Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Invasive Plant Spread and Control Monitoring Report

TEMP-2020-05

KEEYASK

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KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2020-05

INVASIVE PLANT SPREAD AND CONTROL MONITORING

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 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 the non-native plant species that can out-compete or even replace native plants. Non-native plants can be introduced to the Keeyask area by seeds that are brought into the Project site on vehicles, construction equipment, and footwear. There are measures in place under the Project's Environmental Protection Plan to help prevent this, including washing any construction equipment that is coming to the Project site from areas outside the Keeyask region.

This report describes the results of invasive and other non-native plant monitoring conducted during the sixth summer of Project construction.

Scentless chamomile, an invasive plant found at the Keeyask site during construction

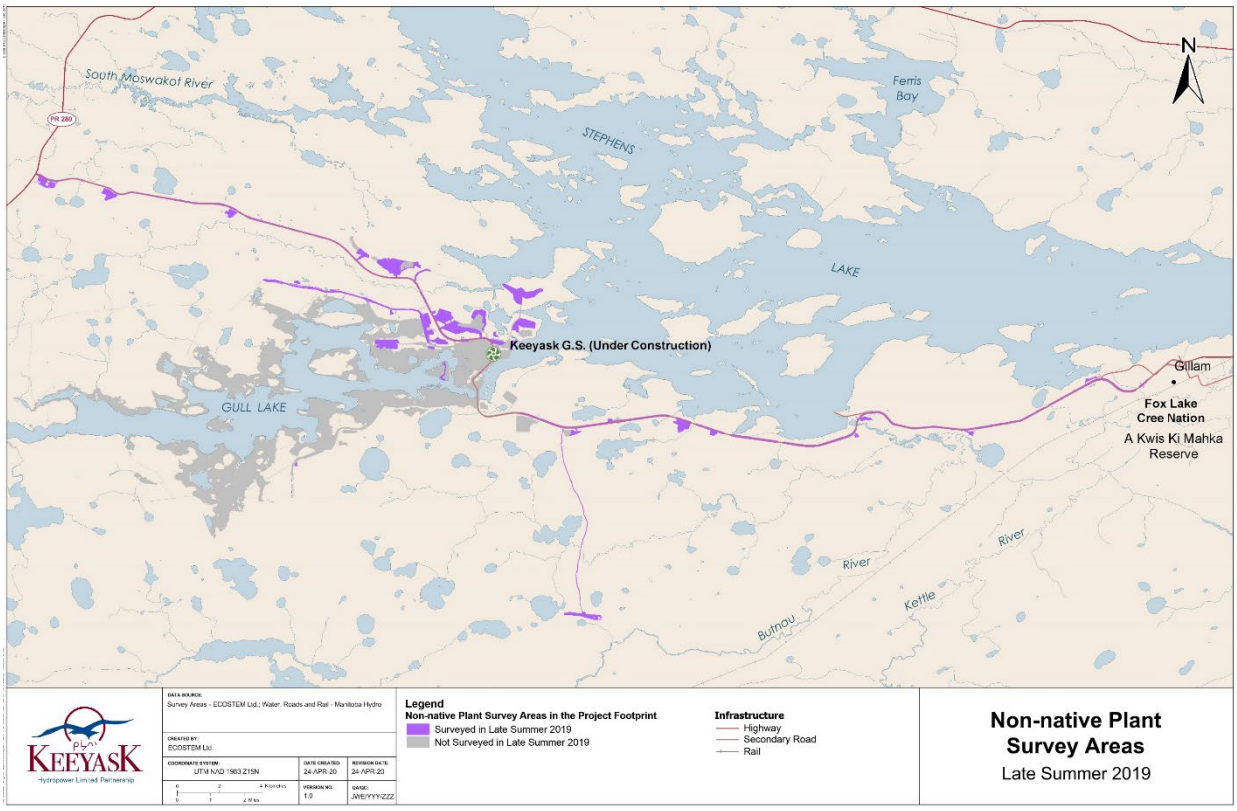
Why is the study being done?

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 natural things on the land. Non-native plants are also a concern because they could be invasive in some local conditions or in the future with changing climate, or they could interfere with rehabilitating native habitat in sites no longer being used by the Project.

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

What was done?

In 2019, non-native plant surveys were carried out within most of the cleared Project areas between July 2 to 5 (early summer), and again between August 20 and 28 (late summer; see map below). Some cleared areas were not surveyed because the people doing the surveys could not safely access them due to construction activity, or because they were very recently cleared and non-native plants would not yet have had time to establish.



Additionally, pre-operation baseline surveys were carried out in the shore zone areas that would be affected by Project operation (within the future reservoir area). These surveys were conducted between August 19 and 21 (late summer).

What was found?

While total non-native plant extent (the general area where plants were present) and cover (the area covered by the plants) increased slightly between the 2018 and 2019 late summer surveys, plant cover decreased slightly as a percentage of surveyed area. Total non-native plant cover remained less than 1% of the surveyed area. As was the case in 2018, most of the non-native plant cover was within cleared areas that were either there before the Project (e.g., cutlines, borrow areas and ditches along the Butnau Road portion of the South Access Road) or that were developed as part of the Keeyask Infrastructure Project (KIP), and are now being used by the Project.

A total of 25 non-native plant species were found during the 2019 surveys, which was three more than recorded in 2018. The new species recorded in 2019 included wormseed mustard, spotted lady's-thumb and shepherd's-purse. None of these species were of high invasive concern.

Lamb's quarters remained the most abundant non-native plant species in 2019, followed by narrow-leaved hawksbeard.

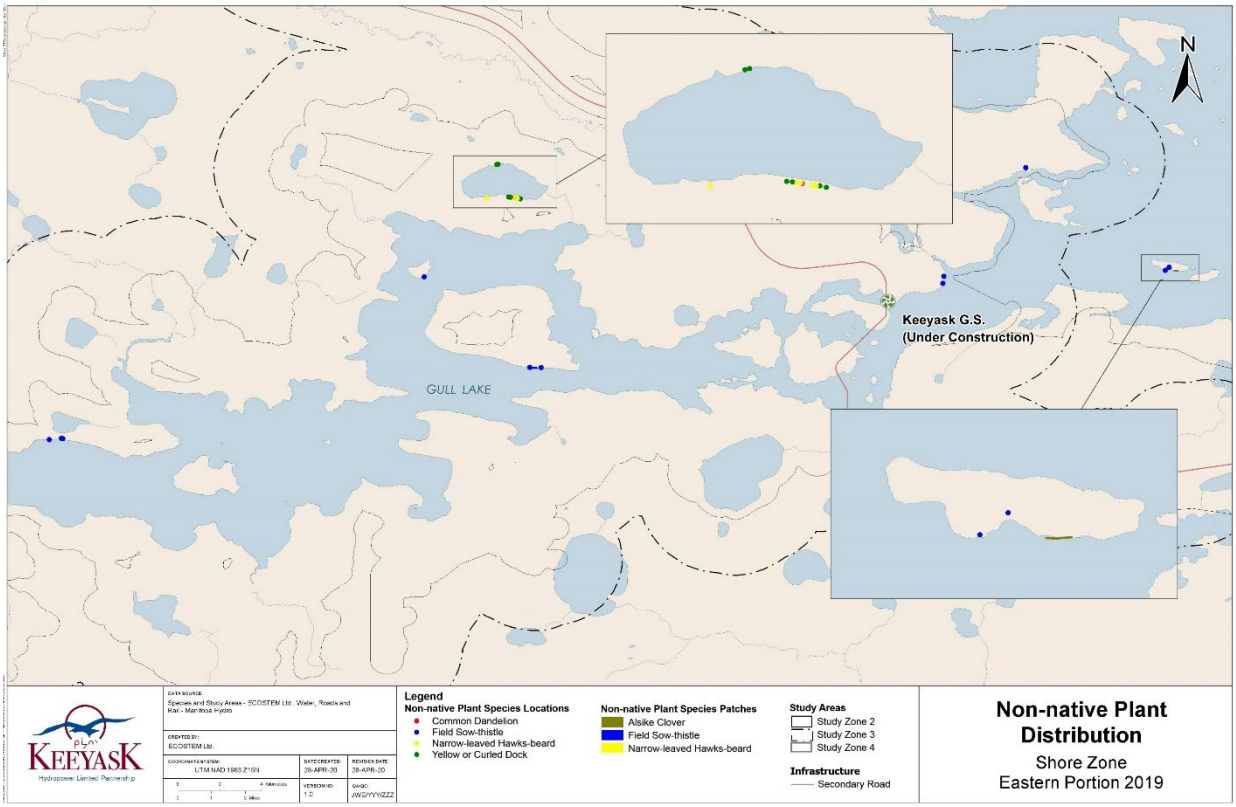
Two of the five most abundant species increased in cover between 2018 and 2019 (lamb's quarters and field sow-thistle), while the other three decreased in cover. This was a positive change from previous years, as all five had been increasing in cover up to August 2018.

Of the 25 non-native plant species found in 2019, ox-eye daisy, scentless chamomile and common tansy are the ones of highest invasive concern for the Project site. The staff conducting the monitoring manually removed all of these plants as soon as they were found during the surveys. Scentless chamomile and ox-eye daisy were not found at the sites where they had been removed in previous years.

Six of the 25 non-native plant species found in 2019 are of moderate invasive concern for the Project site. To minimize further spreading of invasive plants, herbicides were applied in a few key Project areas in early August 2019, followed by mowing in early October 2019. Living plant cover for the target species (i.e., common burdock, field sow-thistle, tufted vetch) was reduced by approximately 42% in the areas treated with herbicides. Surveys in 2020 will assess the effectiveness of both treatments in continuing to reduce non-native plant cover.

In the shore zone, non-native plant cover was low (see map below for the Gull Lake portion of the survey area), ranging from 1.3 to 2.3 m^2/km in the different river zones. Nine non-native plant species were found, with six occurring in the Nelson River shore zone, and three in Little Gull Lake. The most abundant species was common plantain. The species of highest invasive concern found in the shore zone included field sow-thistle, tufted vetch and white sweet clover.

Tufted vetch, an invasive plant found during shoreline surveys in 2019



What does it mean?

As expected, some further spreading of some non-native plant species is happening during Project construction. However, all species combined still cover less than 1% of the Project footprint. Surveys in 2019 appear to indicate that non-native plant cover may be declining or

slowing in some portions of the Project footprint. Non-native plant cover in the shore zone was low, and the species found there were likely present prior to the Project.

Given their potential to spread rapidly, evaluations continued as to whether or not there are practical ways to reduce invasive and other non-native plant species in the Project footprint, or to prevent them from spreading further. Many of these species are commonly found in 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 results from 2019 showed that immediate manual removal was generally effective for species that do not have the ability to produce many new plants from pieces of roots left in the ground. Staff conducting the monitoring surveys will continue to manually remove plants at sites where there are one to a few plants.

The effectiveness of the herbicide treatment in August 2019 was lower than expected, likely due to heavy rains that occurred soon after the treatment. Results from monitoring conducted in 2020 will evaluate the effectiveness of the mowing treatment completed in October 2019, as well as the combined effectiveness of the herbiciding and mowing treatments.

What will be done next?

Additional invasive plant control recommendations will be developed for the 2020 growing season based on the monitoring results to date. Monitoring fieldwork for invasive and other non-native plants will continue in 2020. Where appropriate, additional control measures will be recommended based on what is found during the monitoring.

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STUDY TEAM

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

Fieldwork in 2019 was conducted by Brock Epp, Nathan Ricard and Alanna Sutton of ECOSTEM Ltd.; and Kenneth Ouskun of TCN.

Data analysis and report writing in 2019 were completed by Brock Epp and James Ehnes. GIS analysis and cartography was completed by Alex Snitowski and Brock Epp.

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1.0 INTRODUCTION

Construction of the Keeyask Generation Project (the Project), a 695 megawatt hydroelectric generating station (GS) and associated facilities, began in July 2014. The Project is located at 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.

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 (KHLP 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; KHLP 2012b). The *Terrestrial Effects Monitoring Plan* (TEMP) was developed as part of the licensing process for the Project (KHLP 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 because they can crowd out other plant species and, in extreme cases, 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 invasive and other non-native plants, and to evaluate the effectiveness of mitigation measures. The overall objectives of the Invasive Plant Spread and Control study are to:

- Verify 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.

A previous monitoring study and report (ECOSTEM 2015) evaluated non-native plant spread during construction of the Keeyask Infrastructure Project (KIP), which ended in June 2014. This study is monitoring non-native plant distribution during Project construction and operation. To date, surveys have been conducted in each year from 2015 to 2019. Results for the monitoring conducted annually from 2015 to 2018 are provided in previous reports by ECOSTEM (2016, 2017, 2018a and 2019b respectively). The following presents the monitoring conducted during 2019.

2.0 METHODS

Section 3.3.2 of the TEMP details the methods for this study. The following summarizes the activities conducted in 2019.

2.1 PROJECT COMPONENTS

There were far too many individual Project footprint components to evaluate each one separately for patterns of non-native plant spread. Therefore, the Project footprint was subdivided and grouped into general components (Table 2-1) based on the general type of activity occurring there. Activity type may be an important influence on non-native plant spread or establishment. For example, the “Camp and Work Areas” Project component is dominated by foot and light vehicle traffic, with minimal to no ongoing excavation, while the “Borrow Areas” component is often characterized by ongoing excavation and heavy equipment traffic. For reservoir clearing areas, the ground vegetation and soils are generally undisturbed, which means there is a poor seedbed for non-native plant colonization.

It should be noted that because the subdivision of the Project footprint into activity types is generalized, 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 2-3 shows the locations of the Project components as well as some of their constituent features.

A second level of analysis was based on the length of time since an area was first cleared, the current level of construction activity, and the projects it was used for (e.g., portions of areas cleared for the Keeyask Infrastructure Project (KIP) are also being used for the Project). All of these factors can influence non-native plant distribution and abundance. The categories used for the second level of analysis included:

- Areas used either for the KIP only or minimally affected by the Project;
- Areas used by both the KIP and the Project; and
- Areas used only by the Project.

Areas used for the KIP only are included because they were developed prior to the Project and may be an important seed source for the spreading of non-native plants into other nearby areas.

Table 2-1: General Project components and their associated activity prior to 2019 surveys

Project Component	Description	Activity
North Access Road	Road and right of way	Light and heavy vehicle traffic
South Access Road	Road and right of way	Light and heavy vehicle traffic
Camp and Work Areas	All camps, work areas and attached excavated material placement areas	Foot and light vehicle traffic
Borrow Areas	All borrow areas accessible by road, cleared or excavated, and attached excavated material placement areas	**Active:** Clearing, excavation and heavy equipment traffic **Inactive:** Regenerating vegetation
North Dyke	North dyke clearing, associated excavated material placement and borrow areas, and north channel rock groin	Clearing, excavation, light and heavy vehicle traffic
South Dyke	South dyke clearing and associated excavated material placement and borrow areas	Clearing, excavation, light and heavy vehicle traffic
Generating Station Areas	Generating station, spillway, dam and coffer dam infrastructure, and associated excavated material placement areas	Excavation, construction, heavy and light vehicle traffic
Reservoir Clearing Area	Vegetation clearing in the reservoir areas that are close to Project areas that will be outside of the reservoir	Clearing only

2.2 DATA COLLECTION

2.2.1 FIELD METHODS FOR INLAND AREAS

Early and late summer non-native plant surveys have been conducted in each year from 2014 to 2019, inclusive.

The information collected for the 2019 surveys were the same as in 2018 and 2017. The data collected for 2017 were somewhat modified from previous years. Starting in 2017, the early summer survey was less detailed than the late summer survey. The purpose of the early summer survey was to provide a rapid, spatially focused survey that still allowed for early detection and control of non-native plants that had spread into new areas. For this reason, the 2019 survey was spatially focused on two types of areas: (i) the areas that were newly cleared since August 2018; and, (ii) the areas that were cleared as of August 2018 and that had few to no non-native plants. Further details on methods and rationale are provided in the 2018 report (ECOSTEM 2018a).

Results from the early summer surveys were not expected to be representative of non-native plant distribution and abundance for the entire Project footprint. The purpose of the early summer surveys was to identify sites that may require a timely management response. Consequently, the locations selected for the survey were intentionally those that were believed to both have a higher likelihood to support non-native plants and be new candidates for eradication or control efforts (e.g., identifying locations where non-native plants have recently appeared in recently cleared or excavated locations). In each year, results from the previous late summer survey had already provided the bulk of the information needed to select sites for treatment in the current summer.

Results from the late summer surveys were expected to overestimate non-native plant distribution and abundance for the entire Project footprint. With the exception of the North and South Access roads, surveys of the Project footprint were not conducted in areas where non-native plants were expected to be completely or virtually absent based on results from similar types of areas and in previous years. The two predominant types of areas that were not surveyed were the portions of the Project footprint that were not safe to access due to construction activity (the remainder was not surveyed due to recent bear activity) and the cleared future reservoir area. Inclusion of the zero or very low values from these areas would have reduced the non-native plant percentages for the entire Project footprint.

Given the differences in objectives and associated field methods, results from the 2019 early and late summer surveys are not directly comparable.

Early summer surveys were conducted on July 2 to 5, 2019 at the locations shown in Map 2-1. Late summer surveys were conducted from August 20 to 22 and 25 to 28, 2019 at the locations shown in Map 2-2.

Data generally recorded during the early summer surveys included a GPS waypoint where non-native plants were observed, and notes on species abundance and extent. The exception was when a species of high invasive concern for the Project (Section 2.6) was encountered. In these situations, detailed data were collected using the late summer survey method (see below). Methods for the 2019 early summer non-native plant surveys were the same as those used during the 2018 surveys.

The tools for collecting non-native plant data were modified in 2019 to take advantage of new data collection technology. In late summer, 2019, most of the non-native plant cover was recorded and mapped in the field using electronic tablets. The information recorded using this method was the same as the information recorded in previous years to maintain comparability with results from previous years. Advantages to utilizing the electronic data collection method over the previous method included:

1. Reduction in recording error;
2. Improvements in field data gathering efficiency (i.e. reduced time); and
3. Reduced data entry and GIS processing time.

