the clearing was damaged. In patches PH1839, PH1831 and PH1833, excavation was present, or excavated material was deposited over understorey vegetation near the ROW edge. At PH1874, erosion in

the ROW was carrying sediment down a runnel that extended into the patch, and this sediment was covering vegetation in the understorey. The tree collapse in this patch was also very likely caused, or at least accelerated by the Project.

In two priority habitat patches (PH1829, PH1840), several black spruce (*Picea mariana*) trees at the edge were beginning to collapse into the ROW. At each location, tree roots were likely severed by peat scalping in the adjacent ROW (Table 2-4). Another likely indirect Project effect was at patch PH1832, where one black spruce tree at the cleared edge had fallen down, apparently due to windthrow.

In three other priority habitat patches (PH1835, PH1837, PH1842), which were forest or woodland types, ground moss or lichen was either dead or in poor health. This occurred in localized areas adjacent to the cleared edge, and in one case extended for approximately 15 m along the ROW. The mortality extended less than four meters from the cleared edge at all of the locations.

The three effects possibly due to the Project were on tamarack (*Larix laricina*) trees at patches PH1828, PH1840 and PH1839. At each patch, dead or dying tamarack trees were observed within 20 metres of the cleared ROW. This was the only tree species with dead stems in the patch, and the black spruce appeared to be healthy. Tamarack further from the clearing and at other areas along the ROW edge appeared healthy. The mortality was possibly caused by a combination of root damage and change in the soil moisture regime resulting from the ROW clearing and peat scalping (Photo 2-10).

Table 2-4: Priority habitat patches with effects outside of the cleared GOT and Unit Line ROWs in 2018.

Patch ID	Observed Change Type	Observed Change in Priority Habitat Patch[1]	Direct Effect	Indirect Effect- Primary[2]	Extent	Likelihood that Change is Due to Project
PH1834	Tree damage	Bark and trunk damage to one black spruce tree at the edge.	Mechanical construction damage to tree	-	4	Definite
PH1831	Vegetation loss	Excavated organic material deposited on understorey vegetation inside uncleared vegetation.	Excavated material dropped in edge	-	4	Definite
PH1833	Vegetation mortality	Wood chips deposited over understorey vegetation in first 3 m of the edge.	Wood chips dropped in edge	Changes to soil conditions (e.g., temperature, pH, nutrients)	4	Definite
PH1839	Vegetation loss	Excavation for guyline installation extending 4 m into patch.	Excavation and excavated material in edge.	-	4	Definite
	Tree mortality	Two dead tamarack within 4 m of ROW clearing. 2016 photo found that trees had died recently.	Tree roots possibly severed by peat scalping in the ROW	Possible change to water table, moisture regime or other edge effects due to peat scalping in ROW > Drier moisture regime	3	Possible
PH1874	Tree collapse or mortality. Vegetation loss	Tree collapse/mortality and buried understorey along runnel with surface water, erosion and sediment deposition.	None	Increased water flow down runnel after ROW clearing > Erosion > Sediment burying understorey vegetation	2	Definite
PH1840	Tree collapse	Black spruce trees beginning to collapse around a runnel draining out of the ROW and at uncleared edge.	Tree roots severed by peat scalping in the ROW	Support for tree roots partially removed	3	Likely
	Tree mortality	Two dead tamarack within 4 m of ROW.	None	Possible change to water table, moisture regime or other edge effects (e.g., increased light and wind at edge)	3	Possible
	Tree collapse and mortality	Dying and other collapsing black spruce around the runnel. Not attributed to Project as a 2009 photo found that some collapsing trees and mortality was already underway.	None	-	3	None
PH1829	Tree collapse	Collapsing trees at uncleared edge.	Tree roots severed by peat scalping in the ROW	Support for tree partially removed > Drier moisture regime	3	Likely
PH1832	Tree mortality	Windthrow of black spruce tree at edge of ROW.	None	Windthrow	3	Likely
PH1835	Vegetation mortality	Dead and dying moss extending 3 to 4 m into forest for approximately 15 m along ROW edge.	None	Increased light and wind at edge > Drier soil moisture regime > Drying out of peat and moss	4	Likely
PH1837	Vegetation mortality	Localized dead and dying moss and lichen extending 2 m into forest from ROW edge.	None	Increased light and wind at edge > Drier soil moisture regime > Drying out of moss and lichen	4	Likely
PH1842	Vegetation mortality	Localized dead and dying moss extending approximately 2 m into forest from ROW edge.	None	Drier moisture regime due to peat removal in ROW > Drying out of peat and moss	4	Likely

Patch ID	Observed Change Type	Observed Change in Priority Habitat Patch[1]	Direct Effect	Indirect Effect- Primary[2]	Extent	Likelihood that Change is Due to Project
PH1828	Tree mortality	Dead or dying tamarack trees within 20 m of the cleared ROW edge at two locations.	None	Possible change to water table, moisture regime or other edge effects (e.g., increased light and wind at edge)	3	Possible

Notes: [1] Based on field notes and photos. [2] Only those effects that relate to the direct impacts. ">" indicates the pathway of effects.

PH1874 in July, 2018

PH1874 in August, 2015

Source: ECOSTEM Ltd.

Photo 2-6: Erosion and sediment deposition with tree mortality in priority habitat patch PH1874.

PH1834 (mechanical damage to tree)

PH1831 (excavated material outside ROW)

PH1832 (windthrow at ROW edge)

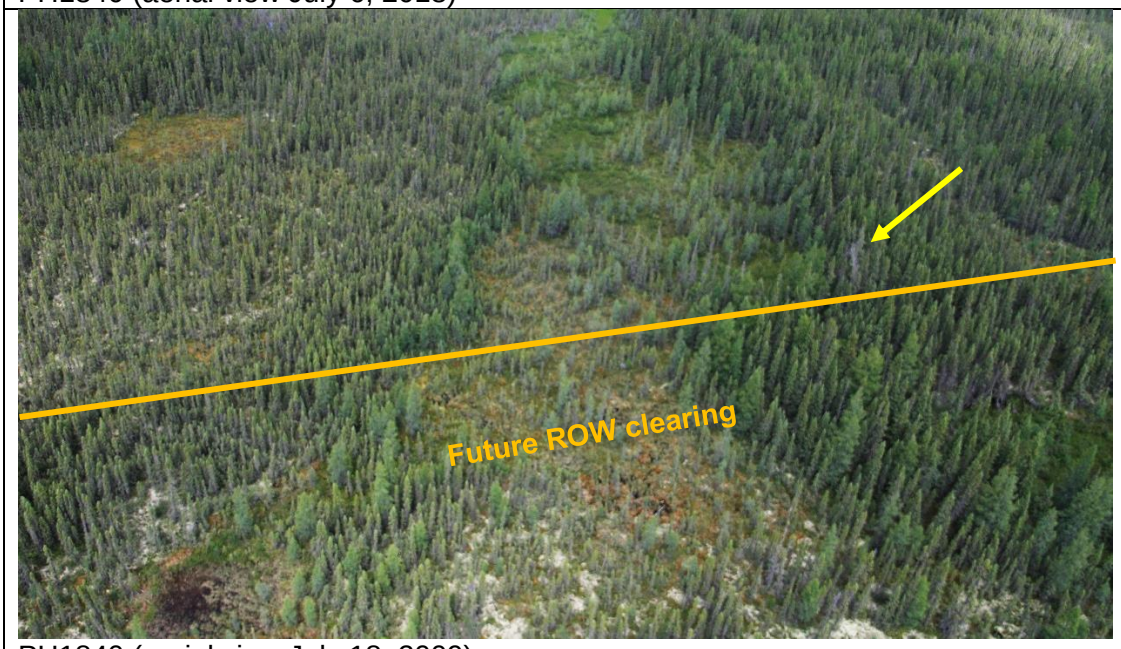
Source: ECOSTEM Ltd. 2018

Photo 2-7: Examples of mechanical damage observed in priority habitat patches in 2018.

Source: ECOSTEM Ltd. 2018

Photo 2-8: Leaning trees adjacent to ROW in priority habitat patch PH1829.

PH1840 (aerial view July 6, 2018)



PH1840 (aerial view July 18, 2009)

Source: ECOSTEM Ltd.

Photo 2-9: Tree collapse and mortality observed beside ROW clearing in 2018 that was present prior to the Project.

PH1837 (dead and dying moss and lichen adjacent to edge of ROW)

PH1839 (dead tamarack)

PH1828 (dead tamarack concentrated at edge of ROW)

Source: ECOSTEM Ltd. 2018

Photo 2-10: Examples of vegetation mortality observed in priority habitat patches in 2018.

2.3.2 ECOSYSTEM DIVERSITY METRICS

2.3.2.1 OVERALL EFFECTS

Monitoring indicated that the total actual amount of priority habitat loss and alteration due to Project clearing and physical disturbance was approximately 248 ha as of September 2019.

None of the 15 priority habitat patches along the Construction Power ROW were entirely or almost entirely removed by Project clearing. Of the 110 priority habitat patches along the Unit Line and GOT ROWs existing prior to the Project, 47 were entirely or almost entirely removed by Project clearing, leaving 63 patches.

The actual potential area of indirect Project effects over the long-term for the actual Project Footprint was estimated using essentially the same very cautious assumption as used in the environmental assessment. That is, all priority habitat within 50 m of the actual Project Footprint will experience indirect effects over the long-term. Where this approach differed from the environmental assessment was the buffer around the station sites was reduced from 150 m to 50 m based on additional evidence provided by subsequent research (see Section 2.4.1.2).

Using this approach, it was estimated that indirect effects from the actual Project Footprint could affect an additional 150 ha of priority habitat. Based on the very cautious estimate of potential indirect effects, the total area of actual direct and indirect effects on priority habitat over the long-term was estimated to be approximately 398 ha.

2.3.2.2 INDIVIDUAL HABITAT TYPES

The Project impacted 29 of the 46 priority habitat types found in the regional study area. The total increased to 32 types when the indirectly affected habitat was included (see previous Section).

Regional cumulative effects from past and current projects and activities were already in the moderate magnitude range for all of the affected priority habitat types. Project effects on some of the priority habitat types were of high or moderate concern because higher than predicted effects could push them into the high magnitude range.

Actual estimated Project effects were at least 0.5 ha lower than predicted for 12 of the priority habitat types (Table 2-5). Types that had reductions of more than 10 ha included Black Spruce Dominant on Mineral, Tamarack Mixture on Shallow Peatland and Low Vegetation on Thin Peatland.

Actual estimated Project effects were at least 0.5 ha higher than predicted for six of the priority habitat types. Three of these types were of potential concern because they already had relatively high regional cumulative effects without the Project (see below). These types included Jack Pine Mixedwood on Mineral, Trembling Aspen Dominant on All Ecosites and Trembling Aspen Mixedwood on All Ecosites. The increases for all three types (Table 2-5) were substantially less than needed to reach the cumulative effects benchmark that would flag them for potential further mitigation.

Of the eight priority habitat types of high concern based on cumulative effects (Table 2-5), seven had less area affected and one was essentially the same (i.e., increase of 0.004 ha).

