



Keeyask Generation Project Terrestrial Effects Monitoring Plan

Invasive Plant Spread and Control Monitoring Report

TEMP-2024-04



KEYYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2024-04

INVASIVE PLANT SPREAD AND CONTROL MONITORING YEAR 2 OPERATION 2023

A Report Prepared for
Manitoba Hydro

By
ECOSTEM Ltd.
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SUMMARY

Background

Construction of the Keeyask Generation Project (the Project) at Gull Rapids began in July 2014. The vast majority of construction activities were completed by fall 2021, and the generating station was fully operational by March of 2022, with all seven units in service.

The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the generating station on the terrestrial environment. Monitoring results will help the KHLP, government regulators, members of local First Nation communities, and the general public understand how construction and operation of the generating station are affecting the environment, and whether or not more needs to be done to reduce harmful effects.

Non-native plants are those plant species that are not naturally found in the Keeyask region. Invasive plants are non-native plant species that can out-compete or even replace native plants.

Non-native plants can be introduced or spread in the Keeyask area by seeds that are brought into the Project site on vehicles, construction equipment, and footwear. During construction and operation, there have been mitigation measures to help minimize this. For example, washing construction equipment that is coming to the Project site from areas outside the Keeyask region is a preventative measure.

This report describes the results of invasive and other non-native plant monitoring conducted during 2023, the second summer of operation monitoring for the terrestrial monitoring studies.



Ox-eye daisy, an invasive plant found at the Keeyask site during construction and operation

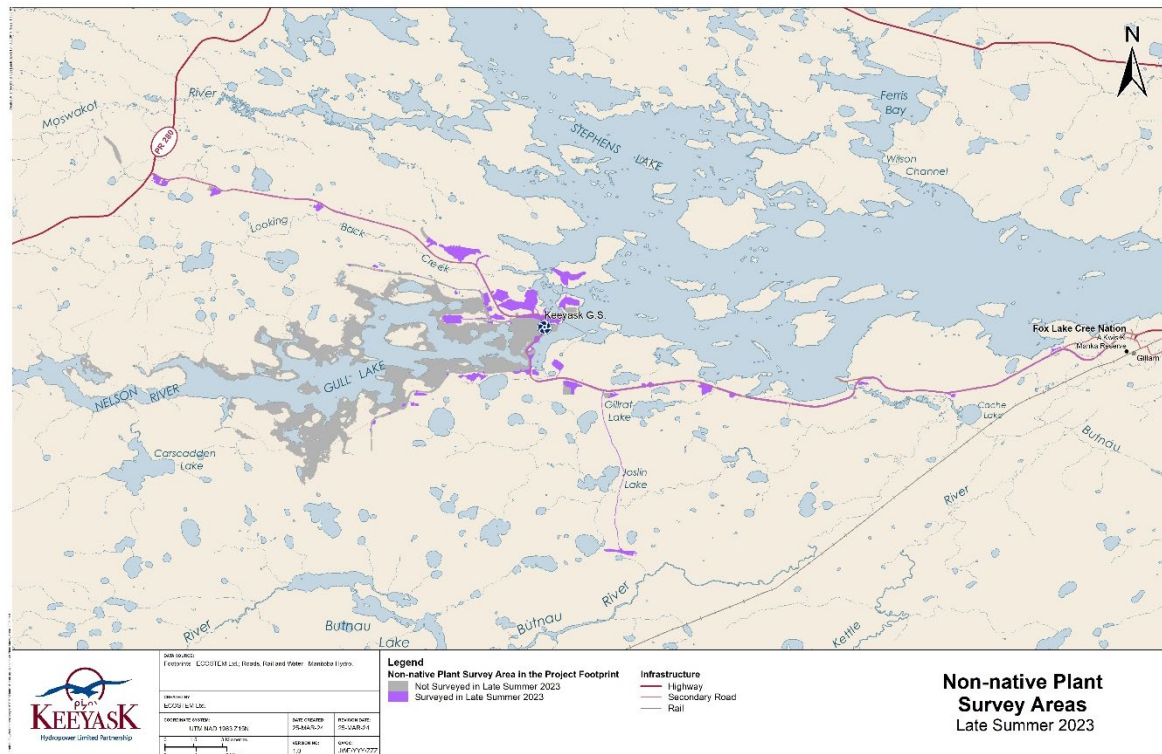
Why is the study being done?

Invasive and other non-native plants are of concern because they can crowd out native plants or prevent native plants from growing where they are normally found. In extreme cases, invasive plants can change the kind of vegetation, soils or other environmental conditions at a site. Non-native plants are also a concern because they could interfere with the Project’s efforts to restore native habitat at sites that are no longer being used by the Project.

Surveys are being done to determine how Project operation is affecting which non-native plants are present, where these plants are found, and to help decide where to carry out measures to control the plants that might become an issue at the Project site.

What was done?

In 2023, non-native plant surveys were carried out within most of the cleared Project areas (see map below) as well as the upstream and downstream shoreline. These surveys occurred between August 19 and 29.



What was found?

Shoreline non-native plant surveys found a total of four species covering approximately 52 lineal m² of shoreline (i.e., 0.7 m²/km of the surveyed shoreline). Most of the non-native plant cover was downstream of the generating station. Field sow-thistle made up most of the non-native plant cover in the shore zone. There was a decrease in non-native plant cover upstream of the generating station since the previous survey, which was in 2019 prior to reservoir impoundment.

For inland portions of the Construction Footprint, non-native plants covered 2.8% (25.6 ha) of the area surveyed in late summer 2023, which was a four-fold increase from the same time in 2022.

Non-native plant cover was highest in the temporary portions of the Construction Footprint, where recent rehabilitation was done. In the permanent portion of the Construction Footprint, cover was highest in the dike and work areas.

A total of 23 non-native plant species were found during the 2023 surveys. No new species were identified in 2023.

Eight non-native species, mainly of lower concern, were the primary contributors to the increase in non-native plant cover between 2022 and 2023. Common dandelion, white and yellow sweet clover, narrow-leaved hawk's-beard, lamb's-quarters, field sow-thistle, common plantain and smooth catchfly all experienced significant increases in cover area.

Of the 23 non-native plant species found in 2023, scentless chamomile and ox-eye daisy are the ones of highest invasive concern for the Project site. Both of these species were found at several sites. The species of highest invasive concern are being controlled by continuing to manually remove the plants as soon as they are found during the surveys.

Five of the 23 non-native plant species found in 2023 are of moderate invasive concern for the Project site. To minimize further spreading of these species, herbicide treatment and/or mowing was recommended for specific sites in 2023. Herbicide treatments were completed between July 26 and August 4, 2023, however the mowing was canceled due to scheduling problems. Monitoring in 2023 confirmed that herbicide treatments carried out in 2022 and 2023 were very effective at controlling the target species where they were applied as prescribed and at least partially effective in controlling spread in some areas.

Grasses were seeded in various locations on the Project site for erosion control and/or to assist with vegetation rehabilitation in 2020 and 2021. The seed certificates for the grass seed mixtures used in seeded areas identified one non-native grass species (diploid annual ryegrass, used for erosion control purposes in EMPAs D16 and D17) and two other non-native species of low invasive concern. The seed mix contained fewer than 25 seeds/25 grams for both invasive species combined. None of the three species were found during subsequent monitoring surveys.

What does it mean?

A decrease in non-native plant cover in the shore zone was anticipated upstream of the generating station because reservoir impoundment was expected to flood many of the previously mapped patches of plants. Surveys in 2023 found that this was the case. Downstream of the generating station, non-native plant cover was similar to that in 2019. During operation, the relatively low level of Project activity along the downstream shoreline reduced the risk of spreading non-native plants. Additionally, reservoir impoundment substantially reduced the abundance of potential upstream seed sources.

For inland areas, the increase of non-native plant cover between 2022 and 2023 reflected the trend previously observed during Project construction, as well as for another recent generating

station project in northern Manitoba. That is, decommissioning of construction areas was followed by a burst of non-native plant cover within the first few years. If the Project areas continue to follow the same trend, then non-native plant cover may continue to increase in recently decommissioned areas, but then slowly decrease over time, particularly if rehabilitation efforts are successful in promoting desirable plant regeneration.

Given their potential to spread rapidly, the monitoring continues to make recommendations for practical ways to reduce invasive and other non-native plant species in the Project footprint, and/or to prevent them from spreading further. Many of these species are commonly found in other disturbed areas in the Keeyask region, particularly along roadsides, making it difficult to prevent vehicles and people from accidentally spreading these species into the Project site.

Monitoring up to 2023 showed that immediate manual removal is generally an effective way to control the species of highest invasive concern and they do not resprout from roots left in the ground after removal. Staff conducting the monitoring surveys will continue to manually remove plants at sites where there are one to a few plants present.

The 2022 herbicide treatment appeared to reduce the cover of target species at locations where the herbicide was applied as prescribed.

What will be done next?

Site-specific invasive plant control recommendations will be developed for the 2024 growing season based on the monitoring results to date. Monitoring fieldwork for invasive and other non-native plants will continue in 2024. Where appropriate, additional control measures will be recommended based on what is found during the monitoring.

ACKNOWLEDGEMENTS

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Chiefs and Councils of Tataskweyak Cree Nation (TCN), War Lake First Nation (WLFN), York Factory First Nation (YFFN) and Fox Lake Cree Nation (FLCN) are gratefully acknowledged for their support of this program.

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1.0 INTRODUCTION

The Keeyask Generation Project (the Project) is a 695-megawatt hydroelectric generating station (GS) and the associated facilities. The Project is located at the former Gull Rapids on the lower Nelson River in northern Manitoba where Gull Lake flows into Stephens Lake, 35 km upstream of the existing Kettle GS. Project construction began in July 2014 and the vast majority of construction activities had been completed by fall 2021. The reservoir was first brought to full supply level in September 2020 and the final generating unit went into service on March 9, 2022.

The *Keeyask Generation Project Response to EIS Guidelines* (the EIS), completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project (KHL 2012a). Technical supporting information for the terrestrial environment, including a description of the environmental setting, effects and mitigation, and a summary of proposed monitoring and follow-up programs is provided in the *Keeyask Generation Project Environmental Impact Statement Terrestrial Supporting Volume* (TE SV; KHL 2012b). The *Terrestrial Effects Monitoring Plan* (TEMP) was developed as part of the licensing process for the Project (KHL 2015). Monitoring activities for various components of the terrestrial environment were described, including the focus of this report, invasive plants, during the construction and operation phases.

Non-native plants are those plants that are growing outside of their country or region of origin. Invasive plants are non-native plants that can out-compete or even replace native plants. Invasive plants are of concern not only because they can crowd out other plant species, but, in extreme cases can change vegetation composition or other ecosystem attributes. Invasive plants have been described as one of the greatest threats to natural areas in Canada (Canadian Food Inspection Agency 2008).

Non-native plant species that are not generally invasive may be problematic for some local conditions or may become so in the future with changing climate (Hellman *et al.* 2008). For example, well-established patches of non-native plants will be a consideration for areas where native habitat will be regenerated.

Since all invasive plants are non-native, this report generally uses “non-native” except when discussing species that are of higher invasive concern for the Project area.

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

- Verify that appropriate seed mixtures were used where seeding is implemented as a rehabilitation or erosion control measure;
- Document the degree of invasive and other non-native plant introduction and spread;
- Recommend appropriate control and eradication programs; and,
- Verify the efficacy of any programs implemented to control or eradicate invasive plants.

The Invasive Plant Spread and Control study includes two components. The first component monitors non-native plant distribution and abundance in Project areas. In the event that control or eradication programs are needed, the second study component provides recommendations and monitors their effectiveness.

Previous reports detail the temporal and spatial patterns of non-native plants during Project construction from 2014 to 2021 (ECOSTEM 2022) and during the first year of operation (ECOSTEM 2023a). This report presents the non-native plant monitoring conducted in 2023, during the second year of operation for the terrestrial monitoring studies.

2.0 METHODS

Section 3.3.2 of the TEMP details the methods for this study. The following summarizes the activities conducted in 2023.

2.1 PROJECT COMPONENTS

Project components for operation are grouped based on their permanence and planned rehabilitation (Table 2-1). At the beginning of Project operation, most of the components that were not required for Project operation (i.e., the temporary Project areas) had been or were in the process of being decommissioned. Additionally, a portion of the permanent and temporary Project areas have undergone various amounts of rehabilitation. Consequently, ongoing use (in areas with permanent infrastructure) and ongoing rehabilitation activities, in combination with time since rehabilitation are two of the major drivers determining non-native plant spread in those areas.

In the permanent Project footprint, ongoing vehicle and foot traffic will continue to contribute to the spreading of non-native plants. There are two types of areas in the temporary Project footprint. In areas that still require site preparation for revegetation (e.g., grading, discing), or are reserved for construction of mitigation features (i.e., the wetland mitigation area), heavy construction activity will continue to affect vegetation cover. In areas that have already been revegetated, foot and vehicle traffic will have mostly ceased, and impediments to vegetation regeneration will be reduced. An important factor is that invasive plant mitigation options will be limited in areas where rehabilitation is completed, as it will be unlikely that chemical measures could be used without affecting planted vegetation.

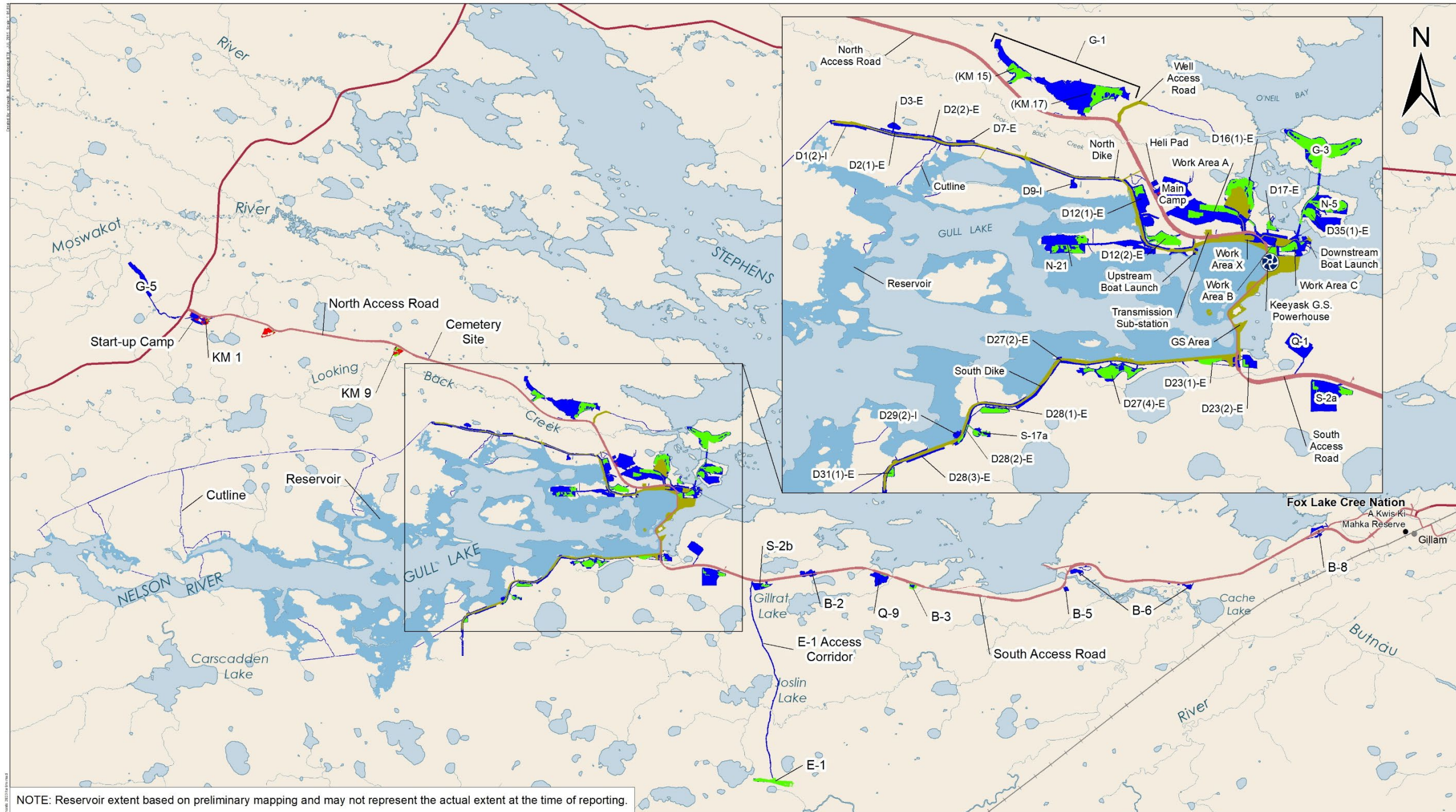
It should be noted that because the subdivision of the Project footprint into activity types (Table 2-1) is generalized for an entire footprint component, there may be small areas within a specific footprint that are from a different activity type. Nevertheless, this categorization aids in the interpretation of broad patterns and trends across the Project site.

Map 2-1 shows the locations of the Project components based on rehabilitation status as well as specific Project features.

Table 2-1: General component categories and their activity during Project operation

Project Footprint Component		Description	Activity
Permanent	Project Infrastructure	Permanent infrastructure and work areas that will be used for Project operation	Light vehicle and foot traffic, Manitoba Hydro personnel
	Access Roads	North and south access roads, which are now part of the provincial highway network	Public use, frequent heavy to light vehicle traffic.
Temporary	Not yet rehabilitated ¹	Temporary areas planned for rehabilitation, but have not been to date	Will be subject to heavy construction activity for site preparation in most locations
	Recently rehabilitated	Temporary areas that have been rehabilitated between 2020 and 2022	Very little to no foot traffic
	Older rehabilitated	Temporary areas that were rehabilitated in 2016	Very little to no foot traffic

Notes: ¹ Includes borrow areas reserved for construction of mitigation features



NOTE: Reservoir extent based on preliminary mapping and may not represent the actual extent at the time of reporting.

<p>Hydropower Limited Partnership</p>	<p>DATA SOURCE: Status and Water - ECOSTEM Ltd.; Roads and Rail - Manitoba Hydro.</p>	<p>Legend</p> <p>Rehabilitation Status</p> <ul style="list-style-type: none"> Access Road Permanent Infrastructure Reservoir Temporary - Not Rehabilitated Temporary - Older Rehabilitated Temporary - Recently Rehabilitated 	<p>Infrastructure</p> <ul style="list-style-type: none"> Highway Secondary Road Rail 	<h2>Rehabilitation Status</h2>
	<p>CREATED BY: ECOSTEM Ltd.</p> <p>COORDINATE SYSTEM: UTM NAD 1983 Z15N</p> <p>DATE CREATED: 01-APR-24</p> <p>REVISION DATE: 17-MAY-24</p> <p>VERSION NO: 1.0</p> <p>QA/QC: JWE/YYY/ZZZ</p>			

Map 2-1: Project components and construction footprint rehabilitation status in 2023

2.2 DATA COLLECTION

2.2.1 INLAND AREAS

Non-native plant surveys have been conducted annually since the start of Project construction. Survey methods evolved as the Project footprint developed from 2014 (beginning of Project construction; only Keeyask Infrastructure Project (KIP) footprints surveyed) to 2023. A detailed description of how the methods evolved throughout Project construction, along with a detailed description of the current survey methods are provided in a previous annual report (ECOSTEM 2022). These methods, and specific additions or deviations for the operation period are summarized below.

With the exceptions of the North and South Access Roads and Dikes, surveys were not conducted in areas where non-native plants were expected to be completely or virtually absent based on results from previous years or from similar types of areas. This included the portions of the Project footprint that have only had tall vegetation cleared and were not further disturbed by the Project. Also, areas that were not safe to access due to construction or wildlife activity were not surveyed.

Surveys were conducted from August 19 to 29, 2023 at the locations shown in Map 2-2.

In 2023, non-native plant cover was recorded and mapped in the field using a combination of electronic tablets and the manual data recording method. ECOSTEM (2022) details how data were recorded for each of these methods.

Surveys were conducted by foot and truck in the portions of the Project Footprint areas meeting the safety and activity criteria described above. There were no active construction areas in 2023, therefore there were no areas avoided for safety reasons.

Three approaches were employed to surveying the Project Footprint depending on the nature of the locations, which were the same approaches used in 2022:

1. A combination of mobile truck-based surveys and systematic foot surveys. Truck-based surveys occurred along the entire lengths of the North and South Access Roads, as well as the North and South Dikes. Foot surveys were conducted at every 2 km.
2. A low-altitude helicopter survey, combined with spot surveys on foot was used for the Ellis Esker (Borrow Area E-1) access corridor.
3. Meandering foot surveys were conducted in the remaining Project areas.

Non-native plant spatial extent at a location was recorded either as a point with an associated number of individuals or as a patch of plants with an associated percent foliage cover class (Table 2-2).

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

Cover Class	Percent Cover Range
Trace	>0 - 0.1%
Very sparse	0.2 - 2%
Sparse	3 - 10%
Low	11 - 25%
Moderate	26 - 50%
High	51 - 75%
Very high	76 - 100%

2.2.1.1 AREAS SURVEYED

Borrow Area B-5 was not surveyed because it was fully covered by ponded water and Borrow Area G-5 was not accessible due to a locked gate. The portion of the South Access Road (SAR) right-of-way that made up the SAR Camp was not surveyed by foot after 2021 because it had been rehabilitated and was now considered part of the SAR.

Areas surveyed in 2023 were generally the same as had been surveyed in 2022. Additional areas surveyed included EMPA D31(1)-E and EMPA D29(2)-I, both on the South Dike.

To reduce the influence of changing total area surveyed when making year-to-year comparisons, non-native plant cover is expressed as a percentage of the total area surveyed, rather than as an absolute area (see ECOSTEM 2022 for additional rationale).