Despite the advantages, there were a few general limitations to using tablets to gather field data. First, the tablets could not be used in heavy rain as this interfered with the touch-screen inputs. Second, the GPS positional accuracy decreased in denser tall vegetation cover or structures to a

much higher degree than the handheld GPS receivers. Third, they were inefficient for rapidly recording data when conducting surveys from a vehicle.

In situations where weather conditions or the survey method (e.g. helicopter surveys) did not allow for use of the tablets, the surveyor reverted to the same data recording method used for late-summer surveys in 2018. As a result, non-native plant cover was recorded in two different ways for the late-summer surveys, however, the data collected was the same, and was combined for the resulting cover maps. Both data collection methods are detailed below.

Late summer non-native plant surveys were conducted in the portions of the Project footprint that had been cleared or disturbed prior to the surveys and were safe to access. A botanist and trained environmental technician conducted surveys on foot and by truck within the cleared areas that were both safe to survey and were not undergoing clearing at the time of the surveys. Due to safety-related access restrictions, some active construction areas, or portions thereof, could not be surveyed in 2019.

Three approaches to selecting survey locations were employed, depending on the nature of the footprint.

For the North and South Access roads, a combination of systematic sampling on foot and mobile truck-based surveys were employed. Sample locations were established every 2 km along each access road. Non-native plants were sampled at every stop except where construction or haul truck activity made stopping unsafe. At each stop, a 100 m transect on each side of the road (*i.e.*, two 100 m transects at each stop) was surveyed by foot. Additionally, the roadsides were scanned while driving approximately 40-50 km/h between each stop and observations of species of high concern or unusual conditions were recorded. It was expected that smaller patches and individual plants would not be recorded.

Spatially focused foot surveys were conducted in the cleared areas along the South Dyke in 2019 for several reasons: large portions of this footprint had only recently been cleared, and/or only had the taller vegetation removed during the winter months; the clearing was distant from known non-native plant seed sources; and, access was difficult. Locations for the foot surveys were selected in two ways - first, by flying over the newly cleared areas in a helicopter and identifying the most likely locations to support non-native plants; and second, by targeting areas that had non-native plants in 2018. Because searches along the South Dyke were focused on locations that were believed to have a higher likelihood to support non-native plants, results were expected to overestimate the abundance of non-native plants for the entire South Dyke footprint.

Most of the North Dyke, and all of the Ellis Esker access corridor was also surveyed by a combination of helicopter and foot surveys due to its length, and inaccessibility by non-construction vehicles. The helicopter was flown at a low altitude above the centre-line of the dyke in two passes, surveying each side of the clearing. Because it was narrow, the Ellis Esker access corridor was surveyed in a single pass. Foot surveys were conducted where needed to confirm plant identification, or to map more complicated patches of plants.

For the remaining areas (which accounted for the majority of the surveyed area), field surveys traversed all cleared areas using a combination of perimeter and meandering walks. The

perimeter of each cleared area was generally surveyed because the non-native plants tended to be clustered in these locations. For the remainder of a cleared area, the surveyor walked to all remaining vegetation patches that had the potential to include non-native plants. The exception to this was areas that posed safety concerns (primarily related to the presence of heavy construction activity).

Data recorded at each location included spatial coordinates, species spatial extent and species abundance. Additional notes were also recorded and photos were taken.

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. The "point with number of individuals" method was typically used in locations where there less than 20 individual plants covering a very small area, while a patch (typically 20 or more plants) was used where there was a large number of plants, and/or the plants covered a large area. Regardless of the data collection tools used (see below), patches are recorded in one of two general methods: (1) as a point with an estimated radius (in meters), which typically applied to small, roughly circular patches in open areas where the boundaries were visible from a single location. These points were later converted to polygons in the GIS. (2) As a patch, spatially defined by a polygon in the field. This method was used for large patches where the boundaries could not be discerned from a single location. The method by which the polygons are defined varied depending on the data collection tools used (see Sections 2.2.2 and 2.2.4).

Once a non-native species patch was defined, the percent plant cover was estimated for each species present and recorded into one of the six classes listed in Table 2-2.

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

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

2.2.2 FIELD METHODS FOR SHORE ZONE AREAS

Non-native plant surveys were conducted by boat in the Project-affected shore zone for the first time during construction monitoring, from August 19 to 21, 2019.

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. Shore segments in Little Gull

Lake, which is currently an off-system waterbody but is part of the future reservoir area, were also surveyed.

Surveys were conducted at a sample of shore segments in the Project hydraulic zone of influence that were expected to remain above the high-water level that would be present after the reservoir was brought to full supply level (159 m asl). For the segments between 14 km and 26 km upstream of the generating station (i.e., where the extent of flooding would generally be very limited), sample locations were systematically positioned along the entire existing shoreline. For the remaining upstream shoreline, sample locations were systematically positioned along the existing shoreline that was expected to be present at full supply level.

Downstream of the generating station, sample locations were systematically located for the first 5 km on the north and south shorelines. Two additional segments were sampled further east on the south shoreline. Map 2-4 shows the shore segments surveyed in 2019.

With one exception, non-native plant distribution and abundance were surveyed from a boat being driven as close to the shoreline as was safe. During the surveys, a botanist scanned the shoreline for non-native plants. For Little Gull Lake, which was not accessible from the upstream or downstream boat launch, the shore segments were sampled by walking along the shoreline.

Non-native plant occurrences were recorded as either points or as bands. Points represented individuals or small patches of plants. Bands represented patches of plants extending along the shoreline.

Data recorded for a point included geographic coordinates, the estimated radius of plant cover and percent plant cover within the radius. Data recorded for a band included geographic coordinates for the start and end of the patch along the shoreline and an estimate of the percent of non-native plants, by species, within the patch. 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.

2.2.3 TABLET-BASED DATA COLLECTION

Non-native plant cover data was collected electronically with tablets during foot-based surveys, when weather conditions allowed the tablets to operate.

Data was collected using a Samsung Galaxy Tab A which has a built-in GPS receiver. Non-native plant cover was mapped directly in the field using Collector for ArcGIS. The most recently available remote sensing imagery was uploaded as a base-map on the tablet to help position the boundaries of patches of plants.

Two feature layers were prepared for field data collection, one for point type features (plant individuals) and “point with radius” patch types, and another for defined polygons. When individuals or patches with a radius were encountered, a new point feature was added in Collector as close to the centre of the patch as possible for the species. When a larger patch was encountered, a polygon was digitized in Collector, either by using the streaming function, and

walking around the patch boundary, or by manually drawing the patch polygon using the base imagery as a reference. After either feature was created, the point or patch attributes were filled in using the form that had been set up for use in Collector. If more than one non-native plant species occurred at the same point, or within the same patch, the feature was copied, and the species and cover attributes were updated.

2.2.4 PAPER-BASED DATA COLLECTION

Manual plant data collection methods in 2019 were the same as those used in 2018. These methods were used when rainfall was too heavy for the tablet's touch-screen input to work, or during higher-speed truck, helicopter, or boat-based data recording.

Non-native plant spatial extent at a site was recorded using field notes in conjunction with waypoints and tracks acquired using a GPS (Garmin Map 62 or Map 78). The notes included the same point and patch attributes that were recorded when the tablets were used.

For non-native plant individuals and small patches (less than 20 plants), a GPS waypoint was recorded as close to centre of the patch as possible. For larger patches, defined polygons were recorded in one of three ways:

1. **Point:** Used for small patches (20 or more plants) that had a relatively regular shape. Typically applied to small patches in open areas where the boundaries were visible from a single point. In these situations, a GPS waypoint was taken at the patch center whenever possible, with an associated ocular estimate of patch radius (in meters) for circular patches or the dimensional length (e.g. 2m x 4m) for rectangular patches.
2. **Band:** Used for patches too large to be recorded as a point and that were linear with a relatively constant width. In these situations, the length of the band of the non-native species (e.g. along a ditch) was walked while a GPS recorded a track log for the species. An estimate of the average bandwidth in meters was recorded. For some wider bands, the bandwidth was recorded using distinct features such as a specific impact area (e.g. width of the transmission line right-of-way).
3. **Defined Area:** Used if the patch could not be recorded as a point or a band. In these situations, the surveyor generally walked around the perimeter of a large homogeneous patch with non-native species cover while recording a GPS track log for the patch. Alternately, the surveyor walked through the area in a zig-zag transect so that the points generally corresponded to the boundaries of the patch. The former method was used when the non-native species could be observed throughout the patch from the outer boundaries, which typically occurred in open barren, or low vegetation areas. The latter method was used in heavily vegetated areas where non-native plants were not visible over a long distance. In this method, waypoints were added while recording the species tracklog to indicate if there was a change in cover.

2.3 TOTAL AREA SURVEYED

2.3.1 EARLY SUMMER

In 2019, early summer non-native plant surveys occurred in approximately 367 ha (6%) of the areas that had been cleared or disturbed by the Project (Table 2-3; Table 2-4). The percentage of the Project footprint surveyed increased to 17% when recently cleared or very large footprint components utilizing different sampling methods were excluded (i.e., the future reservoir area and the North and South Access roads).

The total area included in the 2019 early summer survey was lower than in 2018. This was largely due to the survey locations being targeted based on non-native plant cover in fall 2018. Several areas surveyed during early summer in 2018 because they had little or no non-native plant cover in 2017, were found to have developed more extensive cover in 2018. Those areas were excluded from the early summer surveys in 2019 (see Section 2.2).

Non-native plant surveys were not conducted in the cleared future reservoir areas given the low likelihood that non-native plant distribution had changed, the large size of the reservoir clearing footprint, and the fact that future flooding will eliminate plants that are not close to the shoreline. It had been determined from previous surveys, and from low-level aerial surveys of the southern side of the future reservoir area in 2018 that non-native plants were virtually absent. The apparent virtual absence of non-native plants was thought to be primarily due to two factors: reservoir clearing targeted vegetation taller than 5 feet (leaving the ground vegetation largely intact); and, clearing occurred during the winter, which limited seed spread by vehicles and equipment and resulted in little ground disturbance.

2.3.2 LATE SUMMER

In late summer 2019, ground searches were not possible in several locations for safety reasons. Locations not surveyed due to construction activity included most of the South Dyke, portions of Work Area A (particularly around the rock crusher), in the generating station (GS) area, all of Work Area X, a portion of Borrow Area G1, all of Borrow Areas Q-1 and S-2a, the westernmost SAR survey stop, the easternmost NAR survey stop, the stop between Borrow Areas KM1 and KM4, and the south side of the stop just east of KM4. Based on previous results (ECOSTEM 2017; WRCS and ECOSTEM 2017), it is unlikely that many non-native plants would have established in these areas due to the high volume of construction activity, including ongoing excavation, material stockpiling and vehicle traffic.

Late summer non-native plant surveys in 2019 covered approximately 703 ha (12%) of the cleared or disturbed Project footprint (Table 2-3; Table 2-4). The percentage of the Project footprint surveyed increased to 48% when recently cleared or very large footprint components utilizing different sampling methods footprint components were excluded (i.e., the future reservoir area

and the North and South Access roads. The future reservoir area accounted for 65% of the Project footprint in 2019, including all Project and KIP areas.

Compared with 2018, the total area surveyed in 2019 was 36 ha higher, primarily because the construction activity at the time allowed access to greater portions of some Project components. The largest of these Project components included Borrow Area N-21, portions of the South Access Road, and one borrow area near its west end.

Overall, the locations included in the 2019 and 2018 surveys were similar for most of the Project components (Table 2-3). As noted above, most of the exceptions were due to high levels of construction activity. Portions of Borrow Area N-5 and Borrow Area G-1 were not surveyed for reasons similar to the reservoir clearing area. Only the aboveground vegetation had been cleared in the unsurveyed portions of these borrow areas, and previous surveys found very few non-native plants, with little to no change in cover over time (ECOSTEM 2017; 2018a).

In 2019, the overall borrow area surveyed increased primarily due to the addition of a large, recently excavated borrow area (N-21). Conversely, the amount of area surveyed along the South Dyke in 2019 was only about one-quarter of that surveyed in 2018. This was because construction traffic was heavy along most of the length of the South Dyke, as it was being completed in 2019.

2.3.3 SHORE ZONE

In late summer 2019, approximately 49.1 km of shoreline along 124 transects were surveyed for non-native plants (Table 2-5; Map 2-4). A total of 97 transects along 31.5 km of shoreline were surveyed in the Nelson River upstream of the generating station. Two transects, totalling 1.4 km were sampled along the shore of Little Gull Lake. Twenty-five transects, totalling 16.2 km were surveyed downstream of the generating station.

Table 2-3: Total area (ha) surveyed for non-native plants by year and Project component

Project Component	Early Summer Survey						Late Summer Survey					
	2014	2015	2016	2017	2018	2019	2014	2015	2016	2017	2018	2019
North Access Road[1]	9	9	9	-	-	-	10	9	8	10	9	8
South Access Road[1]	-	-	9	306[4]	268[4]	127[4]	-	-	10	16	13	14
Camp and Work Areas	126	109	163	19	6	16	138	111	186	182	185	173
Borrow Areas	112	119	323	79	131	200	120	131	329	334	329	369
North Dyke	-	-	52	88	108	12	1	-	56	120	124	138
South Dyke[2]	-	-	38	7	3	2	-	-	21	4	8	2
Generating Station Area	-	-	20	10	0	10	-	-	10	6	-	-
Reservoir Clearing Area	-	-	56	0	-	-	-	-	-	0	-	-
Total surveyed area	*247*	*237*	*669*	*509*	*516*	*367*	*269*	*251*	*620*	*671*	*668*	*703*
Total footprint area [3]	*540*	*1,438*	*3,643*	*5,372*	*5,716*	*5,759*	*540*	*1,438*	*3,643*	*5,372*	*5,716*	*5,759*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".
[1] Sampled area consists of a systematic sample of the road (Section 2.1). In addition, cleared areas were scanned for large patches while driving between stops.
[2] The south dyke was surveyed through a series of targeted spot checks.
[3] Approximately 75 ha of KIP borrow areas not used by the Project are included in these totals.
[4] Almost the entire south access road was surveyed by vehicle in early summer using rapid methodology (see Section 2.12).

Table 2-4: Percentage of Project footprint area included in the non-native plant surveys by year and Project component

Project Component	Early Summer Survey						Late Summer Survey					
	2014	2015	2016	2017	2018	2019	2014	2015	2016	2017	2018	2019
North Access Road[1]	5	5	5	-	-	-	5	5	4	5	5	4
South Access Road[1]	-	-	3	94[3]	82[3]	39[3]	-	-	3	5	4	4
Camp and Work Areas	68	48	71	8	3	7	75	49	81	78	78	73
Borrow Areas	90	35	74	16	24	36	96	38	76	68	60	66
North Dyke	-	-	28	45	54	6	3	-	30	61	62	69
South Dyke[2]	-	-	31	4	2	1	-	-	17	2	4	1
Generating Station Area	-	-	9	4	0	4	-	-	4	3	-	-
Reservoir Clearing Area	-	-	3	0	-	-	-	-	-	0	-	-
All surveyed areas	*46*	*17*	*18*	*9*	*9*	*6*	*50*	*17*	*17*	*12*	*12*	*12*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".
[1] Sampled area consists of a systematic sample of the road (Section 2.1). In addition, cleared areas scanned for large patches while driving between stops.
[2] The south dyke was surveyed through a series of targeted spot checks.
[3] Almost the entire south access road was surveyed by vehicle in early summer using rapid methodology (see Section 2.12).

Table 2-5: Number of transects and approximate length of shoreline surveyed in 2019 for non-native plants by zone.

Hydraulic Zone	Length of shoreline surveyed (km)	Number of transects
Nelson River Upstream	31.5	97
Little Gull Lake	1.4	2
Nelson River Downstream	16.2	25
All	*49.1*	*124*

2.4 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 detail is the same as that in the 2018 annual report (ECOSTEM 2019b). Mapping methods are the same for both the inland and shore zone data.

The analysis evaluated non-native plant distribution and abundance in the context of precise clearing and disturbance mapping produced for 2019 (see ECOSTEM 2019a). The primary focus of this report is on the patterns and changes observed in 2019. A detailed comparison of non-native plant spread over all construction years will be provided at the end of Project construction in the monitoring synthesis report.

Species spatial extent and cover data collected using the note-based method was converted into GIS polygons. Where the patch extent method (Section 2.1) was used to record non-native species in the field, patch polygons were created from the GPS tracklogs. After polygons were created from the note-based method data, they, along with the point data, were merged with the point and polygon features produced in the field using the tablets.

Polygons for sites where plants were recorded as individuals in the field were created by applying a fixed radius buffer around the site coordinate. The radius applied for each species at each point was a fixed value for the species multiplied by the number of plants recorded. The radius for one plant of a particular species was the estimated typical area covered by an individual plant (Appendix 1, Table 7-1). Since there were situations where plants were close enough to each other to have overlapping buffers, this method slightly overestimates total non-native plant cover.

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

Non-native plant cover was derived from the patch cover class (Table 2-2) for sites recorded using the “patch method” or from multiples of individual plant area (Appendix 1, Table 7-1) for sites recorded using the “number of individuals” method. The area covered by a species in a mapped patch was calculated by multiplying the patch area by the midpoint of the percent cover class (Table 2-2). For example, a 10 m^2 non-native plant patch with sparse cover for Species A would have a derived area of: 10 m^2 x 6.5% = 0.65 m^2 for Species A.

Factors that affected how the data generated from the mapping were interpreted included GPS accuracy, interpreter bias and variability, total plant cover and access. For GPS accuracy, non-native patch mapping relied on GPS waypoints and track logs for positioning. Depending on the terrain and satellite signal, accuracy of the GPS could vary approximately several meters during and between surveys. The same patch, mapped during different surveys may show different positions or extents from track logs and waypoints even if its boundaries remained unchanged. Such year-to-year differences were expected to be small relative to the size of the footprint of interest.

