KEEYASK TRANSMISSION PROJECT

ENVIRONMENTAL EFFECTS MONITORING

INVASIVE PLANT MONITORING IN 2018

Prepared for

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By

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SUMMARY

Non-native plants are plant species that are growing outside of their country or region of origin (Manitoba Hydro 2012). 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. 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 Keeyask Transmission Project Environmental Effects Monitoring Plan includes monitoring 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. This report provides results for the invasive plant monitoring conducted during the 2018 growing season in the cleared portions of the rights-of-way (ROW) for the Generation Outlet Transmission lines, the Unit lines and the Construction Power lines.

In late August 2018, 17 transects, covering 11 km of ROW length, were surveyed at preselected locations within the cleared ROW. During these surveys, 15.3 m^2 of non-native plant cover was recorded as a few individual plants or small patches of plants at 26 sites. Most of the non-native plant cover was observed close to either a Keeyask Generation Project south access road ditch or the Radisson Converter Station.

The extremely low cover of non-native plants in the surveyed areas (0.001% of the area) was likely due to a combination of factors including the low proportion of the ROW area with exposed mineral substrates, the relatively short time since clearing, limitations on potential sources of seeds, and increasing native vegetation cover.

Seven non-native plant species recorded during the surveys, which was five more than 2017. Of these species, perennial sow-thistle and white sweet clover were of moderate invasive concern while three were of minor invasive concern.

Control recommendations were not developed for the sites with plants of invasive concern for several reasons. At two of the three perennial sow-thistle sites, the plants were immediately removed by ECOSTEM staff due to their degree of invasive concern and the small number of plants present. Control recommendations were not developed for the remaining sites, primarily for two reasons. The likelihood that control efforts would successful was limited by the close proximity of the same non-native plants in either the south access road ditch or the Radisson converter station. Also, ongoing expansion of native plant cover was expected to eventually crowd out or even eliminate non-native plants at some of the sites.

Invasive plant monitoring will continue in 2019.

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STUDY TEAM

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

Fieldwork in 2018 was conducted by Brock Epp and Nathan Ricard of ECOSTEM Ltd. and Barry Flett from TCN.

Data analysis and report writing in 2018 were completed by Brock Epp and James Ehnes. GIS analysis and cartography were completed by Brock Epp and Nathan Ricard.

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1.0 INTRODUCTION

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 Report. The Keeyask Transmission Project Environmental Effects Monitoring Plan (Manitoba Hydro 2015) describes how this monitoring will be undertaken.

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 in 2018.

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 in 2018 included field surveys to address the last two study objectives.

2.0 METHODS

Section 4.2.4 of the Keeyask Transmission Project Environmental Effects Monitoring Plan (Manitoba Hydro 2015) outlines the methods for this study. The following summarizes the activities conducted in 2018.

The non-native plant species recorded during the monitoring were classified into levels of invasive concern for the Project area (Table 2-1).

Table 2-1: Species classification into level of invasive concern.

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 2018). 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.

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 5-2 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.

2.1 DATA COLLECTION

Non-native plant data were collected within the cleared portions of the Project rights-of-way (ROW) on August 22 to 24, and 29, 2018. Data were collected along transects at pre-determined locations dispersed throughout the ROW, and were the same locations that were surveyed in 2017 (Map 2-1). Data was also collected incidentally during priority habitat surveys in the ROW on July 8 and 9, 2018. 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 2017).

Two people walked along each transect. One person led the survey by walking the predetermined transect route that had been 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 they looked like they might include non-native plants. These meandering searches were expected to detect any larger, taller patches of invasive plants situated within the entire cleared ROW width due to its openness given the relatively short time since clearing.

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.