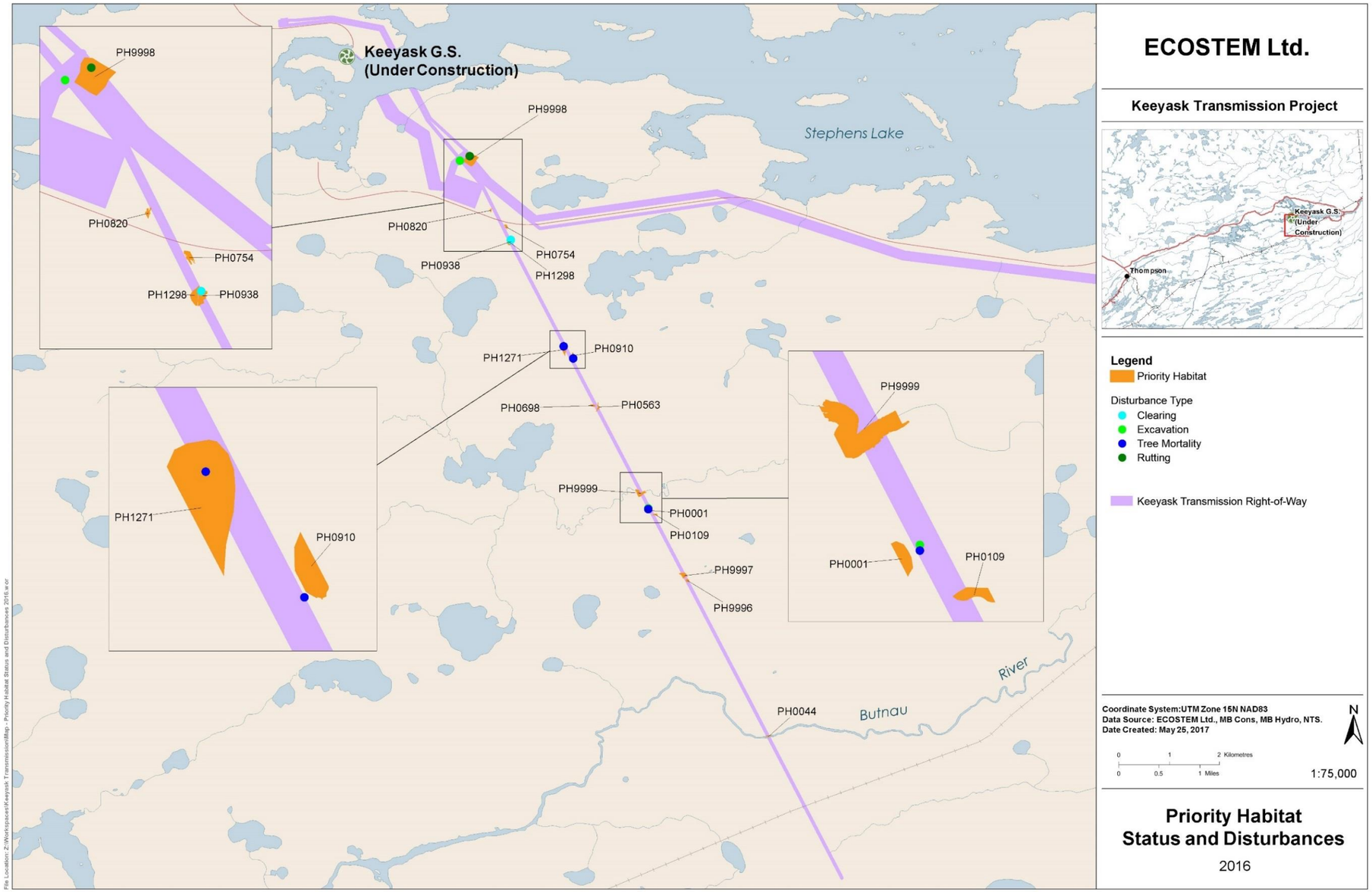
Of the 12 priority habitat types of moderate concern based on cumulative effects, seven had higher than predicted area effects. In all cases, the increase was too small to reach the cumulative effects benchmark that would flag them for potential further mitigation.

Table 2-5: Comparison of predicted and actual Project effects on priority habitat area

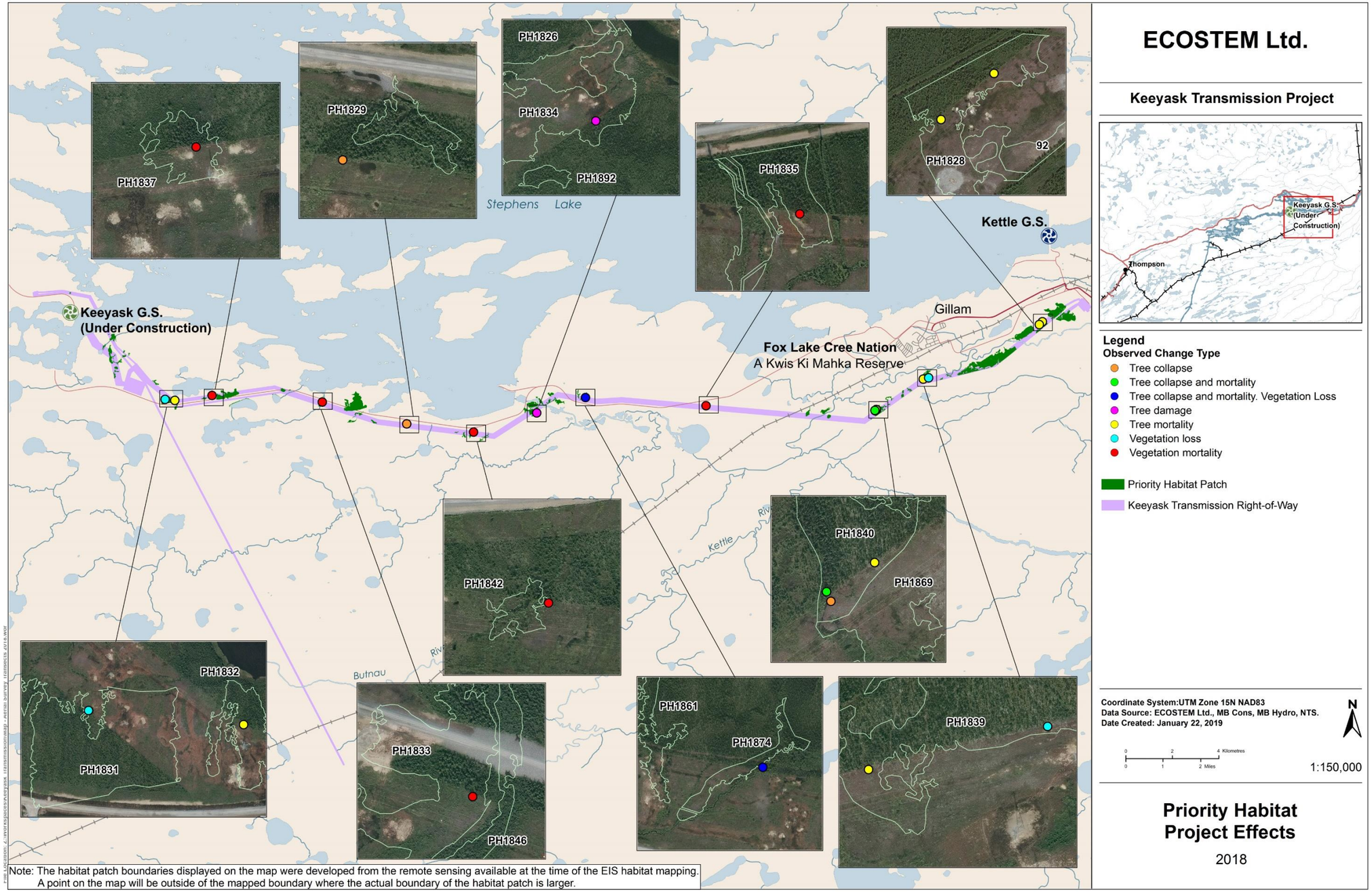
Priority Habitat Type	Cumulat-ive Effects[1]	Predicted Area (ha)			Actual Area (ha)			Difference (ha)		
		Project Foot-print	Indirect	Total	Project Foot-print	Indirect	Total	Project Foot-print	Indirect	Total
Balsam poplar dominant on all ecosites	High	-	-	-	-	-	-	-	-	-
Balsam poplar mixedwood on all ecosites		-	-	-	-	-	-	-	-	-
Black spruce dominant on mineral		44.2	34.0	78.2	44.2	23.5	67.8	0.1	-10.5	-10.4
Black spruce dominant on riparian peatland		1.8	1.7	3.5	1.8	1.5	3.3	0.0	-0.1	-0.1
Black spruce dominant on wet peatland		22.8	15.2	38.0	22.2	12.0	34.3	-0.6	-3.1	-3.7
Black spruce mixedwood on mineral		10.4	1.8	12.2	10.2	2.8	13.0	-0.2	1.0	0.8
Black spruce mixedwood on shallow peatland		-	-	-	-	-	-	-	-	-
Black spruce mixedwood on thin peatland		0.5	-	0.5	0.2	-	0.2	-0.3	0.0	-0.3
Black spruce mixture on mineral	High	2.9	2.5	5.5	1.9	1.3	3.2	-1.1	-1.2	-2.3
Black spruce mixture on shallow peatland	Moderate	9.3	3.7	13.0	9.2	3.3	12.5	-0.1	-0.4	-0.5
Black spruce mixture on thin peatland	High	15.8	9.9	25.7	16.6	8.4	25.0	0.8	-1.5	-0.7
Black spruce mixture on wet peatland		0.8	0.8	1.6	0.9	0.8	1.6	0.0	0.0	0.0
Jack pine dominant on mineral		23.8	11.1	34.9	26.6	13.1	39.7	2.8	2.0	4.8
Jack pine dominant on shallow peatland		-	-	-	-	-	-	-	-	-
Jack pine dominant on thin peatland	Moderate	0.1	-	0.1	0.1	-	0.1	0.0	0.0	0.0
Jack pine mixedwood on mineral	Moderate	1.9	1.7	3.7	2.5	3.2	5.7	0.5	1.5	2.0
Jack pine mixedwood on shallow peatland	Moderate	-	-	-	-	-	-	-	-	-
Jack pine mixedwood on thin peatland	Moderate	-	0.0	0.0	-	0.1	0.1	0.0	0.1	0.1
Jack pine mixture on shallow peatland	Moderate	-	-	-	-	-	-	-	-	-
Jack pine mixture on thin peatland		3.3	0.5	3.8	3.5	0.5	3.9	0.1	0.0	0.1
Low vegetation on riparian peatland		5.8	4.9	10.7	5.6	5.8	11.4	-0.2	0.9	0.7
Low vegetation on shallow peatland		32.8	29.1	61.9	30.4	27.7	58.1	-2.4	-1.4	-3.8
Low vegetation on thin peatland		15.1	11.8	26.8	-	-	-	-15.1	-11.8	-26.8
Low vegetation on wet peatland		23.5	12.7	36.1	22.2	12.0	34.2	-1.3	-0.7	-1.9
Tall shrub on mineral	High	-	-	-	-	0.0	0.0	-	0.0	0.0
Tall shrub on riparian peatland	High	1.4	0.7	2.1	0.8	1.0	1.8	-0.6	0.2	-0.3
Tall shrub on shallow peatland		1.2	0.6	1.7	1.5	0.4	1.8	0.3	-0.2	0.1
Tall shrub on thin peatland	High	2.2	1.4	3.6	2.0	1.1	3.1	-0.2	-0.3	-0.6
Tall shrub on wet peatland	Moderate	1.5	1.6	3.1	1.5	1.6	3.1	0.0	0.0	0.0
Tamarack- black spruce mixture on riparian peatland	Moderate	-	0.0	0.0	-	0.0	0.0	-	0.0	0.0
Tamarack dominant on mineral	Moderate	0.3	0.9	1.2	0.2	0.5	0.7	-0.1	-0.4	-0.5
Tamarack dominant on riparian peatland		-	-	-	-	-	-	-	-	-
Tamarack dominant on shallow peatland	Moderate	0.3	0.1	0.4	0.4	-	0.4	0.1	-0.1	0.0
Tamarack dominant on thin peatland		-	0.0	0.0	-	0.0	0.0	-	0.0	0.0
Tamarack dominant on wet peatland		0.9	1.7	2.6	1.4	1.3	2.7	0.5	-0.4	0.1
Tamarack mixture on mineral		2.3	2.6	4.9	2.0	2.5	4.5	-0.3	-0.2	-0.4
Tamarack mixture on shallow peatland		17.5	10.0	27.4	12.4	4.7	17.1	-5.1	-5.2	-10.3
Tamarack mixture on thin peatland		7.1	5.6	12.7	5.5	5.9	11.4	-1.6	0.3	-1.3
Tamarack mixture on wet peatland		1.8	1.7	3.5	1.7	1.6	3.4	0.0	-0.1	-0.1
Trembling aspen dominant on all ecosites	Moderate	4.8	6.4	11.2	6.7	8.1	14.8	1.8	1.8	3.6
Trembling aspen mixedwood on all ecosites	Moderate	11.0	5.0	16.0	13.8	4.8	18.6	2.8	-0.2	2.6
White birch dominant on all ecosites	High	-	-	-	-	-	-	-	-	-
White birch mixedwood on all ecosites	High	-	-	-	-	-	-	-	-	-
Total		**267.1**	**179.7**	**446.8**	**248.0**	**149.7**	**397.7**	**-19.1**	**-30.0**	**-49.0**

Notes: A "-" indicates absence; a "0.0" indicates a value that rounds to zero. [1] Degree of concern based on regional cumulative effects without the Project.

2.3.3 MAPS



Map 2-2: The status of priority habitat patches, and locations where disturbances occurred outside of the cleared Construction Power ROW



Map 2-3: The status of priority habitat patches, and locations where effects occurred outside of the standard cleared ROW width

2.4 DISCUSSION

2.4.1 PROJECT EFFECTS

2.4.1.1 PRIORITY HABITAT PATCHES

Pre-Project habitat mapping indicated that there were 125 priority habitat patches present along the Construction Power, GOT and Unit Line ROWs. Additional priority habitat patches were not identified by aerial surveys of the ROWs and the subsequent review of the oblique aerial photos acquired during these surveys. This finding was not surprising given the scale of the habitat mapping.