While efforts were made to calibrate plant cover estimates between the different individuals conducting the surveys, some individual bias is always inherent in this measurement method. Furthermore, even for the same individual, there may have been differences in the approach taken to map a particular patch of non-native plants in one year compared with the previous year. For example, an area with very sparse cover of a particular species may have been recorded as a series of individual points during one survey and as a single patch with very sparse cover during another survey (generally because the number and extent of individual points changed). While the actual cover and number of plants may have been the same between surveys (when limiting the comparison to the same spatial extent as the previous year), the current year patch limits and plant cover class could be different. Consequently, results for the area covered by a species could reflect the mapping approach, and not actually a change in non-native plant extents. To minimize this effect, whenever possible, the same individuals were used to conduct the surveys over the monitoring period, and an effort was made to subdivide the areas surveyed by each individual in the same way each time. This element of the field methods was not expected to create a large bias in the overall results even though there could be relatively large differences at specific sites.

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. This could also result in a seasonal bias in which non-native plant cover for some species was underestimated during spring surveys because the plants were small and obscured by other vegetation.

During construction, some areas could not be safely accessed at the time when surveys were conducted due to construction activity (e.g., generating station area, Borrow Area N-21). While effort was made to observe these areas from a distance, it is possible that non-native plants were present but not recorded (note that this does not refer to sites where non-native plants definitely could not be seen if present; such areas are not included as part of the surveyed area). This could result in total cover being underestimated for certain areas in some years. However, any bias was expected to be small as the areas surveyed from a distance were typically in active borrow areas

(i.e., the new substrate was recently exposed). Because the total area surveyed varies due to these reasons, the results are related to total area surveyed, rather than total footprint area, increasing comparability of results from different surveys.

Due to the above factors (particularly the first two), derived species cover, rather than polygon extents, were considered to be a more meaningful measure for interpreting changes in non-native plant abundance between years. Non-native species polygon extents should only be considered as an indication of overall distribution as well as a very broad measure of area covered.

2.5 NON-NATIVE PLANT CONTROL

Several areas were recommended for herbicide application and mowing based on the 2018 findings (see Section 4.2 for details). The areas were those which contained invasive species of high concern that had high potential to spread into other areas. Manitoba Hydro treated these areas with herbicide on August 2 and 3, 2019. Surveys were conducted in the herbicide-treated areas to document the treatment efficacy. Mowing was carried out in early October 2019, after the 2019 field surveys were completed.

The recommended treatment areas were visited prior to the herbicide treatment during the early summer plant surveys. Photo control points were established at strategic locations in the treatment areas so that pre- and post-treatment comparison photos could be acquired. At each photo control location, a marker pipe was planted, and one or more photos, along with the associated bearing(s) and orientation(s) (portrait or landscape) were recorded. During the late summer surveys, non-native plants in the treatment areas were recorded according to the standard survey methods. In addition to the standard data, the percent of dead foliage for each non-native species in the patch was also recorded. The photo control locations were revisited and photos were taken of the same bearing and orientation as the pre-treatment photos.

2.6 INVASIVENESS RANKINGS AND MANAGEMENT STRATEGIES

2.6.1 BACKGROUND

The EIS and EnvPPs 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 construction 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). 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, white clover), particularly along roadsides, making it difficult to prevent them from being spread by human or natural sources.

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. 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 (2020), 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 (2020) 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.

2.6.2 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 2-6). 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 2-7 shows how the invasive concern classification was applied to the non-native plant species recorded in the Project footprint to date.

Table 2-6: 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 et al. (1993) classify as "high" or "moderate" invasives
Level 3	Species that either White et al. (1993) classify as "minor" invasives, or government sources classify as noxious weeds or weed seed species1
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 2-7: 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	Scentless chamomile	*Tripleurospermum inodorum*	Category 2		Tier 2	Secondary
	Ox-eye daisy	*Leucanthemum vulgare*	Category 2		Tier 2	Primary
	Common tansy	*Tanacetum vulgare*	Category 2		Tier 2	
Level 2	Canada thistle	*Cirsium arvense*	Other	Moderate	Tier 3	Primary
	Field sow thistle	*Sonchus arvensis*	Other		Tier 3	Primary
	Common burdock	*Arctium minus*	Other		Tier 3	
	Tufted vetch	*Vicia cracca*	Other			
	White sweet clover	*Melilotus albus*		Moderate		
	Yellow sweet clover	*Melilotus officinalis*		Moderate		
Level 3	Wormwood	*Artemisia absinthium*		Minor	Tier 3	
	Alfalfa	*Medicago sativa*		Minor		
	Lamb's quarters	*Chenopodium album*			Tier 3	
	Common dandelion	*Taraxacum officinale*			Tier 3	
	Narrow-leaved hawks-beard	*Crepis tectorum*			Tier 3	
	Curly dock	*Rumex crispus*				Secondary
Level 4	Wormseed mustard	*Erysimum cheiranthoides*				
	Pineappleweed	*Matricaria discoidea*				
	Bird's-foot trefoil	*Lotus corniculatus*				
	Black medick	*Medicago lupulina*				
	Spotted lady's-thumb	*Persicaria maculosa*				
	Common plantain	*Plantago major*				
	Common timothy	*Phleum pratense*				
	Smooth catchfly	*Silene csereii*				
	Alsike clover	*Trifolium hybridum*				
	Red clover	*Trifolium pretense*				
	White clover	*Trifolium repens*				
	Wheat	*Triticum aestivum*				

Notes: [1] See Table 2-6 for the invasive concern classification. [2] In decreasing order of concern for the Project area. [3] Invasive Species Council of Manitoba (2020). [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).

2.6.3 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 2016).

For application, the generally preferred approach for dealing with individual plants or small patches of Level 1 non-native species appearing in new areas is to eradicate them as soon as they are discovered. Ideally, this is accomplished by manually removing the plant(s) including roots, removing the soil from around the base of the plant, immediately placing all plant and soil material into a double layer of garbage bags, and, disposing of all of the collected material (preferably by burning it). The following describes how the application of this strategy evolved over time during Project monitoring.

When Level 1 plants were found within the Project footprint during the 2015 and 2016 surveys, their locations were reported to Manitoba Hydro environmental site staff, who carried out their removal and disposal using the preferred method described above.

Partway through the 2017 surveys, it was decided that, going forward, ECOSTEM survey staff would manually remove and dispose of the Level 1 plants using the preferred approach described above. Immediate removal was intended to minimize the possibility for these plants to disperse seed or become well-established. Since this decision was made during the 2017 field season, some sites were not treated in this manner during 2017. As the 2017 surveys progressed, Level 2 plants were also immediately removed and disposed of at some sites, provided that the number of plants was low enough that it was practical to do so. This final approach was followed during the 2018 and 2019 surveys.

For the remaining sites with Level 2 plants, key sites were identified for herbicide application. The key sites were selected based on where invasive plants were most prolific and had the highest potential for being spread to other Project areas due to vehicles or footwear picking up seeds and carrying them elsewhere.

To assess the efficacy of herbicide treatments, foliage damage and mortality was used as an indicator for the approximate boundaries for where herbicides were actually applied in the treated sites. When possible, surveys were conducted soon enough after application (less than one month) that the plant remains should still have been present and identifiable to species. This indicator assumed that some degree of mortality would occur on any plants that were contacted by the herbicides. Some treated plants may occur outside of the mapped treated area due to factors such as variability in application rates or a particular species' tolerance to the chemicals used. Section 4.2 provides details.

2.7 SPECIES TREATED SEPARATELY

Native and non-native populations of reed canarygrass (*Phalaris arundinacea*) exist in North America. According to genetic analysis of herbarium specimens, the native reed canarygrass population was widespread in North American as of the early 20th century, extending from Alaska to New Brunswick (Jakubowski *et al.* 2012).

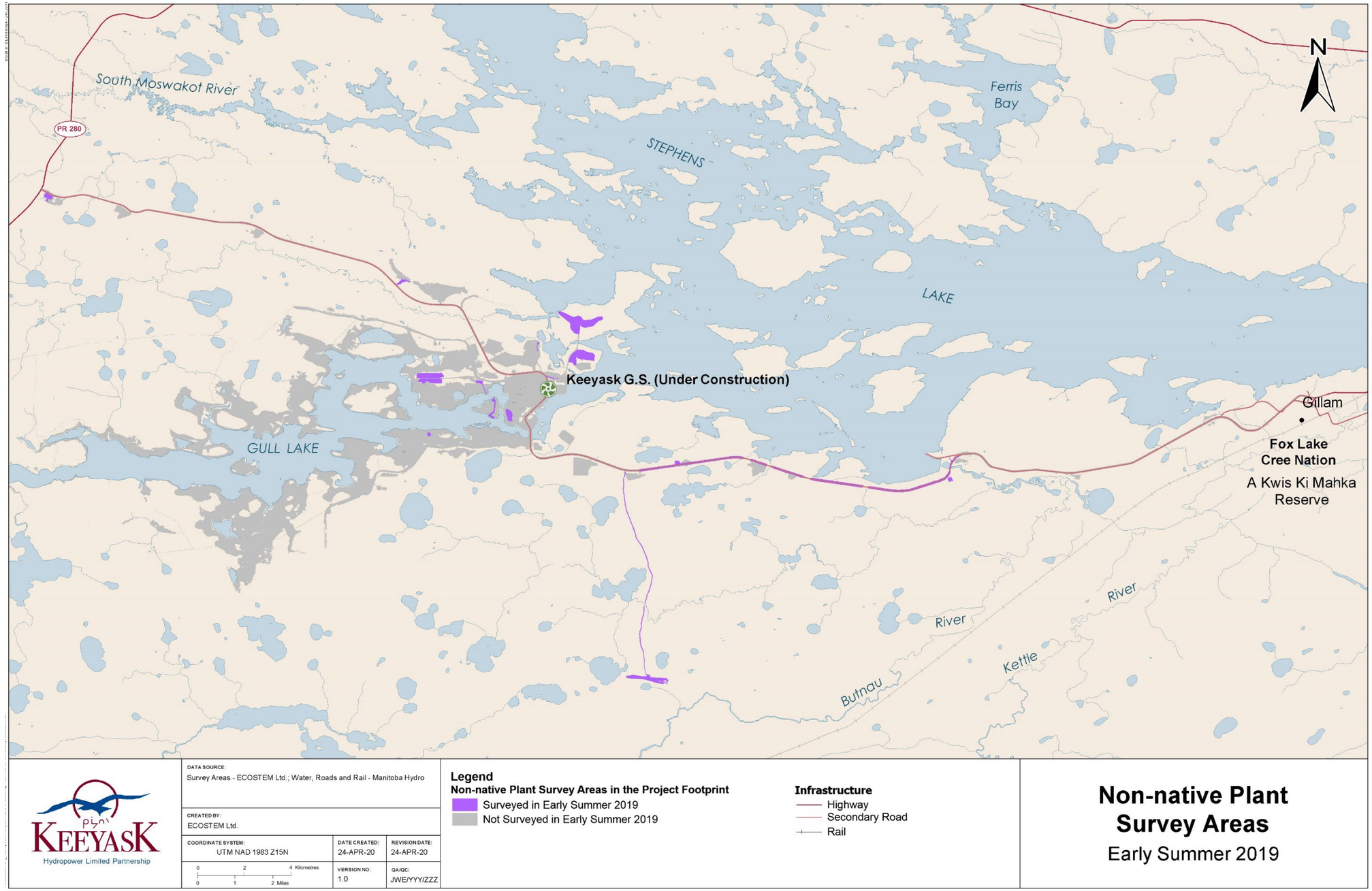
The non-native reed canarygrass population has been introduced from Eurasia on multiple occasions (Lavergne and Molofsky 2004; Lavergne and Molofsky 2007; Brodersen *et al.* 2008; Calsbeek *et al.* 2011). Genetic analysis concluded that the native and Eurasian populations are genetically distinct (Jakubowski *et al.* 2012). Additionally, non-native plants readily hybridize with native plants (Lavergne and Molofsky 2004).

Plants from the non-native or hybridized populations can be very aggressive, to the extent of crowding out native species. White *et al.* (1993) consider reed canarygrass to be a principal invasive plant in Canada.

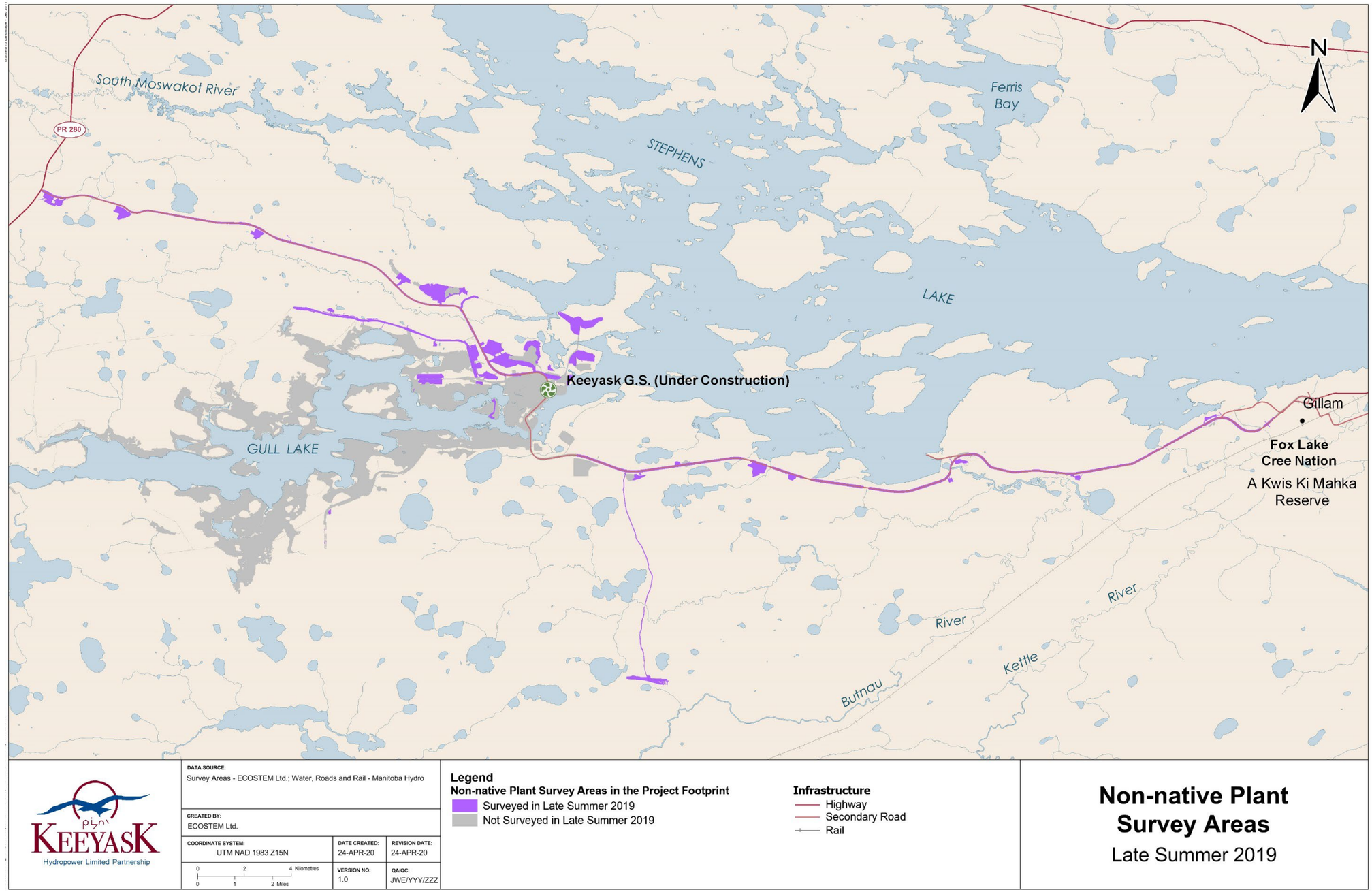
In the field, it is almost impossible to determine whether plants belong to the native, non-native or hybridized population (ISCM 2019). Some authors state that genetic analysis is the only reliable way to make this determination (Hayley 2012). As genetic analysis would be unduly onerous in many situations, some studies classify plants as native or non-native based on whether or not they are exhibiting invasive behavior (Maurer *et al.* 2003; Brodersen *et al.* 2008).

With regard to the Project footprint, evidence to date indicates that the recorded plants are likely from the native population. There is some evidence to suggest that the northern distribution limit of the non-native population in Manitoba is south of Thompson (Lavergne and Molofsky 2004; ISCM 2019). Also, more than a decade of data from the Wuskwatim Generation Project, which is also in northern Manitoba, have not demonstrated aggressive spread of the plants found there. Finally, the plants observed at Keeyask have not suggested aggressive spreading behaviour to date.