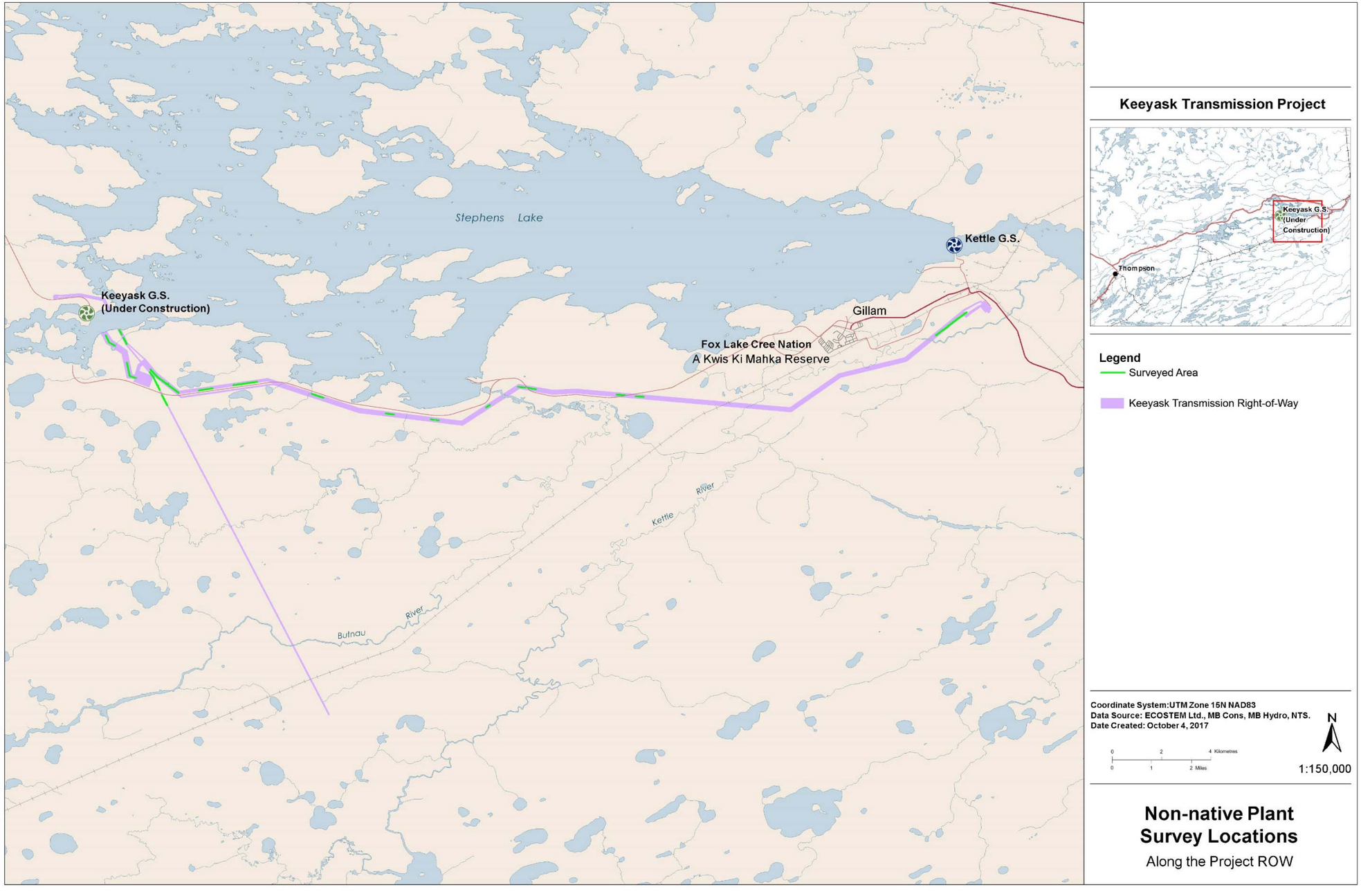
Vegetation patch boundaries were recorded in one of three ways:

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 2-2.

Table 2-2: 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%



Map 2-1: Non-native plant survey locations

2.2 MAPPING

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 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 5-1).

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 2-2) for locations recorded using the “patch method” or from multiples of individual plant area (Appendix Table 5-1) 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 2-2). 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.

3.0 RESULTS

In August 2018, non-native plant surveys were conducted along 17 transects, totalling 11 km in length, in the cleared portion of the Project ROW (Map 2-1).