Aerial and ground surveys of the actual ROWs found that all of the Project impacts on the priority habitat patches situated along the ROWs outside of the standard cleared width were minor. Only one of the effects attributed to the Project was large enough to be seen during low-altitude aerial surveys. Aside from that case, all of the remaining effects were localized, small in area and never extending more than four meters from the edge of ROW clearing. The types of effects included tree damage, tree collapse, tree mortality, understorey vegetation mortality and understorey vegetation loss.

The very limited degree of clearing and physical disturbance outside of the standard ROW width, indicated that Environmental Protection Plan measures were well implemented during Project construction.

Where observed, construction impacts were limited to narrow tracks or clearing of larger trees. The substrate had no apparent disturbance. As these were sparsely treed or untreed wetland and riparian habitat types, it was likely that clearing was conducted when the ground was frozen, which limited construction impacts.

The largest Project effect consisted of collapsing and dying trees extending for approximately 70 m along a pre-existing runnel. The indirect Project effects in this site included erosion, sedimentation and localized flooding produced by water moving from the cleared ROW into the habitat patch.

All of the Project effects on priority habitat patches were classified as habitat disturbance as opposed to habitat loss or alteration due to their small size. The impacts and indirect effects included mechanical damage to trees or substrate, erosion or changes to surface or groundwater flow.

Along the Construction Power ROW, only three priority habitat patches had possible indirect effects. These possible effects consisted of dead or dying tamarack trees at the patch edge closest to the conductors. Project impacts appeared to be the most likely cause of this mortality because it only included trees adjacent to the clearing. It was possible that ROW clearing or transmission tower excavations may have caused tree root damage, permafrost melting or

localized changes to ground/surface water conditions and/or drainage, which eventually led to tree mortality (see Section 7.2.5.1 of EA Report for pathways of potential Project effects). However, a natural cause was also possible since only tamarack was affected, while black spruce still appeared healthy.

At the other two locations along GOT, the cause for tree mortality was more uncertain. While the mortality was limited to tamaracks (black spruce trees still appeared healthy), all of the mortality was within approximately 20 m of the clearing edge. In that case, and the ones along the Construction Power ROW, the Project appeared to be the most likely cause of this mortality since all of the affected trees were adjacent to ROW clearing and trees further away appeared healthy. ROW clearing may have damaged tree roots or indirectly led to localized permafrost melting or changes to ground/surface water conditions and/or drainage, which eventually led to tree mortality (see Section 7.2.5.1 of EA Report for pathways of potential Project effects). However, as stated in ECOSTEM (2017a), a natural cause was also possible since tamarack was the only species with mortality.

At one location along GOT, a tree at the edge of the cleared ROW was snapped by windthrow. A study conducted for the Wuskwatim Transmission Project, which is also in northern Manitoba, found that windthrow was the most common disturbance along the edge of a recently cleared ROW (ECOSTEM 2010).

The other Project sources of likely or possible indirect effects causing tree collapse or mortality were changes to surface or groundwater flow, water table depth, or moisture regime related to ROW clearing. At one location, water flow through the ROW appeared to be causing erosion in the patch. The water and sediment were flowing into the patch along a runnel, causing tree collapse and covering understorey vegetation with sediment.

Direct effects from Project construction at three locations were from excavation outside the cleared ROW, or excavated material being dropped into the patch edge. Indirect effects at the remaining three locations appeared to be caused by edge effects and/or peat scalping in the ROW, which resulted in localized moss and lichen mortality near the patch edge. Possible pathways for these edge effects included increased sun exposure and wind exposure at the forest edge, as well as localized changes to ground moisture and drainage due to clearing and removal of organic substrate in the ROW. These impacts and indirect effects can cause the substrate and moss adjacent to the clearing to dry out. Eldegard et al. (2015) found that moss cover declined substantially from the forest interior to the forest edge along transmission lines.

Ground surveys conducted at the priority habitat patches found that all of the disturbances that had not already been recorded during the aerial surveys were minor based on their nature, size and proximity to the ROW edge. This indicated that ground surveys need not be conducted at every patch.

2.4.1.2 ECOSYSTEM DIVERSITY METRICS

The estimate of indirect Project effects in the environmental assessment and Section 2.3.2.1 used a very cautious assumption (i.e., overestimating potential effects) regarding the potential width of edge effects along the cleared ROW edge. It was assumed that edge effects could extend up to 50 m from the ROW even though it was expected that the width would typically be about 10 m for the ROWs and 50 m for the stations (ECOSTEM 2012).

This very cautious assumption was employed for two reasons. First, to ensure that the areas included in the assessment would capture all potential effects of concern. Second, there was uncertainty as to the actual distance of effects.

Research carried out in northern Manitoba (ECOSTEM 2013; ECOSTEM et al. 2013) after the environmental assessment was written provided additional evidence to confirm the expected extent of indirect habitat effects along various types of linear features. These features included approximately 103 km of roads, 36 km of cutlines and 1,268 km of shoreline on the regulated system. Natural regeneration was also documented for 883 km of cutlines. The edge effects documented by this research rarely extended more than 25 m.

Using a less cautious estimate of indirect Project effects (i.e., 15 m on average) would reduce the total area of indirectly affected priority habitat over the long-term from approximately 150 ha to 46 ha.

2.4.2 COMPARISON WITH EA REPORT PREDICTIONS

The EA Report predicted that the Project would not change the total number of native broad habitat types in the region, and was not expected to substantially change the regional proportions of any of the regionally common or uncommon native habitat types by more than 0.01%. The Report also predicted that, in the absence of mitigation, the Project could affect up to approximately 447 ha of priority habitat, which included 32 of the 46 priority habitat types found in the study region. Depending on the priority habitat type, up to 0.8% of the area would be affected. The EA Report concluded that, the cumulative effects of the Project on ecosystem diversity, in combination with past and current projects and activities, would not be ecologically significant.

Monitoring indicated that all of the Project impacts on the priority habitat patches situated along the Project ROWs were very minor.

Monitoring also indicated that actual Project impacts (i.e., clearing or physical disturbance) on total priority habitat area as of September 2019 was 7% less than predicted. The total area was lower than predicted because locations with reduced clearing exceeded those with increased clearing. The primary source of area reductions was removing the major Keeyask Generation Project impact areas (e.g., access road, borrow areas). These removals were offset by route adjustments that slightly increased ROW length, and by one GOT segment with wider than assumed clearing.

Due to the smaller Project footprint, estimated long-term indirect Project effects on the total amount of priority habitat was 17% less than predicted based on the same very cautious approach used in the EA Report. A less cautious approach, but one that still yielded higher than expected indirect effects, reduced estimated actual long-term indirect effects by two-thirds.

The number of affected priority habitat types was the same as predicted. While some types had lower effects than predicted, others had higher effects. Three of the priority habitat types with higher effects were of potential concern because these types already had relatively high regional cumulative effects without the Project. However, the increases for all three types were substantially less than needed to reach the cumulative effects benchmark that would flag them for potential further mitigation.

Further substantive increases in direct Project impacts on priority habitat are not expected because additional clearing or physical disturbance is not planned, and because ROW maintenance activities are expected to be confined to the existing cleared ROW. Even if there were to be unanticipated additional clearing or physical disturbance, the amount of area that would be required to change the conclusions regarding effects significance are much too high except for extremely rare habitat types (which should be protected by EnvPPs).

There were no unanticipated Project effects on ecosystem diversity.

2.4.3 RECOMMENDATIONS FOR ENVPP MEASURES, FURTHER MITIGATION AND FURTHER MONITORING

The EA Report concluded that the cumulative effects of the Project in combination with past and current projects and activities were already in the moderate magnitude range for all of the priority habitat types. For this reason, Project mitigation included avoiding priority habitat to the extent practicable during final routing of the transmission lines. Additionally, the EnvPPs included measures to minimize the risk that accidental fires, accidental spills and invasive plants would affect priority habitat.

There are no recommendations for revisions to the EnvPPs. Monitoring indicated that EnvPP measures were implemented well during Project construction, and had their intended effects. At the nine priority habitat patches along the Construction Power ROW where clearing was entirely within the standard ROW limits, the clearing was narrower than the standard 60 m ROW width. Reduced clearing resulted either because the EnvPP identified these patches as sensitive sites (which meant that clearing was to be minimized) or because the pre-existing habitat consisted of vegetation that was too short to require clearing. The only recorded case of the EnvPP measures not being fully implemented was machine rutting adjacent to one priority habitat patch. This rutting occurred because machinery passed through when the ground was not fully frozen.

Follow-up mitigation for the priority habitat patches adjacent to the ROWs is not recommended. At all of these patches, the effects were thought to be too small to affect the natural characteristics or functioning of the portion of the patch that was not already experiencing edge effects (i.e.,

resulting from vegetation clearing in the ROW). Additionally, over time, natural revegetation is expected to adequately replace the plants that died, and to cover exposed mineral sites that may become colonization opportunities for invasive plants.

Monitoring during the construction of future projects need not include ground surveys at most of the priority habitat patches along the ROWs provided that the survey methods and terrestrial habitat mapping are completed as they were for this Project. All of the disturbances not observed during aerial surveys were very minor based on their nature, size and proximity to the ROW edge.

It is recommended that ecosystem diversity monitoring be discontinued given that construction effects were lower than predicted, long-term Project effects are expected to be substantially less than predicted and the risk of unanticipated future effects is low.

2.5 CONCLUSIONS

Monitoring found that Project effects on ecosystem diversity during construction were less than predicted. Estimated long-term Project effects on ecosystem diversity are expected to be substantially less than predicted. There were no unanticipated Project effects.

There are no recommendations for revisions to the EnvPPs.

There are no recommendations for further mitigation.

It is recommended that ecosystem diversity monitoring be discontinued given that long-term Project effects are expected to be substantially less than predicted and the risk of unanticipated future effects is low.

3.0 PRIORITY PLANTS

3.1 INTRODUCTION

Priority plants are defined as those plants that are particularly important for ecological and/or social reasons. Priority plants are the native plant species that are highly sensitive to Project features, make high contributions to ecosystem function and/or are of particular interest to the KCNs. The environmental assessment considered a plant species to be highly sensitive to human features if it is globally, nationally, provincially or regionally rare, near a range limit, has low reproductive capacity, depends on rare environmental conditions and/or depends on the natural disturbance regime.

The objectives of the priority plant monitoring are to:

- Confirm actual project effects on the known priority plant locations; and,
- Confirm actual project effects on priority plant habitat.

3.2 METHODS

Section 4.2.2 of the Project's monitoring plan (Manitoba Hydro 2015) outlines the methods for the priority plant monitoring. The following summarizes the methods for the activities conducted for the monitoring.

The plant species included in the priority plant monitoring were generally those which the Manitoba Conservation Data Centre had classified as being provincially very rare to rare at the time when the Project Environmental Impact Statement was written. This included species with conservation concern ranks of S1, S1?, S1S2, S2 or S2?. The two exceptions were small pondweed and Robbins pondweed, since studies for the Keeyask Generating Station EIS (KHLP 2012) concluded that, while these species are provincially rare, they are not rare in the Keeyask region.

On this basis, the plant species included at the outset of this monitoring study were elegant hawk's-beard (*Crepis elegans*), shrubby willow (*Salix arbusculoides*), rock willow (*Salix vestita*), horned pondweed (*Zannichellia palustris*), slender-leaved sundew (*Drosera linearis*), muskeg-lousewort (*Pedicularis macrodonta*) and American milk-vetch (*Astragalus americanus*). Additional provincially very rare to rare plant species found during the vegetation monitoring would also be included.

Field surveys for priority plant surveys were conducted in all of the known priority plant sites on August 20, 2016. All ROW clearing had been completed at the time of the surveys. All known priority plant sites were on or near the Construction Power ROW.

Known priority plant sites within or adjacent to the ROW were visited. At each site, recorded information included the condition of the priority plants, patch size of the species, the degree of site disturbance and the site size. If the target species was not found at the previously recorded site, then the surrounding habitat was searched for other individuals and, if found, a new priority plant site was recorded.

Any other provincially very rare to rare plant species that were incidentally observed during ground surveys conducted for this study or the invasive plant monitoring (Section 4.0) were recorded. Uncommon plants of importance to the Keeyask Cree Nations, which included *wihkis* (sweet flag) and northern Labrador tea (Section 3 in KHLP 2012), were watched out for during field surveys.

If a new priority plant site was found, the site was marked with a GPS. Information including attributes such as site, plant species, plant vigor, site conditions and surrounding habitat was recorded. The site was also flagged off to prevent disturbance. The locations and sizes of the plant patches were later mapped in a GIS (a "patch" could consist of one or a few individual plants). Any newly recorded priority plant sites were reported to Manitoba Hydro.