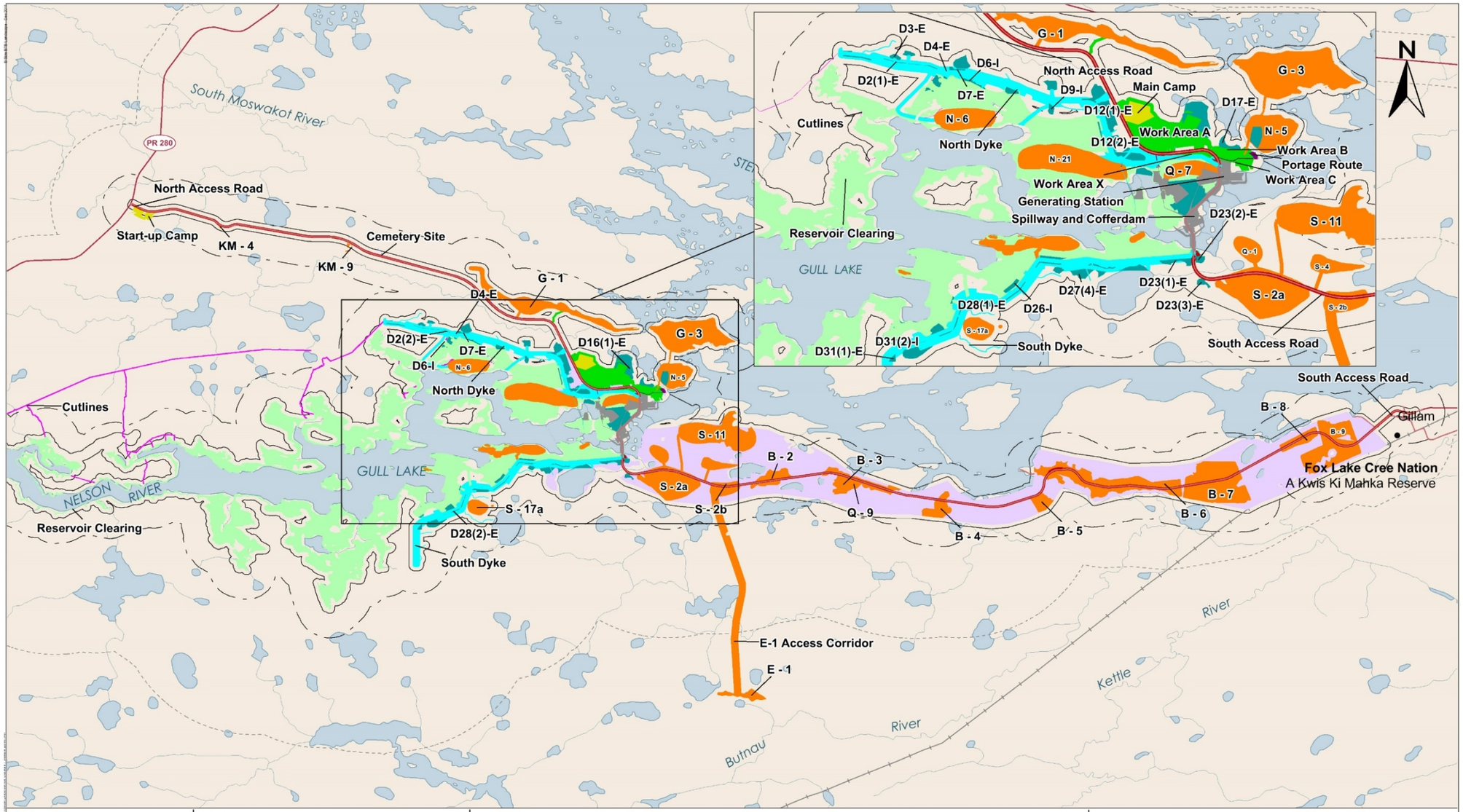
Based on the preceding information, the reed canarygrass plants recorded during Project monitoring to date are assumed to be from the native population. However, it is still possible that some or all plants occurring in the Project footprint are actually from the non-native or hybridized population but past conditions have limited invasive behavior. For this reason, field surveys still recorded reed canarygrass using the same methods as used for other non-native plants. Reed canarygrass observations and results are provided in Appendix 5 in the event that the recorded plants do become invasive in the Project area.



Map 2-1: Early summer non-native plant survey areas in 2019



Map 2-2: Late summer non-native plant survey areas in 2019



DATA SOURCE:
Clearing Area - ECOSTEM Ltd.; Study Areas, Footprints and Generating Stations - Manitoba Hydro; Water - NTS; Roads and Rail - Manitoba Conservation.

CREATED BY: ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	19-DEC-18	19-DEC-18
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: JWE/YYY/ZZZ

KEEYASK Hydropower Limited Partnership

Legend

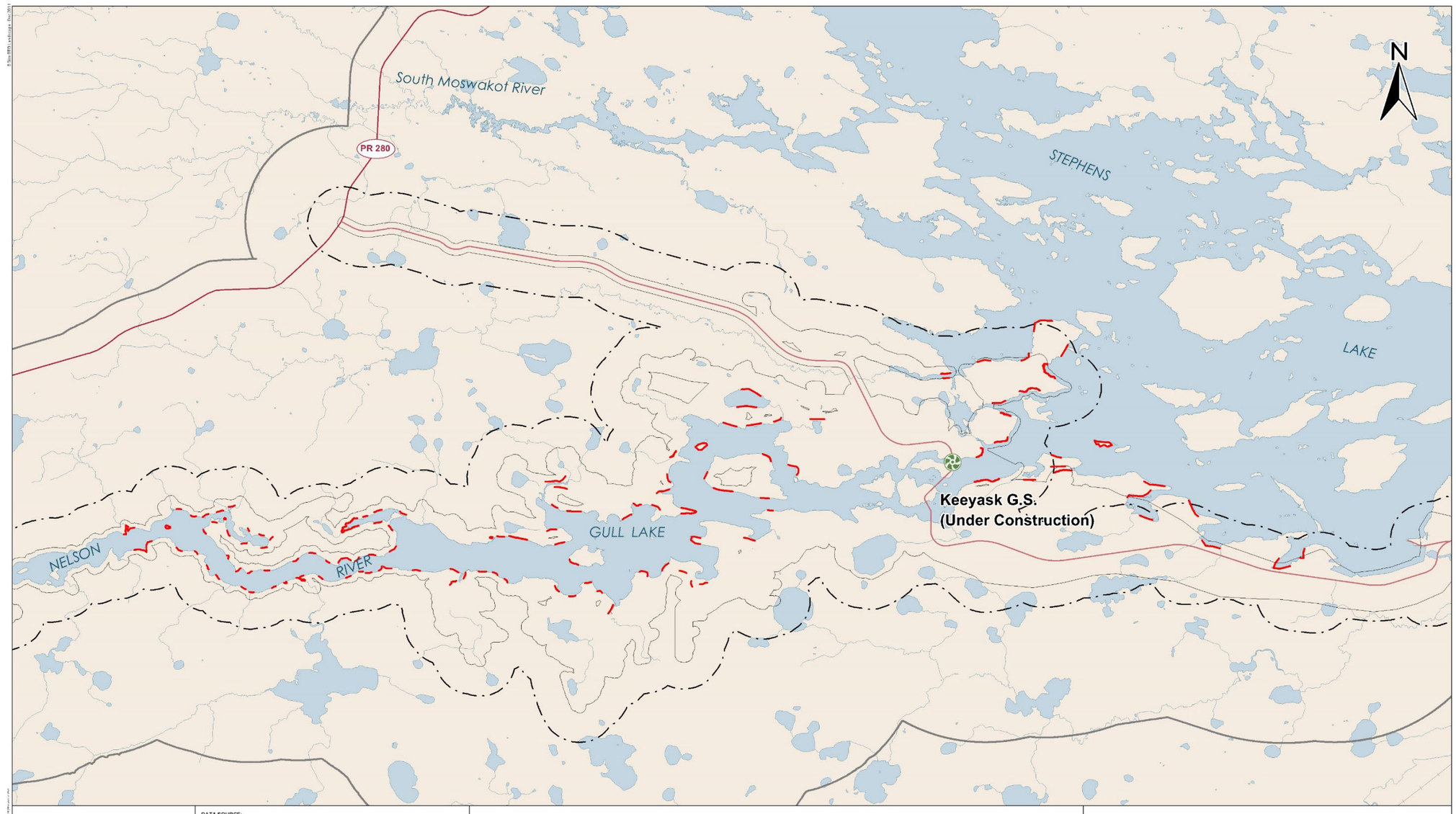
Project Components
- Borrow Area
- Camp
- Cemetery Site
- Cutlines
- EMPA
- Generating Station Area
- Access Roads
- Dykes
- Portage Route
- Possibly Disturbed Project Footprint
- Reservoir Clearing
- Work Area

Infrastructure
- Highway
- Secondary Road
- Rail

Study Areas
- Study Zone 2
- Study Zone 3
- Study Zone 4

Project Components

Map 2-3: Project components



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Surveyed Shoreline and Study Areas - ECOSTEM Ltd.; Water, Roads and Rail - Manitoba Hydro

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	28-APR-20	28-APR-20
0 2 4 Kilometres / 0 1 2 Miles	VERSION NO: 1.0	QA/QC: JWE/YYY/ZZZ

Legend
- Surveyed Shoreline

Study Areas
- Study Zone 2
- Study Zone 3
- Study Zone 4

Infrastructure
- Highway
- Secondary Road
- Rail

Shore Zone Surveyed for Non-native Plants
2019

Map 2-4: Shore zone segments surveyed for non-native plants in the Keeyask hydraulic zone of influence

3.0 RESULTS

3.1 SEASONAL PATTERN IN NON-NATIVE PLANT DISTRIBUTION AND ABUNDANCE

In general, early summer and late summer surveys conducted from 2014 to 2016 indicated that there was a seasonal increase in the number of non-native plant species during each growing season. There was also a seasonal increase in plant extent and cover as a percentage of area surveyed (ECOSTEM 2017).

Results from the 2019 early summer survey confirmed that non-native plants were persisting at sites where they were found in 2018. Additionally, plants had begun to establish, or continued to spread in some areas that had no, or very few, plants in August 2018. These sites included ditches along the SAR west of the Butnau Marina, Borrow Areas B-2, N-21, G-3 and N-5, and the cofferdam access road (Map 3-1).

A total of 10 non-native species were identified during the 2019 early summer survey. The species appearing most frequently at new sites since the 2018 late summer survey were common dandelion (*Taraxacum officinale*), sweet clover (*Melilotus* spp.) and curly dock (*Rumex crispus*). Common dandelion was found at most of the new non-native plant sites in the borrow areas. Sweet clover and yellow dock were spreading along the SAR west of the Butnau Marina, which was the same pattern observed there in 2018.

3.2 OVERALL CHANGES TO NON-NATIVE PLANT DISTRIBUTION AND ABUNDANCE

The following analysis of changes in non-native plant distribution and abundance focuses on the late summer survey since these data best reflect patterns and trends for these indicators (Section 2.1).

As described in Section 2.1, the metrics used to document changes in distribution and abundance were plant extent and plant cover, respectively. Plant extent was measured as the spatial limits of a vegetation patch that included one or more non-native plant species. However, because canopy closure of a species within each mapped patch could range from very sparse to very high, the plant cover metric identified the surface area covered by each species (plant cover was derived from the cover class recorded during field surveys (Table 2-2)).

As of late summer, 2019, overall non-native plant extent had increased to 69.4 ha, or 9.9% of the total area surveyed (Table 3-1). This was an increase of 5.4 ha, which was the smallest increase in extent since 2015 (in contrast, total extent increased by 35.0 ha between 2017 and 2018). It is

unlikely that a large degree of bias was introduced to the total cover metrics due to some different portions of the Project footprint being sampled compared to 2018 (Section 2.3.2). With the possible exception of Work Area X, the areas surveyed in 2018 but not in 2019 were areas that had low non-native plant cover (i.e. the South Dyke). Additionally, there is a high likelihood that the heavy construction activity removed some or all of the non-native plant cover that may have been in those areas previously.

Table 3-1: Total late summer non-native plant extent as a percentage of total area surveyed, by year[1] and Project component

Project Component	2014	2015	2016	2017	2018	2019	Change[3]
North Access Road	0.3	0.9	3.5	4.4	7.6	4.9	-2.8
South Access Road	-	-	0.2	2.8	7.9	7.7	-0.2
Camp and Work Areas	3.2	4.7	4.0	5.9	12.8	13.1	0.3
Borrow Areas	0.3	3.1	2.1	5.1	8.9	8.0	-0.9
North Dyke	-	-	0.1	0.3	7.6	11.5	3.9
South Dyke[2]	-	-	0.0	0.1	0.2	0.2	0.1
Generating Station Area	-	-	0.5	0.2	-	-	-
Reservoir Clearing Area	-	-	-	-	-	-	-
All Types	1.8	3.7	2.4	4.3	9.6	9.9	0.3
Total non-native plant extent (ha)	*4.9*	*9.3*	*14.8*	*28.9*	*64.0*	*69.4*	
Total area surveyed (ha)	*269*	*251*	*620*	*671*	*668*	*703*	

Notes: Numbers that round to zero shown as "0"; absences shown as "-".
[1] Plant extent in some components are not directly comparable with other years because surveyed areas may change due to accessibility.
[2] Proportion of non-native plant cover in south dyke area is likely an overestimate of the proportion for entire footprint because the survey locations were selected based on those with highest potential to have non-native plants (see Section 2.12).
[3] Change from 2018 to 2019; A negative sign means that extent decreased.

Non-native plant extent apparently decreased in several of the surveyed Project components, including the North and South Access Roads, and borrow areas. Increases occurred in the remaining components, with the largest being in the North Dyke. Non-native plants were most widespread in the camp and work areas and North Dyke, and were least widespread along the South Dyke (Map 3-2 to Map 3-6). For the Project components other than the South Dyke, plants were distributed over 4.9% to 13.1% of the surveyed areas. The largest increases in non-native plant extent since late-summer 2018 were along the North Dyke.

Total non-native plant cover increased to 6.0 ha by late summer, 2019, or 0.86% of the total surveyed area (Table 3-2). This was only a 0.2 ha increase from 2018, however the total cover as a percentage of area surveyed decreased slightly. Cover decreased in all surveyed Project components except the South Access Road and North Dyke.

Table 3-2: Total late summer non-native plant cover as a percentage of total area surveyed, by year[1] and Project component

Project Component	2014	2015	2016	2017	2018	2019	Change[3]
North Access Road	0.01	0.07	0.25	0.38	0.62	0.45	-0.17
South Access Road	-	-	0.01	0.36	1.21	2.17	0.96
Camp and Work Areas	0.34	0.77	0.58	0.73	1.20	1.05	-0.15
Borrow Areas	0.05	0.48	0.24	0.46	0.74	0.64	-0.11
North Dyke	-	-	0.00	0.01	0.79	1.10	0.30
South Dyke[2]	-	-	0.00	0.02	0.02	0.00	-0.02
Generating Station Area	-	-	0.03	0.00	-	-	-
Reservoir Clearing Area	-	-	-	-	-	-	-
All surveyed area	0.20	0.59	0.31	0.44	0.88	0.86	-0.02
Total non-native plant cover (ha)	*0.53*	*1.49*	*1.89*	*2.98*	*5.85*	*6.02*	
Total area surveyed (ha)	*269*	*251*	*620*	*671*	*668*	*703*	

Notes: Numbers that round to zero shown as "0"; absences shown as "-".
[1] Plant extent in some components are not directly comparable with other years because surveyed areas may change due to accessibility.
[2] Proportion of non-native plant cover in south dyke area is likely an overestimate of the proportion for entire footprint. See Section 2.1.
[3] Change from 2018 to 2019; A negative sign means that cover decreased.

As a percentage of surveyed area, non-native plant cover was highest (2.2%) along the surveyed segments of the SAR, followed by the North Dyke, the camp and work areas, the borrow areas and the NAR.

While non-native plants continued to colonize or spread in the more recently cleared areas, their cover remained comparatively low in these areas. The majority of the non-native species found in each year since 2015 were in the portions of the Project footprint originally created by or existing before KIP, and which are still being used by the Project (e.g., Start-up Camp, Borrow Area G-1).

Non-native plant extent was highest by far (21.0%) in footprints that were used for the KIP, but have not been further used by the Project (Appendix 4, Table 7-7). Non-native plant cover was

highest (1.4%) in areas utilized by both KIP and the Project, which was similar to what was found in 2018 (Appendix 4, Table 7-8). In portions of the footprint that had not been used since the KIP (with the exception of sites where tree planting was conducted), there was a decrease in both extent and cover of non-native plants each year from 2017 to 2019. In areas used for the KIP that continue to be used by the Project, both non-native plant extent increased from 2018 to 2019, but cover decreased very slightly, which was a change from the previous year, where cover had increased substantially in these areas.

Areas that were more recently cleared, and used only for the Project, had substantially lower non-native plant extent and cover (5.2% and 0.5%, respectively). These were small increases for both metrics since 2018.

In 2019, the distribution of non-native plants on the north and south sides of the Nelson River (Map 3-2 to Map 3-6) was broadly similar to that of 2018 (ECOSTEM 2019), particularly in areas that were utilized by both the KIP and the Project. Since 2018, non-native plants expanded along the North Dyke and the SAR.

Non-native plants also increased in the Excavated Material Placement Areas (EMPAs) that have had minimal construction activity since 2017. These included EMPA D16, D17, and the EMPAs along the North Dyke, particularly D12.

The largest increase in non-native plant extent and cover was observed along the North Dyke (Table 3-1 and Table 3-2). Non-native plants began to expand more rapidly along the North Dyke in 2018, and this had continued up to late summer 2019. While non-native plant extent along the SAR declined slightly since late-summer 2018, total cover nearly doubled.

Non-native plant cover in 2019 had declined around the offices and Hydro yard in Work Area B, and in Work Area C, as well as around the Start-up Camp and Main Camp.

Non-native plants were continuing to spread around the perimeter of Borrow Area G-3, but total cover had declined in nearby Borrow Area N-5 and in its attached EMPA (EMPA D35). In Borrow Area G-1 at KM 15, non-native plant cover had declined since 2018, however it had increased in the more active portion of the area at KM 17.