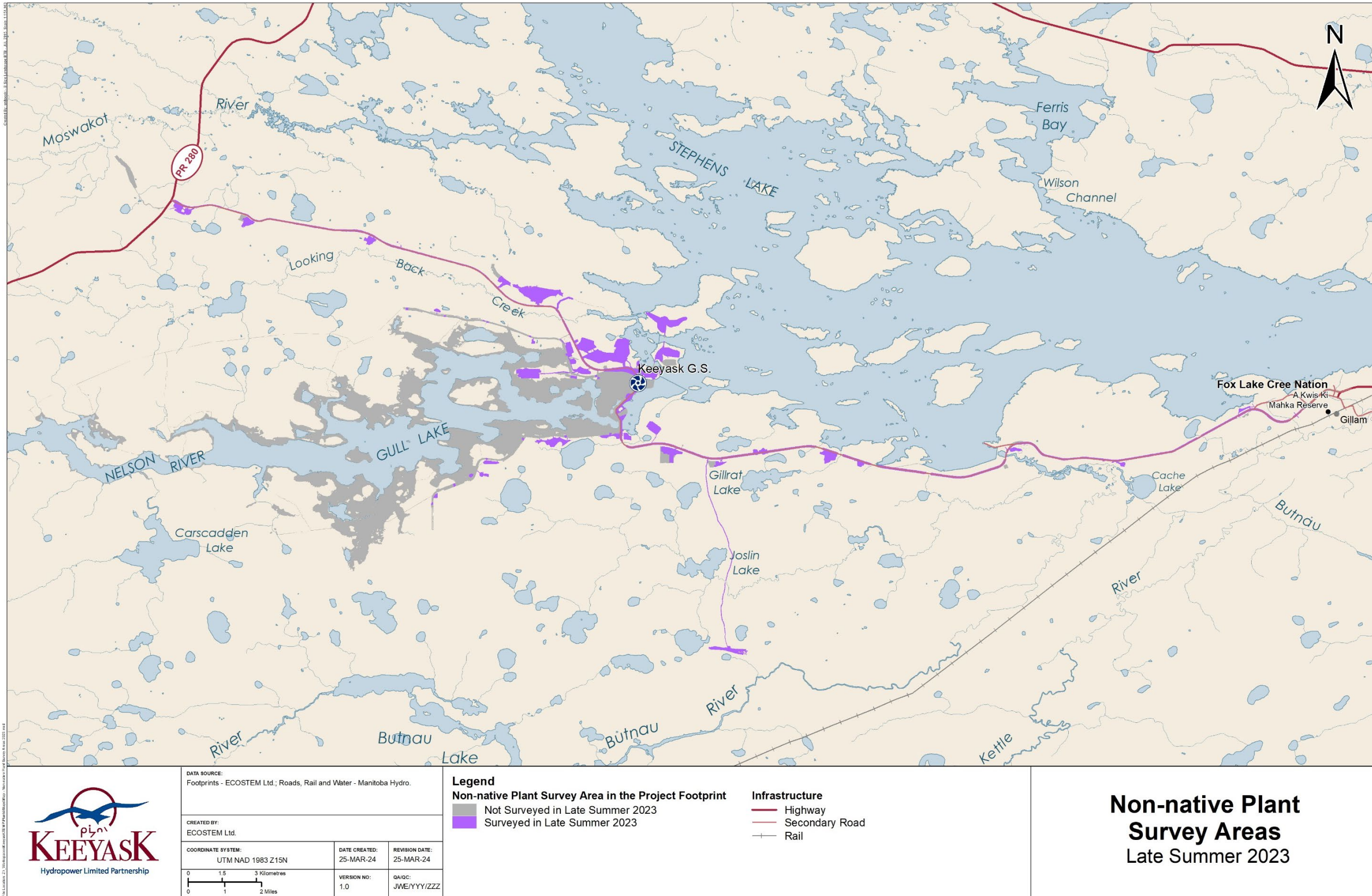
Non-native plant surveys in 2023 covered approximately 908 ha, or 52%, of the cleared or disturbed Project footprint that was not inundated in 2022 (Table 2-3; Map 2-2). Excluding very large footprint components that were not surveyed in full (i.e., the North and South Access Roads and Dikes), the percentage of the Project footprint surveyed increased to 86%.

The total area surveyed in 2023 was 8 ha higher than in 2022 because two South Dike EMPA areas were added to the survey.

Table 2-3: Total area surveyed in 2023 for non-native plants by Project component

Project Component		Area Surveyed (ha)	Percent of Total Component Area
Permanent	Project infrastructure	122	50
	Access roads	26	5
Temporary	Not yet rehabilitated	459	67
	Recently rehabilitated	276	99
	Older rehabilitated	24	100
Total surveyed area		908	52
Areas where only tall vegetation removed		63	
Areas along the dikes and access roads that were not surveyed by foot		668	
Other areas not surveyed		103	
<i>Total footprint area¹</i>		<i>1,742</i>	<i>100</i>

Notes: Numbers that round to zero shown as "0"; absences shown as "-". ¹ Approximately 75 ha of KIP borrow areas not used by the Project are included in these totals.



Map 2-2: Late summer non-native plant survey areas in 2023

2.2.1.2 MAPPING

This report includes detailed non-native plant distribution and abundance mapping derived from the non-native plant cover estimates. These maps show plant patches, by cover class, in the surveyed portions of the Project footprint. The mapping methods for 2023 were the same as those described in detail in the 2021 monitoring annual report (ECOSTEM 2022), which are summarized below along with any deviations from the 2021 methods.

The analysis evaluated non-native plant distribution and abundance in the context of precise clearing and disturbance mapping produced for 2023 (see ECOSTEM 2023b). The primary focus of this report is on the patterns observed in 2023.

Species cover data collected using the note-based method was converted into Geographic Information System (GIS) polygons and points. These data were merged with the point and polygon features produced in the field using the tablets.

As cleared areas regenerate, native vegetation cover may obscure non-native plants, confounding estimates of cover. This could result in a bias toward underestimating non-native plant cover in areas with dense or taller native plants.

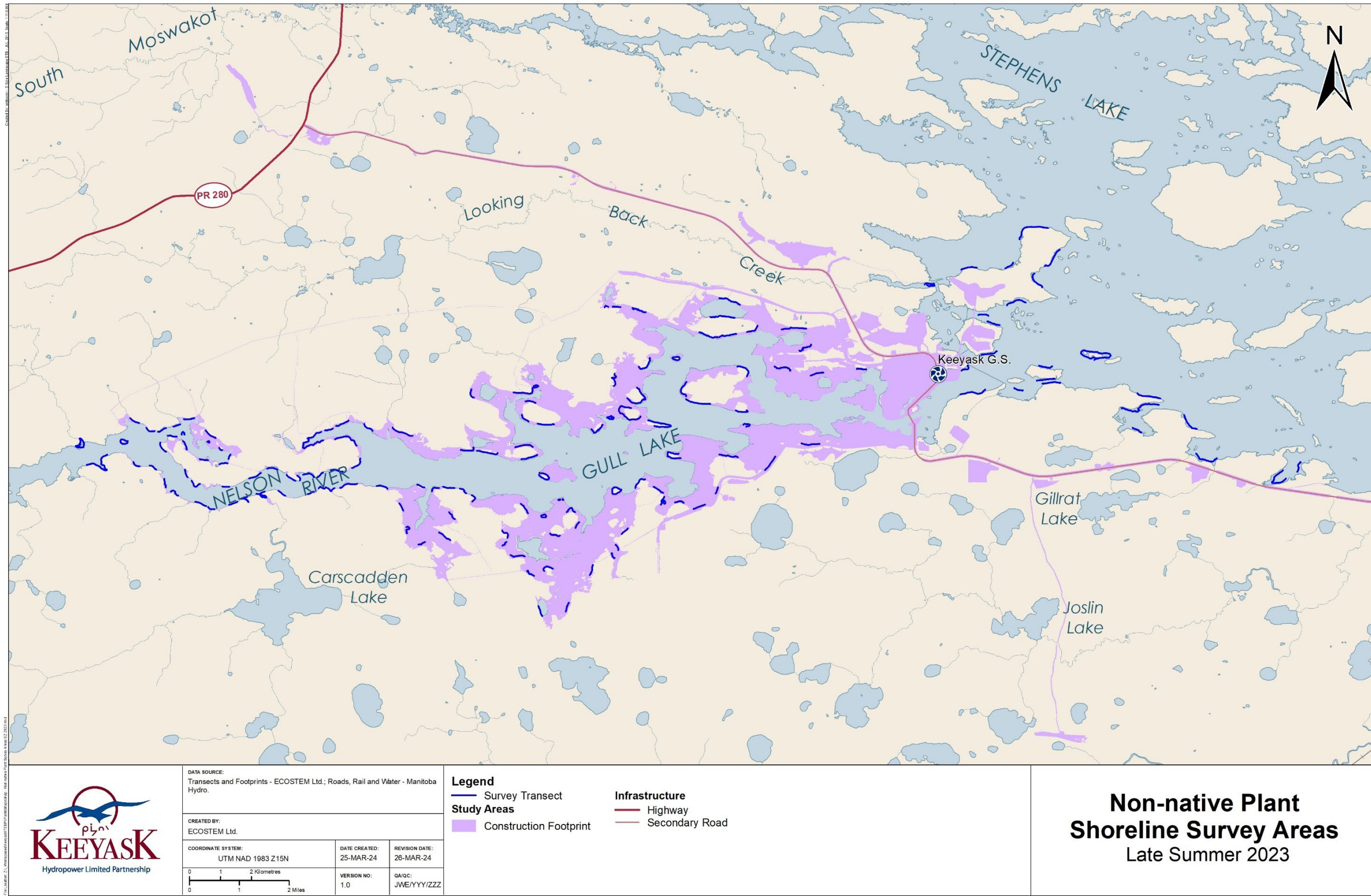
2.2.2 SHORE ZONE

Non-native plant surveys were conducted in the Project-affected shore zone for the first time during Operation, from August 23 to 28, 2023.

Surveys were conducted at a representative sample of shore segments in the Project hydraulic zone of influence (i.e., the areas that are expected to be affected by Project flooding and water regulation) both upstream and downstream of the dam structures. Map 2-3 shows the shore segments surveyed in 2023. A total of 25 transects, covering 17.4 km were surveyed downstream of the dam and 133 transects, covering 59 km of the upstream shoreline.

Surveys were conducted by a combination of helicopter and boat along the shoreline. The helicopter was used in areas where Stephens Lake and/or the Keeyask reservoir was too shallow for the botanist to approach the shoreline close enough observe invasive species from the boat.

Non-native plant occurrences were recorded as either points or as bands, as described for the Project Footprint survey. Due to the limitations of conducting the survey from a boat, and varying proximity from the shoreline vegetation, the accuracy of width estimates and shore zone position was variable, and should be interpreted with this in mind.



Map 2-3: Late summer non-native plant shoreline survey areas in 2023

2.3 INVASIVENESS RANKINGS AND MANAGEMENT STRATEGIES

2.3.1 BACKGROUND

The Project's EIS and mitigation measures include standard control or eradication measures for invasive and other non-native plants, including:

- Contractors that will be using equipment and machinery that was recently used more than 150 km from the Project area will wash that equipment and machinery prior to transport to the Project area.
- Areas that are rehabilitated using a seed mixture will be seeded with a mixture that only contains native and/or non-invasive introduced plant species.
- Areas where there are patches of noxious weeds will be flagged for avoidance if they are not contained in active construction areas.
- Exposed areas shall be revegetated as quickly as possible following construction to prevent soil erosion and the establishment of noxious weeds.

This monitoring study provides additional control or eradication recommendations during operation monitoring. The following summarizes the approach taken to make recommendations regarding which non-native species to prioritize for management, and the types of locations that management efforts will focus on. Appendix 2 details the approach.

It is widely recognized that it is not practical to attempt to eradicate or even control all non-native plant species (e.g., White *et al.* 1993; Morse *et al.* 2004; Ministry of Transportation and Infrastructure *et al.* 2011).

To prioritize and develop management recommendations for non-native plants in the Project area, the focus is on the plant species of highest invasive concern and the situations where there are practical ways to reduce these species or prevent further spreading. Appendix Section 6.1.1 details the sources of information used to assist in evaluating potential invasiveness in the Project area. A limitation for some of the sources used to determine a plant's degree of invasiveness was that they did not include data from the Keeyask region. Of the sources used for ranking a species' degree of invasiveness listed above, ISCM (2022) and White *et al.* (1993) were considered the most relevant ones because their focus is on impacts to ecosystems and biodiversity.

Due to the fact that many of the sources used during this exercise have an agricultural focus, they do not list some species known to be of concern for impacts on native ecosystems and biodiversity (e.g., purple loosestrife). Conversely, these sources also list some native boreal plant species

(e.g., foxtail barley) as weeds since they can be problematic for agriculture. Native boreal species appearing on these lists were not considered to be invasive for the Project area.

2.3.2 INVASIVE CONCERN CLASSIFICATION

The non-native plant species recorded during monitoring to date were classified into one of four levels of invasive concern for the Project area (Table 2-4). Level 1 was the highest level of invasive concern for the Project. Level 1 species included ISCM Category 1 and 2 species (see Appendix Table 6-2 for detailed category criteria).

The second highest 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 lowest level of invasive concern (Level 4 species) included all of the remaining 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.

Table 2-5 shows how the invasive concern classification was applied to the non-native plant species recorded in the Project footprint to date.

Table 2-4: Levels of invasive concern for plants in the Project footprint

Invasive Concern Level	Plant Species Included
Level 1	Species the ISCM classifies as “Category 1” or “Category 2”
Level 2	Species the ISCM classifies as “other” or White <i>et al.</i> (1993) classify as “high” or “moderate” invasives
Level 3	Species that either White <i>et al.</i> (1993) classify as “minor” invasives, or government sources classify as noxious weeds or weed seed species ¹
Level 4	All remaining non-native plant species

Notes: ¹ The government regulations list some native boreal plant species (e.g., foxtail barley) as weeds since they focus on species that are problematic for agriculture. Native boreal species appearing on these lists are not considered to be invasive for the Project area.

Table 2-5: Classification of non-native plant species recorded in the Project footprint into levels of invasive concern

Invasive Concern ¹	Common Name ²	Scientific Name	ISCM Category ³	White et al. Category ⁴	Noxious Weed ⁵	Weed Seed ⁶
Level 1	Scentsless chamomile	<i>Tripleurospermum inodorum</i>	Category 2		Tier 2	Secondary
	Ox-eye daisy	<i>Leucanthemum vulgare</i>	Category 2		Tier 2	Primary
	Common tansy	<i>Tanacetum vulgare</i>	Category 2		Tier 2	
Level 2	Canada thistle	<i>Cirsium arvense</i>	Other	Moderate	Tier 3	Primary
	Field sow-thistle	<i>Sonchus arvensis</i>	Other		Tier 3	Primary
	Common burdock	<i>Arctium minus</i>	Other		Tier 3	
	Tufted vetch	<i>Vicia cracca</i>	Other			
	Smooth brome	<i>Bromus inermis</i>		Moderate		
	White sweet clover	<i>Melilotus albus</i>		Moderate		
	Yellow sweet clover	<i>Melilotus officinalis</i>		Moderate		
Level 3	Wormwood	<i>Artemisia absinthium</i>		Minor	Tier 3	
	Alfalfa	<i>Medicago sativa</i>		Minor		
	Lamb’s-quarters	<i>Chenopodium album</i>			Tier 3	
	Common dandelion	<i>Taraxacum officinale</i>			Tier 3	
	Narrow-leaved hawks-beard	<i>Crepis tectorum</i>			Tier 3	
	Flixweed	<i>Descurainia sophia</i>			Tier 3	
	Curled dock	<i>Rumex crispus</i>				Secondary
Level 4	Canola	<i>Brassica napus</i>				
	Shepherd’s-purse	<i>Capsella bursa-pastoris</i>				
	Wormseed mustard	<i>Erysimum cheiranthoides</i>				
	Pineapple-weed	<i>Matricaria discoidea</i>				
	Bird’s-foot trefoil	<i>Lotus corniculatus</i>				
	Black medick	<i>Medicago lupulina</i>				
	Spotted lady’s-thumb	<i>Persicaria maculosa</i>				
	Common plantain	<i>Plantago major</i>				
	Common timothy	<i>Phleum pratense</i>				
	Smooth catchfly	<i>Silene csereii</i>				
	Alsike clover	<i>Trifolium hybridum</i>				
	Red clover	<i>Trifolium pratense</i>				
	White clover	<i>Trifolium repens</i>				
Wheat	<i>Triticum aestivum</i>					

Notes: ¹ See Table 2-4 for the invasive concern classification. ² In decreasing order of concern for the Project area. ³ Invasive Species Council of Manitoba (2024). ⁴ White *et al.* (1993). ⁵ Government of Manitoba (2017b). Number in column is the Tier in the Act (see text). ⁶ Government of Canada (2016).

2.3.3 GENERAL APPROACH TO MANAGEMENT

The generally preferred overall strategy for addressing invasive (called “weedy” in some publications) non-native plants is a combination of prevention, early detection and eradication because this is generally considered to be the most economical and effective way to manage invasive plants (e.g., Clark 2003; Coastal Invasive Species Committee 2024).

For application, the overall approach for dealing with plants of higher concern (Levels 1 and 2) was the same in 2023 as in previous years. The rationale behind the development of the current approach is provided in greater detail in another annual report (ECOSTEM 2022). The approach is summarized below.

- Individual plants or small patches of Level 1 non-native species are removed manually as soon as they are discovered.
- Individual plants of Level 2 non-native species are removed manually as soon as they are discovered if they are isolated and there are no other plants or patches in the area.
- The remaining sites with Level 2 non-native species are identified for herbicide application if possible, or mowing if herbicide cannot be used at the site.

The efficacy of the treatments is assessed using the methods described in Section 2.3.4. Depending on the conditions at any given site, the management approach for Level 1 or Level 2 species may be modified if an alternate method would be more practical or efficient.

2.3.4 NON-NATIVE PLANT CONTROL

Several areas were recommended for herbicide application and mowing based on the 2022 monitoring results (see Section 3.1.3.2 for details). The areas were those which contained invasive species of high concern that had high potential to spread into other areas.

On June 22 to 25, 2023, a botanist visited the areas that were recommended for herbicide or mowing treatment. The botanist identified if the target species was present in these areas and marked areas to herbicide with pin flags. For areas where herbicide treatment was inappropriate, mowing was prescribed.

Due to scheduling problems, mowing did not take place in 2023 as planned (see Section 3.1.3 for details).

Treated areas from 2022 were surveyed to evaluate the efficacy of the control treatments, as the fall survey from 2022 was done too soon after herbicide application to assess effectiveness. A patch was considered treated with herbicide if there was evidence of herbicide damage on any of the vegetation in the patch. This may be different than the actual area sprayed because the effects of the herbicide can be systemic and may extend beyond the application area for rhizomatous species. Non-native plants in the treatment areas were recorded according to the standard survey

methods. Where there was evidence of treatment, in addition to the standard data, the percent of dead foliage for each non-native species in the patch was also recorded and photos of the treated patches of plants were taken.

Longer-term effectiveness of non-native plant control measures may be assessed by comparing the cover of species targeted for control from the previous year (prior to treatment) to the current year. A reduction in overall cover of these species in footprint components where treatment was applied would be an indicator that the treatments were effective. Consideration of the overall success of the treatment application based on the assessment from the previous year's report (i.e., did herbicide application or mowing impact the target patches?) also informs the interpretation of this comparison.

2.4 SEED MIXTURES USED IN REHABILITATION EFFORTS

Habitat rehabilitation includes seeding some areas with a native grass mixture. The *Keeyask Generating Station Construction Environmental Protection Plan* (KHLP 2016) indicated this mixture is to only include native and/or non-invasive introduced plant species, and of low-quality food value for mammals. This monitoring study confirms which species were included in the seed mixtures.

Manitoba Hydro provided the seed certificates for mixtures used during construction. The list of species was reviewed prior to seeding.

3.0 RESULTS

3.1 INLAND AREAS

3.1.1 OVERALL NON-NATIVE PLANT DISTRIBUTION AND ABUNDANCE

Map 3-1 to Map 3-5 shows the distribution of non-native plant patches within the Construction Footprint. Non-native plants were present in all surveyed Project areas.