3.3 RESULTS

The following summarizes the key priority plant monitoring results. For further details, see the annual report (ECOSTEM 2017c).

A total of 11 priority plant sites were known when monitoring began (Map 3-1). All of these sites had been identified during pre-clearing rare plant surveys.

Only one species, muskeg lousewort (Photo 3-1), was found at these sites. The abundance of muskeg lousewort plants at these sites ranged from one or a few individuals up to larger patches with sparse muskeg lousewort cover.

As 10 of the 11 sites were concentrated in a general area of muskeg lousewort habitat (Map 3-1), the sites were mapped and evaluated as four locations (Table 3-1; Map 3-1).

The monitoring revisited the 11 known sites in the four locations (Table 3-1). Healthy, living plants were found at all of the sites, and there was either no or minimal impacts within each site (Table 3-1).

Where impacts were present, they were confined to the ROW and limited to localized ruts from machinery, or tree removal. There were no other impacts to the low vegetation or ground in the site, both within and outside of the ROW.

There was no indication that Project impacts were creating indirect effects (*e.g.*, alterations to groundwater conditions) that would eventually adversely affect these plants.

The priority plant monitoring did not find additional muskeg lousewort sites or sites with other priority plant species or uncommon species of importance to the Keeyask Cree Nations. No additional priority plant sites were found incidentally during the invasive plant monitoring.

Table 3-1: Muskeg lousewort sites in the Project footprint, and their status in 2016.

Site ID	Occurr-ence Type	Habitat Type	Status	Patch Size (m^2)	Percentage of site disturbed	Disturbance Type
1	Individual	Tamarack- black spruce on wet peatland	Intact	n/a	-	None
2	Patch	Low vegetation on wet peatland	Intact	10,125	5	Machine track
3	Patch	Tamarack- black spruce on wet peatland	Intact	76	100	Tree clearing
4	Patch	Low vegetation on wet peatland	Intact	71	-	none

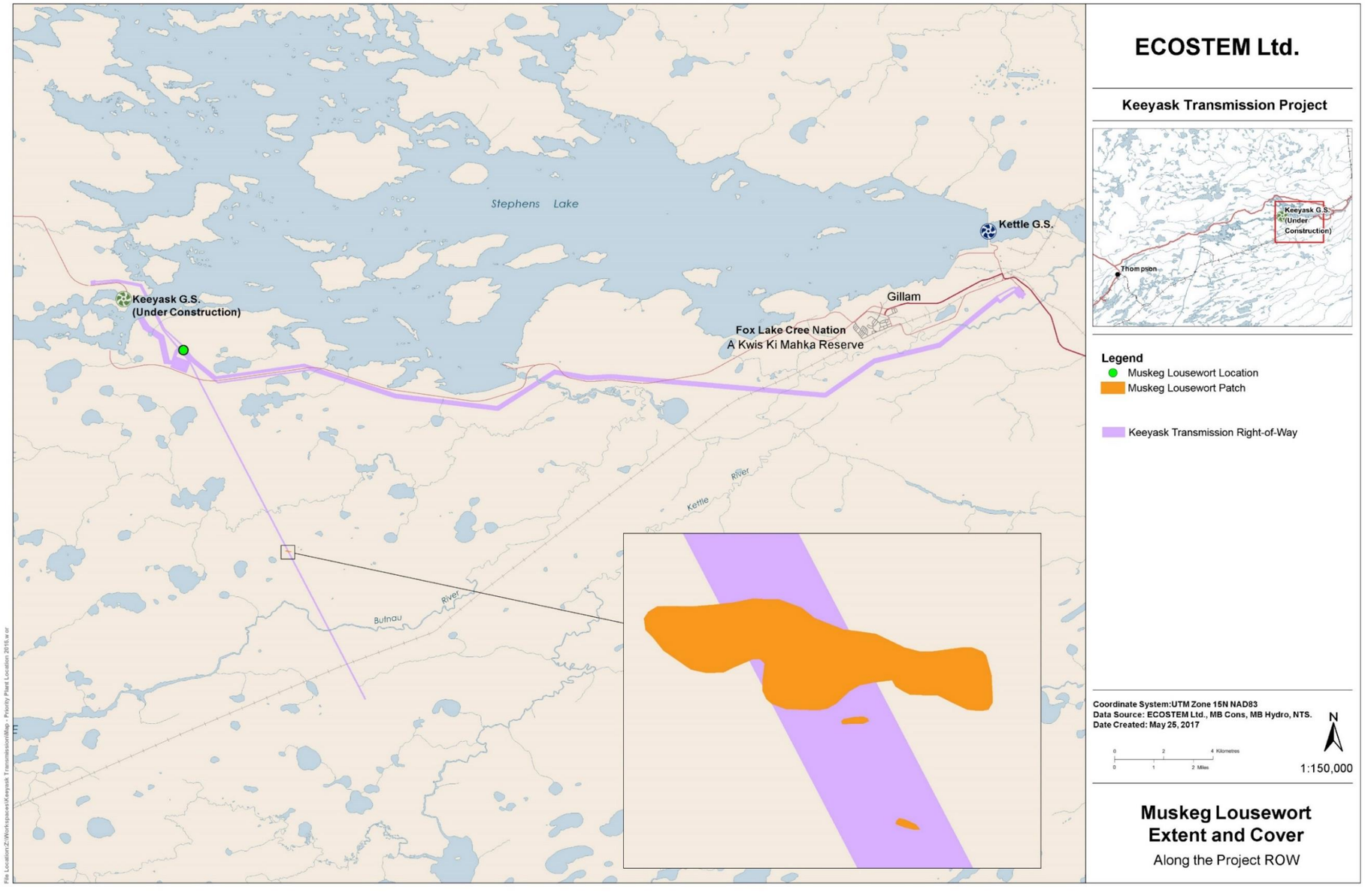
Source: ECOSTEM Ltd. 2016

Photo 3-1: Close-up views of muskeg lousewort growing in the transmission ROW

Source: ECOSTEM Ltd. 2016

Photo 3-2: Horizontal fen supporting a large muskeg lousewort patch within the ROW

3.3.1 MAPS



Map 3-1: Muskeg lousewort locations within or adjacent to the cleared Project ROW

3.4 DISCUSSION

3.4.1 PROJECT EFFECTS

Muskeg lousewort was the only priority plant species known to occur within or near the Project footprint. Based on the results of the 2016 surveys, the known muskeg lousewort populations experienced virtually no or very low Project effects. The primary reasons for this were:

- Vegetation clearing was not required in the portions of the ROW with the muskeg lousewort sites as the vegetation was already low due to site conditions;
- Mitigation recommendations outlined in ECOSTEM (2014) were successfully implemented. These measures included:
  - Place towers outside of the muskeg lousewort avoidance zones;
  - Clear during the winter, after the ground is solidly frozen and there is a protective cover of snow; and,
  - Restrict trails and vehicle traffic within the mapped muskeg lousewort avoidance zones to the same trail used to pull the conductors.

Future adverse effects from invasive plants are not expected. Muskeg lousewort grows in wet, organic sites. Project construction has not disturbed the ground cover or substrate in the known priority plant sites, and the substrates in these sites are organic. The invasive plant monitoring (Section 4.0) only found plants of invasive concern (i.e., Level 2 species (see Section 4.2.3)) in disturbed sites, and all but one of these disturbed sites had mineral substrates.

Effects on priority plant habitat were very low. There was either little or no disturbance at every known habitat patch. The amounts of affected priority plant habitat were also low given that effects on priority habitats (Section 2.3.2) were low (rare plants are more likely to occur in rare habitats).

3.4.2 COMPARISON WITH EA REPORT PREDICTIONS

The EA Report predicted that Project effects on priority plant species during construction were expected to be low. The rarest species were not known to occur in the Project footprint. For the remaining species, Project effects were expected to be nil or low, depending on the species, because from nil to less than 1% of their known sites and habitat would be affected by the Project.

Monitoring confirmed that there virtually no Project effects on the known priority plants. The plants at the known sites appeared to be healthy. Also, the total effect on priority plant habitat was very low (e.g., effects on priority habitat were lower than predicted (Section 2.3.2)).

3.4.3 RECOMMENDATIONS FOR ENVPP MEASURES, FURTHER MITIGATION AND FURTHER MONITORING

Project mitigation included:

- In the segment of the Construction Power Transmission line ROW that is near the swamp lousewort location, access trails will be located to avoid swamp lousewort locations and towers will be sited outside of the area where the ROW crosses this fen;
- Pre-construction rare plant surveys will be conducted in portions of the Terrestrial Plants Local Study Area that were not previously surveyed and have the highest potential for supporting provincially very rare to rare species; and,
- In the unlikely event that a provincially very rare to rare species is discovered in the Project Footprint, the plants will be transplanted outside of the Terrestrial Plants Local Study Area.

Additionally, the Project EnvPPs included measures to minimize the risk that accidental fires, accidental spills and invasive plants would affect priority habitat. It was also noted that mitigation for priority habitats could benefit priority plants to the extent that a species is associated with these habitat types.

There are no recommendations regarding modifications to the EnvPPs. To the extent we have information on how they were implemented, the existing EnvPP provisions resulted in adequate avoidance of the known priority plant locations and of priority plant habitat.

There are no recommendations for further mitigation given that estimated long-term effects are substantially less than predicted and substantial future increases are not expected.

It is recommended that priority plant monitoring be discontinued. The plants at the known sites appeared to be healthy and future indirect Project effects are unlikely. Additionally, the risk invasive plant monitoring results to date are consistent with the prediction that the Project is not substantially increasing the rate at which invasive plants are introduced and/or spread in the Project area (see Section 4.0).

3.5 CONCLUSIONS

Monitoring found that, consistent with predictions, the Project has had very low effects on priority plants. Project effects on priority plants are not expected to increase substantially in the future. There were no unanticipated Project effects.

There are no recommendations for revisions to the Environmental Protection Plans.

There are no recommendations for further mitigation.

It is recommended that priority plant monitoring be discontinued.

4.0 INVASIVE PLANTS

4.1 INTRODUCTION

The Keeyask Transmission Project Environmental Effects Monitoring Plan includes monitoring effects on terrestrial ecosystems and vegetation, focusing on intactness, ecosystem diversity, priority plants and invasive plants. This report provides results for the invasive plant monitoring conducted from 2016 to 2019.

Non-native plants are those plants that are growing outside of their country or region of origin. Invasive plants are those non-native plants that can outcompete or even replace native plants. Invasive plants are of concern because they can materially affect rare plant species, alter soil conditions and, in extreme cases, change vegetation composition or other ecosystem attributes. Other non-native plant species are also of interest because they may become invasive under some local conditions, or may become invasive in the future due to changing climate.

The invasive plant monitoring program includes a single study, the Invasive Plant Spread and Control study. The goals of this study are to determine the degree to which the Project contributes to introducing and spreading invasive and other non-native plants, and to evaluate the effectiveness of mitigation measures. The overall objectives of the Invasive Plant Spread and Control study are to:

- Verify the implementation of mitigation measures such as appropriate seed mixes;
- Document the degree of invasive plant introduction and spread; and
- Recommend appropriate control and eradication programs, if there is introduction and/or spread.

Invasive plant monitoring activities from 2016 to 2019 included field surveys to address the last two study objectives.

4.2 METHODS

Section 4.2.4 of the Project's monitoring plan (Manitoba Hydro 2015) outlines the methods for the invasive plant monitoring. The following summarizes the methods for the activities conducted from 2016 to 2019.

4.2.1 DATA COLLECTION

The cleared portions of the Project rights-of-way were surveyed for non-native plants. Surveys were conducted along transects at pre-determined locations dispersed throughout the ROW (Table 4-1). Most of these transects were situated near existing roads or other infrastructure for two reasons. Previous studies had found that non-native plants in the region primarily occur near

human features and activity (KHLP 2012). Additionally, previous plant surveys on the Construction Power ROW did not observe any non-native plants at locations distant from infrastructure (ECOSTEM 2017a, 2017c).

The 2016 surveys included 11 transects totalling 8.1 km in length (Map 4-1). In 2017, the same transects were resampled, plus an additional six transects to increase the total to 17 transects, and 11.1 km. All 17 transects were re-sampled in 2018 and 2019.

Non-native plant observations were also recorded during priority habitat surveys in the ROW on July 8 and 9 in 2018, and incidentally while walking to and from transect locations.

Table 4-1: Non-native plant survey transects and dates for 2016 to 2019 studies.