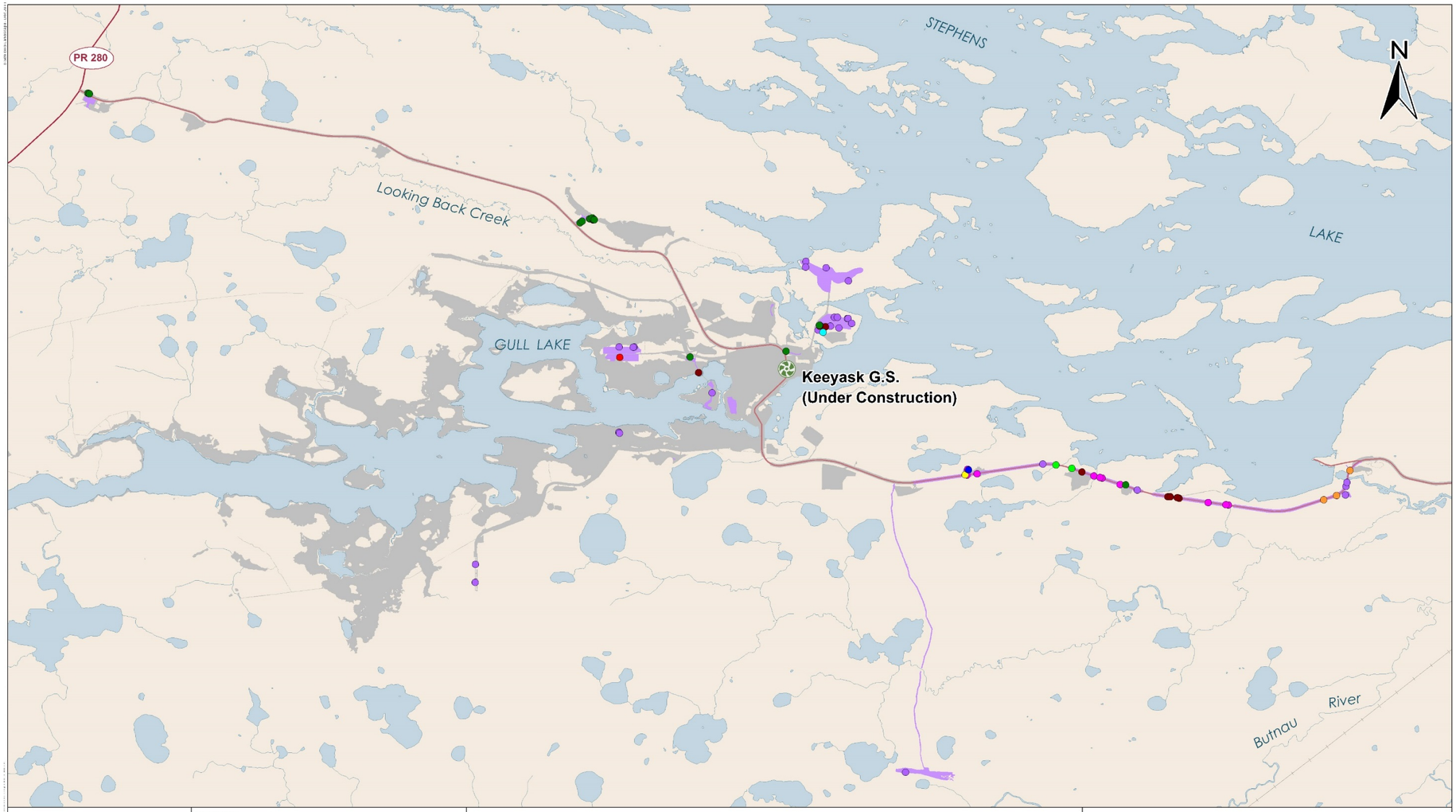
Clearing for the Ellis Esker borrow area (Borrow Area E-1) occurred during the winter of 2017/2018, was in use up to the winter of 2018/2019 after which excavation ceased there. Cleared areas included the winter access road corridor and the borrow area. By late summer 2019, a few patches of non-native plants had established at one site near the edge of the borrow area, and a single plant had established at a site in the access corridor (Map 3-6).

The westernmost 3 km of the SAR was not surveyed in 2018 or 2019 due to heavy construction traffic. For the remainder of the SAR, non-native plant cover had nearly doubled since 2018, with the largest increases occurring east of the Butnau Marina (Map 3-5). Decommissioning of the Sigfusson Northern/Voltage Camp and offices (formerly the SAR Camp) appeared to remove the non-native plant cover that was previously present in 2018. Plants continued to spread in Borrow Area Q-9, and were also establishing in Borrow Area S-2b, which was not accessible for surveys

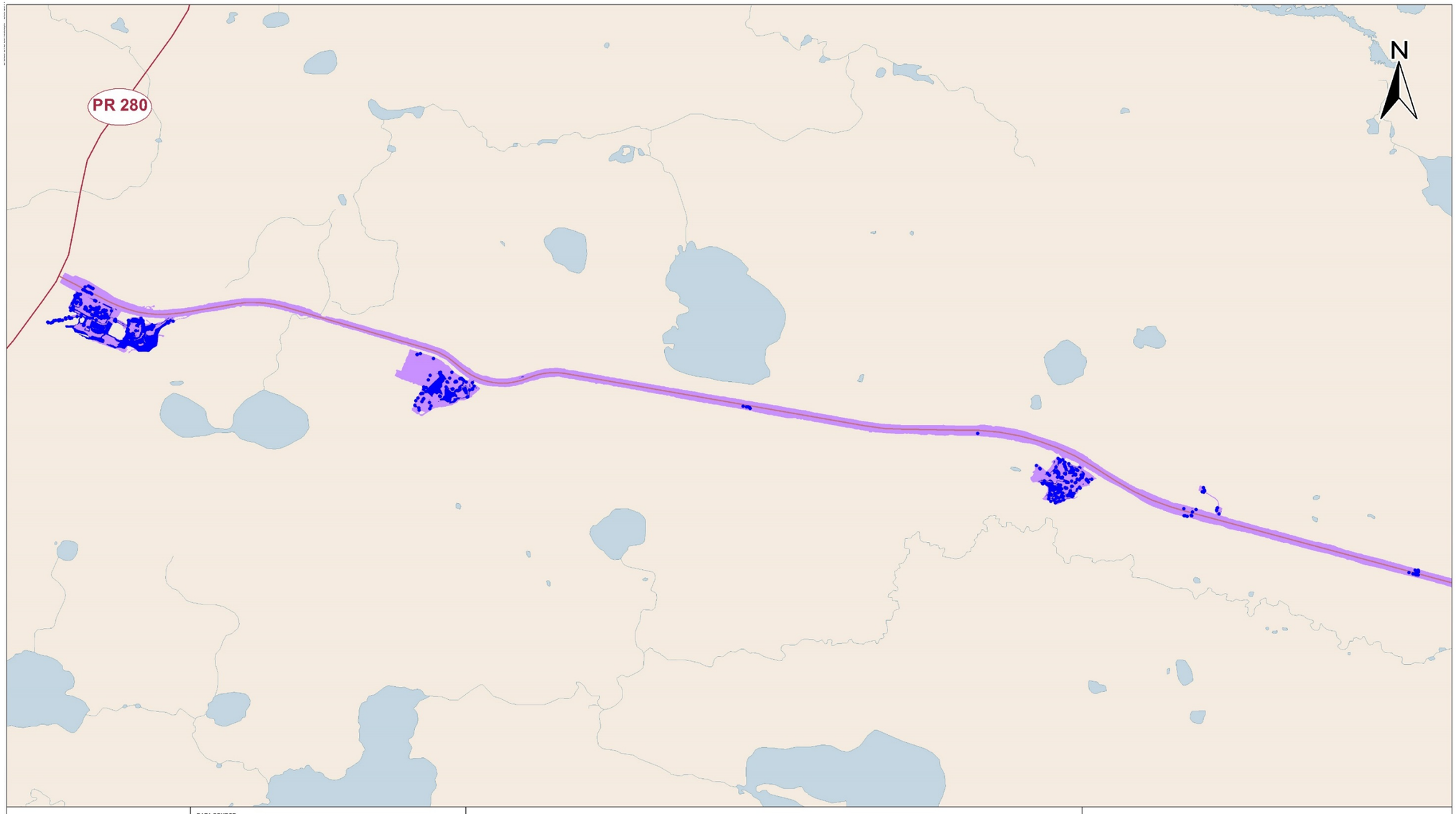
in 2018. Plants also continued to spread in the portion of Borrow Area B-2 where a temporary camp had been previously located.

While non-native plant cover was expanding along the western portions of the SAR, most of the non-native plant cover along the SAR occurred in the ditches east of the Butnau Marina, where the ROW was either in close proximity to or overlapped the old Butnau Road (Map 3-5). Non-native plant extent and cover had been expanding along this portion of the road since 2018, as well as in the west and east sections of Borrow Area B-6, and in Borrow Area B-8.

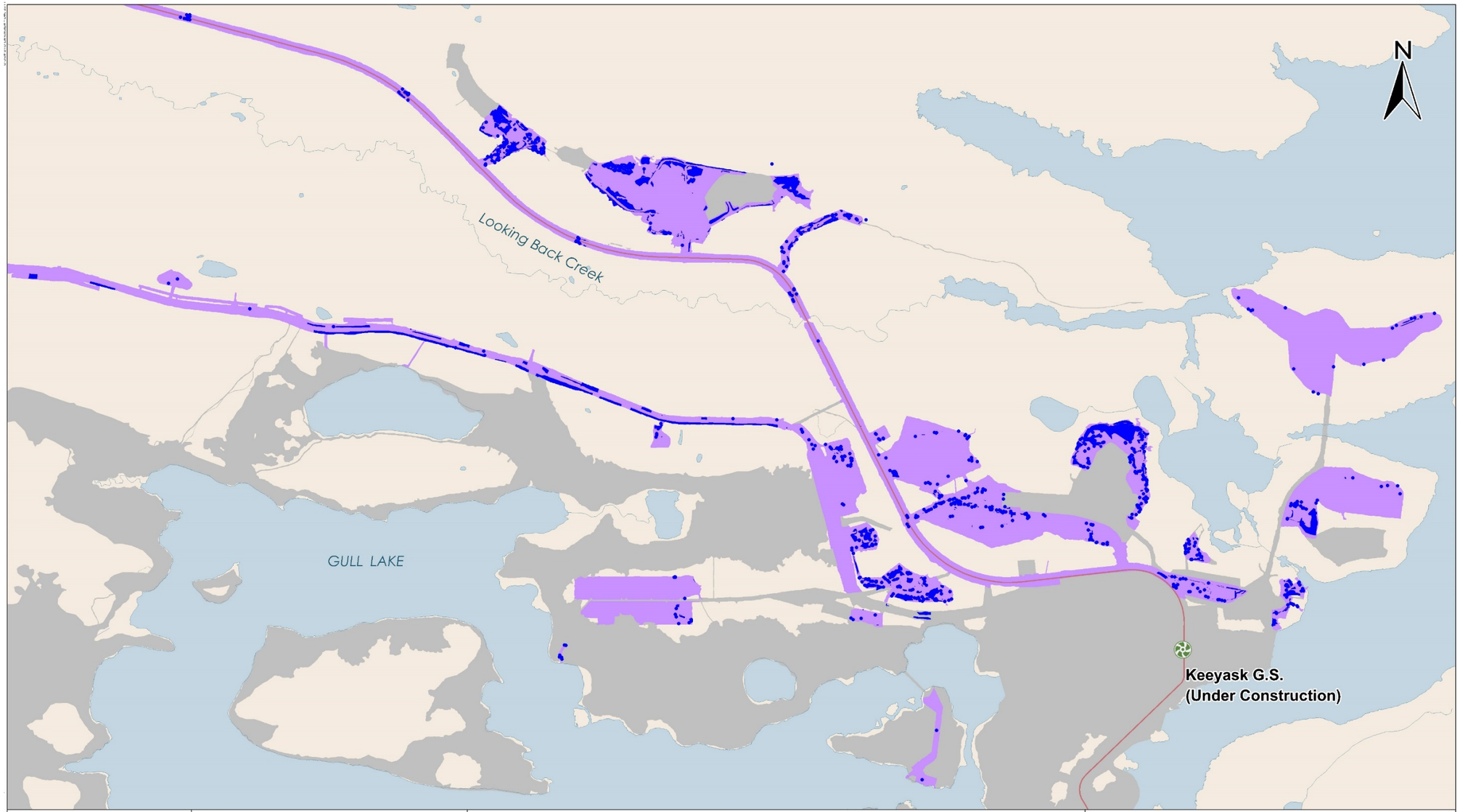
Non-native plant cover along the surveyed portions of the South Dyke remained similar to that recorded in 2018 (Map 3-6). Plant cover remained low overall in late summer 2019, but construction activity along the dyke prevented surveys at many locations that were surveyed in 2018. It is highly likely that some of the plant sites in 2018 have been removed by construction activities in 2019, particularly in Borrow Area S-17a.



Map 3-1: Distribution of non-native plants within the Project footprint during early summer, 2019

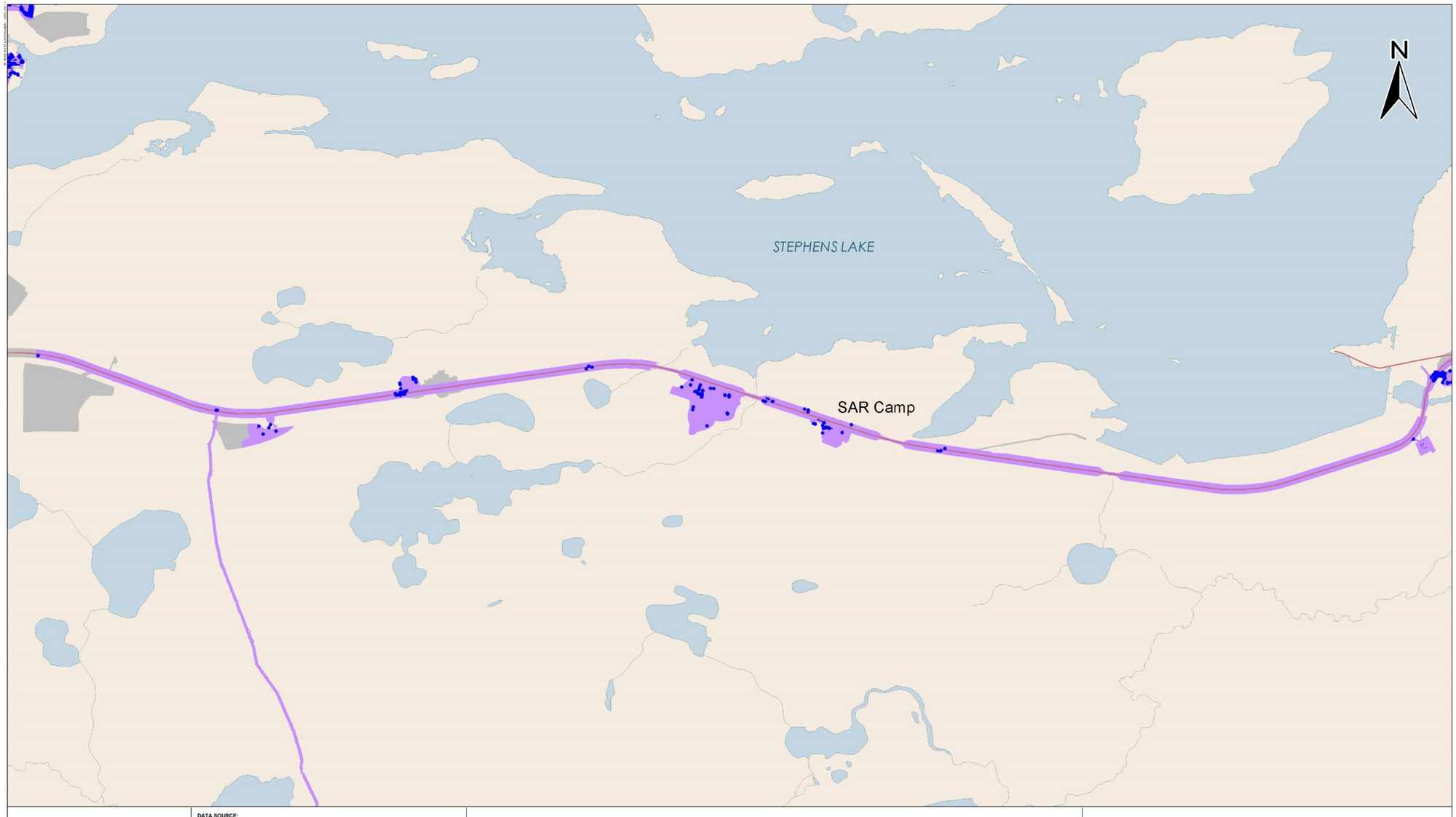


Map 3-2: Distribution of non-native plants during late summer 2019, in the Project footprint along the western portion of the North Access Road



Drag

Map 3-3: Distribution of non-native plants during late summer 2019, in the Project footprint along the eastern portion of North Access Road



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Plant Locations and Survey Areas - ECOSTEM Ltd.; Water, Roads and Rail - Manitoba Hydro

CREATED BY:
ECOSTEM Ltd.