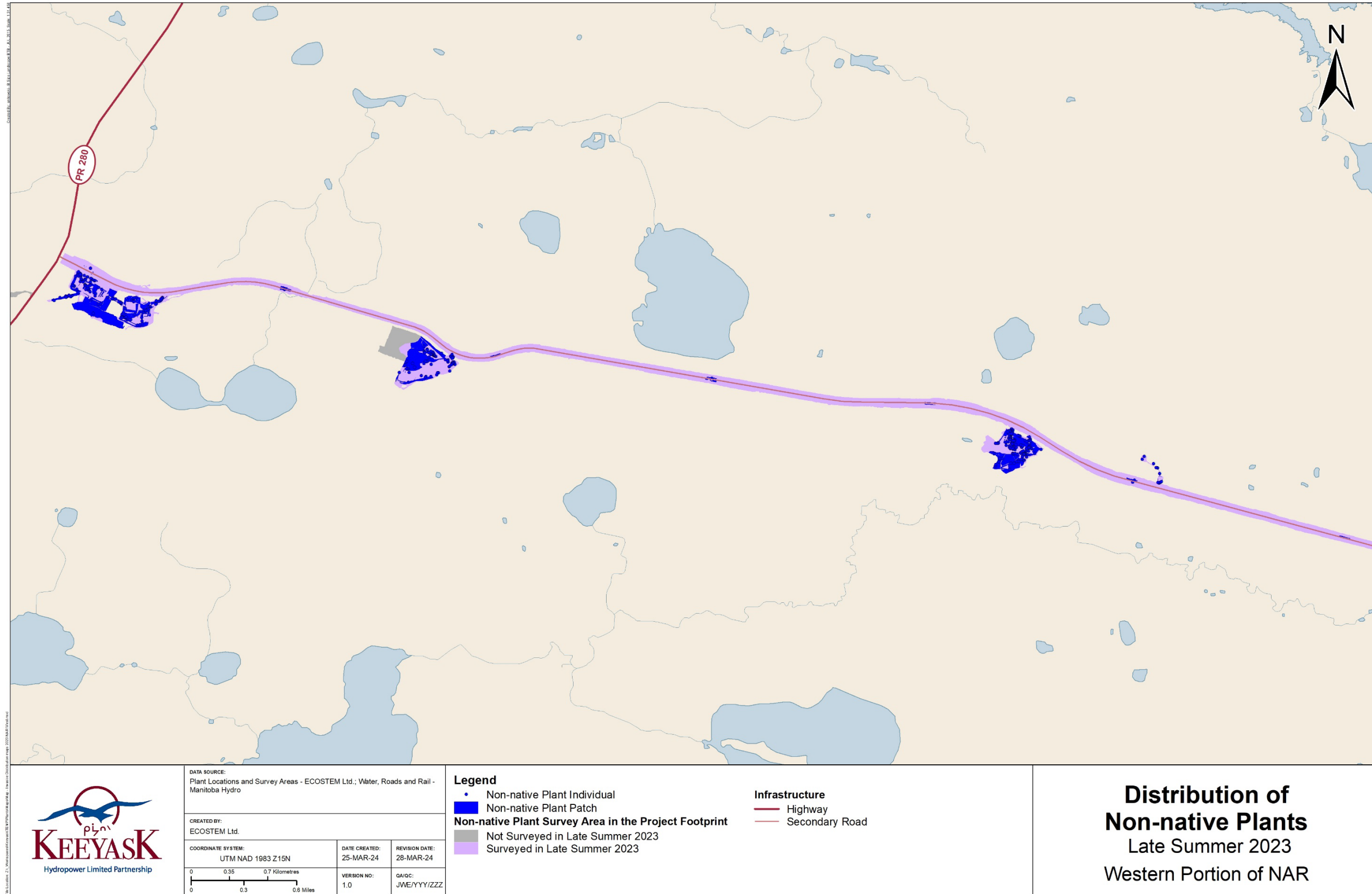
Total non-native plant cover was 25.6 ha by late summer, 2023, or 2.81% of the total surveyed area (Table 3-1). This was an increase from 6.1 ha, or 0.7% of the area surveyed in 2022 (ECOSTEM 2023).

Table 3-1: Total late summer non-native plant cover in 2023 as a percentage of total area surveyed, by Project component

Project Component		Percent of Area Surveyed ¹	
		2022 ²	2023
Permanent	Project Infrastructure	0.40	0.88
	Access Roads	2.07	3.12
	Not yet rehabilitated	0.60	3.66
Temporary	Recently rehabilitated	0.65	2.20
	Older rehabilitated	2.58	3.22
All surveyed areas		0.68	2.81
<i>Total non-native plant cover (ha)</i>		<i>6.1</i>	<i>25.6</i>
<i>Total area surveyed (ha)</i>		<i>900</i>	<i>908</i>

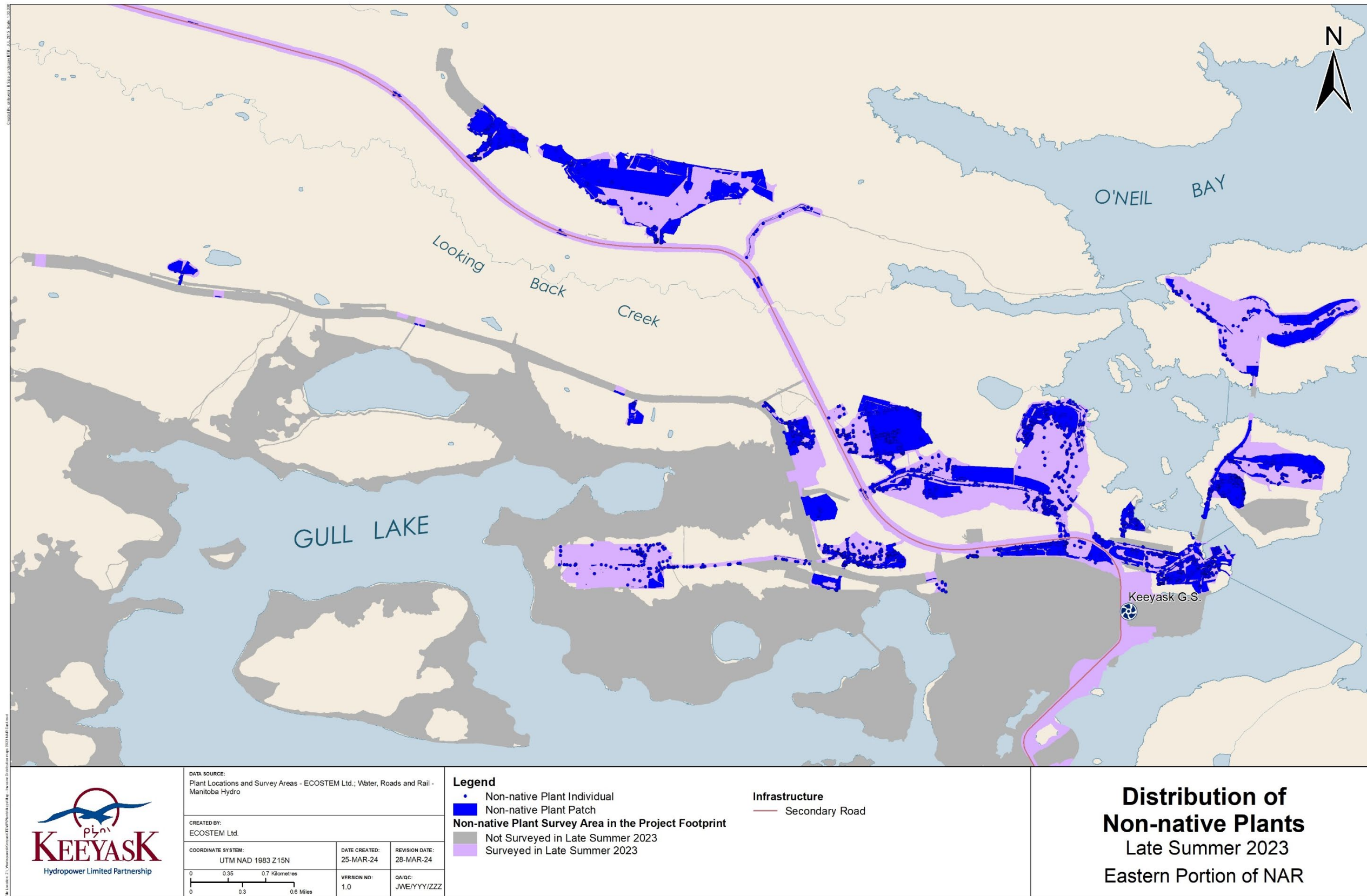
Notes: ¹Numbers that round to zero shown as "0"; absences shown as "-", ² Numbers reflect updated temporary footprint area for 2023.

As a percentage of surveyed area, temporary areas that had not yet been rehabilitated had the highest non-native plant cover (3.66%), followed by areas with older rehabilitation (3.22%), which previously had the highest percent cover in 2022. The lowest percentage cover, in both 2022 and 2023, was found in permanent Project infrastructure areas that were not the Access Roads. None of the Project components experienced a decline in non-native species cover.

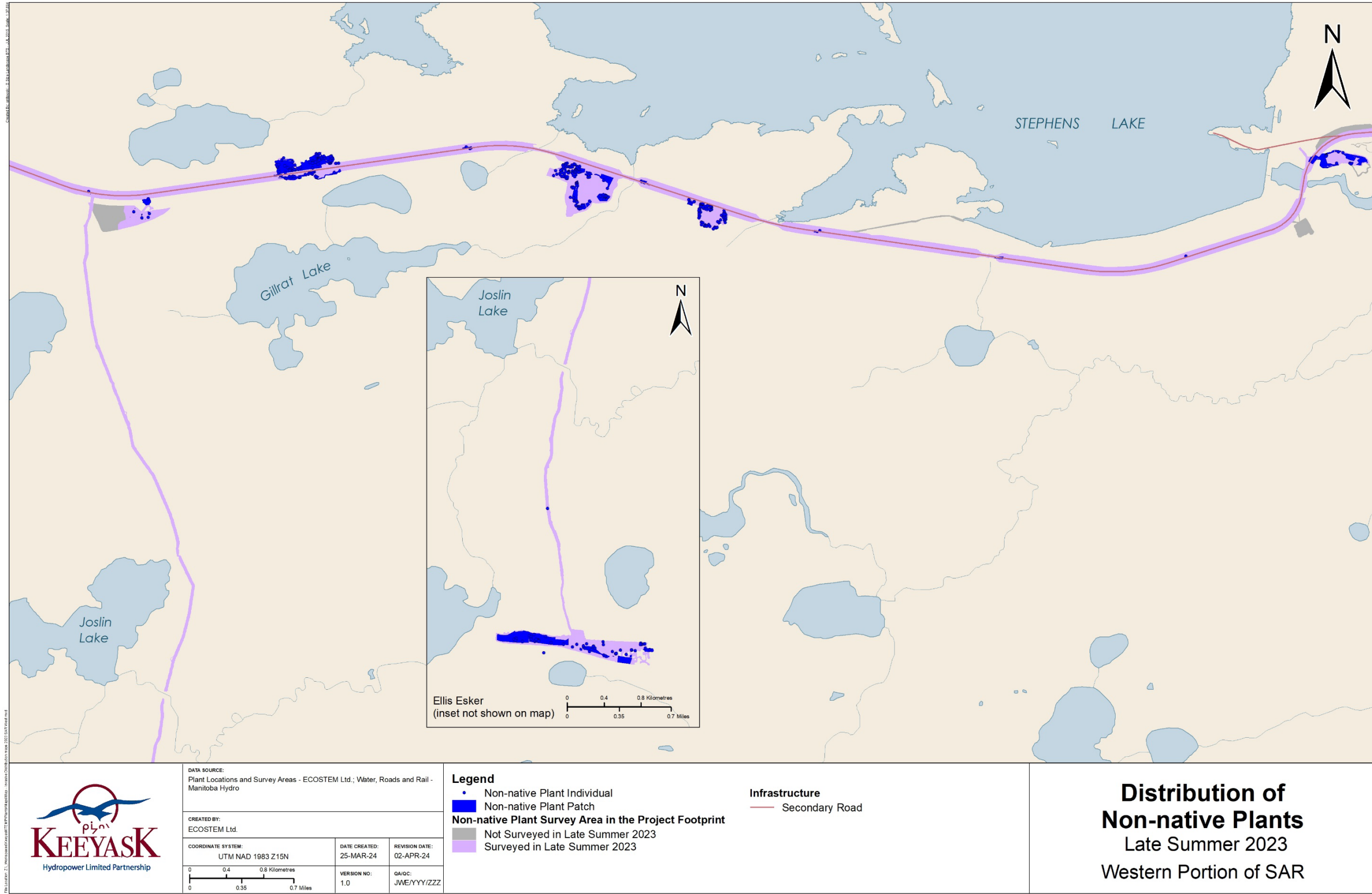


Distribution of Non-native Plants
 Late Summer 2023
 Western Portion of NAR

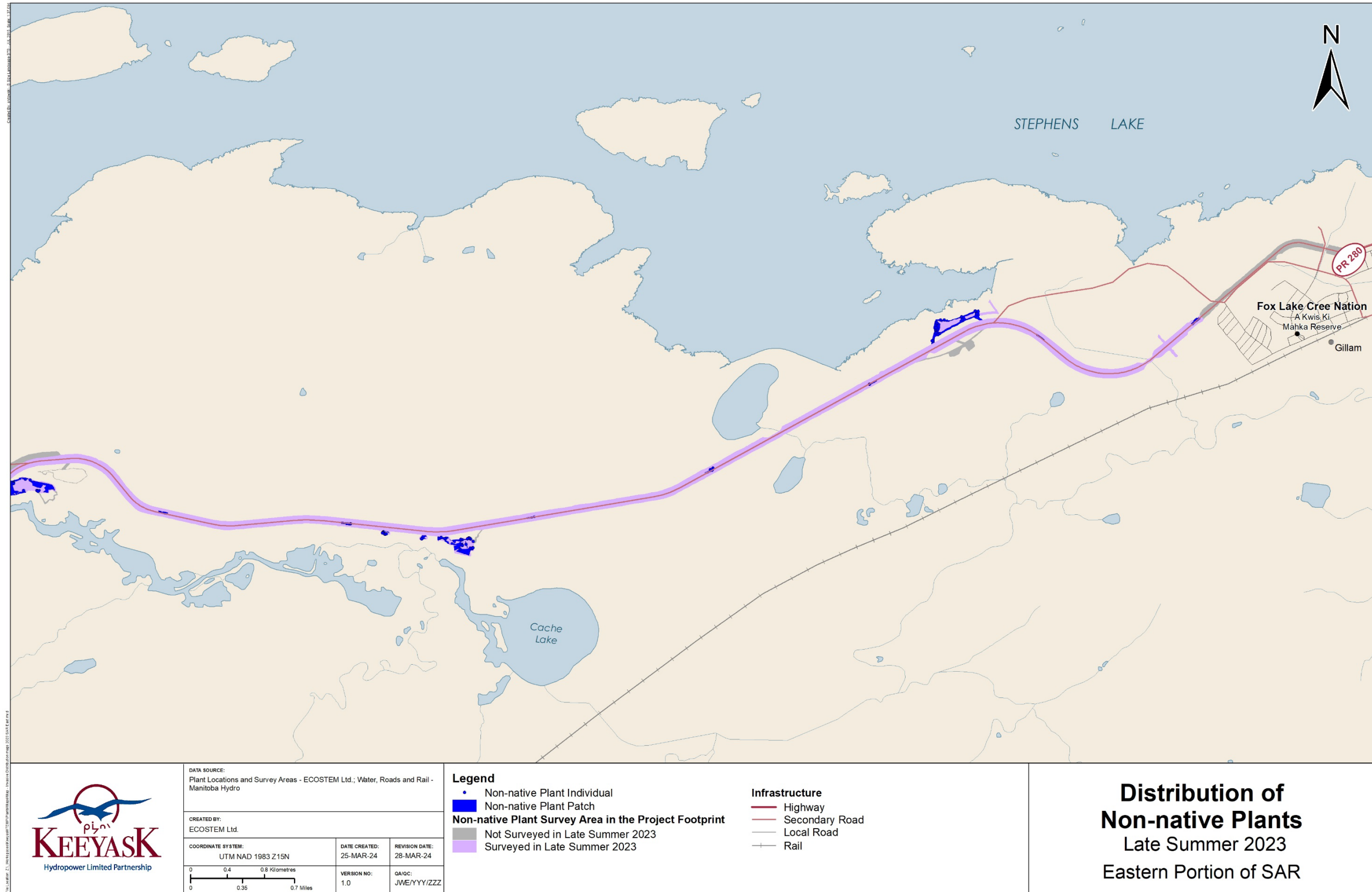
Map 3-1: Distribution of non-native plants during late summer 2023, in the Project footprint along the western portion of the North Access Road



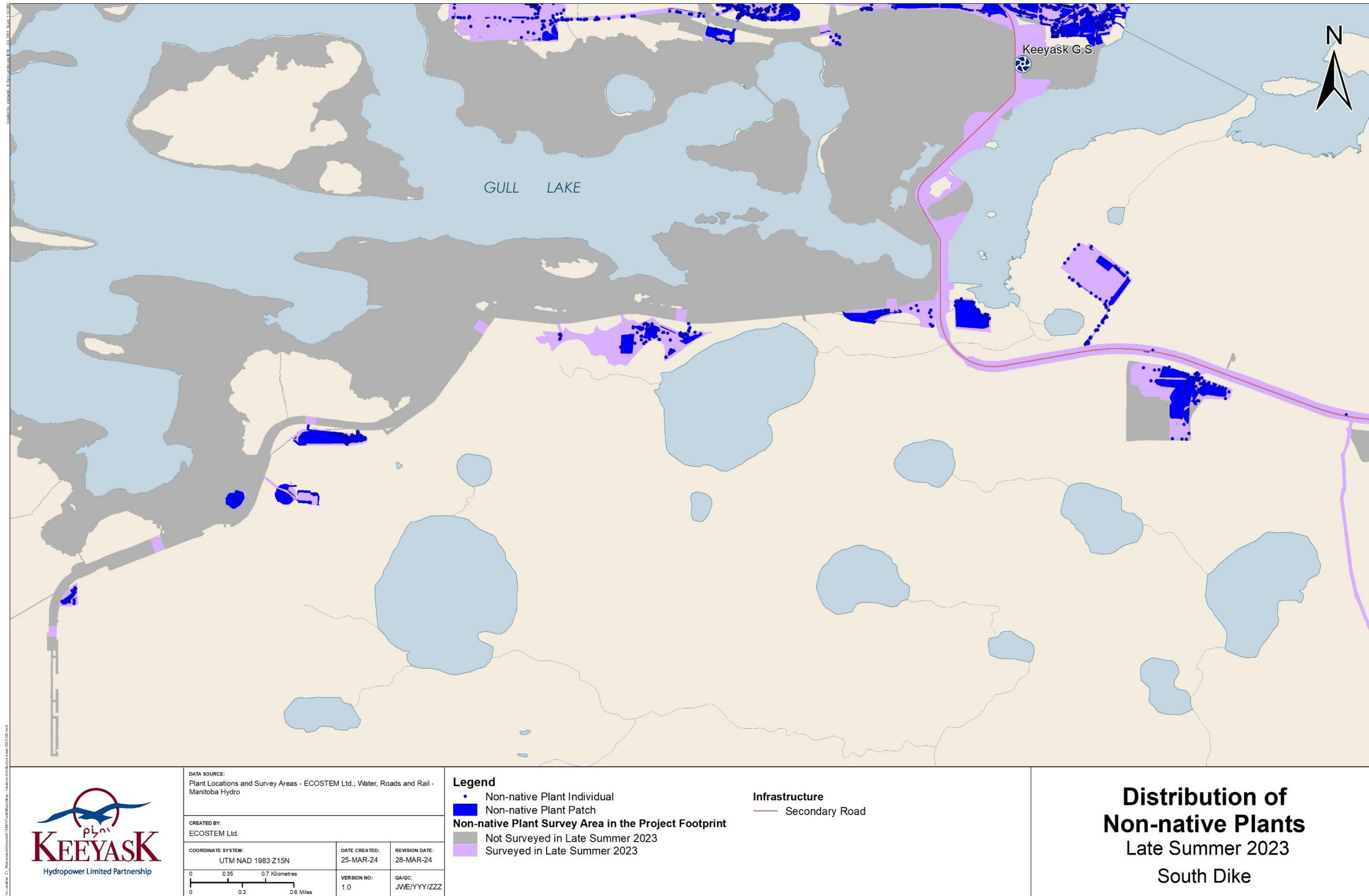
Map 3-2: Distribution of non-native plants during late summer 2023, in the Project footprint along the eastern portion of North Access Road



Map 3-3: Distribution of non-native plants during late summer 2023, in the Project footprint along the western portion of the South Access Road



Map 3-4: Distribution of non-native plants during late summer 2023, in the Project footprint along the eastern portion of the South Access Road



Map 3-5: Distribution of non-native plants during late summer 2023, in the Project footprint in the South Dike area

3.1.2 SPECIES DISTRIBUTION AND ABUNDANCE

A total of 23 non-native plant species were recorded in 2023 from the non-native plant monitoring and from incidental observations during other terrestrial monitoring studies (Table 3-2). All species recorded in 2023 had previously been recorded within the Project Footprint.

Four non-native species recorded in 2022 were not found in 2023 - Shepherd's-Purse, spotted lady's thumb, common timothy and common tansy.

Flixweed was recorded in 2023 for the first time since 2020 in a small patch in Borrow Area B-8.

The five most abundant non-native species in 2023 (Table 3-2) accounted for 78% of all non-native plant cover, and the eight most abundant accounted for 94% (Table 3-3). In descending order of abundance, these species were common dandelion (*Taraxacum officinale*), white and yellow sweet clover (*Melilotus albus* and *M. officinalis*, respectively), narrow-leaved hawk's-beard (*Crepis tectorum*), lamb's-quarters (*Chenopodium album*), field sow-thistle (*Sonchus arvensis*), smooth catchfly (*Silene csereii*) and common plantain (*Plantago major*). Common dandelion was the most abundant species by far at 31% of the total non-native cover, followed by white and yellow sweet cover combined at 23%, and narrow-leaved hawk's-beard at 13%. Narrow-leaved hawk's-beard represented only 5% of the non-native plant cover in 2022.

As a percentage of surveyed area, all of the eight most abundant species increased in cover since 2022 (see last year's annual report (ECOSTEM 2022) for 2021 cover).

Field sow-thistle cover increases were highest in the Boat launch east area, followed by EMPAs D16 (1)-E, D35(1)-E, Borrow Area N-21 and the main Work Areas. Although there were decreases in many of the older KIP created Borrow Areas between 2021 and 2022, a few of these areas saw small increases again in 2023. The biggest decrease in field sow-thistle cover occurred along the SAR, NAR and in Borrow Area B-2.

Narrow-leaved hawk's-beard cover increased from 2022 to become the third most abundant non-native species. The largest increases in cover were in previously active footprint components, such as Borrow Area G-1 at KM-17, where it was more much more abundant than in any previous year. It was also present in Borrow Areas B-2 and B-8, as well as Work Area C.

Since 2022, lamb's-quarters cover increased in Borrow Areas G-1 at KM17, Q-1, G-3, S-2a, Work Area A, EMPA D23(2)-E and EMPA D27(4)-E. Decrease in lamb's-quarters cover occurred mainly in EMPA D23(1)-E.