Non-native plants were observed at 26 sites within the surveyed areas during these surveys (Table 3-1). These 26 sites were clustered at approximately nine locations (sites within 100 m of each other counted as one location, except the transect near Radisson Converter Station which was counted as one). During priority habitat surveys conducted in July 2018, two incidental observations were also made outside of the non-native plant survey areas, bringing the total number of non-native plant sites recorded in 2018 to 28.

Table 3-1: Non-native plant cover observed within the transmission ROW in 2018.

Species	Common Name (invasive concern level[1])	Number of Sites[3]		Total Cover (m^2)[2]	
		Plant Surveys	Incidental Observation	Plant Surveys	Incidental Observation
Chenopodium album	Lamb's-quarters (3)	4	0	9.9	-
Crepis tectorum	Narrow-leaved hawks-beard (3)	15	1	2.7	18.0
Matricaria discoidea	Pineappleweed (4)	1	0	0.0	-
Melilotus albus	White sweet clover (2)	2	0	1.9	-
Plantago major	Common plantain (4)	1	0	0.0	-
Sonchus arvensis	Perennial sow-thistle (2)	3	0	0.7	-
Taraxacum officinale	Common dandelion (3)	3	1	0.1	0.0
All non-native species		*26*	*2*	*15.3*	*18.0*

Notes: [1] See Appendix Table 5-2 for level of invasive concern classification. [2] Sum of numbers greater than total because one site may have more than one species. [3] Numbers that round to zero shown as "0"; absences shown as "-". [4] Includes one incidental observation.

Total non-native plant cover in the areas surveyed in August 2018 was 15.3 m^2 (Table 3-1). At the same surveyed locations in 2017, total cover was 0.13 m^2 (estimated for the four individual plants). Most of the sites with non-native plants included one to a few plants, or small patches of plants.

When the two incidental observations from July were included, total non-native plant cover observed in 2018 increased from 15.3 m^2 to 33.3 m^2 due to one large, sparse patch of plants.

A total of seven non-native plant species were recorded during the August non-native plant surveys (Table 3-1). The incidental observations from July did not add any species.

Lamb's-quarters (*Chenopodium album*) was the most abundant species recorded during the non-native plant surveys, followed by narrow-leaved hawks-beard (*Crepis tectorum*) and white sweet clover (*Melilotus albus*). Narrow-leaved hawks-beard became the most abundant species when the two incidental observations from July were added (Table 3-1). The incidental observation of narrow-leaved hawks-beard increased this species' total cover by 18 m^2.

Five of the seven non-native species were recorded for the first time in 2018. The new species included the three most abundant as well as perennial sow-thistle (*Sonchus arvensis*) and pineappleweed (*Matricaria discoidea*).

Perennial sow-thistle is considered to be a species of invasive concern. It is an "other" species in the Invasive Species Council of Manitoba (ISCM) classification, a noxious weed in Manitoba, and a weed seed in Canada (Appendix Table 5-2). Perennial sow-thistle was found growing at three sites in the Project ROW (Map 3-1). Four plants were found growing 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 found growing in the GOT ROW less than one kilometre from the Radisson Converter Station. These plants were immediately removed by ECOSTEM staff due to their relatively high level of concern and the small number of plants. A 3 m^2 patch of perennial sow-thistle with low plant cover, which had already seeded (Photo 3-1), were found growing at another location in the GOT ROW on the north side of the South Access Road, west of the camp in the B-2 Borrow Area. These plants were not removed.

Photo 3-1: Patch of perennial sow-thistle growing in the GOT ROW near the South Access Road.