Year	Survey Dates	Number of Transects[1]	Total Length (km)	Approximate Area Surveyed (ha) [2]	
				All Taxa	Conspicuous Taxa
2016	July 8, 9	11	8.1	8.1	124.6
2017	August 22, 29	17	11.1	11.1	198.8
2018	August 22-24, 29	17	11.1	11.1	198.8
2019	August 18-20	17	11.1	11.1	198.8

Notes: [1] Identical transect locations from 2017 to 2019, and includes the locations from 2016.
[2] Approximate area surveyed calculated as the transect length multiplied by the minimum transect width, which was 10 m, for All Taxa; and transect length multiplied by the ROW width, which varied by transect, for Conspicuous Taxa.

The field methods were identical for all survey years.

Two people walked along each transect. One person led the survey by walking the predetermined transect route that had been pre-recorded in a handheld GPS unit (Garmin Map62 or Map78). A botanist followed behind, surveying a band centred on the transect. The width of the surveyed band varied based on what was visible from the transect line (primarily influenced by the terrain and height of vegetation), but was never less than 10 m wide.

Additionally, the botanist walked to vegetation patches away from the transect if it appeared that they might include non-native plants. These meandering searches were expected to detect any larger, taller patches of non-native plants situated within the entire cleared ROW width due to its openness given the relatively short time since clearing. As a result of this method, the area covered by the survey on each transect varies (Table 4-1). All non-native taxa were identified and tallied in a band at least 10 wide, centred on the transect. Large (“conspicuous”) non-native plants (e.g. mature sweet clover or field sow-thistle) may be detected for the entire width of the ROW.

Increasing native vegetation cover and height in the cleared ROW may have introduced a bias over time with respect to detectability of non-native plants. Taller and denser native vegetation cover decreases the distance at which non-native plants could be seen from the transect, particularly for smaller species or single, short plants. Over time, the actual cover of some non-

native plant species may become increasingly underestimated. The degree of this bias up to 2019 was expected to be low since native vegetation cover was still relatively short in most areas of the cleared ROW.

Field surveys recorded all non-native plants regardless of whether or not they were also invasive. When a non-native plant location was found, data recorded at each species location included spatial coordinates, spatial extent and abundance. Additional notes were also recorded and photos were taken.

The spatial extent of non-native plants at a location was recorded either as a patch or as a point with an associated number of individuals. The “point with number of individuals” method was typically used in locations where there less than 20 individual plants covering a very small area. In these situations, the number of plants of each species and a GPS waypoint (using a Garmin Map 62 or Map 78) were recorded as close to centre of the patch as possible for the species.

For the remaining non-native plant locations, recorded patch data included estimated vegetation patch boundaries and non-native plant cover by species. Patch boundaries were obtained using a handheld GPS for each vegetation patch that included one or more non-native plant species. The percent cover of each non-native species within the vegetation patch boundaries was then visually estimated.

Vegetation patch boundaries were recorded in one of three ways:

1. **Point:** Used for small patches that had a relatively regular shape. Typically applied to small patches in open areas where the boundaries were visible from a single point. In these situations, a GPS waypoint was taken at the patch center whenever possible, with an associated ocular estimate of patch radius (in meters) for circular patches or the dimensional length (e.g. 2m x 4m) for rectangular patches.
2. **Band:** Used for patches too large to be recorded as a point and had a relatively regular band shape. In these situations, the length of the band of the non-native species (e.g. along a ditch) was walked while a GPS recorded a track log for the species. An estimate of the average band width in meters was recorded. For some wider bands, the band width was recorded using distinct features such as a specific impact area (e.g. width of the transmission line right-of-way).
3. **Defined Area:** Used if the patch could not be recorded as a point or a band. In these situations, the surveyor generally walked around the perimeter of a large homogeneous patch with non-native species cover while recording a GPS track log for the patch. Alternately, the surveyor walked through the area in a zig-zag transect so that the points generally corresponded to the boundaries of the patch. The former method was used when the non-native species could be observed throughout the patch from the outer boundaries, which typically occurred in open barren, or low vegetation areas. The latter method was used in heavily vegetated areas where non-native plants were not visible over a long distance. In this method, waypoints were added while recording the species tracklog to indicate if there was a change in cover.

For each non-native species patch, plant cover was estimated and recorded into one of the six classes listed in Table 4-2.

Table 4-2: Cover class and associated percent cover ranges used for non-native plant surveys

Cover Class	Percent Cover Range
Very sparse	>0 - 3%
Sparse	3 - 10%
Low	11 - 25%
Moderate	26 - 50%
High	51 - 75%
Very high	76 - 100%

4.2.2 MAPPING

The mapping methods were identical for all survey years.

Distribution and abundance maps were produced by creating GIS polygons from the spatial extent and cover data recorded during the field surveys. Where the patch extent method (Section 4.2.1) was used to record non-native species in the field, patch polygons were created from the GPS tracklogs. Polygons for locations where plants were recorded as individuals in the field were created by applying a radius buffer around the location coordinate. The radius applied for each species at each point was a fixed value for the species multiplied by the number of plants recorded. The radius for one plant of a particular species was the estimated typical area covered by an individual plant (Appendix Table 6-1).

The non-native plant mapping provided two measures of non-native plant cover. One measure was the overall spatial extent of one or more non-native plant species, which also indicated species distribution. The other measure was the area covered by each species (approximate plant cover), which was used to indicate abundance. Non-native plant cover will almost always be lower than plant extent due to less than complete canopy closure within some of the mapped patches.

Non-native plant cover was derived from the patch cover class (Table 4-2) for locations recorded using the “patch method” or from multiples of individual plant area (Appendix Table 6-1) for locations recorded using the “number of individuals” method. The area covered by a species in a mapped patch was calculated by multiplying the patch area by the midpoint of the percent cover class (Table 4-2). For example, a 10 m^2 non-native plant patch with sparse cover for Species A would have a derived area of: 10 m^2 x 6.5% = 0.65 m^2 for Species A.

4.2.3 INVASIVE CONCERN

The non-native plant species recorded during the monitoring were classified into levels of invasive concern for the Project area (Table 4-3).

Table 4-3: Level of invasive concern classification for non-native species recorded in the Project area.

Invasive Concern Level	Species Included
Level 1	Species the Invasive Species Council of Manitoba classifies as "Category 1" or "Category 2"
Level 2	Species the Invasive Species Council of Manitoba classifies as "other" or White et al. (1993) classify as "high" or "moderate" invasives
Level 3	Species that either White et al. (1993) classify as "minor" invasives, or government sources classify as noxious weeds or weed seed species
Level 4	All remaining non-native plant species

The highest level of invasive concern for the Project (Level 1 species) included ISCM Category 1 and 2 species. ISCM Category 1 species are invasive plants which are not present in Manitoba, but may be present in cultivation and not yet known to have escaped (ISCM 2020). ISCM Category 2 species are invasive plants which are present in Manitoba, capable of further spread, have an established pathway for spread and easily identifiable with available resources. ISCM Category 1 and 2 species are on the early detection and rapid response list. Species that ISCM lists as "other" include invasive species that are present in Manitoba, and are of some concern but not on the early detection and rapid response list.

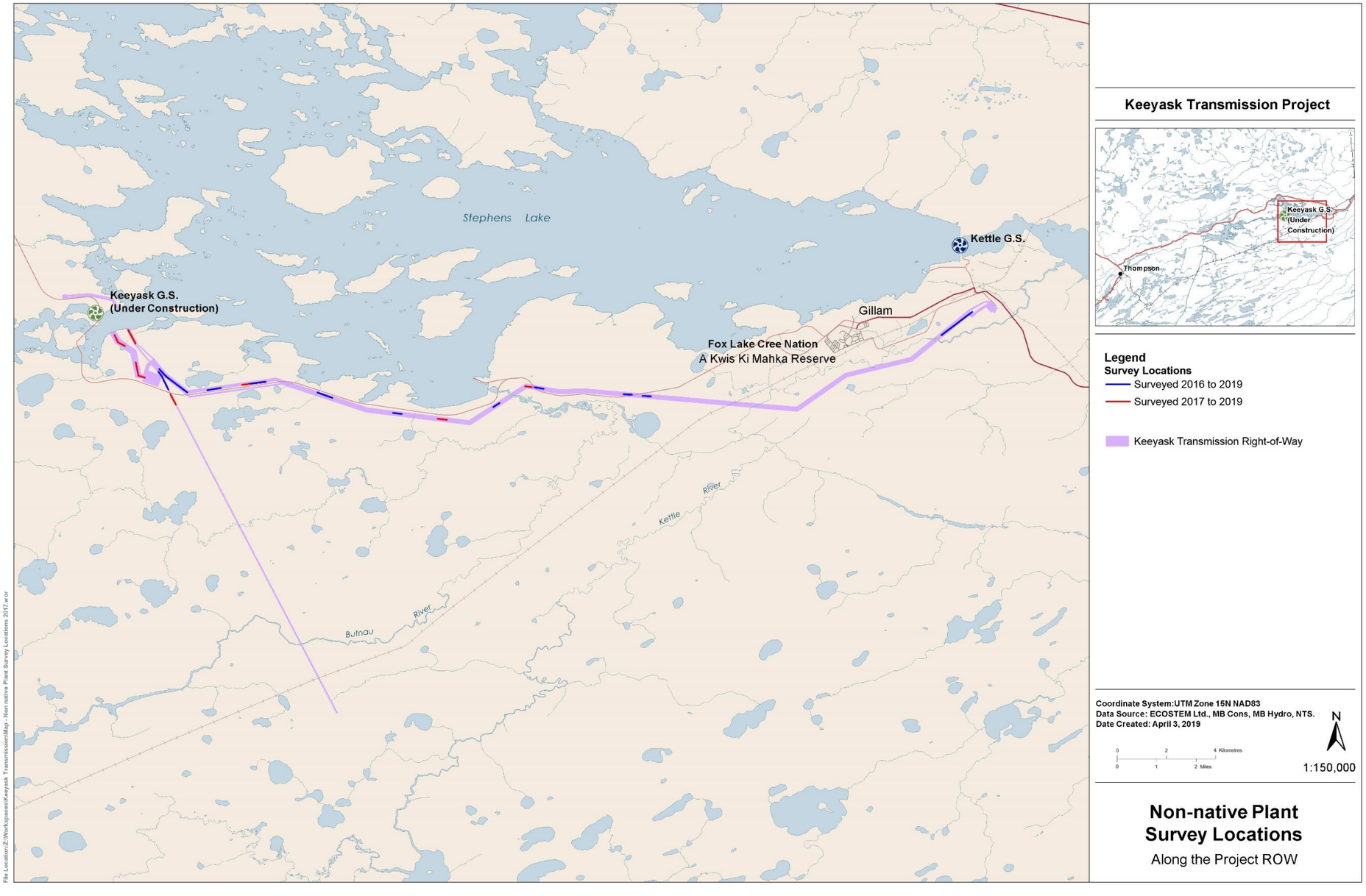
The second level of invasive concern for the Project (Level 2 species) included ISCM "other" species of concern and/or the non-native species that White et al. (1993) classify as being principal or moderate invasives in Canada. These species also have the potential to crowd out native species in many of the conditions where non-native plants are found.

The third highest level of invasive concern (Level 3 species) included non-native species that White et al. (1993) classify as minor invasives in Canada and/or the species that government sources classify as noxious weeds or weed seed species (Government of Manitoba 2017).

The fourth and final level of invasive concern (Level 4 species) included all of the non-native plant species not already included in another level. Species at the third and fourth levels may become problematic in some locations and/or conditions (*e.g.*, changed climate). They will also be a consideration when developing revegetation plans for areas being rehabilitated to native habitat types.

Appendix Table 6-2 identifies non-native species that may be found in the Project area, their level of invasive concern and the sources for the invasive concern classification.

4.2.4 MAPS



Map 4-1: Non-native plant survey locations in 2016 to 2019

4.3 RESULTS

The following summarizes key monitoring results for invasive plants. For further details, see the annual reports (ECOSTEM 2017b, 2018b and 2019c).

4.3.1 2016

Exposed mineral substrates in the cleared ROW were quite limited following clearing (Photo 4-1).

Photo 4-1: Example of minimal exposure of mineral substrates in cleared ROW

Permanent Transects

Non-native plants were found at only one location along the 8.1 km of permanent transects surveyed in 2016 (Table 4-1). A single patch of common dandelion (*Taraxacum officinale*) was found along a pre-existing cutline in the ROW near the Radisson Converter Station. Footprint mapping after construction was complete determined this patch to be outside of the Project ROW.

The outer boundary of the patch of common dandelion plants included an area of approximately 88 m^2. Common dandelion cover within the patch was very sparse. Estimated total dandelion cover was 1.3 m^2.

Incidental Observations

There were no incidental non-native plant observations in 2016.

Table 4-4: Number of sites with non-native plants along the permanent transects in the ROWs, by year.