The largest total sweet clover increases were in Work Area X (previously called Borrow Area N-22; ECOSTEM 2023) and EMPA D16 (1)-E, which also experienced the largest increase in 2022. Additional areas where sweet clover increased include Borrow Areas B-6, Q-9, S-2a, EMPA D12(1)-E and D17-E, as well as the remaining Work Areas and both the North Access Road (NAR) and SAR. Few areas recorded a decrease in sweet clover cover, including Start-up camp, Borrow Area KM 4 and the well access road.

Table 3-2: Total approximate late summer non-native species cover (m²) in the Project footprint, by year

Common Name^{1,2}	Species	2022	2023
<u>Common Dandelion</u>	<i>Taraxacum officinale</i>	18,408	78,063
<u>Narrow-leaved Hawks-beard</u>	<i>Crepis tectorum</i>	3,002	34,216
<i>White Sweet Clover</i>	<i>Melilotus albus</i>	9,246	30,020
<u>Lamb's-quarters</u>	<i>Chenopodium album</i>	9,303	26,347
<i>Unidentified Sweet Clover</i>	<i>Melilotus</i> spp.	2,849	25,487
<i>Field Sow-thistle</i>	<i>Sonchus arvensis</i>	4,740	16,151
Smooth Catchfly	<i>Silene csereii</i>	2,630	13,066
Common Plantain	<i>Plantago major</i>	1,295	12,014
Alsike Clover	<i>Trifolium hybridum</i>	3,287	8,909
<i>Yellow Sweet Clover</i>	<i>Melilotus officinalis</i>	2,580	4,413
White Clover	<i>Trifolium repens</i>	57	1,770
Wormseed Mustard	<i>Erysimum cheiranthoides</i>	170	1,668
<u>Alfalfa</u>	<i>Medicago sativa</i>	426	1,259
<i>Tufted Vetch</i>	<i>Vicia cracca</i>	247	1,091
Pineappleweed	<i>Matricaria discoidea</i>	649	484
<u>Curled Dock</u>	<i>Rumex crispus</i>	60	408
Red Clover	<i>Trifolium pratense</i>	3	47
<u>Wormwood</u>	<i>Artemisia absinthium</i>	153	37
Scentless chamomile	<i>Tripleurospermum inodorum</i>	223	35
Flixweed	<i>Descurainia sophia</i>		13
Bird's-foot Trefoil	<i>Lotus corniculatus</i>	64	4
Black Medick	<i>Medicago lupulina</i>	0	3
Ox-eye Daisy	<i>Leucanthemum vulgare</i>	0	0
<i>Canada Thistle</i>	<i>Cirsium arvense</i>	1	0
Shepherd's-Purse	<i>Capsella bursa-pastoris</i>	4	-
Spotted Lady's-thumb	<i>Persicaria maculosa</i>	1,504	-
Common Timothy	<i>Phleum pratense</i>	0	-
Common Tansy	<i>Tanacetum vulgare</i>	0	-
<i>All species</i>		<i>60,950</i>	<i>255,505</i>
<i>Total Area Surveyed</i>		<i>8,997,436</i>	<i>9,077,055</i>

Notes: Numbers that round to zero shown as "0"; absences shown as "-". ¹ Bolded species are Level 1 invasive concern (Table 2-5). Italicized species are Level 2 invasive concern. Underlined species are Level 3 invasive concern. Remaining species are non-native species that may become problematic in some sites and/or condition. ² Species difficult to distinguish until they flower are combined into a broader taxon. *Melilotus* spp. includes *M. albus* and *M. officinalis*.

Table 3-3: Total approximate cover of non-native species as a percentage of total cover for all non-native species, by year

Common Name^{1,2}	Species	2022	2023
<u>Common Dandelion</u>	<i>Taraxacum officinale</i>	30	31
<u>Narrow-leaved Hawks-beard</u>	<i>Crepis tectorum</i>	5	13
<i>White Sweet Clover</i>	<i>Melilotus albus</i>	15	12
<u>Lamb's-quarters</u>	<i>Chenopodium album</i>	15	10
<i>Unidentified Sweet Clover</i>	<i>Melilotus spp.</i>	5	10
<i>Field Sow-thistle</i>	<i>Sonchus arvensis</i>	8	6
Smooth Catchfly	<i>Silene csereii</i>	4	5
Common Plantain	<i>Plantago major</i>	2	5
Alsike Clover	<i>Trifolium hybridum</i>	5	3
<i>Yellow Sweet Clover</i>	<i>Melilotus officinalis</i>	4	2
White Clover	<i>Trifolium repens</i>	0	1
Wormseed Mustard	<i>Erysimum cheiranthoides</i>	0	1
Spotted Lady's-thumb	<i>Persicaria maculosa</i>	2	0
Pineappleweed	<i>Matricaria discoidea</i>	1	0
<u>Alfalfa</u>	<i>Medicago sativa</i>	1	0
<i>Tufted Vetch</i>	<i>Vicia cracca</i>	0	0
<u>Wormwood</u>	<i>Artemisia absinthium</i>	0	0
Flixweed	<i>Descurainia sophia</i>	-	0
Bird's-foot Trefoil	<i>Lotus corniculatus</i>	0	0
<u>Curled Dock</u>	<i>Rumex crispus</i>	0	0
<i>Smooth Brome</i>	<i>Bromus inermis</i>	0	0
Scentless chamomile	<i>Tripleurospermum inodorum</i>	0	0
Red Clover	<i>Trifolium pratense</i>	0	0
<i>Canada Thistle</i>	<i>Cirsium arvense</i>	0	0
Ox-eye Daisy	<i>Leucanthemum vulgare</i>	0	0
Black Medick	<i>Medicago lupulina</i>	0	0
Common Timothy	<i>Phleum pratense</i>	0	-
Common Tansy	<i>Tanacetum vulgare</i>	0	-
Shepherd's-Purse	<i>Capsella bursa-pastoris</i>	0	-
<i>All species</i>		100	100
<i>Total Area Surveyed (m²)</i>		8,997,436	9,077,055

Notes: Numbers that round to zero shown as "0"; absences shown as "-". ¹ Bolded species are Level 1 invasive concern (Table 2-5). Italicized species are Level 2 invasive concern. Underlined species are Level 3 invasive concern. Remaining species are non-native species that may become problematic in some sites and/or condition. ² Similar species that are difficult to distinguish until they flower are combined into a broader taxon. *Melilotus* spp. includes *M. albus* and *M. officinalis*.

3.1.3 EFFORTS TO MANAGE INVASIVE PLANTS

The non-native species that were considered for management measures included all the Level 1 species (Section 2.3.2), which were the species of highest invasive concern for the Project footprint. Level 2 species were candidates for management measures if they were not already well-established in multiple locations. Level 3 and Level 4 species were opportunistically managed within locations where Level 1 or 2 species were treated.

Nine of the 23 non-native species recorded in 2023 were classified as being Level 1 or 2 (Table 2-5). None of these were an ISCM Category 1 species, and none were a Tier 1 species in the *Noxious Weeds Act* of Manitoba.

The Level 1 species found in 2023 were ox-eye daisy (*Leucanthemum vulgare*) and scentless chamomile (*Tripleurospermum inodorum*). Level 2 species included Canada thistle (*Cirsium arvense*), field sow-thistle, tufted vetch (*Vicia cracca*), and white and yellow sweet clover.

Strategies employed to date to manage non-native plants include prevention, eradication and control. An example of a prevention measure implemented during invasive plant monitoring during Project operation are that staff conducting the surveys clean their footwear before they leave a surveyed area.

The three primary eradication and control methods employed to date were rapid manual removal, herbicide treatments, and mowing at key sites. The following describes these measures.

3.1.3.1 RAPID MANUAL REMOVAL AND OTHER NON-CHEMICAL ACTIONS

The rapid manual removal (i.e., by hand) strategy was applied to Level 1 plants at sites with one to a few plants (see Section 2.3.3 for the removal methods). Such plants were immediately removed when they were found. The following provides results by degree of invasive concern.

3.1.3.1.1 LEVEL 1 NON-NATIVE SPECIES

The two Level 1 non-native species recorded in 2023 were ox-eye daisy and scentless chamomile. No instances of common tansy were recorded in 2023. All three species are an ISCM Category 2 species or a Tier 2 species in the provincial *Noxious Weeds Act* (Table 2-5). Scentless chamomile is also a weed seed plant in the federal Weed Seeds Order. All three of these species were found and monitored during Project operation. The characteristics of these species are described in detail in a previous annual report (ECOSTEM 2022).

To date, the rapid manual removal appears to have been effective for the Level 1 species (Section 2.3.3; see ECOSTEM 2022). The following describes the situations for individual species in 2023.

In 2023, scentless chamomile was found growing in the two areas where it has previously been identified, including in Borrow Area B-2 (Appendix 3, Map 6-1; Photo 3-1, and in the large patch

discovered in Borrow Area N-5 in 2022. All these plants were immediately removed and disposed of by ECOSTEM field staff.

Ox-eye daisy was recorded at three sites in Borrow Area G1 at KM-15 (Appendix 3, Map 6-2; Photo 3-2). One of the sites in Borrow Area KM-15 was located near (within approximately 7 m) a site recorded in 2022. No plants were found growing in Borrow Area B-2, where it was identified in 2022. All plants found were removed by ECOSTEM staff (Photo 3-3).

Common tansy was not found growing in 2023, including at both locations where it was discovered and removed in 2022.



Photo 3-1: Scentless chamomile patch growing in Borrow Area N-5 on August 23, 2023



Photo 3-2: Ox-eye daisy (white flowers) growing in Borrow Area G1 at KM-15 on August 21, 2023



Photo 3-3: Ox-eye daisy manual removal from Borrow Area G1 at KM-15 on August 21, 2023

3.1.3.1.2 LEVEL 2 NON-NATIVE SPECIES

Five Level 2 non-native species were recorded in 2023. Of these, the ISCM “other” species included Canada thistle, field sow-thistle and tufted vetch. The first two of the preceding species are also Tier 3 species in the provincial *Noxious Weeds Act*. White *et al.* (1993) classify white sweet clover, yellow sweet clover, and Canada thistle as moderately invasive in Canada. Canada thistle is also classified as a weed seed plant in the federal Weed Seeds Order (Table 2-5). The characteristics of these species are described in detail in a previous annual report (ECOSTEM 2022). All these species were previously found in the Project footprint during construction.

Manual removal has not been successful for Level 2 species in most cases. The following describes the situations for individual species in 2023.

Surveys in 2023 did not find any individuals of Canada thistle near patches recorded previously in Borrow Area KM-4 or EMPA D35(1)-E (Appendix 3, Map 6-8). Three individuals were found at a site in Borrow Area B-2, near the site where plants were previously found. A few individuals were also recorded in a new location in Borrow Area E-1. The plants in Borrow Area B-2 were not

removed because they were established patches. Those sites will be targeted for treatment with herbicide in 2024 and re-visited during the late-summer surveys.

Tufted vetch plants (Photo 3-4) were found in several new areas during the 2023 surveys (Appendix 3, Map 6-9 and Map 6-10). These included scattered individuals in all of the Work Areas. Tufted vetch continued to grow in or around most of the sites where it had previously occurred.

Rapid manual removal was not employed (and not recommended) at the remaining tufted vetch sites along the SAR and in adjacent borrow areas east of the Butnau Marina. In these cases, the plants were well established at these sites and in areas adjacent to or near the Project footprint.



Photo 3-4: Tufted vetch growing in Borrow Area G-1 at KM-15, June 26, 2023

The rapid manual removal protocol was not applied for white and yellow sweet clover. White sweet clover (Photo 3-5) was already widespread in the Project footprint, and in disturbed areas throughout the Keeyask region, prior to the Project. As of August 2023, the two species remained collectively the second most abundant non-native species.



Photo 3-5: White sweet clover growing in the ditch of the NAR, August 25, 2022

3.1.3.1.3 LEVEL 3 AND 4 NON-NATIVE SPECIES

Seven of the remaining 16 non-native species were Level 3 invasive concern, and 9 were Level 4. These species were not managed, unless they fell within areas treated chemically or by mowing for species of higher invasive concern (see Section 3.1.3.2).

While the Level 3 and 4 non-native species were fairly common in disturbed areas surrounding the Project, a few of these species appeared to be spreading rapidly.

3.1.3.2 HERBICIDE TREATMENTS AND MOWING AT KEY SITES

3.1.3.2.1 TREATMENTS

Herbicide application at key sites, with follow-up mowing where required, was the second management strategy employed to date to control invasive plants. The key sites were selected based on a combination of which invasive species were present, where these species were most prolific, accessibility, and which sites had the highest potential for providing seed that could be spread to other Project areas (i.e., due to vehicles or footwear picking up seeds and carrying them elsewhere).

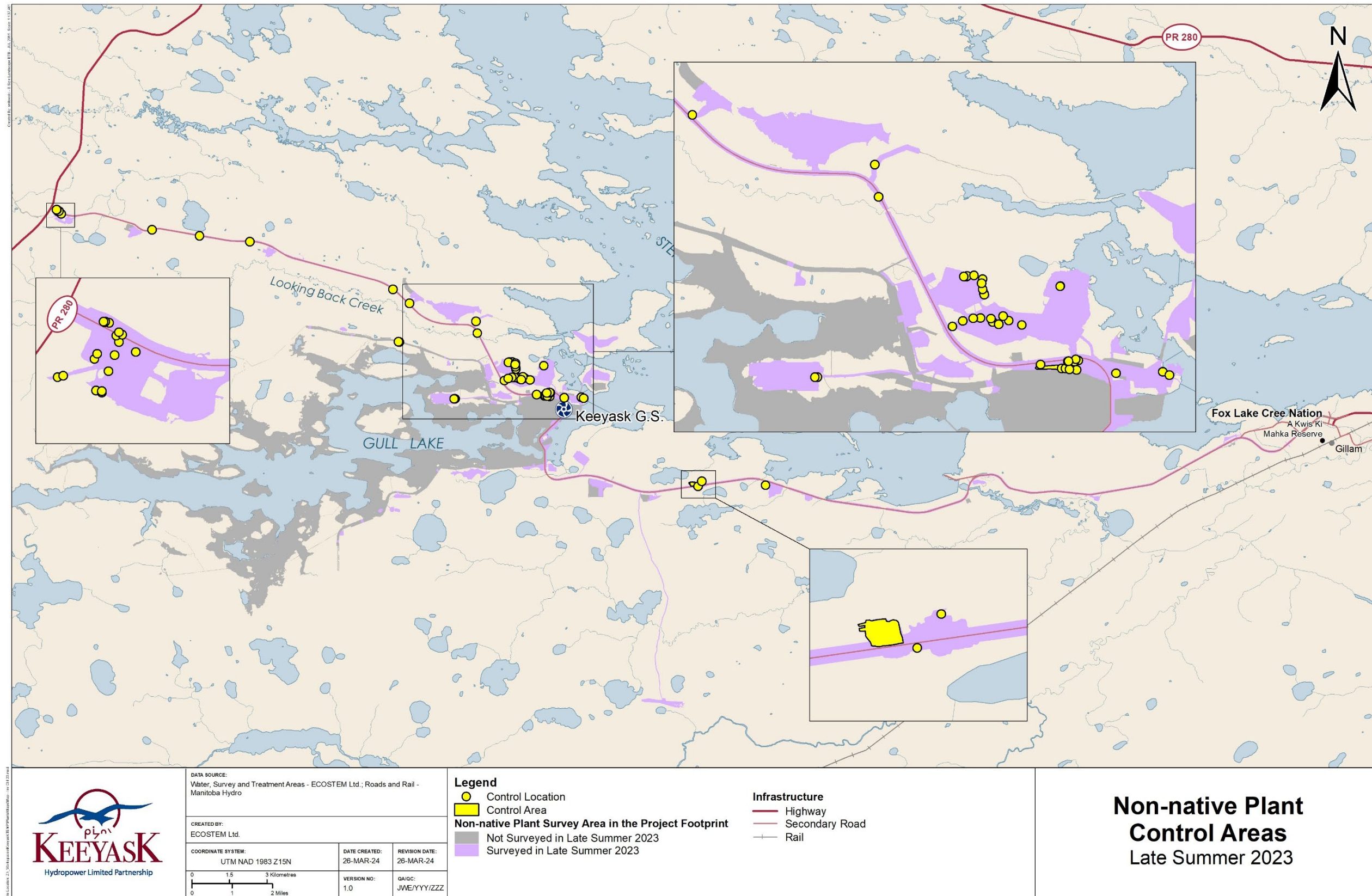
Several sites containing target species, predominantly field sow-thistle (Photo 3-6), were selected for herbicide and/or mowing treatment in 2023 (Map 3-6). Herbicide treatments were completed

between July 26 and August 4, 2023. Unfortunately, scheduling problems led to mowing treatments being canceled.

One area near the downstream boat launch was marked for mowing in 2023, due to its proximity to Stephens Lake (Map 3-6). Several areas in Borrow Area KM 15 were marked for mowing, as access to the site was reduced due to decommissioning of the road and the extent of rehabilitation efforts.



Photo 3-6: Field sow-thistle growing in Borrow Area KM 1, August 26, 2023



Map 3-6: Key areas selected for invasive plant herbicide control and mowing in 2023

3.1.3.2 EFFICACY OF TREATMENTS

Areas Treated in 2022 and 2023

Table 3-4 summarizes the dates, locations and herbicide mixture used for the treatments in 2022 and 2023.

Table 3-4: Herbicide treatments carried out at key sites in 2022 and 2023

Treatment Dates	Areas Treated ¹	Herbicide Mixture ²
August 17 and 18, 2022	Start-up Camp and NAR gate staging area, North Dike, NAR, Borrow Area G-1 (KM-15), Main Camp, Work Area A, Borrow Areas Q-9, B-3, Sigfusson Northern/Voltage Camp (SAR, decommissioned), portions of Work Area X	Escort – 23005 (140 g/ha), Vanquish – 26980 (4 L/ha), Roundup – 33653 (5 L/ha).
July 26 to August 4, 2023	Start-up Camp and NAR gate staging area, North Dike, NAR, Borrow Area G-1 (KM-15), Main Camp, Work Area A, Borrow Areas Q-9, B-3, portions of Work Area X	Escort (140 g/ha), Visionmax (5 L/ha), Banvel (5 L/ha), Hasten (2.5 L/ha)

Notes: ¹ Herbicide was applied to target patches within the indicated areas. ² "L/ha" = Litres per hectare; "g" = Grams; "g/ha" = Grams per hectare.

The overall effectiveness of the herbicide treatments in 2022 could not be evaluated using the 2022 field data (see ECOSTEM 2023) because not enough time had passed for the effects of the herbicide to become apparent. The herbicide treatment occurred later than planned in 2022, and the non-native plant surveys commenced one day after the application of the herbicide was completed. Some herbicide effects were observed in some of the treated areas that were surveyed two weeks after the treatment (Photo 3-7), but generally not to the extent expected for an effective treatment.

Most of the 2022 marked patches were revisited and evaluated during the spring and summer surveys in 2023. The effects of the treatment from 2022 were much more visible in early 2023 (Photo 3-8) than they had been during the 2022 late summer invasive survey. Because the locations treated in 2023 generally overlapped with the locations treated in 2022, the efficacy of the 2022 treatments was considered in combination with the efficacy of the 2023 treatments.



Photo 3-7: Flagged site near Work Area X after herbicide treatment in August, 2022



Photo 3-8: Flagged site on the SAR in June 2023 after herbicide treatment in August 2022

Of the 55 sites marked for herbicide treatment in 2022, and 25 marked in 2023, 39 were confirmed to have been treated (note that some sites marked in 2023 were also marked in 2022). Of these sites, 30 had 98% mortality or higher and in 28 sites there was no evidence of the target species remaining in the patch. Four of the remaining sites had a mortality of less than 90%. In these cases, a portion of the marked area had been missed and remnant patches remained at these locations (incidentally, these remnants were re-marked for the 2023 herbicide procedure).

Comparing the 2022 and 2023 cover of target species in areas where herbicide treatments were applied, total cover was lower in 2023 in six footprint components (Table 3-5). Target species was absent or nearly absent in Borrow Area B-3, the Helicopter Pad, and the North Dike. There were also decreases in cover along both the North and South Access Roads. Overall increases in cover for the target species occurred in the remaining treated footprint components.

Table 3-5: Cover (m²) of target species in areas with herbicide-treated sites¹ before and after treatment in 2022 and 2023, by affected area

Common Name	Treated Area	Pre-treatment cover (August, 2022)	Post-treatment cover (August, 2023)	Cover Change ²
Field Sow-thistle ³	Borrow Area B-3	3	0	-2
	Borrow Area KM 17	43	271	228
	Borrow Area Q-9	13	17	4
	Heli Pad	17	0	-17
	Main Camp	36	438	402
	NAR	191	80	-111
	North Dike	5	-	-5
	SAR	1,269	858	-410
	Well Access Road	1	1	-1
	Work Area A	132	950	818
	Work Area C	13	664	651
	Work Area C/Boat Launch East	208	3,523	3,315
	Work Area X	209	1,173	965
	<i>Total</i>	<i>2,139</i>	<i>7,976</i>	<i>5,837</i>
Tufted vetch ⁴	Borrow Area B-3	2	3	1
<i>All non-native species</i>		<i>2,141</i>	<i>7,979</i>	<i>5,838</i>

Notes: Numbers that round to zero shown as "0"; absences shown as "-".¹ Only sites with identifiable non-native plants are included. ² A negative sign means that cover decreased. ³ Based on 13 areas. ⁴ Based on 1 area

3.1.4 SEED MIXTURES USED IN REHABILITATION EFFORTS

Rehabilitation efforts including grass seeding carried out up to September 2022 are described in another monitoring report (ECOSTEM 2023c). No new areas were rehabilitated through grass seeding since 2022.

None of the non-native species identified in the planted seed mixtures were found in 2023.