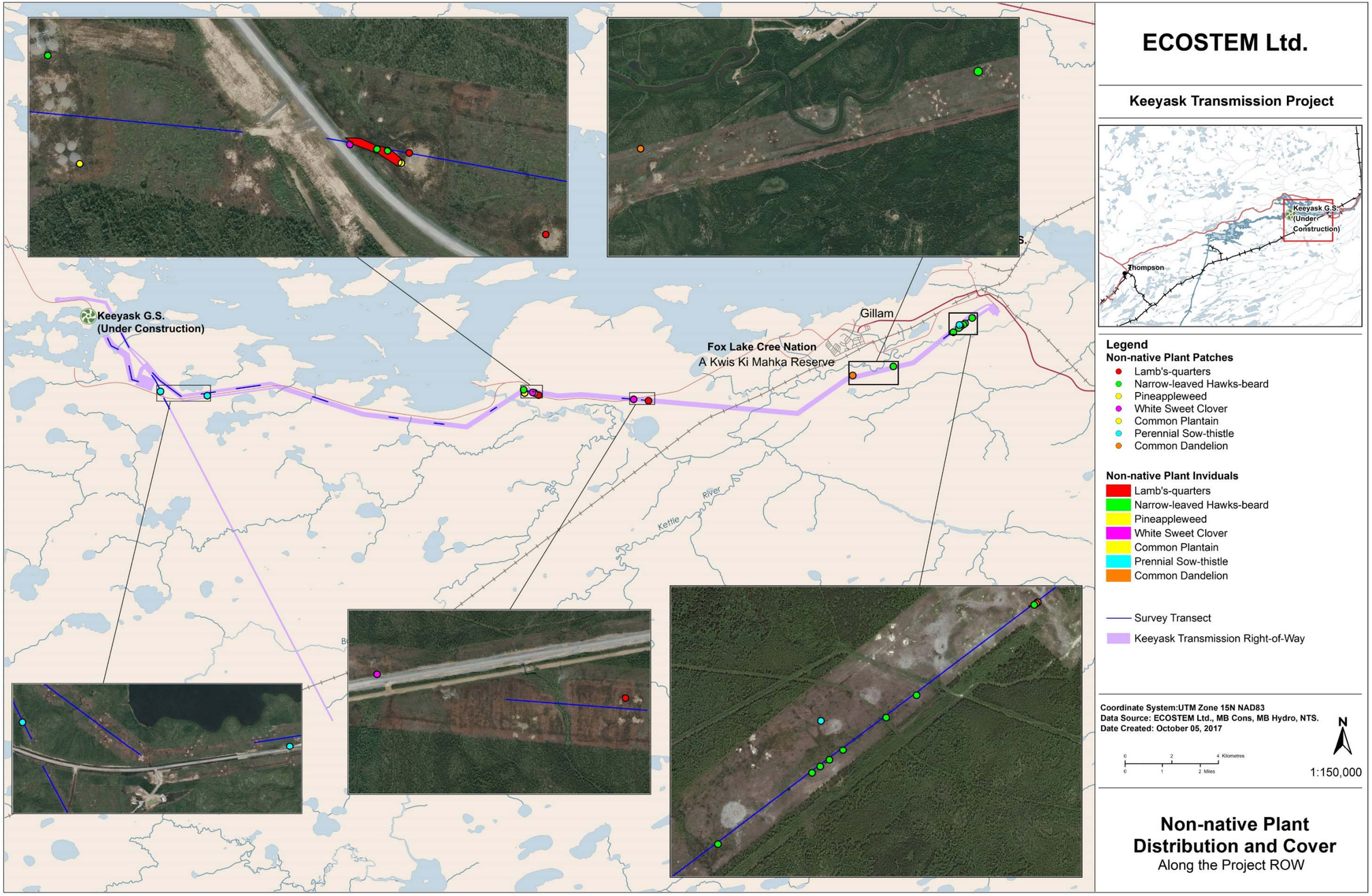
White sweet clover (Photo 3-2) was the other recorded species of relatively high invasive concern. It is classified as a moderately invasive species by White et al. (1993). White sweet clover was found at two sites (Map 3-1), both of which were near or adjacent to where the ROW crossed the South Access Road.

The remaining five non-native species are not listed as an invasive species in Canada (White *et al.* 1993), or a species of concern by the Invasive Species Council of Manitoba (ISCM 2018). However, common dandelion, narrow-leaved hawks-beard and lamb's quarters are considered to be noxious weeds in Manitoba (Government of Manitoba 2017).