Species		Survey Year			
Common Name[1]	**Scientific Name**	**2016**	**2017**	**2018**	**2019**
Field sow-thistle	*Sonchus arvensis*	-	-	2	2
White sweet clover	*Melilotus albus*	-	-	2	-
Lamb's-quarters	*Chenopodium album*	-	-	4	13
Narrow-leaved hawks-beard	*Crepis tectorum*	-	-	14	15
Common dandelion	*Taraxacum officinale*	1	3	3	5
Pineappleweed	*Matricaria discoidea*	-	-	1	-
Common plantain	*Plantago major*	-	1	1	1
Smooth catchfly	*Silene csereii*	-	-	-	1
All species		1	4	27	37

Notes: [1] Species in bold font are invasive concern level 2; species in italicized font are invasive concern level 3 (Section 4.2.3).
[2] Numbers that round to zero shown as "0"; absences shown as "-".

Table 4-5: Non-native plant cover (m^2) along the permanent transects in the ROWs by year.

Species		Survey Year			
Common Name[1]	**Scientific Name**	**2016**	**2017**	**2018**	**2019**
Field Sow-thistle	*Sonchus arvensis*	-	-	0.7	3.2
White Sweet Clover	*Melilotus albus*	-	-	1.9	-
Lamb's-quarters	*Chenopodium album*	-	-	9.9	405.8
Narrow-leaved Hawks-beard	*Crepis tectorum*	-	-	2.7	22.1
Common Dandelion	*Taraxacum officinale*	1.3	0.1	0.1	6.0
Pineappleweed	*Matricaria discoidea*	-	-	0.0	-
Common Plantain	*Plantago major*	-	0.0	0.0	0.0
Smooth Catchfly	*Silene csereii*	-	-	-	0.1
All non-native species		1.3	0.1	15.2	437.2
Percentage of belt transect area		0.002	<0.001	0.014	0.397
Percentage of ROW segment area surveyed by belt transect		$1.1*10^{-4}$	$6.3*10^{-6}$	$7.6*10^{-4}$	0.022

Notes: [1] Species in bold font are Level 2 invasive concern; species in italicized font are Level 3 invasive concern (Section 4.2.3).
[2] Numbers that round to zero shown as "0"; absences shown as "-".

4.3.2 2017

Permanent Transects

Non-native plants were found at four sites at three general locations along the 11.1 km of permanent transects surveyed in 2017 (Table 4-4; Map 4-2). Every site included only one single plant. Common dandelion (*Taraxacum officinale*) was growing in three sites, and common plantain (*Plantago major*) in the remaining site. The foliate cover for all of these plants totaled less than one square meter.

Two of the common dandelion plants as well as the single common plantain plant were found in the ROW near the south access road ditch (Map 4-2), and two of these three locations were where the GOT ROW crossed the South Access Road east of the Butnau Marina. The third common dandelion plant was found on a machine trail near the eastern end of the GOT ROW near the Radisson Converter Station.

Incidental Observations

There were no incidental observations in 2017.

4.3.3 2018

Permanent Transects

By August 2018, the number of non-native plant sites on the permanent transects increased from four to 27 (Table 4-4), and total non-native plant cover increased from less than 1 m^2 to approximately 15 m^2 (Table 4-5).

In 2018 non-native plant sites were clustered around five locations (Map 4-2). Three of these locations were the same three that were identified in 2017 (i.e., the GOT ROW, near the Radisson Converter Station, near the South Access Road where it crosses the ROW just east of the Butnau Marina, near the South Access Road ditch toward the west end of the GOT ROW). The locations in the GOT ROW just east of Butnau Marina and near the Radisson Converter Station had the largest clusters of plants. The two new locations were near the South Access Road at another crossing to the east of the above one, and one in the Construction Power ROW (approximately 200 m north of the South Access Road).

Five additional non-native species were identified in the Project ROWs for the first time, including field sow-thistle (*Sonchus arvensis*), white sweet clover (*Melilotus albus*), lamb's quarters (*Chenopodium album*), narrow-leaved hawks-beard (*Crepis tectorum*) and pinappleweed (*Matricaria discoidea*).

Lamb's quarters made up nearly two-thirds of the total non-native plant cover (approximately 15 m^2) in 2018, most of which was in a single large patch near the South Access Road crossing east of Butnau Marina (Table 4-5; Map 4-2). Narrow-leaved hawks-beard was the most widespread with respect to number of sites, and made up the second highest proportion of the total cover.

Incidental Observations

Three incidental observations increased the total number of recorded non-native plant sites from 28 to 31 (Table 4-6). Two of the sites were at one location in the GOT ROW south of the Town of Gillam and one site was on the north side of the GOT ROW near the Radisson Converter Station (Map 4-3). Two of these sites included a single plants of field sow-thistle and common dandelion. One site was a large patch with sparse narrow-leaved hawks-beard cover. Including these observations increased the total non-native plant cover from 15.3 m^2 to 33.3 m^2, with virtually all of this increase due to the one large, sparse patch of plants (Table 4-6).

Table 4-6: Incidental non-native plant observations, by year[1].

Species		2018		2019	
Common Name[2]	**Scientific Name**	**Number of Sites**	**Total Cover (m^2)**	**Number of Sites**	**Total Cover (m^2)**
Field sow-thistle	*Sonchus arvensis*	1	0.0	-	-
Lamb's-quarters	*Chenopodium album*	-	-	1	0.1
Narrow-leaved hawks-beard	*Crepis tectorum*	1	18.0	-	-
Common dandelion	*Taraxacum officinale*	1	0.0	-	-
Pineappleweed	*Matricaria discoidea*	-	-	1	0.0
All non-native species		3	18.1	2	0.1

Notes: [1] None recorded in 2016 or 2017. [2] Species in bold font are invasive concern level 2; species in italicized font are invasive concern level 3 (Section 4.2.3). [3] Numbers that round to zero shown as "0"; absences shown as "-".

4.3.4 2019

Permanent Transects

In 2019, non-native plants were observed at 37 sites along the permanent transects (Table 4-4; Map 4-2). The sites were clustered in six locations, five of which were the same locations where plants were found in 2018 (i.e., three sites in the GOT ROW near the South Access Road, the Construction Power ROW near the South Access Road, the GOT ROW near the Radisson Converter Station). The new location included a few sites scattered in the GOT and Construction Power ROWs between the Nelson River and the switching station.

By August 2019, total non-native plant cover along the permanent transects increased from approximately 15 m^2 to 437.2 m^2 (Table 4-5). This represented approximately 0.4% of the total area surveyed for all non-native plant taxa in the Project ROWs, and 0.02% of the area surveyed for conspicuous taxa (see Table 4-1).

Six non-native plant species were recorded during the 2019 surveys (Table 4-4). Lamb's-quarters was the most abundant species by far, making up most (93%) of the total non-native plant cover

in the surveyed portions of the Project ROW (Table 4-5). This was followed by narrow-leaved hawks-beard and common dandelion. Smooth catchfly (*Silene csereii*), was recorded for the first time in 2019 at one site at the northwestern end of the GOT ROW near the Nelson River.

Lamb's quarters also made up the vast majority of the increase in non-native plant cover between 2018 and 2019 (increasing from 10 m^2 to 406 m^2). Most of this expansion was associated with a single large patch near the South Access Road where it crosses the Project ROW just east of the Butnau Marina, which was already present in 2018 (Map 4-2).

Perennial sow-thistle was found growing at two sites in the Project ROW (Map 4-3). A patch with low cover was found growing in the Construction Power ROW approximately 50 m south of the South Access Road (Map 4-4). This was approximately 400 m from the location north of the South Access Road that was found in 2018.

Incidental Observations

In 2019, two sites with non-native plants were observed incidentally at one location outside of the pre-determined survey areas (Table 4-6). These included Individuals of lamb's quarters and pineappleweed that were found in the GOT ROW on the south side of the switching station (Map 4-3). When the incidental observations were included, the total number of non-native species recorded in 2019 increased to seven, and total non-native plant cover observed in 2019 increased from 437.2 m^2 to 437.3 m^2.

Photo 4-2: Common dandelion growing in the GOT ROW in 2017.

Photo 4-3: White sweet clover growing beside the South Access Road where it crosses the GOT ROW in 2018.

Photo 4-4: Patch of perennial sow-thistle growing near the edge of the GOT ROW north of the South Access Road in 2019.

4.3.4.1 SPECIES OF CONCERN AND CONTROL MEASURES

Non-native plant species at the Level 1 degree of concern were not recorded during monitoring to date. Field sow-thistle (Photo 4-4) and white sweet clover (Photo 4-3) were the only Level 2 species recorded during the monitoring.

Field Sow-thistle

Small patches or individual field sow-thistle plants found during the surveys were immediately removed by ECOSTEM staff due to their relatively high level of concern and the small number of plants. In 2018, small patches or individuals of field sow-thistle were removed from two sites (Map 4-4). Four plants were removed at one site in the Construction Power ROW approximately 200m north of the Keeyask Generation Project south access road (the South Access Road), and a single plant was removed in the GOT ROW less than one kilometre from the Radisson Converter Station.

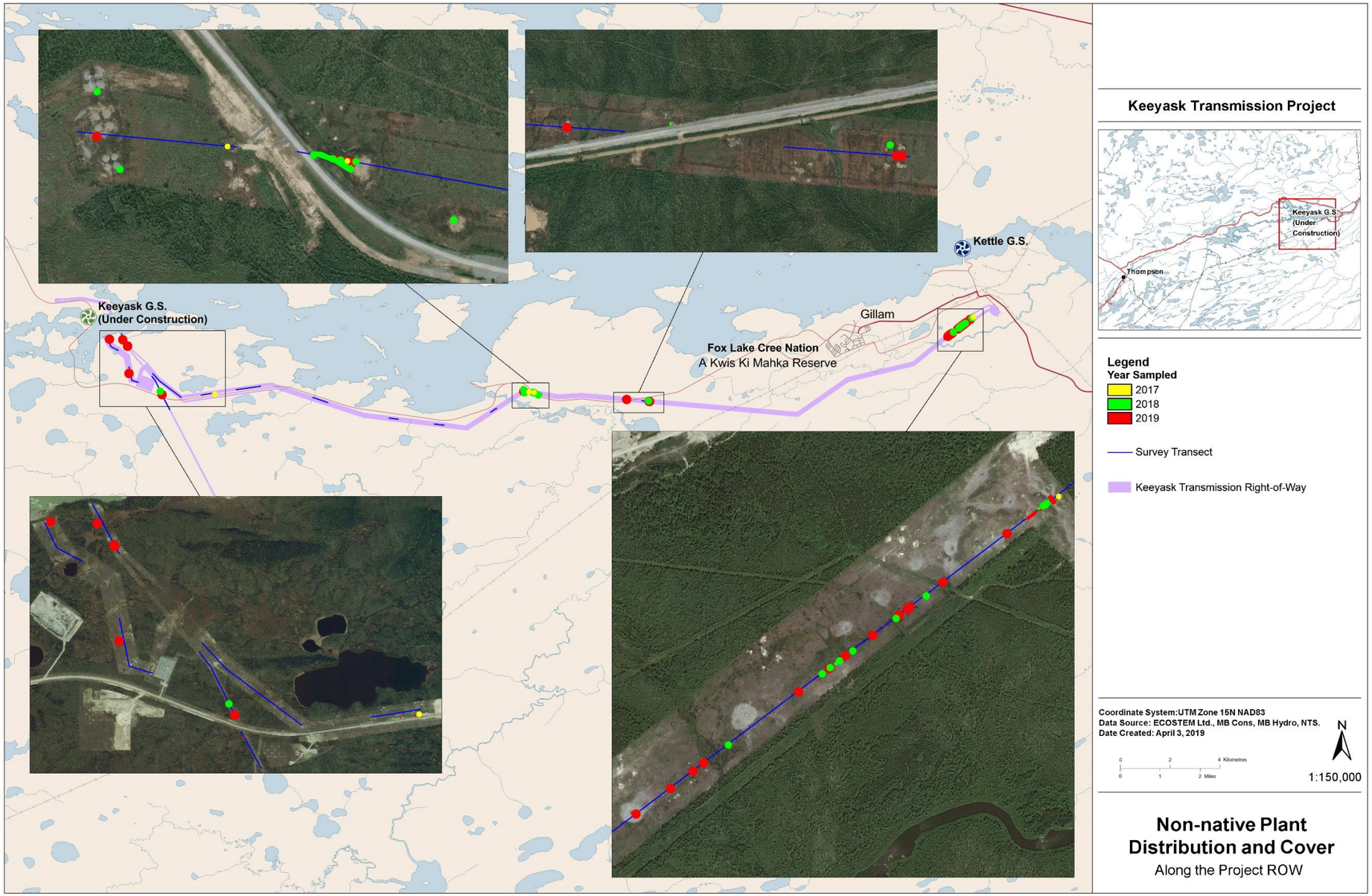
In 2019, no new plants were found at the site in the Construction Power ROW. It is not known if plants re-established at the incidentally observed site in the GOT ROW because this site was not re-visited in 2019 as it was not near a survey transect.