3.2 SHORE ZONE

3.2.1 OVERALL

A total of 52 m² of non-native plant cover was recorded along the approximately 76.4 km of shoreline transects surveyed in 2023 (Table 3-6). The distribution of the species was not even across the hydraulic zones (Map 3-7 and Map 3-8). More than two thirds of the non-native plant cover was located downstream of the generating station.

Table 3-6: Non-native plant cover along the surveyed shoreline by hydraulic zone in 2023

Hydraulic Zone	Length of shoreline surveyed (km)	Non-native plant cover (m ²)	Non-native plant cover as proportion of shoreline surveyed (m ² /km)
Downstream of Generating station	17.4	37	2.1
Upstream of Generating station	59.1	15	0.3
<i>All</i>	<i>76.4</i>	<i>52</i>	<i>0.7</i>

3.2.2 SPECIES DISTRIBUTION AND ABUNDANCE

On a per kilometer of shoreline basis, non-native plant abundance was 2.1 m²/km along downstream transects of the shoreline, compared to 0.3 m²/km along upstream transects.

A total of four non-native species were recorded in the shore zone (Table 3-7). Of these, field sow-thistle was the most abundant, and of the highest concern level, making up 89.5% of the total cover. This was followed by curly dock (*Rumex crispus*; 9.6%), common dandelion (0.8%) and lamb's-quarters (0.1).

Field sow-thistle was recorded in both hydraulic zones but was much more abundant along the older downstream shoreline. It was primarily found along the shoreline near the downstream boat

launch, on the south side of the Borrow Area G-3 island and the south side of a small island straight east of the downstream boat launch, close to a cabin. The upstream locations of the field sow-thistle were scattered along the newly created reservoir. The small amount of lamb’s quarters recorded was also found along the downstream shoreline. Curly dock and common dandelion were both recorded exclusively on the upstream transects.

Table 3-7: Non-native plant species in the surveyed shore zone in 2023 by hydraulic zone

Common Name ^{1,2}	Species	All Zones		Upstream of Generating station		Downstream of Generating station	
		Total cover (m ²)	Number of sites	Total cover (m ²)	Number of sites	Total cover (m ²)	Number of sites
<u>Lamb's-quarters</u>	<i>Chenopodium album</i>	0.0	1	-	-	0.0	1
<u>Yellow or Curled Dock</u>	<i>Rumex crispus</i>	5.0	5	5.0	5	-	-
<i>Field Sow-thistle</i>	<i>Sonchus arvensis</i>	46.8	12	9.5	5	37.2	7
<u>Common Dandelion</u>	<i>Taraxacum officinale</i>	0.4	3	0.4	3	-	-
<i>All</i>		<i>52.2</i>	<i>21</i>	<i>15.0</i>	<i>13</i>	<i>37.3</i>	<i>8</i>

Notes: ¹Numbers that round to zero shown as "0"; absences shown as "-", ² Italicized species are Level 2 invasive concern. Underlined species are Level 3 invasive concern.

3.2.3 CHANGES SINCE 2019

Overall, the total non-native plant cover recorded along the shoreline in 2023 was half of what was recorded in 2019 (Table 3-8), even though the total length of the shore zone survey increased by 27m. The non-native plant cover primarily decreased in the upstream zone between 2019 and 2023. Expressed as the proportion of the shoreline surveyed, non-native plant cover in the upstream zone cover decreased by 2.1 m²/km, whereas the proportion in the downstream zone increased by 0.2 m²/km.

All of the species recorded in 2023 had also been recorded in 2019 (Table 3-9). Five additional species had been recorded in 2019 and not in 2023, including narrow-leaved hawk’s-beard, white sweet clover, common plantain, alsike clover and tufted vetch. The most abundant species in 2019 were common plantain and alsike clover, recorded exclusively in the upstream and downstream zones, respectively. Neither species was recorded during the 2023 survey. The third most common species in 2019 was field sow-thistle. Field sow-thistle was the only species recorded in both upstream and downstream zones in both 2019 and 2023.

Table 3-8: Non-native plant cover along the surveyed shoreline by year

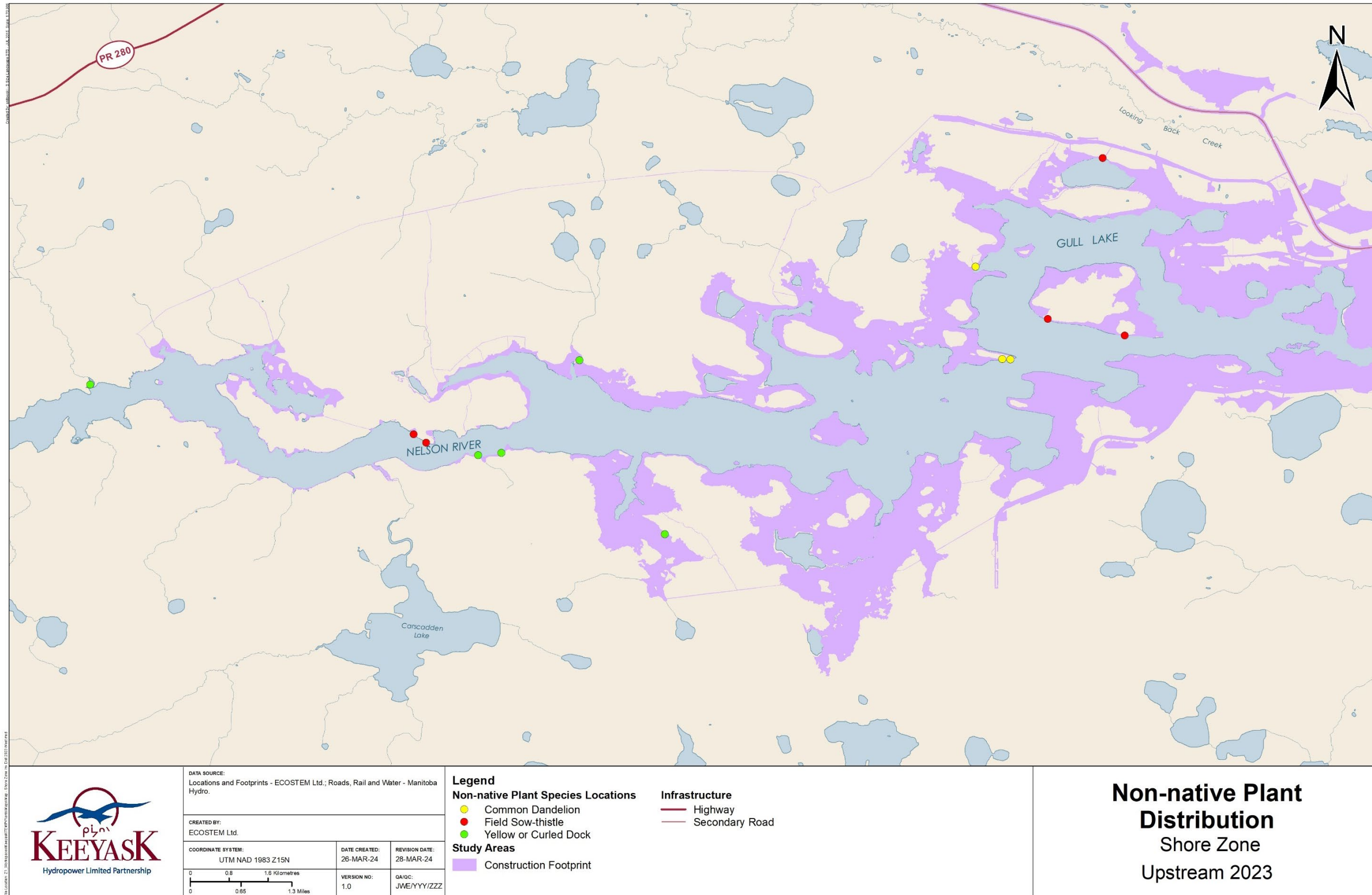
Hydraulic Zone	Year	Length of shoreline surveyed (km)	Non-native plant cover (m ²)	Non-native plant cover as proportion of shoreline surveyed (m ² /km)
Downstream of Generating station	2019	16	32	2.0
	2023	17	37	2.1
	<i>Change¹</i>	<i>1</i>	<i>5</i>	<i>0.2</i>
Upstream of Generating station	2019	33	76	2.3
	2023	59	15	0.3
	<i>Change</i>	<i>26</i>	<i>-61</i>	<i>-2.1</i>
All	2019	49	108	2.2
	2023	76	52	0.7
	<i>Change</i>	<i>27</i>	<i>-55</i>	<i>-1.5</i>

Notes: ¹Negative numbers indicate a decrease from 2019 to 2023.

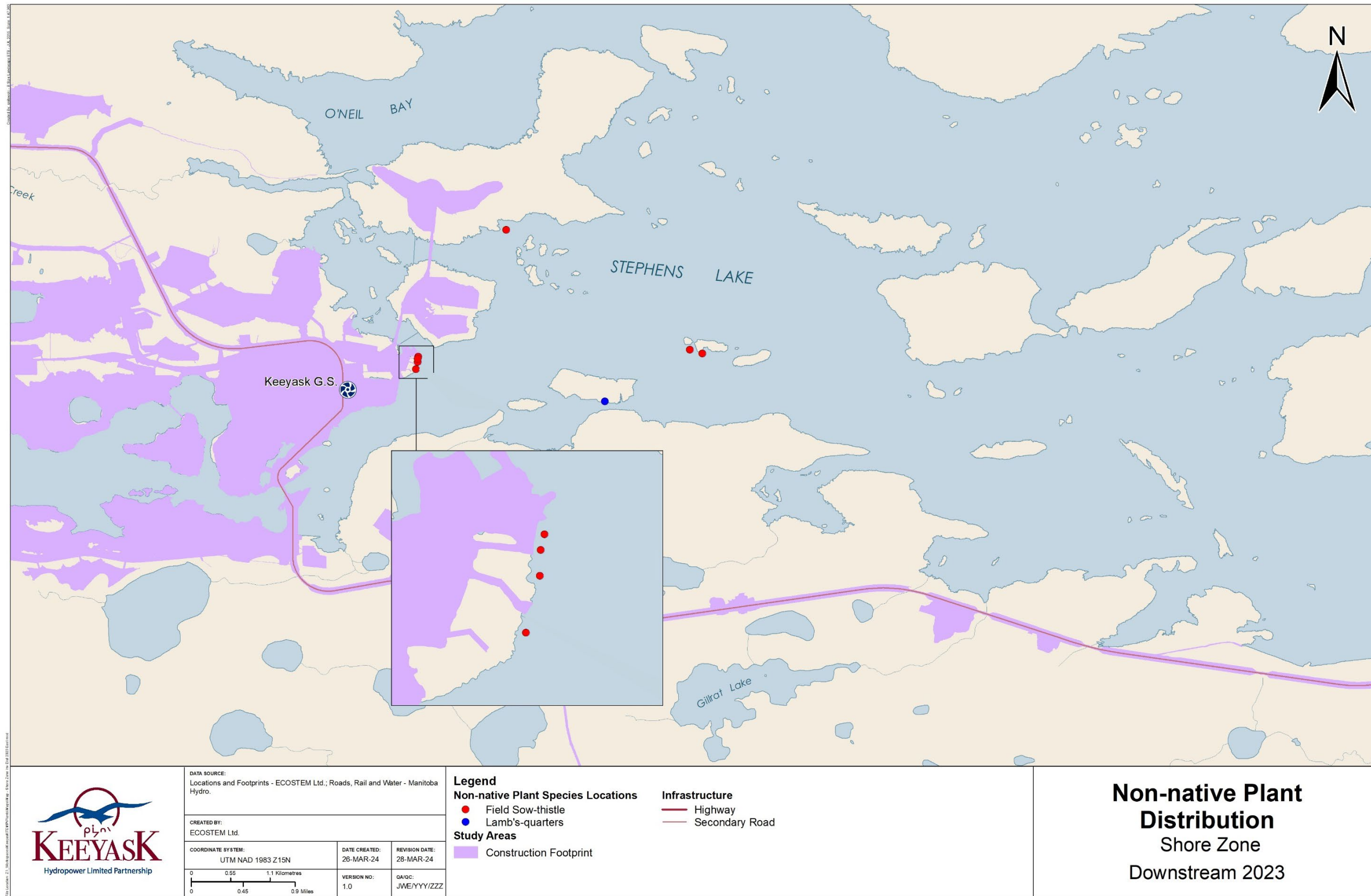
Table 3-9: Non-native plant cover and percentage of total non-native plant cover along the surveyed shoreline, by year

Common Name ^{1,2}	Species	2019		2023	
		Total cover (m ²)	Percentage of total cover	Total cover (m ²)	Percentage of total cover
<u>Lamb's-quarters</u>	<i>Chenopodium album</i>	0.2	0.2	0.0	0.1
<u>Narrow-leaved Hawks-beard</u>	<i>Crepis tectorum</i>	0.4	0.4	-	-
<i>White Sweet Clover</i>	<i>Melilotus albus</i>	0.2	0.2	-	-
Common Plantain	<i>Plantago major</i>	61.1	56.8	-	-
<u>Curled Dock</u>	<i>Rumex crispus</i>	1.3	1.2	5.0	9.6
<i>Field Sow-thistle</i>	<i>Sonchus arvensis</i>	12.0	11.2	46.8	89.5
<u>Common Dandelion</u>	<i>Taraxacum officinale</i>	0.1	0.1	0.4	0.8
Alsike Clover	<i>Trifolium hybridum</i>	25.2	23.4	-	-
<i>Tufted Vetch</i>	<i>Vicia cracca</i>	7.2	6.7	-	-
<i>All</i>		107.7	100.0	52.2	100.0

Notes: ¹Numbers that round to zero shown as "0"; absences shown as "-", ² Bolded species are Level 1 invasive concern (Table 2-5). Italicized species are Level 2 invasive concern. Underlined species are Level 3 invasive concern. Remaining species are non-native species that may become problematic in some sites and/or condition.



Map 3-7: Non-native plants in the shore zone of the upstream surveyed portions of the Keeyask hydraulic zone of influence shoreline in 2023



Map 3-8: Non-native plants in the shore zone of the downstream surveyed portions of the Keeyask hydraulic zone of influence shoreline in 2023

4.0 DISCUSSION

4.1 INLAND AREAS

4.1.1 OVERALL CHANGES TO NON-NATIVE PLANT DISTRIBUTION AND ABUNDANCE

As of late August 2023, after eight years of construction and two years of operation, total inland non-native plant cover remained low at less than 3% of the total area surveyed. This percentage was likely an overestimate for the entire Project footprint because the areas not included in the surveys generally had low non-native plant cover (see Section 2.2).

Although total non-native plant cover in 2023 was relatively low, it still represented a four-fold increase over the previous year's cover (ECOSTEM 2023a). Total non-native plant cover was also twice as much as was measured in 2021, which held the previous high "water mark" in terms of non-native species cover since the beginning of construction.

The large increase in non-native plant cover was attributed to the end of Project construction. Construction completion changed the overall degree and types of activity in the Project footprint, which altered the factors influencing non-native plant spread. For example, decreased construction activity was expected to reduce the spreading of non-native plants by foot and vehicle traffic in most of the footprint. Counteracting this was the ending of active excavation and vegetation removal, which allows non-native and other plants to expand unimpeded. This was a trend observed and described at the end of construction monitoring for various footprint components, which saw large increases in non-native plant cover shortly following decommission and site preparation for rehabilitation (ECOSTEM 2022). Over the past two years, large portions of the Construction Footprint were decommissioned and prepared for planting or rehabilitation. As such, it was anticipated that relatively large increases in non-native plant cover would be observed in 2023 for the areas that were more recently prepared and planted. However, it is also expected that with additional time the non-native cover will start to decrease in those same areas due to increasing regeneration of desirable vegetation (ECOSTEM 2023a).

Additional support for this conclusion comes from differences in non-native plant cover between footprint components when evaluated based on ongoing activity type and time since rehabilitation. These differences reflected trends that were observed during construction monitoring (ECOSTEM 2022). Grouping the Project components based on permanence and time since rehabilitation more effectively monitor trends in non-native plant cover for the operation period. This will help to anticipate non-native plant spread during operation and develop more effective management strategies.

4.1.2 CHANGES IN SPECIES DISTRIBUTION AND ABUNDANCE

The largest contributors to the overall increase in non-native plant cover from 2022 to 2023 were common dandelion, white and yellow sweet clover, lamb's-quarters and narrow-leaved hawk's-beard cover. Several possible reasons for these increases are outlined below.

Year-to-year changes in lamb's-quarters cover were erratic. Cover increased dramatically between 2020 and 2021 and were primarily in areas that had recently been decommissioned (ECOSTEM 2022). This was followed by a large drop in lamb's-quarters cover between 2021 and 2022. While cover increased again in 2023, it did not surpass the total cover of 2021.

Non-native plant monitoring during Project construction (ECOSTEM 2022), and for another recent generation project in northern Manitoba (ECOSTEM 2018) suggested that lamb's-quarters largely drove an apparent decline in non-native plant cover, beginning several years after construction activity ceased. A sharp increase in lamb's-quarters after decommissioning, followed by a rapid decline in subsequent years had been observed in many of the older areas of the Construction Footprint (ECOSTEM 2022). The sharp increase in cover in 2023 is likely the latest surge in lamb's-quarters after the recent decommissioning of many of the Project areas over the last 2 years.

In 2023, lamb's-quarters was most abundant in temporary areas where the more recent rehabilitation efforts have been carried out, which corresponds to the trends previously observed during construction (see above). If this trend continues during operation, it is expected that total lamb's quarters cover will eventually decrease as time passes after temporary footprint decommissioning. Additionally, vegetation rehabilitation efforts should contribute to crowding out some plants.

The increase in white and yellow sweet clover cover between 2022 and 2023 also generally corresponded to the trend observed for lamb's-quarters. Sweet clover increase was highest in the temporary areas where more recent rehabilitation efforts have been carried out. Construction monitoring found that the cover of this species fluctuated annually, regardless of the amount of construction activity where it was found (ECOSTEM 2022), and 2023 represented the highest peak to date. Possible reasons for this pattern included species response to varying environmental conditions; periodicity in the species life cycle; and a bias in plants visibility depending on the height and density of other vegetation.

Sweet clover is an abundant plant in the ditches along Provincial Road (PR) 280 (KHLP 2012b), suggesting that it is spread by vehicle traffic. If this is the case, then it is expected that traffic will continue to introduce sweet clover (and other non-native plants that occur along PR 280) along the NAR and SAR as these roads are now part of the provincial highway system.

Narrow-leaved hawk's-beard was among the most, or second most abundant non-native species at various times and places during construction (ECOSTEM 2022). Since the end of construction, this species had been on the decline and was only the sixth most abundant non-native species by the fall of 2022. As was the case with many of the other species, 2023 saw a resurgence of this species to a cover higher than previously recorded in the Project Footprint. By the fall of 2023,

narrow-leaved hawk's-beard was the third-most abundant non-native species. This trend follows those of lamb's-quarters and white and yellow sweet clover, occurring mainly in the temporary Project areas, where more recent rehabilitation effort has been undertaken (0.33% of surveyed area).

The large increases in common dandelion and common plantain also followed a similar trend as described above. For both species, areas with the largest increases were the recently rehabilitated and un-rehabilitated temporary footprint areas. Unlike the species discussed above (with the exception of sweet clover), the permanent footprint areas also had large increases in cover for these species. Trends observed for these species during the construction period generally showed a steady increase in cover from year to year in portions of the footprint not actively being excavated (ECOSTEM 2022), and this appears to be a continuation of that trend.

Scentless chamomile (Level 1 invasive concern) was one of the few species that had a relatively large decrease in total cover between 2022 and 2023. In 2023, scentless chamomile cover was approximately 35 m², which was down from 223 m² in 2022.

The largest patch of scentless chamomile was recorded in Borrow Area N-5, where it had first been recorded in 2022. Although this patch was larger in size than in 2022, it was less dense. It appears that the manual removal of the plants in 2022 was effective at limiting the spread of this species at this location. Plants were also found at other locations where they were previously removed in Borrow Area B-2. It is possible that a seed bank may have developed at those locations. Those locations will be monitored closely for additional individuals of this species in coming years. It is recommended that traffic be limited or avoided at those locations to reduce opportunities for seed to be spread to other areas.

In 2023, ox-eye daisy (Level 1 species of concern) was found in two new locations and in one location where it was observed in 2022. Seeds may have been spread during road maintenance activities or by vehicles, and/or by human foot traffic; however, the manual removal of the plants in 2022 seems to have been effective in several areas. Continued monitoring will determine if the plant continues to appear at new locations in the Project footprint.

Common tansy (Level 1 species of concern) was not recorded in 2023 in any new or previously recorded locations, indicating that manual removal has been an effective means of control for this species to date. Continued monitoring will determine if the plant continues to appear at new locations in the Project footprint.

4.2 SHORE ZONE

Plant cover upstream of the generating station was expected to be lower than in 2019 due to the recent reservoir impoundment. Impoundment in September 2020 would have flooded the previously existing non-native plants along the shoreline. It was expected that insufficient time would have passed since impoundment for non-native plants to establish along the new shorelines.

Results confirmed that reservoir impoundment produced a decrease in non-native plant cover in the affected (upstream) zone, and this decrease was large. Also, several species that were previously recorded in the upstream zone were not recorded in 2023. Many of the non-native plant locations recorded in 2023 within the upstream zone were found where flooding was less extensive and corresponded to locations recorded during the 2019 surveys.

Non-native plant cover in the downstream zone remained relatively stable between the 2019 and 2023 surveys. This was not surprising for several reasons. Conditions in the downstream zone during construction had kept invasive plant cover low. During operation, the relatively low level of Project activity along the downstream shoreline minimized this mechanism for spreading non-native plants. Additionally, reservoir impoundment substantially reduced the abundance of potential upstream seed sources.