Most of the non-native plant cover was concentrated near where a ROW crossed the South Access Road or in the ROW near the Radisson Converter Station (Map 3-1). All but two of the 28 sites included a few individual plants or a small patch of plants. A 649 m^2 patch of lamb's quarters with very sparse cover was found growing in the GOT ROW adjacent to the South Access Road just east of the Butnau Marina. The two incidental observations included one 1,200 m^2 patch of narrow-leaved hawks-beard with very sparse cover growing in the GOT ROW by a transmission tower near the Town of Gillam.

Most plants were found growing on exposed mineral substrates, especially around transmission towers.

Photo 3-2: White sweet clover growing beside the South Access Road where it crosses the ROW.



Map 3-1: Non-native plant distribution and cover

4.0 SUMMARY AND CONCLUSIONS

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 Project's Environmental Assessment Report predicted that the Project is not expected to substantially increase the rate at which invasive plants are introduced and/or spread in the Project area (Manitoba Hydro 2012). Project environmental protection plans include measures to reduce the risk that construction activities will transport non-native plant seeds into the Project area.

The Invasive Plant Spread and Control study is monitoring the degree to which the Project contributes to introducing and spreading invasive and other non-native plants. This study also recommends control measures where appropriate, and evaluates the effectiveness of mitigation measures.

Non-native plant surveys have been carried out in the Project ROW during the growing season of each year since 2016. During the August 2018 surveys, non-native plants were observed at 26 sites within the surveyed areas of the cleared Project ROW. A total of seven species were observed, five of which were not recorded in 2017. The two species recorded in both 2017 and 2018 were common dandelion and common plantain. The species recorded only in 2018 included lamb's quarters, narrow-leaved hawks-beard, pineappleweed, white sweet clover and perennial sow-thistle. Two incidental observations of non-native plants recorded during priority habitat surveys in July 2018 did not add any new species.

Total non-native plant cover recorded in the non-native plant survey areas increased from 0.13 m^2 in 2017 to 15.3 m^2 in 2018. Although the increase in cover from 2017 to 2018 was proportionately large, total cover still comprised a very small percentage (0.001%) of the total area surveyed. This was particularly significant since the transect locations were biased towards being relatively close to existing human features.

Most of the non-native plant cover observed during the 2018 surveys was close to either the South Access Road ditch or the Radisson Converter Station. This was the same pattern as observed for the few plants found in 2017 (ECOSTEM 2018b). It was quite possible that the plants in the Project ROW had originated from existing plants along the South Access Road, especially considering that non-native plants were not found in surveyed portions of the ROW that were either more distant from the road or separated from the road by uncleared vegetation.

The two incidental observations of non-native plants recorded during the July 2018 priority habitat surveys were less than one kilometer from the Town of Gillam. That segment of the GOT ROW is an expansion of an old clearing for the Radisson to Kelsey Transmission Line ROW. Based on anecdotal observations, non-native plants were likely well established in the area for many years

prior to the Project due to the proximity to Gillam. ATV traffic is common in the town and the pre-existing trails and ROWs in the area (Photo 4-1), which provides a dispersal mechanism for non-native plant seeds.

Photo 4-1: A segment of the Radisson to Kelsey Transmission ROW in 2011 showing ATV tracks and a connecting ATV trail near the site of the incidental non-native plant observations (future GOT ROW adjacent to the right side of ROW in photo).

The three most abundant non-native species recorded in 2018 were not observed in 2017. This was likely due to the increasing non-native plant cover along the South Access Road. Non-native plant studies conducted for the Keeyask Generation Project in 2018 (ECOSTEM in prep.) found that non-native plant cover along the South Access Road, including the species observed in this study, had increased by more than 200% since 2017, particularly west of the Butnau marina. Other studies (ECOSTEM 2012; KHLP 2012) showed that invasive plants were well established along the public roads in the region. The increasing cover observed near the east end of the ROW may be due to close proximity to the Radisson Converter Station, where non-native plants have been well established for many years (anecdotal observation by field staff). It is also possible that some plants observed in 2018 were already present in 2017, but not seen by the surveyors due to native plant cover and/or timing of flowering. Narrow-leaved hawks-beard is typically a small

plant that quickly deteriorates after flowering, which makes it difficult to detect in denser vegetation.