Field sow-thistle plants at two of the sites recorded in 2019 were not removed by ECOSTEM staff because it was highly unlikely that manual removal would eradicate field sow-thistle at these sites. There were many plants in these sites, and they had already established a root system.

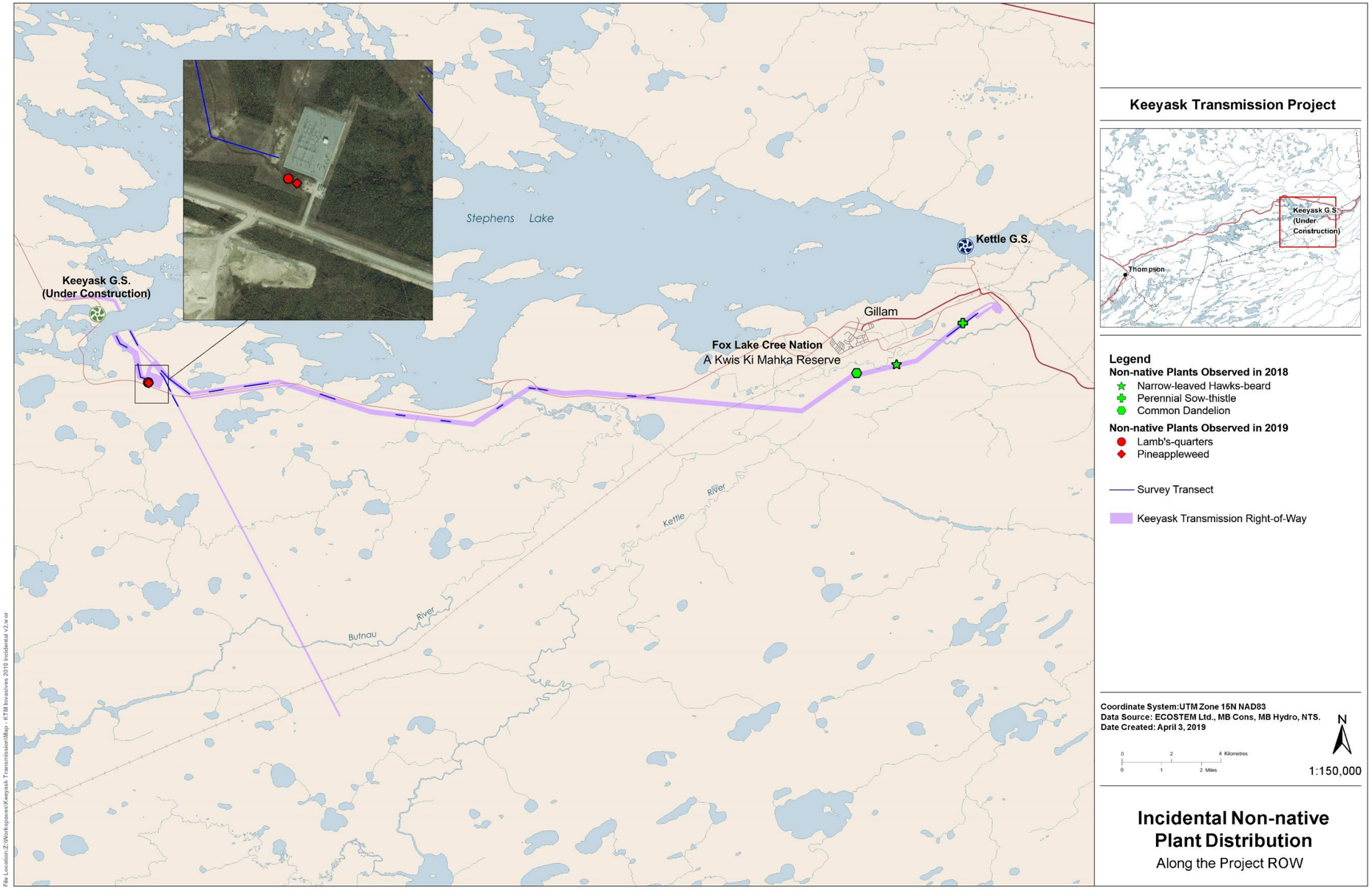
White Sweet Clover

White sweet clover was found at two sites (Map 4-4), both of which were near or adjacent to where the ROW crossed the South Access Road. These plants were not removed by ECOSTEM staff, because they were already becoming established along the South Access Road.

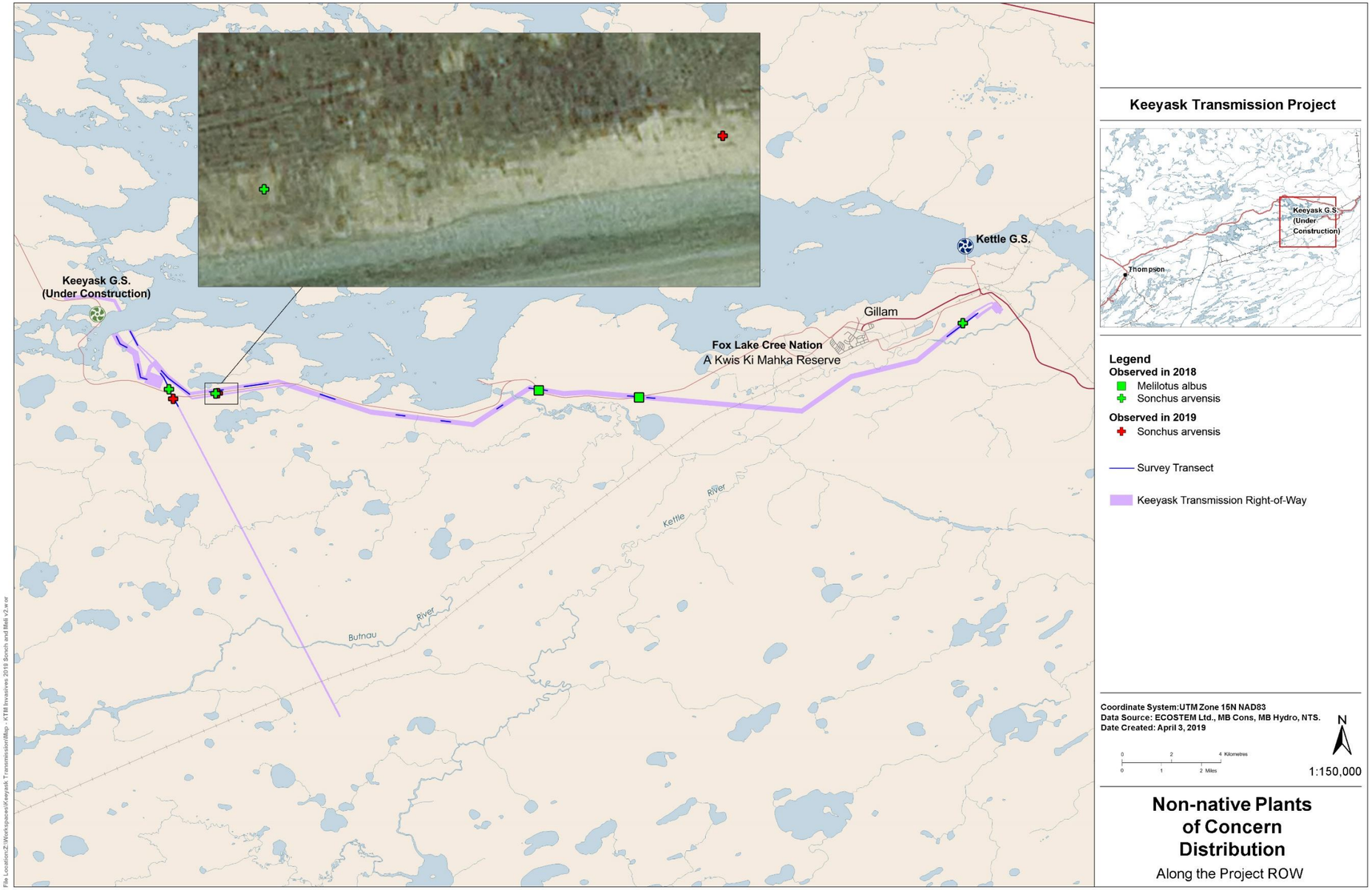
4.3.5 MAPS



Map 4-2: Non-native plant distribution and cover in the Construction Power and GOT ROWs by year.



Map 4-3: Incidentally observed non-native plant sites in the GOT ROW.



Keeyask Transmission Project

Legend

Observed in 2018
- Melilotus albus
- Sonchus arvensis

Observed in 2019
- Sonchus arvensis
- Survey Transect
- Keeyask Transmission Right-of-Way

Coordinate System:UTM Zone 15N NAD83
Data Source: ECOSTEM Ltd., MB Cons, MB Hydro, NTS.
Date Created: April 3, 2019

0 2 4 Kilometres
0 1 2 Miles

N

1:150,000

Non-native Plants of Concern Distribution

Along the Project ROW

Map 4-4: Non-native plant species of concern in the Construction Power and GOT ROWs.

4.4 DISCUSSION

4.4.1 PROJECT EFFECTS

The very large increase in the number of recorded non-native plant sites along the permanent transects between 2017 and 2018 (4 to 27 sites) was attributed to Keeyask Generation Project (KGP) construction activities and to Project spreading of plants that were long-established in the Radisson Converter Station footprint. All of the sites beyond the vicinity of the Radisson Converter Station were recorded where a ROW crossed the Keeyask Generation Project South Access Road (SAR) constructed for the KGP. Non-native plants were present in the area cleared by the KGP for the SAR and its ditches near all of the sites found in the Project ROW.

The only new non-native plant location recorded in 2019 included a few sites scattered in the ROW segment between the switching station and the Nelson River. While this ROW segment does not cross the SAR, the access road to the switching station comes from the SAR. KGP monitoring recorded the same non-native species along the SAR, and within 1.2 km of the switching station access road. Transmission towers had also recently been constructed in these segments of the ROW, and the associated traffic was the most likely mechanism for the spread of non-native plants into that location.

Although the increase in total non-native plant cover from 2017 to 2019 (15.2 m^2 to 437.2 m^2) was proportionately very large, non-native plant cover still comprised a very small percentage of the total area surveyed. Calculating the percentage of area with non-native plant cover using the belt transect area (i.e., a 10 m band along the transect length) likely overestimated the actual percentage non-native plant cover for the Project footprint. This was because some of the cover was outside of the belt transect given that the surveyor meandered through the cleared ROW to investigate locations that were more likely to support non-native plants (i.e. transmission tower bases). The actual percentage of ROW with non-native plant cover was probably closer to the value determined from using the entire ROW width (i.e., closer to 0.02% than to 0.4%).

The explanation for why non-native plant cover remained very low in the cleared portions of the ROW was a likely combination of: (i) the very low proportion of the ROW area with exposed mineral substrates; (ii) the relatively short time since ROW clearing; (iii) limitations on potential seed input; and, (iv) increasing native plant cover.

Other studies in the region have found that non-native plant species are most common on exposed mineral substrates (ECOSTEM 2012; ECOSTEM unpublished data). Only a very small proportion of the ROWs had exposed mineral substrates, which lowered the availability of higher quality seedbeds for non-native plant species. The paucity of exposed mineral substrates was attributed to three factors. With the exception of transmission tower bases, construction clearing was intended to remove taller vegetation only. Also, vegetation clearing generally occurred when the ground was frozen, which minimized unintentional mineral substrate exposure. Finally, native vegetation was expanding and covering exposed mineral substrates.

Regarding the relatively short time since clearing, previous extensive studies in the region showed that non-native species were extremely rare in undisturbed native habitat (KHLP 2012). When the vegetation in such habitat is cleared, time is required for non-native plants to colonize from other areas or from viable seeds buried in the soil.

The amount of time required for colonization from other areas to occur is expected to vary with distance from established non-native plant populations, among other things. Long-existing human infrastructure and other features (e.g., cutlines) are typically the primary locations for established non-native plant populations. Most of the plant cover found from 2016 to 2019 was in close proximity to well-established seed sources at the Radisson Converter Station and the Town of Gillam, along the decommissioned section of Butnau Road as well as the locations of construction and traffic associated with the Keeyask Generation Project. Also, the increases in total non-native plant cover in 2018 and 2019 were mostly limited to sites where plants had already established.

Along much of their total length, the ROWs are distant from and/or somewhat sheltered from existing human infrastructure and activity. Where the ROW approaches or follows existing infrastructure, it is somewhat sheltered from that infrastructure by a band of native vegetation that ranges from 20 m to more than 800 m in width. Many of the narrowest vegetated bands are along the SAR, which was only recently cleared during Keeyask Generation Project construction.