4.3 EFFORTS TO MANAGE INVASIVE PLANTS

4.3.1 EVALUATION

4.3.1.1 EFFICACY

The rapid manual removal (i.e., by hand) control strategy for invasive plants continued to be effective for species of Level 1 invasive concern provided they were removed before they dispersed seed. The three Level 1 species all decreased in cover between 2022 and 2023 despite the overall rise in non-native species cover, suggesting that manual removal of the plants in 2022 occurred in time to negate the accumulation of seed banks.

Manual removal has generally not been effective for Level 2 species. The most plausible possible explanations for the lower efficacy compared with Level 1 species were that new plants were produced from already well-established root systems and/or seeds in the seed bank.

The herbicide treatments were clearly effective where they were applied as prescribed. However, in many areas the large increase in total cover for the target species in 2023 appears to have offset any reductions caused by the herbicide treatment (Table 3-5). In other words, the target species were spreading from areas that were not treated with herbicide and via other transport mechanisms.

This raises the question as to whether the treatments were effective at preventing spread from herbicide treated areas to other areas. The evidence from 2023 mapping suggests that the treatments may have been at least partly effective based on decreases in cover for the target species, particularly along the access roads, the helicopter pad, Borrow Area B-3 and the North Dike. The effectiveness along the North Dike was aided by broader maintenance herbicide treatments in summer 2023 to control vegetation cover adjacent to the dikes.

There are several explanations for the apparent differences in effectiveness of herbicide treatment for the remaining footprint components. Patches along the NAR and SAR were a major focus for the 2022 and 2023 herbicide treatments. Most of the known patches along the access roads, and areas accessible from them, were treated. The majority of treated patches in 2022 and 2023 were associated with those components. The proportion of area treated was relatively limited in the remaining camp and work areas where increases were seen. This was primarily due to lower abundance and distribution of the target species in those components in 2022, limited accessibility to portions of those components, and because portions of those components were already rehabilitated (planted) and off limits for herbicide treatment. Furthermore, rehabilitation activities in those components may have introduced the target species to areas where they were previously absent, and therefore not targeted for herbicide in 2022 or 2023. Consequently, much of the increase in cover may not have arisen from the patches targeted for herbicide treatment in 2022 and 2023.

A key factor contributing to the lower efficacy of herbicide control was the timing of the treatment. Herbicide application occurred in late August 2022, and many plants may have already set and dispersed seed, spreading and establishing new cohorts for the following year. Anecdotal evidence found that many of the treated patches in the downstream boat launch area had set seed after being treated.

The effectiveness of mowing is unclear as mowing was not carried out in 2022. The area close to the downstream boat launch area, which was marked for mowing was instead treated with herbicide (ECOSTEM 2023a). In 2021, it was recommended that target patches be mowed twice, once early in July (before plants have seeded), and again in late August. Mowing in 2021 occurred in late July at one location, and mid-August at the remaining recommended sites due to availability of workers to carry out the mowing. A second mowing treatment was carried out at a few of the sites in early September. Mowing was not undertaken in 2023, due to scheduling problems.

4.3.1.2 RECOMMENDATIONS

The only situation for which an eradication strategy for Level 1 and 2 plant species is both feasible and likely to succeed is within those footprint components where these species occur as small patches in one to a few sites.

Rapid manual removal has been effective to date for the Level 1 species that meet the preceding criteria (Section 3.1.3.1.1). Monitoring surveys in 2024 will determine if rapid manual removal continues to be effective for controlling these species.

Rapid manual removal has only been partially effective for Level 2 species. It was effective where it was applied to small patches in 2016.

As described in Section 3.1.3.1.2, the manual removal method will only be implemented in the following situations. Rapid manual removal by staff conducting the monitoring surveys will continue to be employed for newly found Level 1 and 2 species. For previously recorded sites, rapid manual removal will not be implemented for species that reproduce prolifically by rhizomes

(e.g., Canada thistle) and where either the plants are mature or it appears the plants have already developed a root system (see Section 3.1.3.1.2). Herbicide application will be considered for these sites.

Additional herbicide applications are recommended to control or eradicate invasive plants at key sites where it remains feasible to do so. Where herbicide applications are not feasible, multiple mowing treatments are recommended. The first mowing treatment should be applied in early July, before plants have set seed, and a second mowing should occur in late August. Key sites will be identified for treatment in summer 2024 using the same criteria as in previous years.

4.3.2 PREVENTION

Preventing further invasive plant spread remains important as more of the Project Footprint is decommissioned and rehabilitated. Also, there will be some further increases in footprint area associated with the construction of wetland mitigation areas which will create additional opportunities for invasive plant spread.

Opportunities to use chemical control methods will become more limited over time because herbicides could damage desirable native vegetation after an area has been rehabilitated. Several additional prevention strategies were described in the final construction annual report (ECOSTEM 2022). For areas where chemical control is not possible, preventative strategies include:

- Promote native plant regeneration;
- Avoid or minimize travel through areas infested with invasive plants;
- Avoid or limit traffic in areas that have been rehabilitated, and where desirable vegetation is establishing; and,
- Continue to employ preventative strategies outlined in the Environmental Protection Plan (KHLP 2015) during remaining construction activities, including decommissioning.

Site decommissioning and rehabilitation activities are currently underway, which addresses the strategy to promote native plant regeneration (see ECOSTEM 2023b for ongoing rehabilitation activities in the Project footprint). It is recommended that the remaining three strategies listed above continue to be employed.

4.4 SEED MIXTURES USED IN REHABILITATION EFFORTS

The EIS and project mitigation indicate that seed mixtures used for rehabilitation or erosion control will only contain native species and/or non-invasive introduced plant species (i.e., will not contain sweet clover or other invasive species) and will be of low quality food value for mammals.

All but one species included in the specified grass seed mix were native to Manitoba, or the western provinces of Canada. The exception was diploid annual ryegrass, which is a non-native, but is a non-invasive species chosen specifically for erosion control in two EMPAs. It is a quick-

growing non-native species commonly used in Manitoba as forage (Manitoba Agriculture 2023), and as a cover to reduce soil erosion. Diploid annual ryegrass food value for mammals in the Keeyask region is expected to be low (R. Berger, pers. comm.).

The seed certificate indicated that seed of two other non-native species of low invasive concern (green foxtail (*Setaria viridis*) and barnyard grass (*Echinochloa crus-gali*)) were present in very small amounts in the seed mix. At eight seeds/25 grams, total weed seeds were below the maximum of 50 allowed for unintended weed species in Canada Certified No. 1 grade seed. Neither of these species were subsequently found in the seeded areas during invasive plant surveys in 2023.

Surveys in 2023 did not find any evidence that other non-native or invasive plants were introduced into rehabilitated areas through grass seeding.

Areas rehabilitated by grass seeding will continue to be monitored in 2024.

5.0 SUMMARY AND CONCLUSIONS

In 2023, non-native plant surveys were conducted in the shore zone as well as the inland portions of the Project Footprint. The most recent previous shore zone survey was conducted in 2019, while inland surveys have been conducted annually since 2014.

Shore zone non-native plant surveys were conducted along 76 km of shoreline, including 59 km and 17 km upstream and downstream of the generating station, respectively. These surveys found four species on 52 lineal m² of the shoreline (i.e., 0.7 m²/km of the surveyed shoreline), mainly downstream of the generating station. Non-native plant cover in the shore zone was low, and sites with non-native plants were usually limited to small patches or a single to a few individuals. Field sow-thistle represented 90% of the non-native species cover on the shoreline and was mainly found to be growing on the older, more established shoreline in Stephens Lake.

No mitigation is recommended for non-native plants in the shore zone because total non-native plant cover remained very low, was reduced upstream of the generating station following reservoir impoundment and did not substantively change downstream since 2019. Shoreline invasive surveys will occur again in 2025 in order to monitor the changing shoreline situation.

Inland non-native plant surveys in August 2023 covered 52% of this portion of the Construction Footprint. This was the highest percentage surveyed to date, made possible by the cessation or reduction of construction activity in many portions of the Footprint.

Non-native plants in 2023 covered 2.8% (25.6 ha) of the surveyed Construction Footprint. This was a four-fold increase from 2022, and twice as high as the previous cover maximum in 2021. As noted below, species that are typically widespread and of lower invasive concern contributed to a large proportion of the increased cover.

The increase of non-native plant cover between 2022 and 2023 reflected the trend previously observed during construction, as well as for another recent generating station project in northern Manitoba. That is, decommissioning of construction areas was followed by a burst of non-native plant cover within the first few years. If the Project areas continue to follow the same trend, then non-native plant cover may continue to increase in recently decommissioned areas, but then slowly decrease over time, particularly if rehabilitation efforts are successful in promoting desirable plant regeneration.

Other factors that may have contributed to the increase of non-native plant cover between 2022 and 2023 included the variability in growing conditions, natural life cycle patterns and/or natural population dynamics for different plant species.

Non-native plant cover was highest in the temporary portions of the Construction Footprint, where recent rehabilitation was done. In the permanent portion of the Construction Footprint, cover was highest in the dike and work areas.

A total of 23 non-native plant species were found during the 2023 surveys. No new species were identified in 2023. One species that had not been recorded in 2022 was observed again in 2023 (flixweed). Five species recorded in 2022 were not recorded in 2023.

Eight, mainly lower concern, non-native species were the primary contributors to the increase in non-native plant cover between the 2022 and 2023 surveys. Common dandelion, white and yellow sweet clover, narrow-leaved hawk's-beard, lamb's-quarters, field sow-thistle, common plantain and smooth catchfly all experienced significant increases in cover area.

Plants from two species of highest invasive concern for the Project area were found during the 2023 monitoring. Ox-eye daisy was found at a few locations in Borrow Areas G-1 at KM-15, and scentless chamomile was found at a few sites in Borrow Areas B-2 and N-5. ECOSTEM field staff removed all these plants by hand after they were found and documented.

Monitoring to date has indicated that manual removal of invasive plants of highest concern (i.e., scentless chamomile, common tansy, ox-eye daisy) was generally effective. It is recommended that manual removal of these species continue.

Herbicide treatments were clearly effective where they were applied as prescribed. However, it appeared that herbicide treatment in 2022 had limited effectiveness in preventing spread of the target species and reducing cover at some of the targeted sites, particularly along the NAR and SAR. Several factors were thought to have contributed to this. While total cover for the target species generally increased in the various footprint components, most increases were in components that had a lower proportion of their area treated, due to access and/or the need to protect planted trees. Additionally, much of the new cover may have spread from plants that were introduced after the treatment sites were identified in 2022, and from sites that were not included for treatment. Also, the late timing of the 2022 herbicide treatment likely reduced treatment effectiveness because many plants had already dispersed seed.

Grasses were seeded in various locations on the Project site in 2020 and 2021 for erosion control and/or to assist with vegetation rehabilitation. The seed certificates for the grass seed mixtures used in seeded areas identified one non-native grass species (diploid annual ryegrass, used for erosion control purposes in EMPAs D16 and D17) and two other non-native species of low invasive concern. The seed mix contained fewer than 25 seeds/25 grams for both species combined and none of these three species were found during subsequent monitoring surveys.

Site-specific invasive plant control recommendations are being developed for the 2024 growing season based on the monitoring results to date. Invasive and other non-native plant monitoring will continue in 2024.

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APPENDIX 1: NON-NATIVE PLANT INDIVIDUAL AREAS

Table 6-1: Estimated radius and derived area for individual non-native plant species in 2023

Species	Estimated Radius (cm)	Derived Area (m²)
<i>Arctium minus</i>	25	0.196
<i>Artemisia absinthium</i>	25	0.196
<i>Avena sativa</i>	4	0.005
<i>Brassica napus</i>	10	0.031
<i>Bromus inermis</i>	4	0.005
<i>Capsella bursa-pastoris</i>	5	0.008
<i>Chenopodium album</i>	10	0.031
<i>Leucanthemum vulgare</i>	10	0.031
<i>Cirsium arvense</i>	10	0.031
<i>Cirsium vulgare</i>	15	0.071
<i>Crepis tectorum</i>	8	0.020
<i>Descurainia sophia</i>	15	0.071
<i>Erysimum cheiranthoides</i>	20	0.126
<i>Helianthus annuus</i>	20	0.126
<i>Hordeum jubatum</i>	4	0.005
<i>Lotus corniculatus</i>	25	0.196
<i>Matricaria discoidea</i>	7.5	0.018
<i>Medicago lupulina</i>	10	0.031
<i>Medicago sativa</i>	25	0.196
<i>Melilotus albus</i>	25	0.196
<i>Melilotus officinalis</i>	25	0.196
<i>Oenothera biennis</i>	20	0.126
<i>Persicaria maculosa</i>	15	0.071
<i>Phalaris arundinacea</i>	15	0.071
<i>Phleum pratense</i>	3	0.003
<i>Plantago major</i>	10	0.031
<i>Secale cereale</i>	4	0.005
<i>Silene csereii</i>	10	0.031
<i>Sonchus arvensis</i>	10	0.031
<i>Tanacetum vulgare</i>	25	0.196
<i>Taraxacum officinale</i>	10	0.031
<i>Trifolium hybridum</i>	20	0.126
<i>Trifolium pratense</i>	20	0.126
<i>Trifolium repens</i>	20	0.126
<i>Tripleurospermum inodorum</i>	5	0.008
<i>Triticum aestivum</i>	4	0.005
<i>Verbascum thapsus</i>	20	0.126
<i>Vicia cracca</i>	20	0.126

APPENDIX 2: INVASIVENESS RANKINGS AND MANAGEMENT STRATEGIES

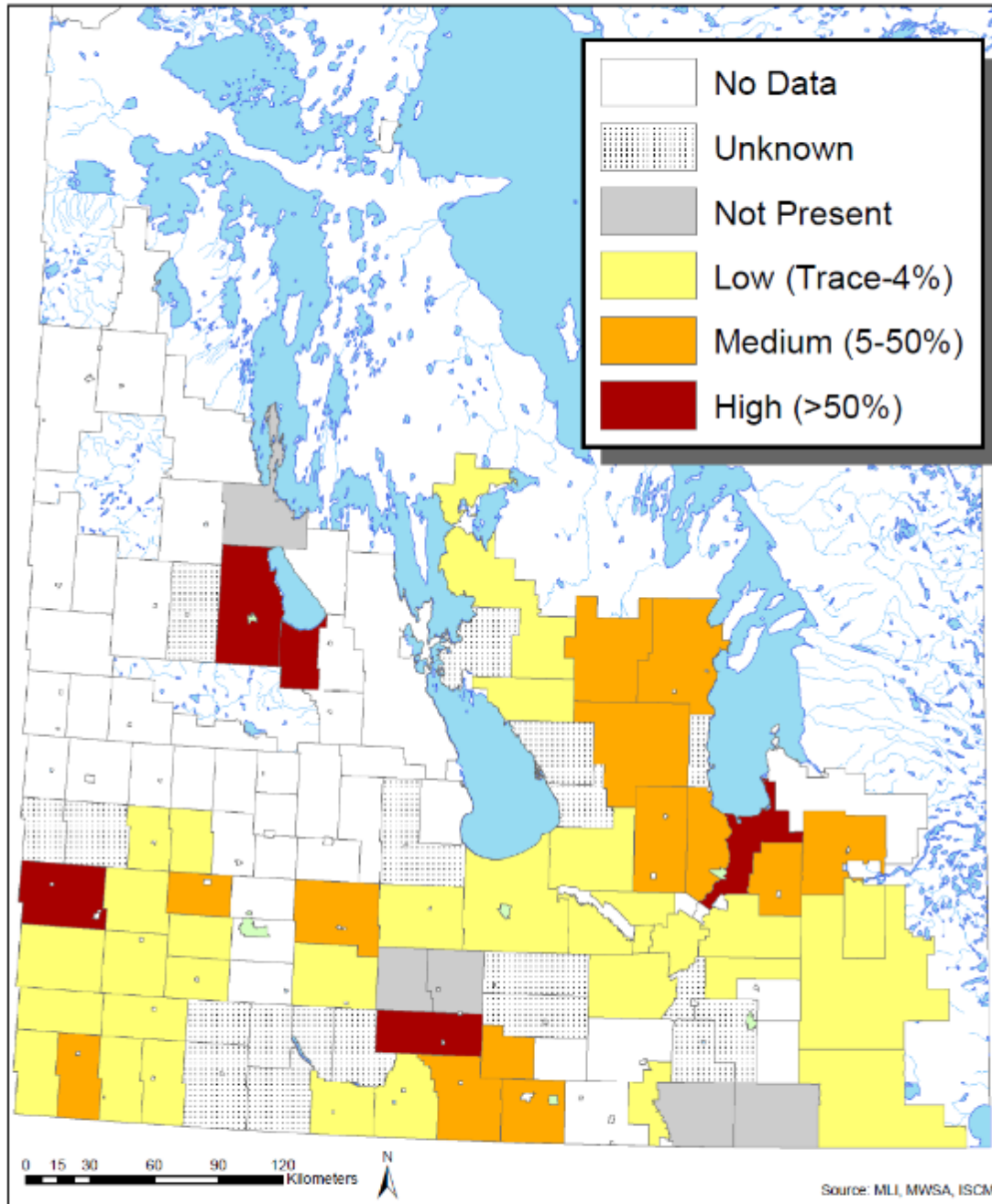
6.1.1 BACKGROUND


This monitoring study provides additional control or eradication recommendations during operation monitoring. The following describes the approach taken to make recommendations regarding which non-native species to prioritize for management, and the types of locations that management efforts will focus on.

It is widely recognized that it is not practical to attempt to eradicate or even control all non-native plant species (e.g., White *et al.* 1993; Morse *et al.* 2004; Ministry of Transportation and Infrastructure *et al.* 2011). For example, some species are already too widespread and well-established to implement an approach that removes plants at a faster rate than they reappear in the same sites and establish in new sites. Many of the non-native species recorded during Project monitoring are commonly found in disturbed areas throughout the Province (e.g., field sow-thistle (*Sonchus arvensis*) and white sweet clover (*Melilotus albus*)), particularly along roadsides, making it difficult to prevent them from being spread by human or natural sources.

Maps produced by the Invasive Species Council of Manitoba (ISCM) demonstrate the widespread distribution of noxious weeds in southern Manitoba. For example, Figure 6-1 provides a general impression of how widespread scentless chamomile (a highly invasive species) was in southern Manitoba in 2011. However, this map considerably understates scentless chamomile distribution and abundance as data are missing for a high proportion of municipalities.

Scentless Chamomile (*Matricaria perforata*) Infestation in Manitoba Municipalities in 2011



 Invasive Species Council of Manitoba
www.invasivespeciesmanitoba.com
 (204) 232-6021

*An estimate is based on the % of sections (640 acres) infested within a RM

Source: ISCM 2024.

Figure 6-1. Scentless Chamomile infestation in Manitoba municipalities in 2011

As noted above, it is not practical to eradicate or even control all non-native plant species. For this reason, numerous ranking systems have been developed to prioritize which non-native plant species to target, which types of locations should be focused on and/or the preferred management strategies. Examples of publications that review some of these systems include Williams and Newfield (2002), Wikeem (2007) and Carlson *et al.* (2008).

Three themes which frequently appear in systems that prioritize and/or determine which non-native plant species to actively manage (e.g., White *et al.* 1993; Morse *et al.* 2004; Ministry of Transportation and Infrastructure *et al.* 2011) are:

1. The potential for the species to cause major harm to ecosystems, conservation values or human health;
2. The species' current and expected future distribution and abundance; and,
3. The likelihood that management efforts can achieve their objectives over the long-term.

This monitoring study uses the preceding three themes to prioritize and develop management recommendations for non-native plants in the Project area. Management recommendations focus on the plant species of highest invasive concern (first and second themes) and the situations where there are practical ways to reduce these species or prevent further spreading (third theme).

For this monitoring, the primary sources used to classify the potential for a non-native plant species to have substantial adverse effects on ecosystems or biodiversity in the Project area were the ISCM (2024), White *et al.* (1993), the Provincial *Noxious Weeds Act* (Government of Manitoba 2017a) and the Federal Weed Seeds Order (Government of Canada 2016). While the federal *Plant Protection Act* was also relevant from the regulatory perspective, few of the species currently on its list occur in Manitoba, and those that do are limited to a few locations in the southern portion of the province.

The primary additional sources of information that assisted with evaluating potential invasiveness in the Project area, and with developing management recommendations, included the Biology of Canadian Weeds Series (Canadian Weed Science Society. 2019a), the Biology of Invasive Alien Plants in Canada (Canadian Weed Science Society. 2019b), Manitoba Agriculture (2019) and results from EIS or monitoring studies for this and other projects in northern Manitoba. The last of these sources also provided some information regarding patterns of distribution and abundance in the Project region.

A limitation for some of the sources used to determine a plant's degree of invasiveness was that they did not include data from the Keeyask region. The observed degree of invasiveness for the species included in these sources was generally obtained in regions subject to much different climates than that occurring in the Project region. Local invasiveness can differ greatly from that observed in other regions (Carlson *et al.* 2008).

Of the sources used for ranking a species' degree of invasiveness listed above, ISCM (2022) and White *et al.* (1993) were considered the most relevant ones because their focus is on impacts to ecosystems and biodiversity. The Provincial *Noxious Weeds Act* and the Federal Weed Seeds Order were developed to address impacts on the agricultural economy or the viability of the agricultural operations. An upshot of this agricultural focus is that these regulations do not list

some species known to be of concern for impacts on native ecosystems and biodiversity (e.g., purple loosestrife). Conversely, these regulations also list some native boreal plant species (e.g., foxtail barley) as weeds since they can be problematic for agriculture. Native boreal species appearing on these lists were not considered to be invasive for the Project area.