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	24-APR-20	24-APR-20
0 400 800 Metres 0 800 1600 Feet	VERSION NO: 1.0	QA/QC: JWE/YYY/ZZZ

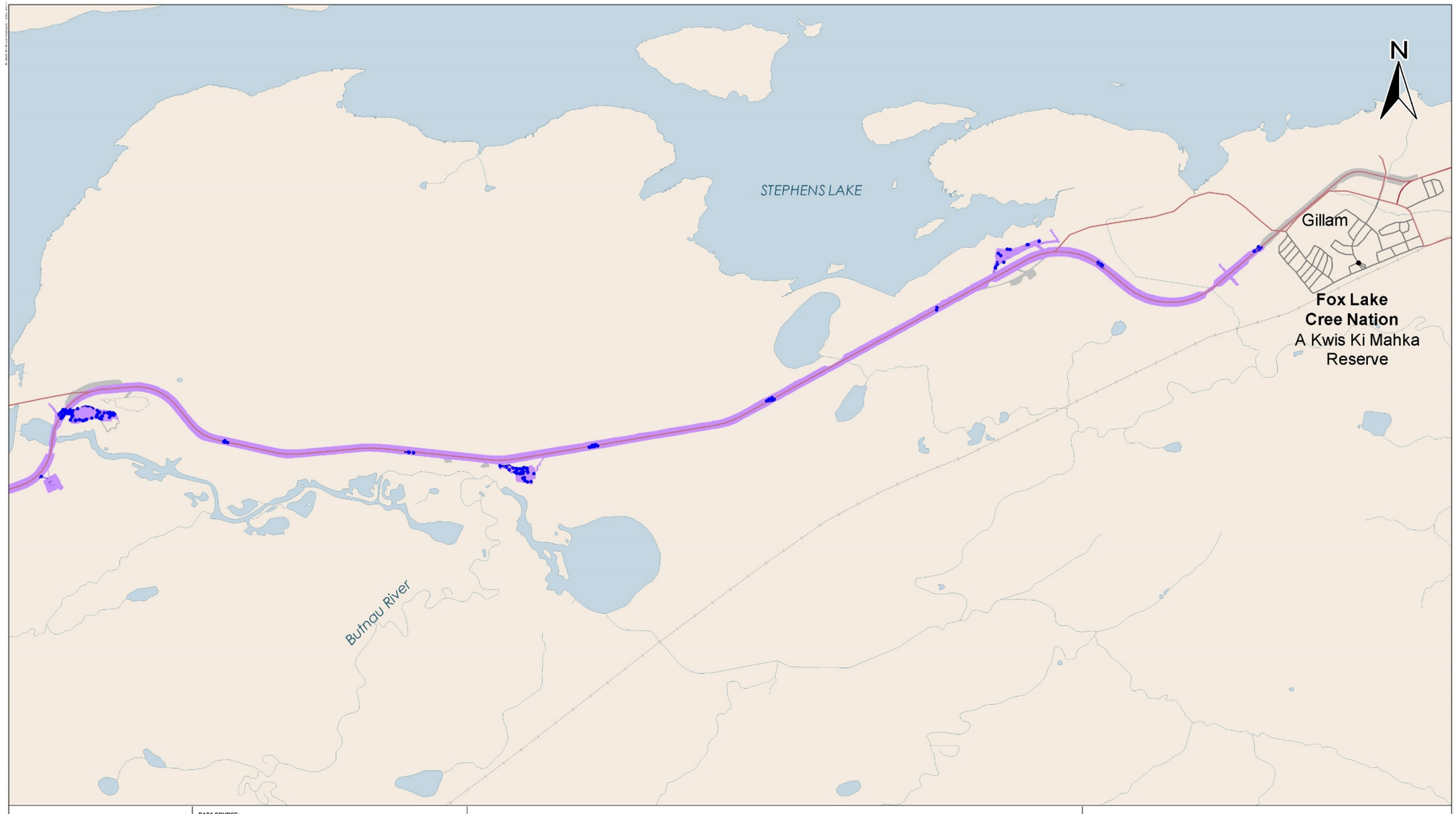
Legend
- Non-native Plant Individual
- Non-native Plant Patch

Non-native Plant Survey Areas in the Project Footprint
- Surveyed in Late Summer 2019
- Not Surveyed in Late Summer 2019

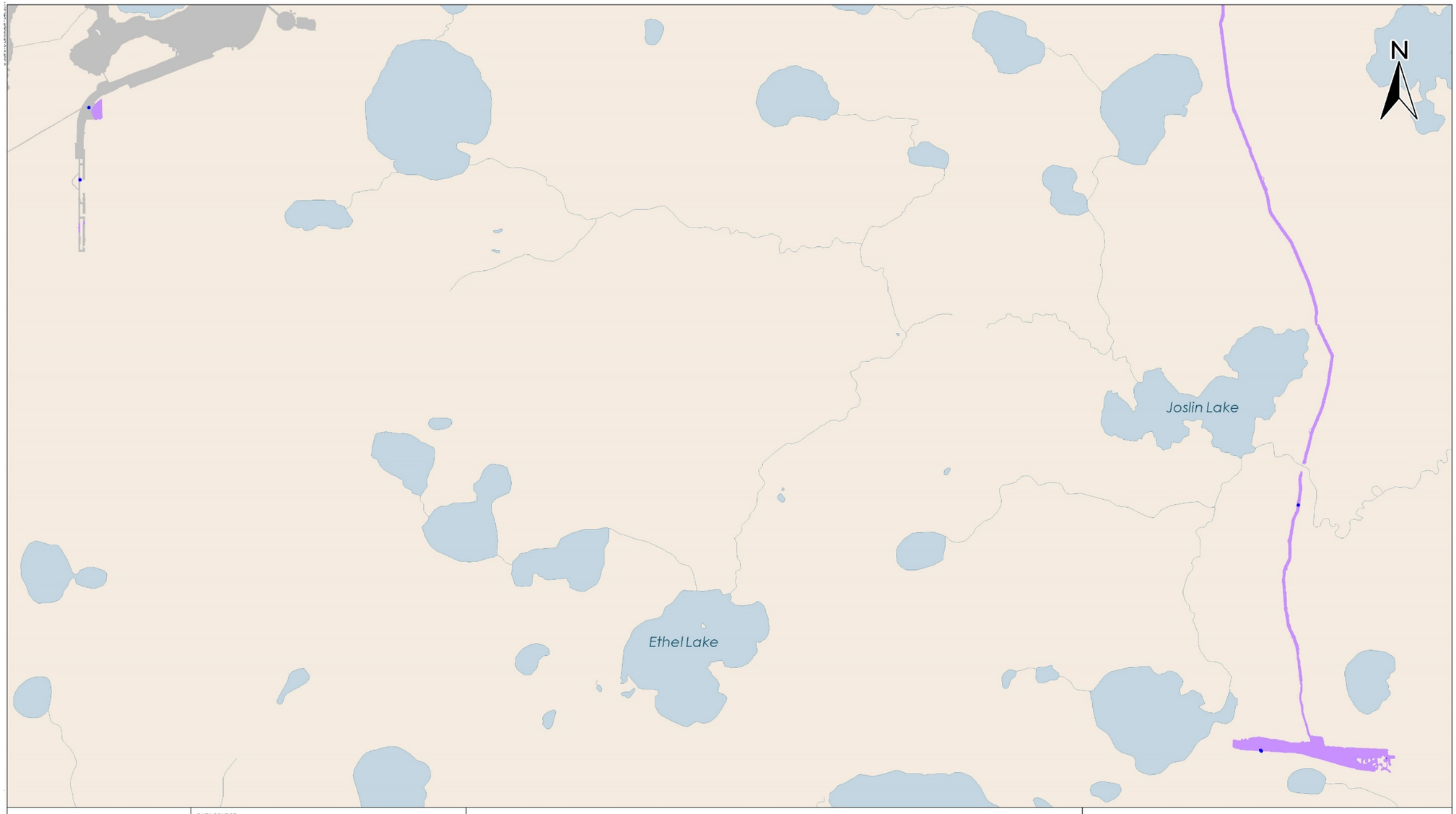
Infrastructure
- Secondary Road

Distribution of Non-native Plants
Late Summer 2019
Western Portion of SAR

Map 3-4: Distribution of non-native plants during late summer 2019, in the Project footprint along the western portion of the South Access Road



Map 3-5: Distribution of non-native plants during late summer 2019, in the Project footprint along the eastern portion of the South Access Road



Map 3-6: Distribution of non-native plants during late summer 2019, in the Project footprint in the Ellis Esker area

3.3 CHANGES TO SPECIES DISTRIBUTION AND ABUNDANCE

A total of 25 non-native plant species were recorded in 2019 (Appendix 4, Table 7-6) from the non-native plant monitoring and from incidental observations. This was three more than recorded in 2018. The distribution and abundance of the five most abundant non-native species recorded in 2019 in Project footprints north and south of the Nelson River are shown in Map 7-1 to Map 7-20 in Appendix 3.

The four most abundant non-native species in 2019 (Table 3-3) accounted for 85% of all non-native plant cover (Table 3-4). These species were lamb's quarters (*Chenopodium album*), narrow-leaved hawks-beard (*Crepis tectorum*), white sweet clover (*Melilotus albus*) and common dandelion (*Taraxacum officinale*), each accounting for 43%, 18%, 13% and 11% of the total non-native cover in 2019, respectively (Table 3-4). The next most abundant species was field sow-thistle (*Sonchus arvensis*) (6% of the total non-native cover), followed by seven species at between one and two percent.

Only two of the five most abundant species increased in cover since 2018. Both lamb's-quarters and field sow-thistle cover increased by approximately 30% since late summer 2018. White sweet clover and common dandelion cover both decreased by a similar proportion, and narrow-leaved hawks-beard cover was slightly lower compared with 2018.

Three species were recorded for the first time in 2019. These included shepherd's-purse (*Capsella bursa-pastoris*), wormseed mustard (*Erysimum cheiranthoides*) and spotted lady's-thumb (*Persicaria maculosa*). Shepherd's purse was found at a single site in the Start-up Camp. Wormseed mustard was widespread in EMPA D12, and spotted lady's-thumb was found growing on moist mineral soil in EMPA D12 and Borrow Area B-5. Species found during previous surveys but not recorded again in late summer 2019 (Table 3-3) included wormwood (*Artemisia absinthium*), black medick (*Medicago lupulina*), rye (*Secale cereal*) and wheat (*Triticum aestivum*).

For rye, five individuals were found growing at three nearby sites beside the Start-up Camp in 2014. These plants were never found there again during subsequent surveys. Wheat was found growing from straw bales brought on site in 2016, but had disappeared by late summer 2019.

Cover for each of wormwood, black medick and bird's-foot trefoil was extremely low in surveys from previous years. These plants may still be present in the Project footprint, but were not detected at the time of the 2019 surveys.

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

Common Name[1,2]	Species	2014	2015	2016	2017	2018	2019
Lamb's-quarters	*Chenopodium album*	2,903	8,844	6,342	15,229	19,812	25,817
Narrow-leaved Hawks-beard	*Crepis tectorum*	-	-	586	1,314	11,040	10,808
White Sweet Clover	*Melilotus albus*	532	2,252	3,015	4,949	11,591	7,839
Common Dandelion	*Taraxacum officinale*	1,291	2,422	5,268	5,521	10,302	6,792
Field Sow-thistle	*Sonchus arvensis*	252	972	1,111	1,656	2,562	3,338
Yellow Sweet Clover	*Melilotus officinalis*	0	2	109	254	543	1,235
Alsike Clover	*Trifolium hybridum*	25	242	190	91	833	1,021
Unidentified Sweet Clover	*Melilotus* spp.	72	-	1,838	67	307	851
Common Plantain	*Plantago major*	80	121	268	246	741	674
Tufted Vetch	*Vicia cracca*	-	-	0	38	170	563
Wormseed Mustard	*Erysimum cheiranthoides*	-	-	-	-	-	495
Smooth Catchfly	*Silene csereii*	-	5	26	32	294	338
Curled Dock	*Rumex crispus*	-	-	100	19	148	204
Alfalfa	*Medicago sativa*	124	11	14	40	98	102
Spotted Lady's-thumb	*Persicaria maculosa*	-	-	-	-	-	77
Pineappleweed	*Matricaria discoidea*	-	18	29	325	74	32
Common Burdock	*Arctium minus*	-	-	0	-	5	5
Canada Thistle	*Cirsium arvense*	-	0	0	1	2	1
Bird's-foot Trefoil	*Lotus corniculatus*	-	-	0	0	-	0
Common Tansy	*Tanacetum vulgare*	-	-	-	-	0	0
Shepherd's-Purse	*Capsella bursa-pastoris*	-	-	-	-	-	0
Common Timothy	*Phleum pratense*	-	-	0	0	0	0
Red Clover	*Trifolium pratense*	0	0	-	1	0	0
White Clover	*Trifolium repens*	0	0	0	-	-	0
Unidentified Clover	*Trifolium* spp.	-	-	-	-	-	0
Scentless chamomile	*Tripleurospermum inodorum*	-	0	0	0	1	0
Ox-eye Daisy	*Leucanthemum vulgare*	-	-	-	-	0	0
Wormwood	*Artemisia absinthium*	-	0	1	1	1	-
Black Medick	*Medicago lupulina*	0	1	-	0	-	-
Rye	*Secale cereale*	0	-	-	-	-	-
Wheat	*Triticum aestivum*	-	-	30	21	-	-
All species		*5,280*	*14,890*	*18,927*	*29,805*	*58,524*	*60,191*

Notes: Numbers that round to zero shown as "0"; absences shown as "-". [1] Bolded species are Level 1 invasive concern (Table 2-7). 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 3-4: Total approximate cover of a non-native species as a percentage of total cover for all non-native species, by year

Common Name[1,2]	Species	2014	2015	2016	2017	2018
Lamb's-quarters	*Chenopodium album*	55	59	34	51	34
White Sweet Clover	*Melilotus albus*	10	15	16	17	20
Narrow-leaved Hawks-beard	*Crepis tectorum*	-	-	3	4	19
Common Dandelion	*Taraxacum officinale*	24	16	28	19	18
Field Sow-thistle	*Sonchus arvensis*	5	7	6	6	4
Alsike Clover	*Trifolium hybridum*	0	2	1	0	1
Common Plantain	*Plantago major*	2	1	1	1	1
Yellow Sweet Clover	*Melilotus officinalis*	0	0	1	1	1
Unidentified Sweet Clover	*Melilotus* spp.	1	-	10	0	1
Smooth Catchfly	*Silene csereii*	-	0	0	0	1
Tufted Vetch	*Vicia cracca*	-	-	0	0	0
Curly Dock	*Rumex crispus*	-	-	1	0	0
Alfalfa	*Medicago sativa*	2	0	0	0	0
Pineappleweed	*Matricaria discoidea*	-	0	0	1	0
Common Burdock	*Arctium minus*	-	-	0	-	0
Canada Thistle	*Cirsium arvense*	-	0	0	0	0
Wormwood	*Artemisia absinthium*	-	0	0	0	0
Scentless chamomile	*Tripleurospermum inodorum*	-	0	0	0	0
Ox-eye Daisy	*Leucanthemum vulgare*	-	-	-	-	0
Common Timothy	*Phleum pratense*	0	0	-	0	0
Common Tansy	*Tanacetum vulgare*	-	-	-	-	0
Red Clover	*Trifolium pratense*	-	-	0	0	0
Bird's-foot Trefoil	*Lotus corniculatus*	-	-	0	0	-
Black Medick	*Medicago lupulina*	0	0	-	0	-
Rye	*Secale cereale*	0	-	-	-	-
White Clover	*Trifolium repens*	0	0	0	-	-
Wheat	*Triticum aestivum*	-	-	0	0	-
All species		*100*	*100*	*100*	*100*	*100*

Notes: Numbers that round to zero shown as "0"; absences shown as "-". [1] Bolded species are Level 1 invasive concern (Table 2-7). 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*.

3.4 NON-NATIVE PLANTS IN THE SHORE ZONE

A total of 108 m^2 of non-native plant cover was recorded along the approximately 41.9 km of shoreline surveyed in 2019 (Table 3-5). Just over two-thirds of the total cover was upstream of the generating station.

Non-native plant cover was distributed fairly evenly between the upstream and downstream portions of the Nelson River shoreline. When expressed in a per kilometer of shoreline basis, the total cover upstream and downstream was similar, at 2.3 m^2/km and 2.0 m^2/km, respectively (Table 3-5). Non-native plant cover was lower along Little Gull Lake, which is not currently connected to the Nelson River (1.3 m^2/km).

A total of nine non-native plant species were recorded in the shore zone (Table 3-6). Of these, common plantain was the most abundant, making up more than half (57%) of the total cover. This was followed by alsike clover (*Trifolium hybridum*; 25%) and field sow-thistle (12%).

The distribution of the species was not even across the hydraulic zones (Map 3-7 and Map 3-8). Common plantain was widely distributed, but found only upstream of the generating station, while alsike clover was found in a single large patch on an island in Stephens Lake (near a cabin). Field sow-thistle was distributed in both the upstream and downstream zones of the Nelson River. Three species (narrow-leaved hawks-beard, curled dock and common dandelion) were recorded along the Little Gull Lake shoreline, and none of them were found on the Nelson River shoreline.

Of the species found in the shore zone, three were at a higher level of invasive concern (Level 2; Section 2.6.2). These included field sow-thistle, tufted vetch and white sweet clover. Field sow-thistle was distributed at 19 sites upstream and downstream of the generating station (Map 3-7 and Map 3-8). Tufted vetch occurred in a band along the shore at a single site on the south side of the Nelson River upstream of Gull Lake. White sweet clover was found growing at a single site on the shoreline approximately 1 km upstream from the tufted vetch location.