The likely explanation for why non-native plant cover remained very low in the cleared portions of the ROW was a combination of the:

- Very low proportion of the ROW area having exposed mineral substrates;
- Relatively short time since ROW clearing;
- Limitations on potential seed input; and,
- Increasing native plant cover.

The first three of these reasons were the same as those given for low non-native plant cover in 2017 (ECOSTEM 2018b).

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 small proportion of the ROW 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 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 in 2018 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.

Relative to its total length, much of the ROW is 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 South Access Road, which was only recently cleared during Keeyask Generation Project construction.

Factors that appeared to be limiting the potential input of non-native seeds included winter clearing, environmental protection plan provisions for equipment cleaning and the age of nearby recently cleared areas. Snow cover was expected to reduce the colonization effect of equipment moving through sites, both 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. Finally, much of the ROW that is adjacent to existing infrastructure follows the recently constructed Keeyask Generation Project South Access Road, where non-native plant cover was relatively low in 2017 (ECOSTEM 2018a) and 2018 (ECOSTEM in prep.).

In 2018, expanding native plant cover in the ROW (Photo 4-2) 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.

Photo 4-2: Regenerating native vegetation in transmission ROW.

Two of the species recorded during the 2018 surveys, perennial sow-thistle and white sweet clover are considered to be of moderate invasive concern. The perennial sow-thistle plants found at two of the three sites were immediately removed by ECOSTEM staff. Plants at the third site were not removed due to the larger size of the patch.

Control recommendations were not developed for the observed non-plant sites due to the degree of invasive concern, the likelihood that control efforts would be successful and/or the presence of natural agents of control.

Control recommendations were not developed for common plantain and pinappleweed as they are not considered to be of invasive concern in the Project area.

Common dandelion, lamb's quarters and narrow-leaved hawks-beard are only of minor invasive concern (they are considered noxious weeds in Manitoba), as these species are not known to crowd out native vegetation. Also, as all three species were more abundant nearby in the South Access Road footprint, it is unlikely that control efforts in the ROW would ultimately be effective unless control efforts are simultaneously carried out in the South Access Road footprint (which is a different project). In the case of dandelion and narrow-leaved hawks-beard, winds readily spread their light airborne seeds. Finally, given that there was very limited exposure of mineral substrates for non-native plants to colonize and native vegetation regeneration was occurring, it was anticipated that ongoing native plant regeneration will limit further establishment and eventually control or even eliminate non-native plant cover.

The remaining two species, perennial sow-thistle and white sweet clover, were of higher invasive concern. Field staff had already removed the perennial sow-thistle plants found at two of the three sites. The patch of plants at the remaining site overlapped South Access Road footprint. For this patch, it is unlikely that control efforts in the ROW would ultimately be effective unless coordinated with others carrying out control efforts in the South Access Road footprint. As with other non-native species, it was anticipated that the paucity of exposed mineral substrates and ongoing expansion of native plant cover would limit further establishment and eventually control or even eliminate perennial sow-thistle.

For white sweet clover, the recorded sites overlapped South Access Road footprint where this species is becoming increasingly established. White sweet clover is also ubiquitous in human-disturbed areas. It is unlikely that control efforts in the ROW would ultimately be effective due to proximity to the South Access Road. Also, given the limited amount of vegetation clearing and mineral substrate exposure in the ROW, it was possible that ongoing expansion of native plant cover will limit further establishment and eventually control or even eliminate white sweet clover.

Over the long-term, proximity to the South Access Road, which will become a portion of the highway from Thompson to Gillam, will likely be a continual source of non-native plants. Promoting the expansion of native herbaceous and low shrub vegetation is expected to be the best way to limit how much the South Access Road spreads invasive plants into the ROW.

Results from invasive plant monitoring conducted to date are consistent with the prediction that the Project is not expected to substantially increase the rate at which invasive plants are introduced or spread in the Project area.

Invasive plant monitoring will continue in 2019.

5.0 LITERATURE CITED

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APPENDIX 1:
DETAILED TABLES

Table 5-1: 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 5-2: 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).