An additional reason for including the *Noxious Weeds Act* of Manitoba is that it includes some management obligations for species encountered during construction activities. This Act creates a general duty to destroy species it identifies as noxious weeds because they are a significant threat to Manitoba's agricultural economy or to the viability of the agricultural operations. The Act states that: "Each occupant of land, or, if the land is unoccupied, the owner thereof, or the agent of the owner, and each person, firm, or corporation who or which is in control of, or in possession of, or in charge of, land, shall destroy all noxious weeds and noxious weed seeds growing or located on the land as often as may be necessary to prevent the growth, ripening and scattering of weeds or weed seeds."

The degree of management response required by the Act depends on the species' threat to agricultural crops. Species are categorized into one of three degrees of threat, which are Tier 1, 2 or 3. The Act requires that a landowner, occupier or contractor:

- a) destroy all tier 1 noxious weeds that are on land that the person owns or occupies;
- b) destroy all tier 2 noxious weeds that are on land that the person owns or occupies if the area colonized by the weeds is less than five acres [2.023 ha];
- c) control all tier 2 noxious weeds that are on land that the person owns or occupies if the area colonized by the weeds is five acres [2.023 ha] or more; and
- d) control a tier 3 noxious weed that is on land that the person owns or occupies if the weed's uncontrolled growth or spread is likely to negatively affect an aspect of Manitoba's economy or environment in the area of the land or the well-being of residents in proximity to the land.

The Act defines control as curtailing the weed's growth and preventing its spread beyond its current location.

It is noted that, as there are no agriculture crops near the Project, weeds in the Project site do not pose a local threat to agricultural operations. Equipment or vehicles moving from the site to other regions could transport weed propagules into agricultural areas.

6.1.2 INVASIVE CONCERN CLASSIFICATION

As noted above, ISCM (2022) and White *et al.* (1993) were the primary sources for ranking a species' degree of invasiveness. To provide background for this study's invasive concern classification, the criteria used in the ISCM and White *et al.* (1993) classifications are first presented.

Table 6-2 provides the ISCM invasive plant categories, criteria for inclusion in a category and the minimum management criteria. Category 1 and 2 species are the species considered to pose the

greatest threats, and have a management response that includes eradication if feasible. The essential differences between these categories is that Category 1 includes species not yet known to be present in natural areas and species declared to be noxious weeds. Species that ISCM lists as “other” are not on the early detection and rapid response list.

White *et al.* (1993) classify alien plants in Canada as being either a principal, moderate or minor invasive. Principal Invasive Aliens are the species considered to pose the greatest threat to natural areas. Moderate Invasive Aliens are the species considered to pose an intermediate level of threat to natural areas. Minor Invasive Aliens are the species considered to be only minor problems.

Table 6-2. ISCM invasive plant categories, criteria for inclusion and minimum management criteria

Categories and Criteria for Inclusion	Minimum Management Criteria
Category 1 Species	
<ul style="list-style-type: none"> • These invasive plants are not present in Manitoba, but may be present in cultivation¹ but not yet known to have escaped, and/or • If listed as a Manitoba Noxious Weed, and/or • If on the List of Pests Regulated in Canada and • Capable of establishing in Manitoba based upon climate variables • A pathway of introduction exists • Easily identifiable with available resources. 	<ul style="list-style-type: none"> • Eradication is first option if detected and if feasible. • A lead agency should be identified and a management committee formed to develop an eradication strategy. • An education and awareness program is required. • Provincial ban on sale and trade. • Species may be moved to next category if found in Manitoba.
Category 2 Species	
<ul style="list-style-type: none"> • These invasive plants are present in Manitoba and • Capable of further spread and • Pathways for spread are present and • Easily identifiable with available resources. 	<ul style="list-style-type: none"> • Eradication is first option, when feasible. • Containment and control programs are second option. • Education and awareness programs to foster prevention. • A response plan is available or under development.
Other Species	
<ul style="list-style-type: none"> • Other terrestrial invasive plants 	<ul style="list-style-type: none"> • Not specified in the ISCM website.

Source: ISCM (2024).

Notes: ¹ Cultivated as a garden plant, for ornamental horticulture, water ponds or gardens, for lawns; and is outside its natural range.

The non-native plant species recorded during monitoring to date were classified into one of four levels of invasive concern for the Project area (Table 2-4). Level 1 was the highest level of invasive concern for the Project. Level 1 species included ISCM Category 1 and 2 species.

The second highest 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 lowest 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.

Table 2-5 shows how the invasive concern classification was applied to the non-native plant species recorded in the Project Footprint to date.

Table 6-3 classifies non-native species that have not been recorded to date but could potentially occur in the Project Footprint. These included species that are known to be present in Manitoba, and are listed as Tier 2 or 3 noxious weeds in Manitoba (Government of Manitoba 2017b), or are listed as Category 2 or Other invasive plants by the ISCM (2024).

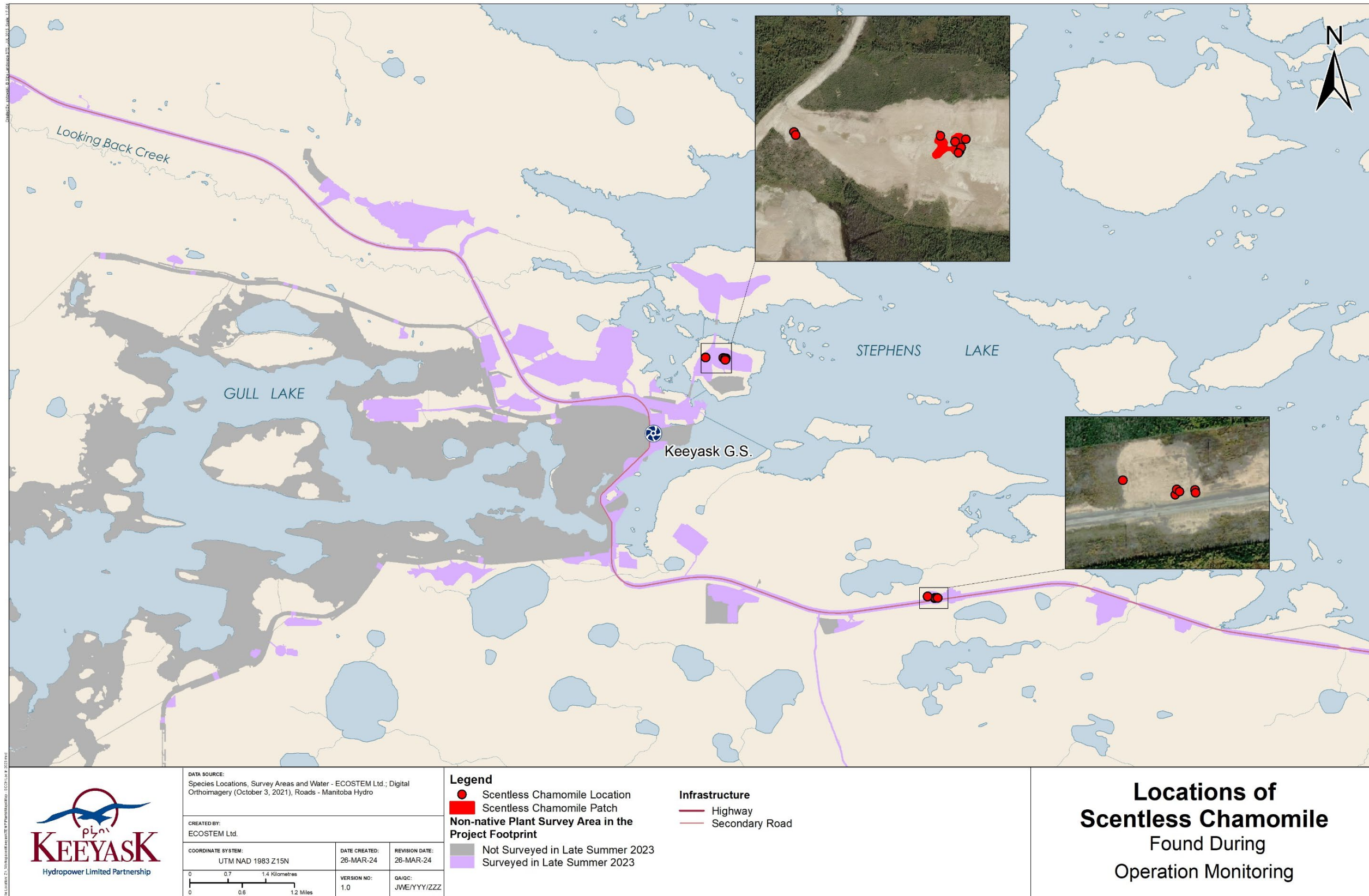
Table 6-3: Invasive concern classifications for non-native plant species that could potentially occur in the Project Footprint

Invasive Concern ¹	Common Name ²	Scientific Name	ISCM Category ³	White <i>et al.</i> Category ⁴	Noxious weed ⁵	Weed Seed ⁶	
Level 1	Hoary alyssum	<i>Berteroa incana</i>	Other		Tier 2		
	Japanese brome	<i>Bromus japonicus</i>	Category 2		Tier 2		
	Downy brome	<i>Bromus tectorum</i>	Category 2		Tier 2		
	Flowering Rush	<i>Butomus umbellatus</i>	Category 2	Principal			
	Thistle, nodding	<i>Carduus nutans</i>	Category 2	Minor	Tier 2	Prohibited	
	Blueweed	<i>Echium vulgare</i>	Category 2				
	Spurge, leafy	<i>Euphorbia virgata</i>	Category 2	Principal	Tier 2	Prohibited	
	Baby's-breath	<i>Gypsophila paniculata</i>	Other		Tier 2		
	St. John's-wort	<i>Hypericum perforatum</i>	Category 2	Moderate	Tier 2		
	Large Touch-me-not	<i>Impatiens glandulifera</i>	Category 2				
	Scabious, field	<i>Knautia arvensis</i>	Category 2		Tier 2		
	Toadflax, Dalmatian	<i>Linaria dalmatica</i>	Category 2		Tier 2	Primary	
	Toadflax, yellow	<i>Linaria vulgaris</i>	Category 2		Tier 3	Primary	
	Purple Loosestrife	<i>Lythrum salicaria</i>	Category 2	Principal		Primary	
	Bartsia, red	<i>Odontites vulgaris</i>	Category 2		Tier 2	Prohibited	
	Common reed, invasive	<i>Phragmites australis ssp. australis</i>	Category 2		Tier 2		
	Buckthorn, European	<i>Rhamnus cathartica</i>	Category 2	Principal	Tier 3		
	Bouncingbet	<i>Saponaria officinalis</i>	Category 2		Tier 2		
	Level 2	Garlic Mustard	<i>Alliaria petiolata</i>	Other	Principal		
		Bellflower, creeping	<i>Campanula rapunculoides</i>	Other		Tier 3	
Thistle, bull		<i>Cirsium vulgare</i>	Other		Tier 3		
Field Bindweed		<i>Convolvulus arvensis</i>	Other			Primary	
Common Hound's Tongue		<i>Cynoglossum officinale</i>	Other				

Invasive Concern¹	Common Name²	Scientific Name	ISCM Category³	White <i>et al.</i> Category⁴	Noxious weed⁵	Weed Seed⁶
	Japanese Knotweed	<i>Fallopia japonica</i>	Other			
	Giant hogweed	<i>Heracleum mantegazzianam</i>	Other			
	Dame's-rocket	<i>Hesperis matronalis</i>	Other	Minor		
	Tansy Ragwort	<i>Jacobaea vulgaris</i>	Other			Primary
	Scotch Thistle	<i>Onopordum acanthium</i>	Other			
	Orange Hawkweed	<i>Pilosella aurantiaca</i>	Other			
	Common Buttercup	<i>Ranunculus acris</i>	Other			
	Cockle, white	<i>Silene latifolia</i>	Other		Tier 3	Primary
	Puncture Vine	<i>Tribulus terrestris</i>	Other			
	Cow-cockle	<i>Vaccaria hispanica</i>	Other			Secondary

Notes: ¹ See Table 2-4 for the invasive concern classification. ² In decreasing order of concern for the Project area. ³ Invasive Species Council of Manitoba (2022). ⁴ White *et al.* (1993). ⁵ Government of Manitoba (2017b). Number in column is the Tier in the Act (see text). ⁶ Government of Canada (2016).

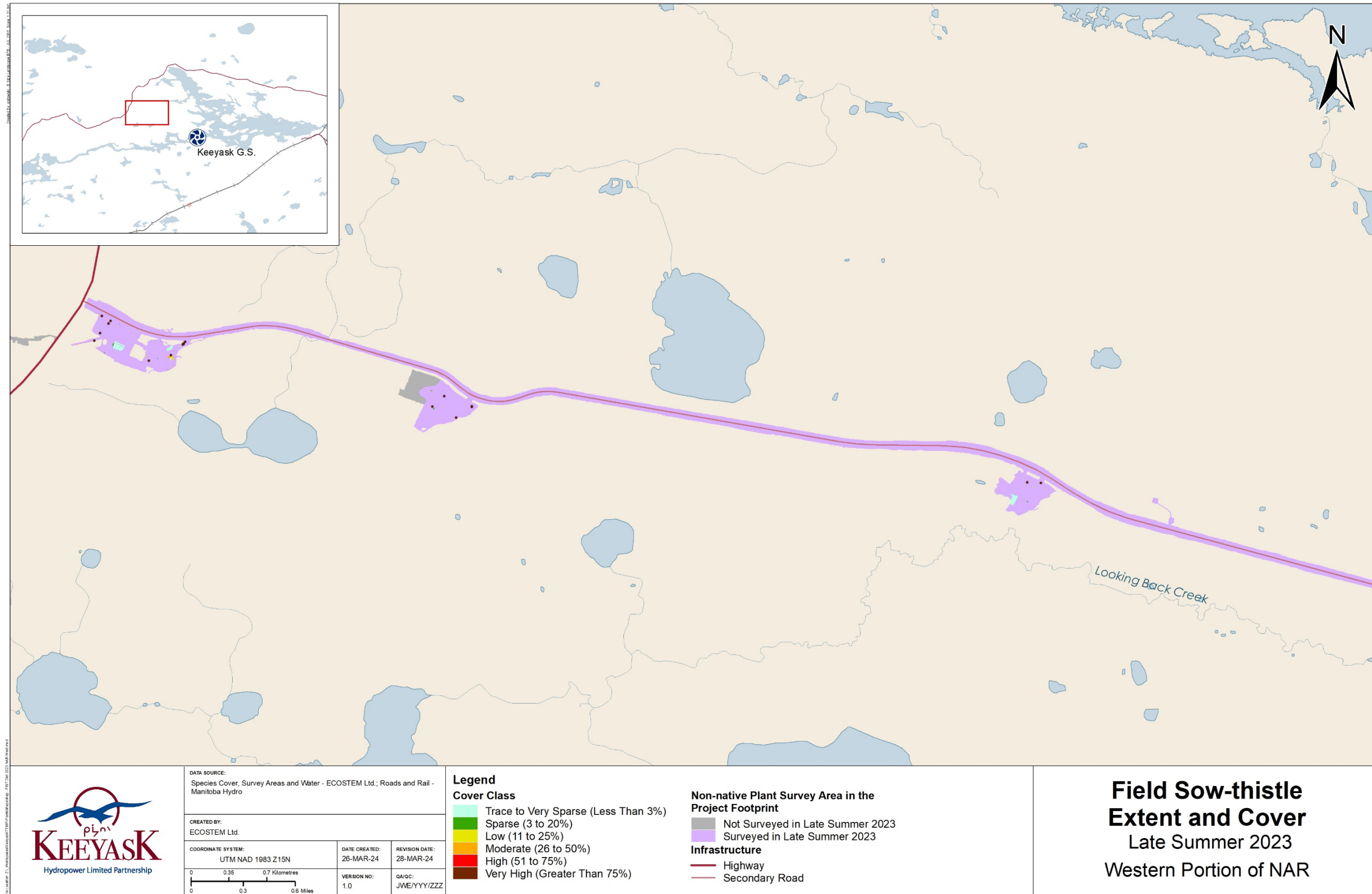
APPENDIX 3: NON-NATIVE PLANT DISTRIBUTION MAPS



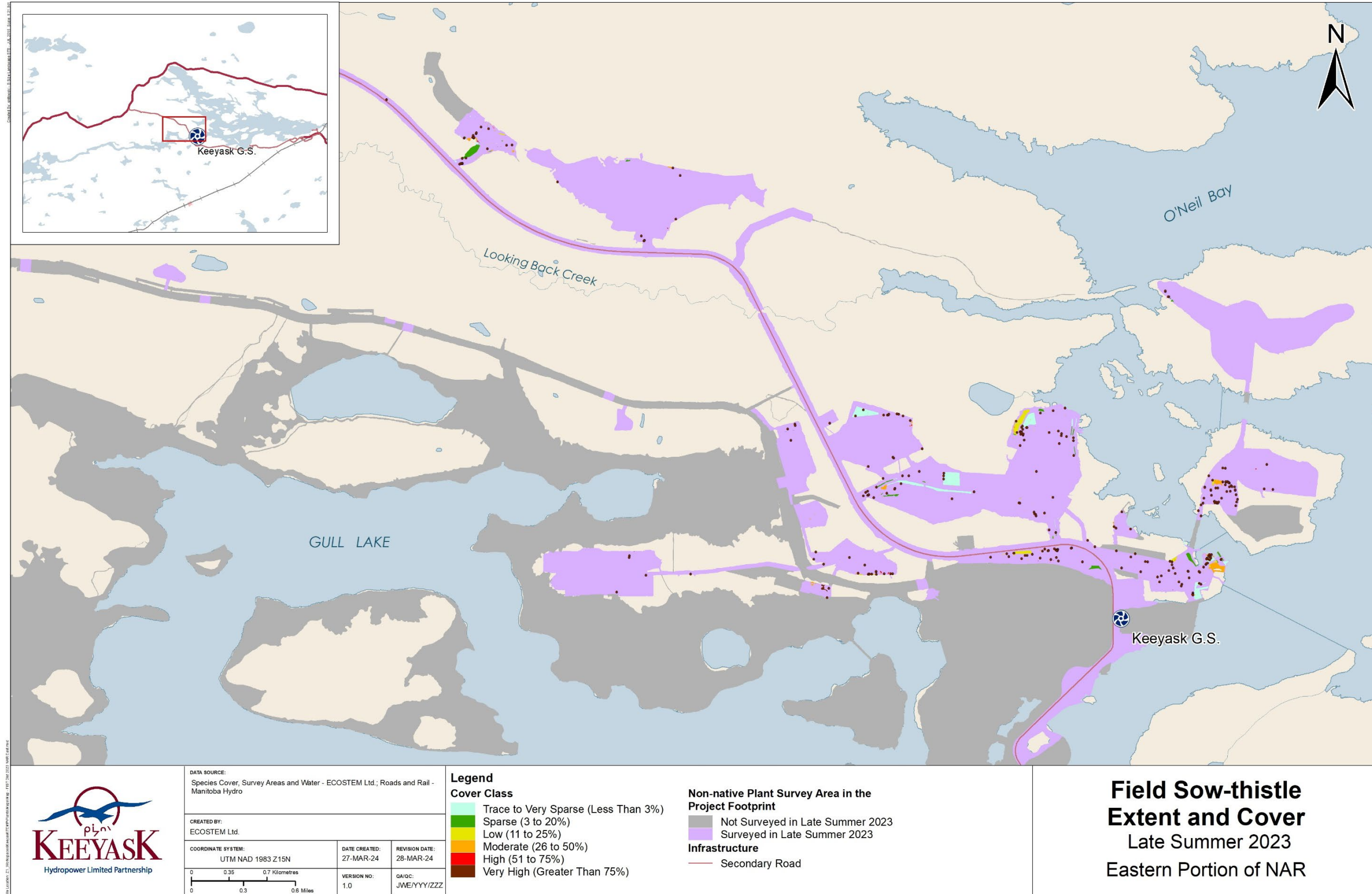
Map 6-1: Locations of scentless chamomile identified during Project operation monitoring in 2023



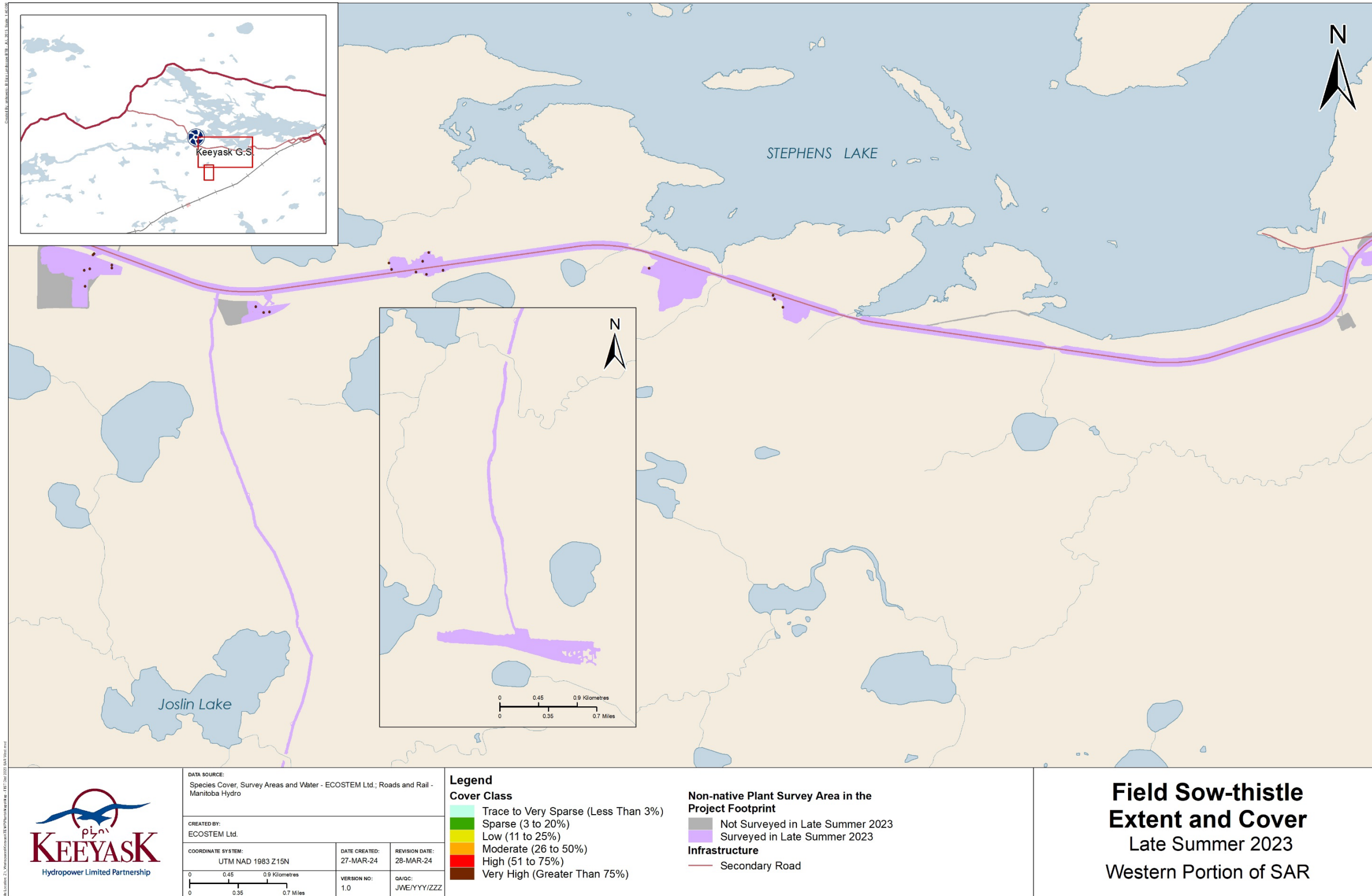
Map 6-2: Locations of ox-eye daisy identified during Project operation monitoring in 2023