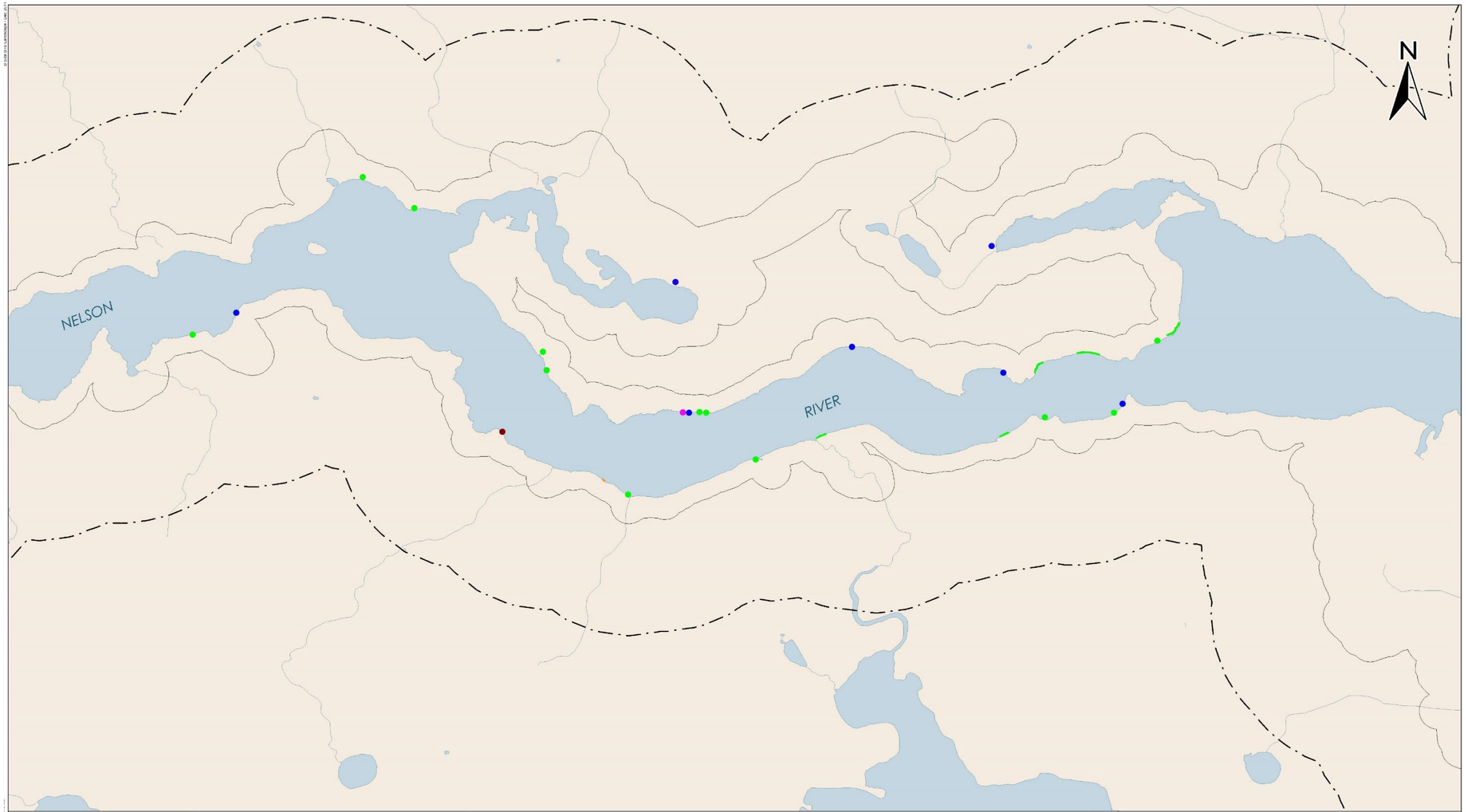
Table 3-5: Non-native plant cover along the surveyed shoreline by hydraulic zone in 2019

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)
Nelson River Upstream	31.5	74	2.3
Little Gull Lake	1.4	2	1.3
Nelson River Downstream	16.2	32	2.0
All	*49.1*	*108*	*2.2*

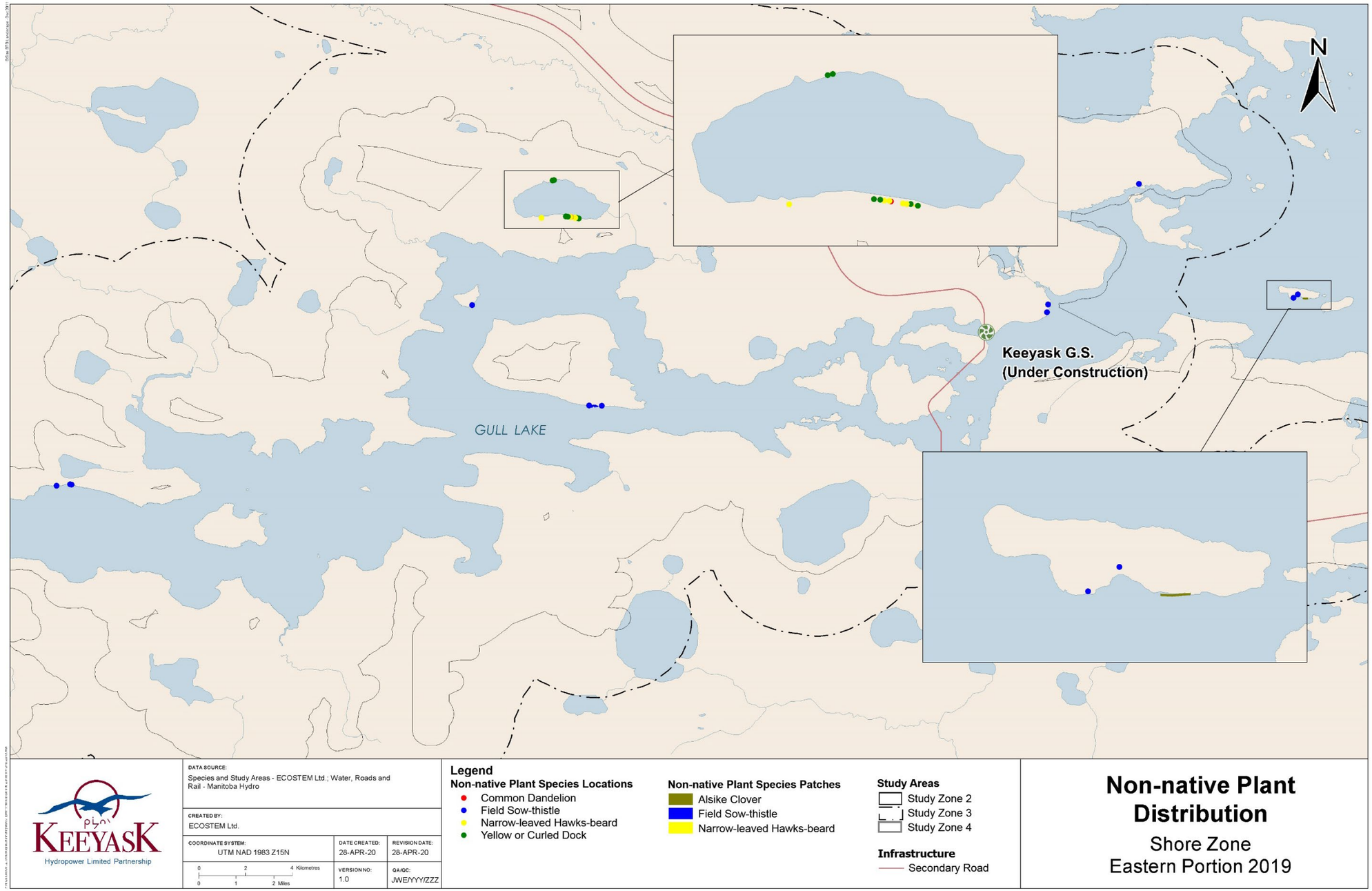
Table 3-6: Non-native plant species in the surveyed shore zone in 2019 by hydraulic zone

Common Name[1]	Species	All Zones		Nelson River Upstream		Little Gull Lake		Nelson River Downstream	
		Total cover (m^2)	Number of sites	Total cover (m^2)	Number of sites	Total cover (m^2)	Number of sites	Total cover (m^2)	Number of sites
Lamb's-quarters	*Chenopodium album*	0.2	1	0.2	1	-	-	-	-
Narrow-leaved Hawks-beard	*Crepis tectorum*	0.4	6	-	-	0.4	6	-	-
White Sweet Clover	*Melilotus albus*	0.2	1	0.2	1	-	-	-	-
Common Plantain	*Plantago major*	61.1	19	61.1	19	-	-	-	-
Yellow or Curled Dock	*Rumex crispus*	1.3	6	-	-	1.3	6	-	-
Field Sow-thistle	*Sonchus arvensis*	12.0	19	5.3	14	-	-	6.7	5
Common Dandelion	*Taraxacum officinale*	0.1	2	-	-	0.1	2	-	-
Alsike Clover	*Trifolium hybridum*	25.2	1	-	-	-	-	25.2	1
Tufted Vetch	*Vicia cracca*	7.2	1	7.2	1	-	-	-	-
All		*107.7*	*56*	*74.0*	*36*	*1.8*	*14*	*31.9*	*6*

Notes: Numbers that round to zero shown as "0"; absences shown as "-". [1] Bolded species are Level 1 invasive concern (Table 2-7). 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 western surveyed portions of the Keeyask hydraulic zone of influence shoreline in 2019



Map 3-8: Non-native plants in the shore zone of eastern surveyed portions of the Keeyask hydraulic zone of influence shoreline in 2019

4.0 EFFORTS TO MANAGE INVASIVE PLANTS

Non-native species that were candidates for management measures included all of the species that were of the highest invasive concern for the Project footprint (i.e., Level 1 species; Section 2.4.3). Level 2 species were candidates for management measures if they were not already well-established in multiple locations. Level 3 and Level 4 species could be opportunistically included within locations where Level 1 or 2 species are treated.

Nine of the 25 non-native species recorded in 2019 (Appendix 4, Table 7-6) were classified as being Level 1 or 2 (Table 2-7), which are the levels of the highest invasive concern for the Project footprint. Of these, none were an ISCM Category 1 species, and none were a Tier 1 species in the *Noxious Weeds Act* of Manitoba.

Level 1 species (Table 2 4) included ox-eye daisy, scentless chamomile and common tansy. Level 2 species included Canada thistle, field sow-thistle, tufted vetch, common burdock, and white and yellow sweet clover.

Strategies employed to date to manage non-native plants include prevention, eradication and control. Prevention measures are included in the Environmental Protection Plans (e.g., washing equipment before transporting to site). Examples of other prevention measures are: monitoring staff clean their footwear before they leave a surveyed area; and site environmental staff have received non-native plant identification training and resources.

The three primary methods employed to date to eradicate or control Level 1 and 2 plants were rapid manual removal, herbicide treatments, and mowing at key sites. The following describes the eradication or control measures implemented to date.

4.1 RAPID MANUAL REMOVAL AND OTHER NON-CHEMICAL ACTIONS

The rapid manual removal strategy was applied to Level 1 plants at sites with one to a few plants (see Section 2.6.3 for the removal methods). Such plants were immediately removed when they were found.

4.1.1 LEVEL 1 NON-NATIVE SPECIES

The three Level 1 non-native species recorded in 2019 were ox-eye daisy, scentless chamomile and common tansy. All three species are an ISCM Category 2 species or a Tier 2 species in the

provincial *Noxious Weeds Act* (Table 2-7). Scentless chamomile and ox-eye daisy are also weed seed plants in the federal Weed Seeds Order.

To date, the rapid manual removal appears to have been effective for the Level 1 species (Section 2.6.3). The following describes the situations for individual species.

Ox-eye Daisy

Ox-eye daisy is an introduced ornamental perennial (Photo 4-1). It can quickly spread by both seed and rhizomes (ISCM 2020).

In August 2019, one ox-eye daisy plant was found growing in Borrow Area Q-9 (Photo 4-1; Appendix 3, Map 7-21). The plant was removed by ECOSTEM field staff after it was recorded. A single ox-eye daisy plant that was found in Borrow Area G-1 in 2018 was not removed because ECOSTEM staff had to leave the area in response to a weather alert (ECOSTEM 2019b). That plant was removed in early summer, 2019. No other plants were found nearby in 2019.

Sites that had ox-eye daisy plants that were removed in 2018 were revisited in 2019. These sites included one in Borrow Area G-1 and one at the Sigfusson Northern/Voltage Camp. Neither of these sites had any ox-eye daisy plants in late summer 2019.

Scentless Chamomile

Scentless chamomile (Photo 4-2) is an annual to short-lived perennial. It is a fast-growing prolific seed producer that can form dense monocultures (LSSG 2010).

Field surveys identified one scentless chamomile plant in the Start-up Camp footprint (on the path to the well in 2015), in EMPA D17 in 2016, and in EMPA D16 in 2017, and several plants were found in the Start-up Camp, EMPA D16, and Work Area B in 2018 (Appendix 3, Map 7-22). Shortly after the 2015 and 2016 plants were found, it was recommended that Manitoba Hydro site staff remove and dispose of these plants using the preferred method. Manitoba Hydro site staff carried out the scentless chamomile plant removal shortly thereafter. ECOSTEM staff removed the plants found in 2017 and 2018.

The sites where scentless chamomile plants had been removed in prior years were revisited in 2019. These sites had no scentless chamomile plants.

In August 2019, scentless chamomile was found growing at three new sites: one in the ring road ditch in the Main Camp, and two in EMPA D16 (Photo 4-2). All of these plants were immediately removed and disposed of by ECOSTEM field staff.

Common Tansy

Common tansy (Photo 4-3) is a perennial that spreads through seeds and its extensive root system. Seeds from this plant can germinate after being in the ground for up to 25 years (ISCM 2020).

Common tansy was found growing at a single site along the North Dyke in late summer, 2019 (Photo 4-3; Appendix 3, Map 7-23). The plant was immediately removed by ECOSTEM field staff.

Common tansy was found growing at another site along the North Dyke in 2018. It was immediately removed by ECOSTEM staff. Visits to the site in 2019 did not find any new plants at that site.

Photo 4-1: Ox-eye daisy growing in Borrow Area Q-9 on August 26, 2019

Photo 4-2: Scentless chamomile growing in EMPA D16 on August 23, 2019

Photo 4-3: Common tansy growing beside the North Dyke on August 20, 2019

4.1.2 LEVEL 2 NON-NATIVE SPECIES

Six Level 2 non-native species were recorded in 2018. Of these, the ISCM "other" species included Canada thistle, field sow-thistle, common burdock (*Arctium minus*), and tufted vetch. The first three 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 2-7).

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

Canada Thistle

Canada thistle is a perennial that has the capacity to proliferate from roots left in the ground after manual removal, and infestations can develop quickly (Saskatchewan Ministry of Agriculture 2008; Manitoba Agriculture 2019).

Canada thistle is the only Level 2 species that, in addition to meeting the criteria for inclusion in this level, is also a provincial Tier 3 noxious weed, a White *et al.* moderate invasive and a federal weed seed (Section 2.6.2).

Canada thistle was found at three sites during the 2015 and 2016 surveys (Appendix 3, Map 7-24). Plants were not observed again at one of the sites during surveys in subsequent years. The remaining two sites were included in the areas treated with herbicides (see Section 4.2).

Surveys in 2017 found two new sites with Canada thistle, one with two individuals near the south ditch surrounding the Start-up Camp, and one small patch at the eastern corner of Borrow Area KM-4. Because the patches were small, it was recommended that the plants be removed where feasible (Hutchinson 1992; Alberta Invasive Plant Council 2014). The preferred disposal method was the same as the one described above for scentless chamomile, with particular attention to removing the main root to the extent feasible. The plants at the latter site were removed and disposed of by ECOSTEM field staff in 2017. ECOSTEM field staff returned to the site at the Start-up Camp in 2017, and no new plants were found. However, plants at both sites had re-established in 2018, and were removed by ECOSTEM field staff in early and late summer. Surveys in September 2019 found that the plants had re-established in both the Start-up Camp and Borrow Area KM-4 in 2019.

Canada thistle was found at other sites in 2018. One site was a small patch growing next to the North Dyke. These plants were removed by ECOSTEM staff. The second site was a more extensive patch in the ditch along the NAR (Appendix 3, Map 7-24). This patch was too extensive and interspersed among other plants to be removed by hand. The plants at both of these sites were not found again in 2019. No new sites for Canada thistle were found in 2019.

Canada thistle is known to have the capacity to proliferate from roots left in the ground after manual removal, and infestations can develop quickly (Saskatchewan Ministry of Agriculture

2008; Manitoba Agriculture 2019). As plants have reappeared after more than one removal, it is apparent that root systems have become established.

The overall management strategy for Canada thistle was modified after 2018 because plants reappeared in the same site after several removals and manual removal can amplify vegetative spread. Canada thistle plants will no longer be removed at sites where the plants are mature or where they have reappeared after one removal of a plant. While manual removal will continue to include roots, there will be increased efforts to remove all of them at sites with one to a few plants.

Because there was only a single plant found at the previously known site in the Start-up Camp, it was removed by ECOSTEM staff in 2019.

Field Sow-Thistle

Field sow-thistle is a perennial that can spread both through seeds as well as through an extensive root system, and are capable of reducing the number of plant species in communities (ANHP 2011e; Manitoba Agriculture 2019).

Field sow-thistle was already sparsely but fairly widespread in the Project footprint, and in disturbed areas throughout the Keeyask region, prior to the Project. By 2015, field sow-thistle was already becoming well established in Project footprint components that were previously utilized by the KIP, particularly at the Start-up Camp, and in Borrow Area G-1 at KM-15. To limit further spread, ECOSTEM field staff implemented the rapid manual removal protocol at sites where only a small number of plants were present during the 2017, 2018 and 2019 surveys.

Of the sites containing field sow-thistle, Borrow Area G-1 at KM-15 and the Main Camp were treated with herbicide in early August, 2019. Several areas were also targeted for mowing (see Section 4.2). Monitoring in 2020 will assess the effectiveness of both the herbicide treatment and mowing on controlling this species at these sites.

Results from the 2019 late summer survey indicated that field sow-thistle cover continued to expand in all sites that it was already established in, and had expanded into some new sites, specifically along the North Dyke (Photo 4-4). The patches along the North Dyke were too large for manual removal at the time of the survey.

The best form of control for field sow-thistle is removing or killing the plants before the extensive root system develops (Manitoba Agriculture 2019). Like Canada thistle, field sow-thistle infestations can develop quickly from roots left in the ground after manual removal. The overall management strategy for field sow-thistle is the same as described for Canada thistle.

Photo 4-4: Field sow-thistle patch growing along the North Dyke in August, 2019.

Common Burdock

Common burdock is a biennial plant forming a rosette in the first year, and a tall flowering stem in the second year (AISC 2014). The plant proliferates by seed, and the large basal leaves can shade out other herbaceous plants favouring its own species (ANHP 2010; AISC 2014).

In 2016, a single common burdock plant was found growing near the Main Camp.

The plant's remains, along with its attached burrs, were removed by ECOSTEM staff in early summer 2017. No new plants were found in 2017. However, by early summer 2018, a patch with many small plants was found growing at that site (Appendix 3, Map 7-25). None of the plants had flowered by late summer 2018. The site was recommended for herbicide treatment shortly after being found. The patch of plants was missed by the contractor, and was recommended for herbicide treatment early in the 2019 growing season (ECOSTEM 2019b).

Early summer surveys in 2019 found that the patch was still present, and the plants had still not flowered. The plants were treated with herbicide in early August, and no living plants were found there during the late summer surveys (Photo 4-5). This plant was not found at any other sites in the Project footprint during 2019 surveys.