Factors that appeared to be limiting the potential input of non-native seeds included clearing when the ground is frozen, environmental protection plan provisions for equipment cleaning and the age of nearby recently cleared areas. Snow cover was expected to reduce the spreading effect of equipment moving through sites by reducing the number of seeds picked up and transported, and by reducing exposure of mineral substrates. Additionally, efforts to clean equipment prior to arriving at the Project should have reduced the amount of non-native seed transported into the ROW.

Much of the ROW that is adjacent to existing infrastructure follows the recently constructed Keeyask Generation Project SAR, where non-native plant cover was still relatively low in 2017 (ECOSTEM 2018a), but was increasing in cover in 2018 and 2019 (ECOSTEM 2019a; ECOSTEM in prep.). The increase in cover in the ROW near the SAR paralleled the increases recorded in the SAR corridor.

Finally, the expanding native plant cover in the ROW in 2019 (Photo 4-5) continued to be a possible factor that was limiting the establishment or spreading of non-native plants. Expanding native plant cover should at least somewhat reduce non-native plant cover through shading and competition for resources. Native plant cover should also create a hindrance to the colonization of new non-native plants as plant litter and live plant parts gradually reduce the surface area of exposed mineral substrates.

Over the long-term, the proximity of the Project footprint to the SAR, which will become a portion of the highway from Thompson to Gillam, will likely be a continual source of non-native plants.

Photo 4-5: Regenerating native vegetation in transmission ROW in 2019

4.4.2 COMPARISON WITH EA REPORT PREDICTIONS

The EA Report predicted that the Project was not expected to substantially increase the rate at which invasive plants are introduced and/or spread in the Project area, primarily for two reasons. First, the vast majority of clearing is in undisturbed native habitat (i.e., places where invasive plants are typically absent). Second, Project environmental protection plans include measures to minimize the risk that equipment and activities will transport invasive plants into the Project area.

Invasive plant monitoring to date suggests that Project activities have made limited contributions to the spread of non-native plants in the Project area. The non-native plants recorded in the Project ROWs appear to have originated from other nearby projects that were either pre-existing or constructed at the same time as the Project. So far, non-native plants have been confined to areas that are in close proximity to these other projects. Given these observations, natural dispersal will be an ongoing mechanism for spreading non-native plants into the adjacent ROWs.

4.4.3 RECOMMENDATIONS FOR ENVPP MEASURES, FURTHER MITIGATION AND FURTHER MONITORING

There are no definite recommendations regarding modifications to the EnvPP. To the extent we are aware of how the EnvPP measures were implemented, they appeared to have been effective in limiting the introduction and spreading of invasive plants. It was the case that the Project was very effective at minimizing clearing and minimizing disturbance outside of the standard cleared ROW width. As another example, the EnvPP required vehicles to come to the site clean and without weed species. Environmental inspectors were onsite confirming this requirement was being followed. Some vehicles were not accepted on to the job site and had to be cleaned and repaired before allowed back (Wiens pers. comm. 2020).

Control recommendations were not developed during the monitoring to date due one or more of the following factors: the plants were immediately removed by field staff as soon as they were found, the degree of invasive concern for the species; the likelihood that control efforts would be successful; and/or, the presence of natural agents of control. It is unlikely that plants from the two species of concern for the Project area can be controlled because they are in close proximity (200 m or less) to other non-Project features (i.e. SAR, Radisson Converter Station) which have established plants. Natural dispersal and ongoing foot or vehicle traffic will continue to bring seed into the adjacent ROW.

Control recommendations are not provided in the report for the same reasons as during the monitoring. Over the long-term, the SAR will likely be a continual source of non-native plants into the Project footprint given that the SAR will become a portion of the highway from Thompson to Gillam. Promoting the expansion of native herbaceous and low shrub vegetation in the ROW and, where allowable, in the SAR corridor is expected to be the best way to limit the expansion of non-native plants in the ROW.

It is recommended that invasive plant monitoring be discontinued for several reasons. Project effects are consistent with predictions, the two recorded species of invasive concern are either close to or part of much larger patches in the South Access Road corridor, the ongoing regeneration of native plants will likely control these species and the risk of unanticipated future effects is low.

4.5 CONCLUSIONS

Monitoring found that the Project's contribution to the introduction and spreading of invasive plants was very low, as predicted. There were no unanticipated Project effects.

There are no recommendations for revisions to the EnvPPs. There are no recommendations for further mitigation given that long-term effects are expected to be substantially less than predicted.

It is recommended that invasive plant monitoring be discontinued.

5.0 LITERATURE CITED

ECOSTEM. 2010. Wuskwatim Transmission Project Biophysical Monitoring Program: Forest ecosystem edge and cleared RoW effects. Prepared for: E. Hicks & Associates and Manitoba Hydro by ECOSTEM Ltd., June 2010.

ECOSTEM. 2012. Keeyask Transmission Project. Terrestrial habitat, ecosystems and plants technical report. Prepared for Manitoba Hydro by ECOSTEM Ltd., September 2012.

ECOSTEM Ltd. 2013. Responses of Terrestrial Habitats to Reservoir Flooding and Water Regulation in Northern Manitoba. Prepared for Manitoba Hydro. Keeyask Generation Project Environmental Studies Program Report # 11-05. 170pp.

ECOSTEM. 2014. Rare plants found on Keeyask Transmission Power right-of-way. A memorandum prepared for Manitoba Hydro by ECOSTEM Ltd., October 2014. 6pp.

ECOSTEM. 2017a. Keeyask Transmission Project: Environmental Effects Monitoring – Ecosystem Diversity Monitoring in 2016. A report prepared for Manitoba Hydro by ECOSTEM Ltd., June 2017.

ECOSTEM. 2017b. Keeyask Transmission Project: Environmental Effects Monitoring - Invasive Plant Monitoring in 2016. A report prepared for Manitoba Hydro by ECOSTEM Ltd., May 2017.

ECOSTEM. 2017c. Keeyask Transmission Project: Environmental Effects Monitoring – Priority Plant Monitoring in 2016. A report prepared for Manitoba Hydro by ECOSTEM Ltd., May 2017.

ECOSTEM. 2018a. Keeyask Generation Project Terrestrial Effects Monitoring Plan Report #TEMP-2018-05: Invasive Plant Spread and Control Monitoring Report. A report prepared for Manitoba Hydro by ECOSTEM Ltd., June 2018.

ECOSTEM. 2018b. Keeyask Transmission Project: Environmental Effects Monitoring - Invasive Plant Monitoring in 2017. A report prepared for Manitoba Hydro by ECOSTEM Ltd., February 2018.

ECOSTEM. 2019a. Keeyask Generation Project Terrestrial Effects Monitoring Plan Report #TEMP-2019-05: Invasive Plant Spread and Control Monitoring Report. A report prepared for Manitoba Hydro by ECOSTEM Ltd., June 2019.

ECOSTEM. 2019b. Keeyask Transmission Project: Environmental Effects Monitoring – Ecosystem Diversity Monitoring in 2019. A report prepared for Manitoba Hydro by ECOSTEM Ltd., January 2019.

ECOSTEM Ltd. 2019c. Keeyask Transmission Project: Environmental Effects Monitoring - Invasive Plant Monitoring in 2018. A report prepared for Manitoba Hydro by ECOSTEM Ltd., January 2019.

ECOSTEM Ltd., Wildlife Resources Consulting Services Inc. and Stantec Consulting Ltd. 2013. Habitat Relationships and Wildlife Habitat Quality Models for the Keeyask Region. Draft Report Prepared for Manitoba Hydro. Keeyask Generation Project, Environmental Studies Program, Report # 13-02.

Eldegard, K., Totland, O. and S.R. Moe. 2015. Edge effects on plant communities along power line clearings. Journal of Applied Ecology. 52: 871–880.

Government of Canada. 2016. Weed Seeds Order, 2016. Minister of Justice, Government of Canada [Online] http://laws-lois.justice.gc.ca.

Government of Manitoba. 2017. The Noxious Weeds Act. Government of Manitoba, C.C.S.M. c. N110.

ISCM (Invasive Species Council of Manitoba). 2020. Invasive plants & animals in Manitoba. [Online] http://www.invasivespeciesmanitoba.com/site/index.php. [accessed March, 2020].

Keeyask Hydropower Limited Partnership (KHLP). 2012. Keeyask Generation Project Environmental Impact Statement: Terrestrial Environment Supporting Volume, Winnipeg, Manitoba. June 2012.

Manitoba Hydro. 2012. Keeyask Transmission Project environmental assessment report. Prepared by Manitoba Hydro, November 2012.

Manitoba Hydro 2015. Keeyask Transmission Project Environmental Effects Monitoring Plan. Prepared for: Manitoba Conservation and Water Stewardship, Environmental Approvals Branch, July 2015. 61pp.

White, D.J., Haber, E., and Keddy, C. 1993. Invasive plants of natural habitats in Canada: an integrated review of wetland and upland species and legislation governing their control. Canadian Wildlife Service, Ottawa, Canada. 121 pp.

Wiens, Jonathan. 2020. Biophysical Analyst (Terrestrial). Manitoba Hydro, Winnipeg, MB. Email correspondence with James Ehnes, ECOSTEM Ltd., Winnipeg, MB, May 1, 2020.

6.0 APPENDICES

APPENDIX 1:
DETAILED TABLES

Table 6-1: Estimated radius and derived area for individual plant species

Species	Estimated Radius (cm)	Derived Area (m^2)
Arctium minus	25	0.196
Artemisia absinthium	25	0.196
Avena sativa	4	0.005
Capsella bursa-pastoris	5	0.008
Chenopodium album	10	0.031
Chrysanthemum leucanthemum	10	0.031
Cirsium arvense	10	0.031
Cirsium vulgare	15	0.071
Crepis tectorum	8	0.020
Descurainia sophoides	15	0.071
Helianthus annuus	20	0.126
Hordeum jubatum	4	0.005
Lotus corniculatus	25	0.196
Matricaria discoidea	7.5	0.018
Medicago lupulina	10	0.031
Medicago sativa	25	0.196
Melilotus albus	25	0.196
Melilotus officinalis	25	0.196
Oenothera biennis	20	0.126
Phleum pratense	3	0.003
Plantago major	10	0.031
Secale cereale	4	0.005
Silene csereii	10	0.031
Sonchus arvensis	10	0.031
Taraxacum officinale	10	0.031
Trifolium hybridum	20	0.126
Trifolium pratense	20	0.126
Trifolium repens	20	0.126
Tripleurospermum inodorum	5	0.008
Triticum aestivum	4	0.005
Verbascum thapsus	20	0.126
Vicia cracca	20	0.126

Table 6-2: Invasive concern classifications for known non-native plant species in the Project area.

Invasive Concern	Common Name[1]	Scientific Name	ISCM Category[2]	White *et al.* Category[3]	Noxious Weed[4]	Weed Seed[5]
Level 1	Scentless chamomile	*Tripleurospermum inodorum*	Category 2		yes	secondary
	Ox-eye daisy	*Leucanthemum vulgare*	Category 2		yes	primary
	Common tansy	*Tanacetum vulgare*	Category 2		Yes	
Level 2	Canada thistle	*Cirsium arvense*	other	moderate	yes	primary
	Common burdock	*Arctium minus*	other		yes	
	Perennial sow thistle	*Sonchus arvensis*	other		yes	primary
	Tufted vetch	*Vicia cracca*	other			
	Reed canary grass	*Phalaris arundinacea*		principal		
	White sweet clover	*Melilotus albus*		moderate		
	Yellow sweet clover	*Melilotus officinalis*		moderate		
Level 3	Wormwood	*Artemisia absinthium*		minor	yes	
	Alfalfa	*Medicago sativa*		minor		
	Lamb's quarters	*Chenopodium album*			yes	
	Common dandelion	*Taraxacum officinale*			yes	
	Narrow-leaved hawks-beard	*Crepis tectorum*			yes	
	Yellow or curled dock	*Rumex crispus*				secondary
Level 4	Pineappleweed	*Matricaria discoidea*				
	Bird's-foot trefoil	*Lotus corniculatus*				
	Black medick	*Medicago lupulina*				
	Common plantain	*Plantago major*				
	Common timothy	*Phleum pratense*				
	Smooth catchfly	*Silene csereii*				
	Alsike clover	*Trifolium hybridum*				
	Red clover	*Trifolium pretense*				
	White clover	*Trifolium repens*				
	Wheat	*Triticum aestivum*				

Notes: [1] In decreasing order of concern for the Project area. [2] Invasive Species Council of Manitoba (2018). [3] White et al. (2003). [4] Government of Manitoba (2017). [3] Government of Canada (2016).