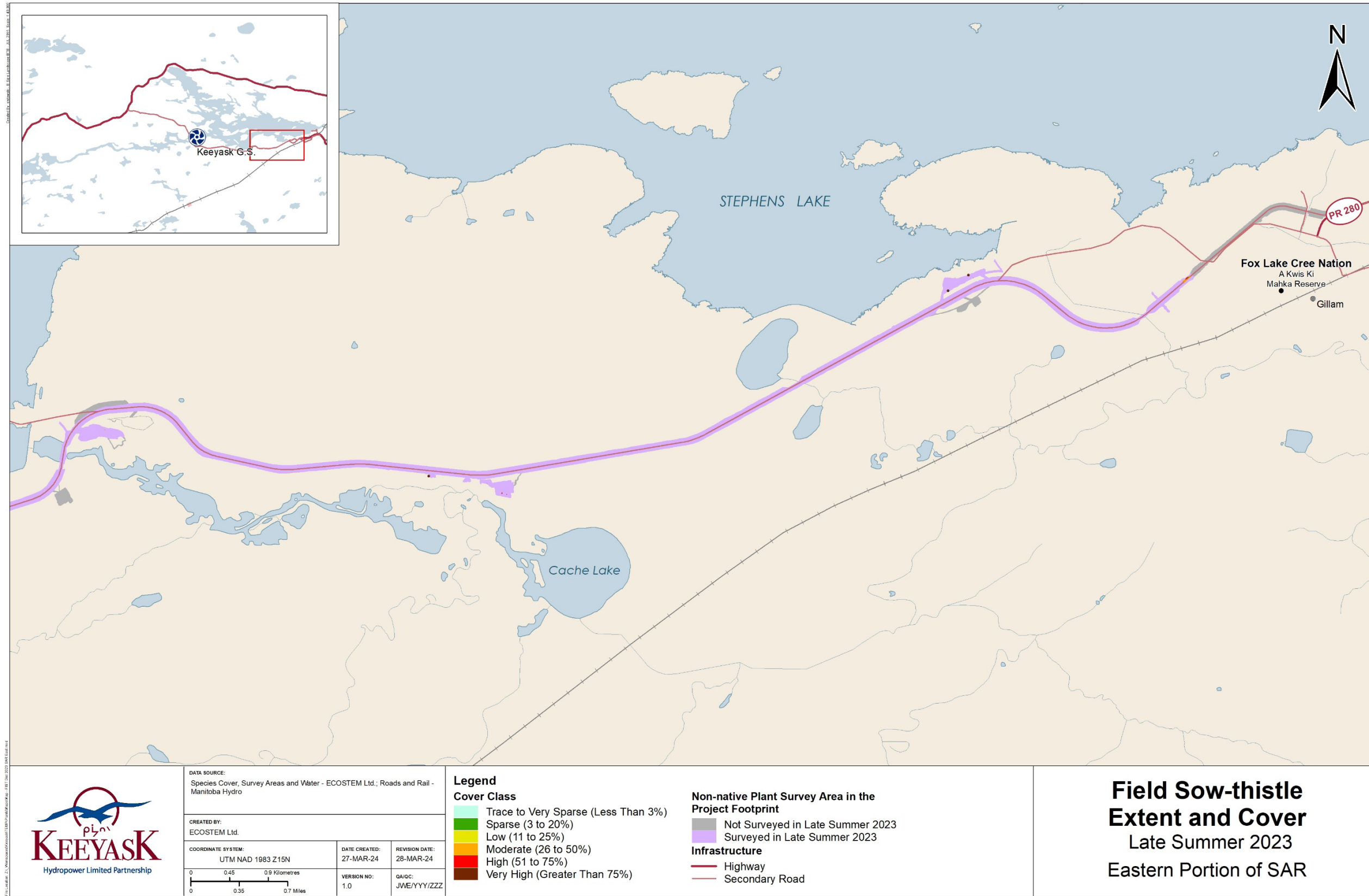
Map 6-3: The distribution and abundance (cover class) of field sow-thistle in the Project footprint along the western portion of the North Access Road in late summer, 2023



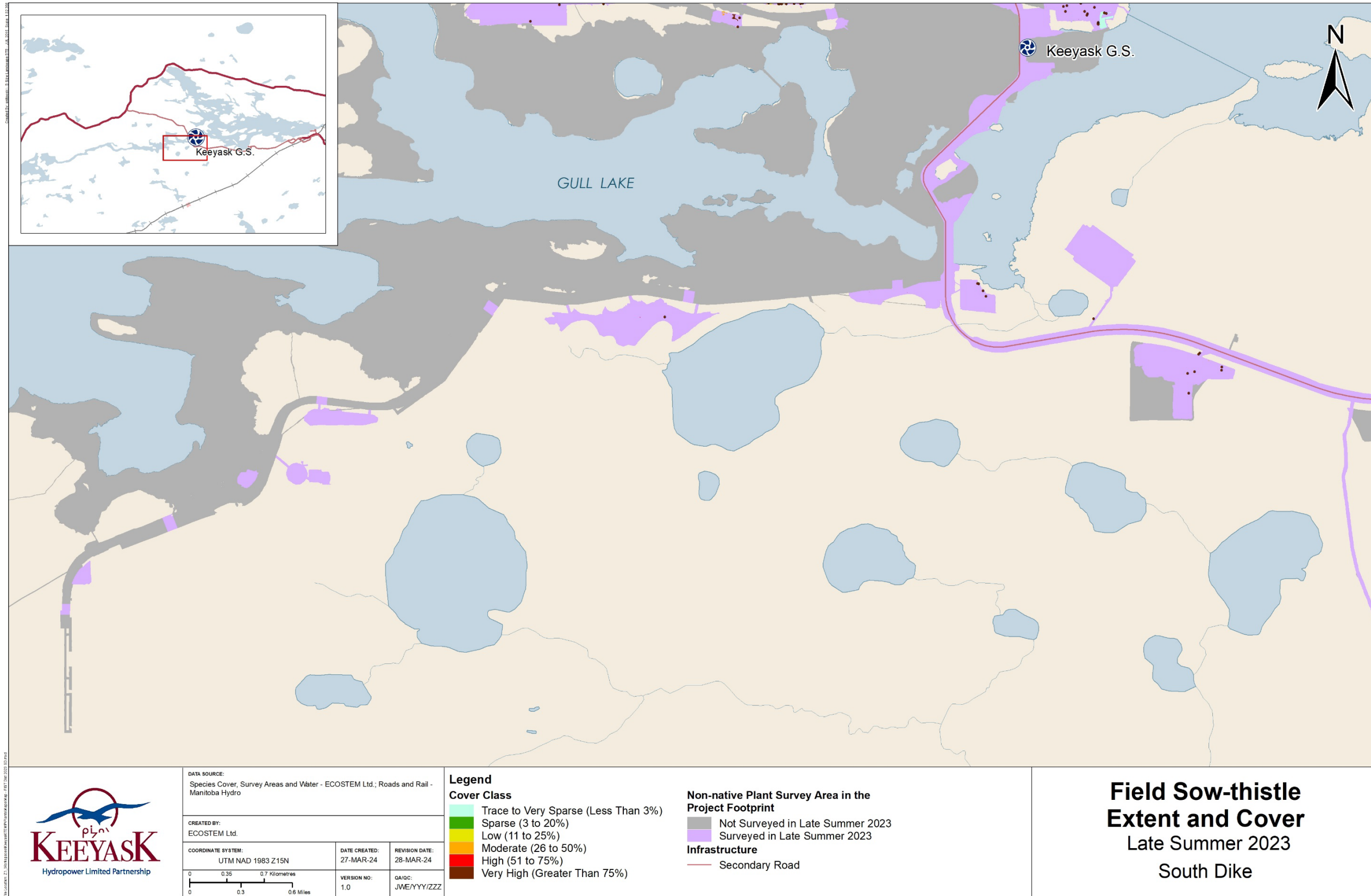
Map 6-4: The distribution and abundance (cover class) of field sow-thistle in the Project footprint along the eastern portion of the North Access Road in late summer, 2023



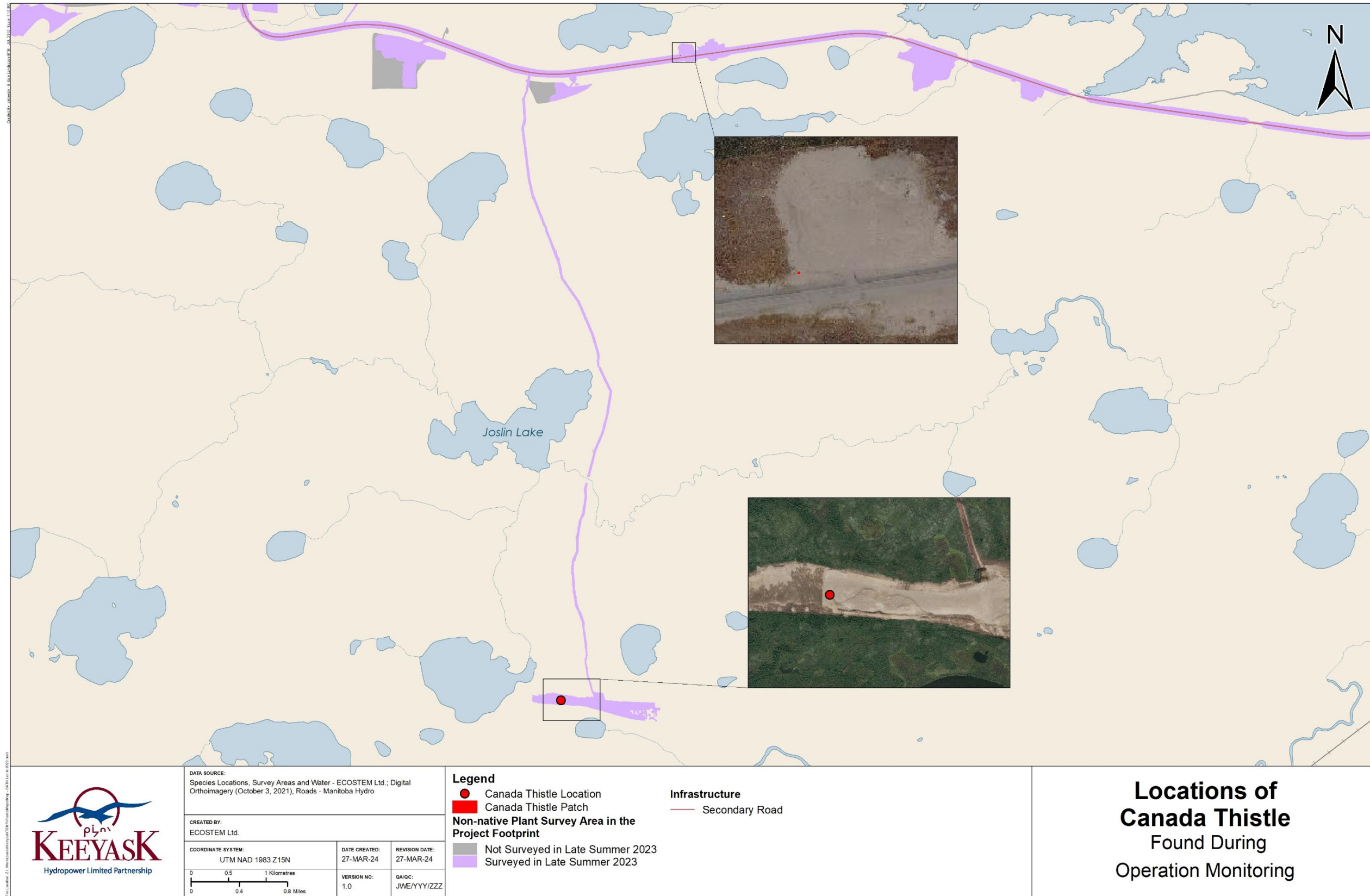
Map 6-5: The distribution and abundance (cover class) of field sow-thistle in the Project footprint along the western portion of the South Access Road in late summer, 2023



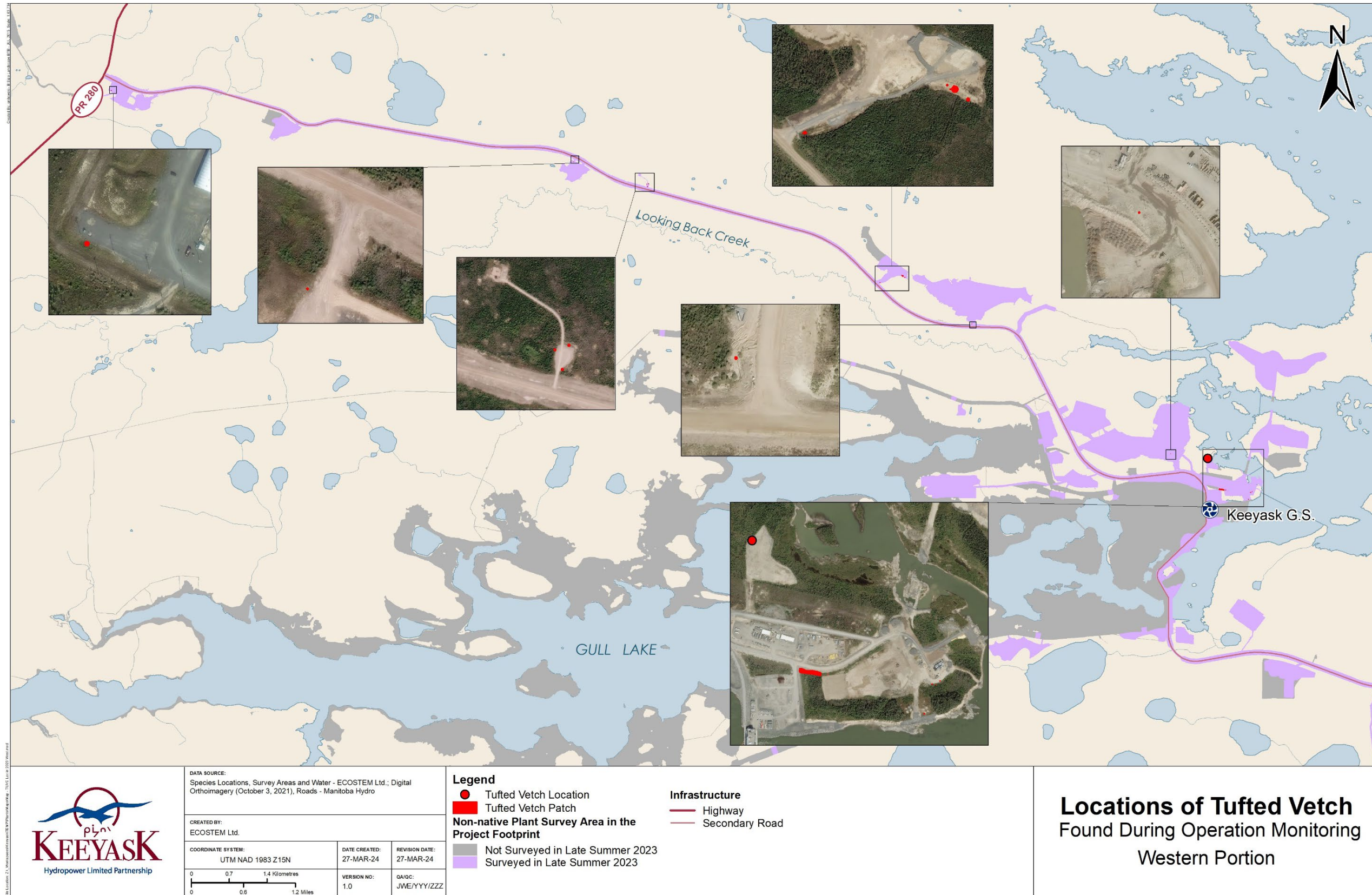
Map 6-6: The distribution and abundance (cover class) of field sow-thistle in the Project footprint along the eastern portion of the South Access Road in late summer, 2023



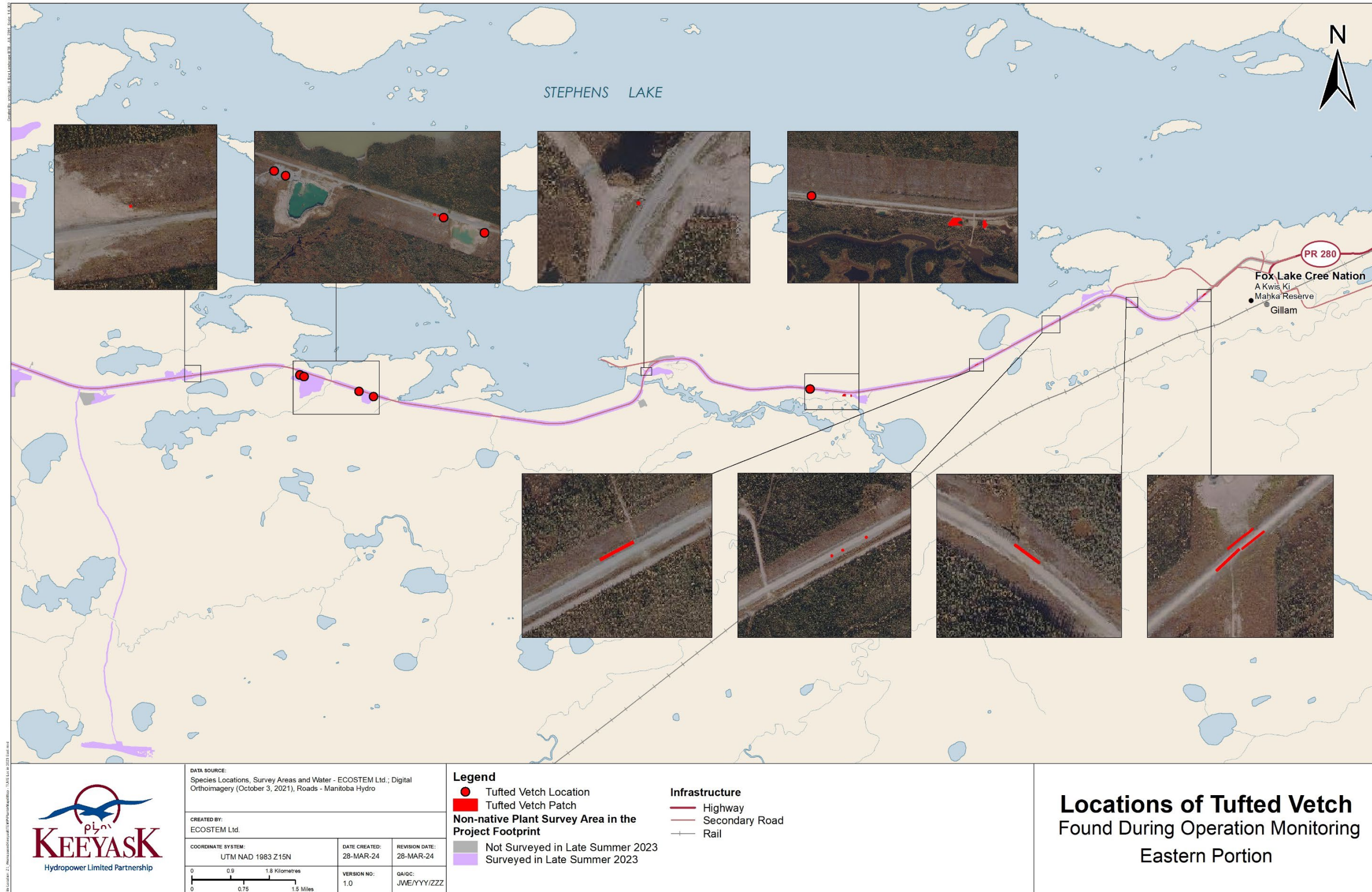
Map 6-7: The distribution and abundance (cover class) of field sow-thistle in the Project footprint along the South Dike in late summer, 2023



Map 6-8: Canada thistle locations identified during Project operation monitoring in 2023



Map 6-9: Tufted vetch locations identified during Project operation monitoring in 2023 (western portion of Project footprint)



Map 6-10: Tufted vetch locations identified during Project operation monitoring in 2023 (eastern portion of Project footprint)