Photo 4-5: Herbicide-killed common burdock near the Main Camp in August, 2019.

Tufted Vetch

Tufted vetch is a trailing perennial that can spread by seed as well as rhizomes, and can overgrow surrounding vegetation and alter soil chemistry (ANHP 2011a; ISCM 2020).

Tufted vetch plants were most widespread along the SAR east of the Butnau Marina, where larger patches were recorded at three sites in the ditch in 2019. Previous surveys indicated that tufted vetch was already well established in this site and in nearby areas, particularly along the old Butnau Road and in the Town of Gillam.

Tufted vetch plants were found at three new sites west of the Butnau Marina during the 2019 surveys (Appendix 3, Map 7-26). One was a single plant in the Memorial Site, one was a patch in Work Area A, and the third was a larger patch in Borrow Area B-3 south of the Sigfusson Northern/Voltage Camp site. Two additional patches of tufted vetch in Borrow Area G-1 were at a site where a plant was present in 2018.

ECOSTEM field staff implemented the rapid manual removal protocol in the Cemetery Site since there were only a few plants there. The patches in Work Area A and Borrow Area B-3 were too large to manually remove at the time of the surveys. The two plants in Borrow Area G-1 were in

an area targeted for herbicide treatment. These plants were treated in early August (Section 4.2.1).

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

White and Yellow Sweet Clover

White and yellow sweet clover are biennial plants that spread prolifically by seed, and rapidly invade open areas, shading out other vegetation (ANHP 2011f).

Yellow sweet clover plants have continued to expand in both extent and cover. However, total cover for white sweet clover decreased by approximately 32% between August 2018 and August 2019. This was not because somewhat different areas being surveyed in 2018 and 2019. Areas surveyed in 2018 but not 2019 had very low or no sweet clover cover. White sweet clover extent and/or cover continued to increase along the SAR, and was recorded along the North Dyke for the first time in 2019, but there was a net decrease in the other footprint components. Yellow sweet clover cover increased in all Project footprint components where it was present, except for the SAR.

The rapid manual removal protocol was not applied for white and yellow sweet clover. White sweet clover was already fairly widespread in the Project footprint, and in disturbed areas throughout the Keeyask region, prior to the Project. This species had expanded considerably in extent and/or cover from 2014 to 2018, before decreasing in 2019. As of August 2019, it was the third most abundant non-native species. White and yellow sweet clover are commonly found in disturbed areas throughout the Province, particularly along roadsides, making it difficult to prevent them from spreading.

White and yellow sweet clover were present in some of the key sites treated with herbicides in 2019 (Section 4.2).

4.1.3 LEVEL 3 NON-NATIVE SPECIES

Six of the non-native species recorded in the Project footprint were Level 3 invasive concern. All are considered to be noxious weeds, weed seed species and/or minor invasives in Canada (Table 2-7). Level 3 species recorded in 2019 included lamb's quarters, narrow-leaved hawk's-beard, common dandelion, curly dock, and alfalfa (*Medicago sativa*). Wormwood (*Artemisia absinthium*) was recorded in previous years, but not found in 2019.

Lamb's Quarters

Lamb's quarters is an annual that spreads by seeds, which can remain viable in the soil for up to 40 years (ANHP 2011c; Manitoba Agriculture 2019).

Lamb's quarters has been the most abundant of the Level 3 species in every year of Project monitoring (Table 3-4). Results from the 2016 surveys suggested that lamb's quarters cover was possibly beginning to decline (ECOSTEM 2017). However, by late summer 2017 lamb's-quarters extent and cover had increased substantially to its highest level since construction began (ECOSTEM 2018a). Plant cover continued to increase to late summer 2019 at a fairly consistent rate. Plant cover and/or extent increased in all footprints where the plant was already present, except for the NAR, where it decreased to approximately a third of its cover in 2018.

Narrow-leaved Hawks-beard

Narrow-leaved hawks-beard is an annual that reproduces by seed, and can rapidly colonize areas delaying the establishment of other plants (ANHP 2011d; Manitoba Agriculture 2019).

By late summer 2019, narrow-leaved hawks-beard was the second-most abundant non-native species in the Project footprint. However, total cover had remained steady, or decreased very slightly since 2018. Some of the apparent decrease may be due to Work Area X not being surveyed in 2019, but in 2018, less than 2% of the total cover for that species was in that area. This species has continued to spread along the North Dyke, which had the highest cover for this species. Except for the NAR, total cover in the remaining footprint components declined since August 2018 (Appendix 3, Map 7-18).

Common Dandelion

Common dandelion is a perennial that spreads prolifically by seed, as well as by shoots from root crowns (ANHP 2011b; Manitoba Agriculture 2019). Common dandelion is an early colonizer, and can also establish in existing vegetation and compete for resources and pollinators (ANHP 2011b).

Common dandelion cover has rapidly expanded since 2017, nearly doubling by late summer 2018. By 2019, total common dandelion cover had decreased by about 34%. Some of the apparent decrease may be due to Work Area X not being surveyed in 2019, but in 2018, less than 5% of the total cover for that species was in that area. Decreases in cover occurred in the camp and work areas, and borrow areas, particularly in the areas used by the KIP, or by both the KIP and the Project. Plants continued to spread along the North Dyke, and along the North and South Access Roads.

Total cover for the remaining species at Level 3 invasive concern was relatively low.

4.1.4 LEVEL 4 NON-NATIVE SPECIES

The remaining 11 non-native species recorded in the Project footprint were Level 4, or the lowest level of invasive concern, for the Project footprint.

Wheat

Volunteer wheat is an annual that produces by seeds that can remain viable in the soil for one to three years (Manitoba Agriculture 2019).

Surveys in 2016 reported the presence of healthy volunteer wheat plants growing from straw being stored in the Spillway Laydown Area (ECOSTEM 2017). These straw bales were brought to site for erosion control. It was thought that the straw bales contained viable wheat seeds. Given the developmental stage of the plants at the time of the 2016 surveys, it appeared unlikely that they could produce viable seed before a fall frost would kill the plants. By early summer 2017, the bales had been moved to Borrow Area G-3. A substantial amount of wheat was growing out of the remnants of straw left on the ground in the Spillway Laydown Area, as well as from straw that was spread in Borrow Area G-3 and in EMPA D16.

By late summer 2018, no new wheat plants were growing from the remnants of the straw at any site, except for a few plants growing directly from the stockpiled bales in Borrow Area G-3. Manitoba Hydro environmental staff indicated that the remaining bales would be buried in Borrow Area G-3. As of late summer 2019, the bales had not been buried. However, no volunteer wheat plants were recorded during the surveys.

Other Species

While the remaining Level 4 non-native species were fairly common in disturbed areas surrounding the Project, few of these species appeared to be spreading rapidly. Wormseed mustard, spotted lady's-thumb and shepherd's-purse were recorded for the first time in 2019, but their distribution was limited, and their overall cover was relatively low. These species will continue to be monitored. Alsike clover (*Trifolium hybridum*) also continued to expand in extent and/or cover, particularly along the SAR and in the Start-up Camp.

4.2 HERBICIDE TREATMENTS AT KEY SITES

4.2.1 TREATMENTS

Herbicide application at key sites was the second management strategy employed to date for the control of invasive plant species. 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).

The first herbicide treatment (ECOSTEM 2016) was recommended for five key sites located in the Start-up Camp, Borrow Area KM-1, Borrow Area G-1, Work Area B and the Sigfusson Northern/Voltage Camp (referred to as the SAR Camp in earlier reports). The treatments were implemented on August 25, 2016 in four of the five sites (Map 4-1). The SAR Camp was not

treated. The herbicide mixture was 5.0 liters Vantage, 0.5 liters Milestone and 0.375 liters Esplanade applied at a rate of 700 liters per hectare.

A second herbicide treatment was recommended for 14 sites in 2018, including seven high priority sites, and seven lower priority sites. Herbicide treatments were applied during the last week of July, 2018 in four of the seven high priority sites. The treated sites were in the Start-up Camp, the Main Camp, Work Area B, and the Sigfusson Northern/Voltage Camp. The boat launch area in Work Area C was not sprayed because it was considered to be too close to the water. Borrow Area G-1 and the NAR Gate staging area were not treated.

In 2018, the herbicide mixture used in the sites along the NAR was Clearview (230 g./ha), Esplanade (0.3 L/ha) and Roundup HC (5 L/ha). The herbicide mixture used at the Sigfusson Northern/Voltage Camp was 2,4-D Ester 700 (2 L/ha), Blue Dye WSP40 (1 package/ha), Clearview (230 g./ha), Esplanade (0.375 L/ha) and Roundup HC (5 L/ha).

In 2019, a third, more focused herbicide treatment was recommended for targeted species in six treatment areas, including at the Start-up Camp and NAR Gate staging area, Borrow Area G-1, the Main Camp, Work Area B and the decommissioned Sigfusson Northern/Voltage Camp location (Map 4-1). The species targeted for treatment included common burdock, Canada thistle, ox-eye daisy, field sow-thistle, common tansy, scentless chamomile and tufted vetch. Herbicide application targeted known sites for these species at the five general locations, and was carried out on August 2 to 5. In total, 1.75 ha was treated with a mix of 0.167 g of Navius + 4L of VP480, and 4.5 ha was treated with a mix of 8L GalonXRT + 8L of VP480.

A follow-up mowing treatment was also carried out in early October 2019. This treatment targeted the same species as the herbicide treatment, and focused on patches that were either missed by, or survived the herbicide treatment. The mowing occurred later than recommended, so it is uncertain whether it will be effective in controlling the plants because they may have already entered dormancy for the winter.

4.2.2 EFFICACY OF TREATMENTS

The overall effectiveness of the herbicide treatments is uncertain at this stage. Despite promising initial results, the 2016 treatment was later found to be ineffective, likely due to the late timing of application. While initial results were good for the 2018 treatment, surveys in 2019 found that plant cover for the target species had recovered or exceeded the pre-treatment cover. ECOSTEM (2019b) provides details for the 2016 and 2018 herbicide treatment results.

In 2019, the herbicide treatments reduced total non-native plant cover by approximately 42% within the six treatment areas, and by approximately 42% for the target species. This was lower than the reduction following the 2018 treatment (84%). There were two reasons for this. First, the herbicide applications in 2019 were targeting specific patches of plants in the treatment areas, whereas in 2018 they were blanket applied over more area. Second, heavy rainfall occurred shortly after the treatments, possibly reducing their efficacy.

Based on the total cover of live and deceased non-native plants, total non-native plant cover over all of the sites prior to treatment was approximately 4,277 m^2 in early August, 2019 (Table 4-2). Total non-native plant cover was highest by far in the Borrow Area G-1.

A total of 16 non-native species were identified within the sites that were treated. Sweet clover (white or yellow) was the most abundant species in the treatment areas, making up 42% of the total non-native plant cover, followed by field sow thistle (29%) and common dandelion. Species at Levels 1 and 2 invasive concern included field sow-thistle, common burdock, sweet clover and tufted vetch.

Herbicide coverage varied among treatment sites (Appendix 4, Table 7-9), with the planned sites in Borrow Area G-1 and the Main Camp having the highest portion of its area apparently receiving herbicides (94% and 72%, respectively). Target species were not found in the Sigfusson Northern/Voltage Camp area and Work Area B, and there was no evidence of herbicide application there.

With respect to individual species, 13 of the 16 non-native species in the treated sites were impacted (Appendix 4, Table 7-10) because the herbiciding was selectively applied within the entire key site. Based on foliage mortality, treatment coverage for these species ranged from 39% to 100% of their total cover. The three species (shepherd's-purse, pineappleweed, and white clover) that had very low to no impacts, had low cover, and appeared to be missed by the targeted herbicide applications. All three of the targeted species at the highest two levels of invasive concern (Table 2-7) were treated.

Within treated patches, plant mortality ranged from 27% to 100%, with an overall average of 63% mortality. Figure 4-1 provides examples of the effect of the treatment in the different areas. Living foliage among the treated patches was generally in poor condition regardless of the mortality rate for the entire patch. At the time of the surveys, which was approximately three weeks after the herbicide treatment, there appeared to be limited plant regrowth in the treated areas.

When considering all non-native plant cover in the areas receiving herbicides, including patches not treated and foliage that survived treatment, overall live non-native plant cover in the treated sites was reduced by 42%, to 2,464 m^2 (Table 4-1). The largest overall cover reductions were in the Main Camp, where 62% of the non-native plant cover was killed, followed by Borrow Area G-1 with 56% (Table 4-2). Common burdock, tufted vetch, lamb's-quarters and alsike clover had the highest overall reductions in cover following treatment (100%, 93%, 65% and 64%, respectively), while the lowest was common plantain, common dandelion and alfalfa (all under 30%). When considering only the treated patches, mortality ranged similarly (Appendix 4, Table 7-11). The mortality rate for treated patches of the three targeted species was 100% for common burdock, 42% for field sow-thistle, and 93% for tufted vetch.

While herbicide application was highly effective in the treated sites, it had a small effect on total non-native plant cover in the overall Project footprint. Following treatment, live non-native plant cover was reduced from 6.0 ha to 5.8 ha, or from 0.86% to 0.83% of the total area surveyed. The overall proportion of the most highly affected non-native plant species did not substantially change in the footprint as a whole. The relatively small reduction was expected because the treatments

were focused over a small portion of the Project footprint where species of higher concern were present, and there was a high potential for spread.

Total impacts on species were better when considering only those that were specifically targeted for herbicide treatment in the treated areas, the overall live plant cover for the all of the areas of the Project footprint that were surveyed was reduced from 3,905 m^2 to 3,368 m^2 (a 14% reduction), or from 0.06% to 0.05% of the total area surveyed. When considering only the species at Levels 1 and 2 invasive concern that were present in the treated areas, the overall live plant cover was reduced from 1.4 ha to 1.2 ha (a 10% reduction), or from 0.20% to 0.18% of the total area surveyed (Appendix 4, Table 7-12).

The cover reduction for the targeted species, particularly field sow-thistle, from the herbicide treatments was lower than expected because the mortality was lower than expected in Borrow Area G-1, which contains a large percentage (38%) of the total field sow-thistle cover in the Project footprint. It was thought that the lower than expected efficacy was likely due to heavy rains that occurred shortly after application. Another contributor to the lower than expected reduction was that it appeared that patches of field sow thistle targeted for treatment in the Main Camp area were also missed (Figure 4-1).

Mowing was carried out in areas that were either missed by the herbicide applicators, or where the efficacy of the herbicide was lower than expected. The effectiveness of the mowing will be evaluated during the 2020 surveys.

Table 4-1: Non-native species cover in herbicide-treated locations before and after treatment in 2019

Common Name	Pre-treatment cover (m^2)	Post-treatment cover (m^2)	Percent change
Common Burdock	5	0	-100
Shepherd's-Purse	0	0	0
Lamb's-quarters	236	83	-65
Narrow-leaved Hawks-beard	145	85	-42
Pineappleweed	21	21	0
Alfalfa	1	1	-15
Field Sow-thistle	1,254	731	-42
White and Yellow Sweet Clover	1,791	932	-48
Common Plantain	127	94	-26
Yellow or Curled Dock	65	44	-33
Smooth Catchfly	56	24	-57
Common Dandelion	536	434	-19
Alsike Clover	40	15	-64
White Clover	0	0	0
Tufted vetch	0	0	-93
All non-native species	4,277	2,464	-42

Notes: Numbers that round to zero shown as "0"; absences shown as "-".[1] Percent change; A negative sign means that cover decreased.

Table 4-2: Non-native species cover in herbicide-treated sites before and after treatment in 2019, by treatment site

Common Name	Borrow Area G-1			Start-up Camp			NAR Gate Staging Area			Main Camp			Work Area B			SAR Camp		
	Pre-treatment cover (m^2)	Post-treatment cover (m^2)	Percent change	Pre-treatment cover (m^2)	Post-treatment cover (m^2)	Percent change	Pre-treatment cover (m^2)	Post-treatment cover (m^2)	Percent change	Pre-treatment cover (m^2)	Post-treatment cover (m^2)	Percent change	Pre-treatment cover (m^2)	Post-treatment cover (m^2)	Percent change	Pre-treatment cover (m^2)	Post-treatment cover (m^2)	Percent change
Common Burdock	-	-	-	-	-	-	-	-	-	5	-	-100	-	-	-	-	-	-
Shepherd's-Purse	-	-	-	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-
Lamb's-quarters	235	82	-65	1	1	0	-	-	-	-	-	-	-	-	-	0	0	0
Narrow-leaved Hawks-beard	125	65	-48	0	0	0	-	-	-	-	-	-	20	20	0	0	0	0
Pineappleweed	20	20	0	0	0	0	-	-	-	0	0	0	-	-	-	-	-	-
Alfalfa	0	0	-30	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-
Field Sow-thistle	1,227	705	-43	5	5	0	17	17	-4	4	4	0	-	-	-	-	-	-
White and Yellow Sweet Clover	299	225	-25	702	694	-1	8	8	0	2	2	0	-	-	-	2	2	0
Common Plantain	779	2	-100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow or Curled Dock	121	89	-26	5	5	-13	0	0	0	0	0	0	0	0	0	0	0	0
Smooth Catchfly	65	44	-33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Common Dandelion	55	24	-57	0	0	0	-	-	-	0	0	-42	-	-	-	-	-	-
Alsike Clover	196	102	-48	206	197	-4	5	5	-2	7	7	0	122	122	0	0	0	0
White Clover	1	1	-50	12	10	-15	0	0	0	27	4	-87	-	-	-	-	-	-
Tufted vetch	-	-	-	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-
All non-native species	*3,125*	*1,360*	*-56*	*932*	*913*	*-2*	*31*	*30*	*-2*	*46*	*17*	*-62*	*142*	*142*	*0*	*2*	*2*	*0*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".[1] Percent change; A negative sign means that cover decreased.

A

Borrow Area G-1 on July 4, 2019

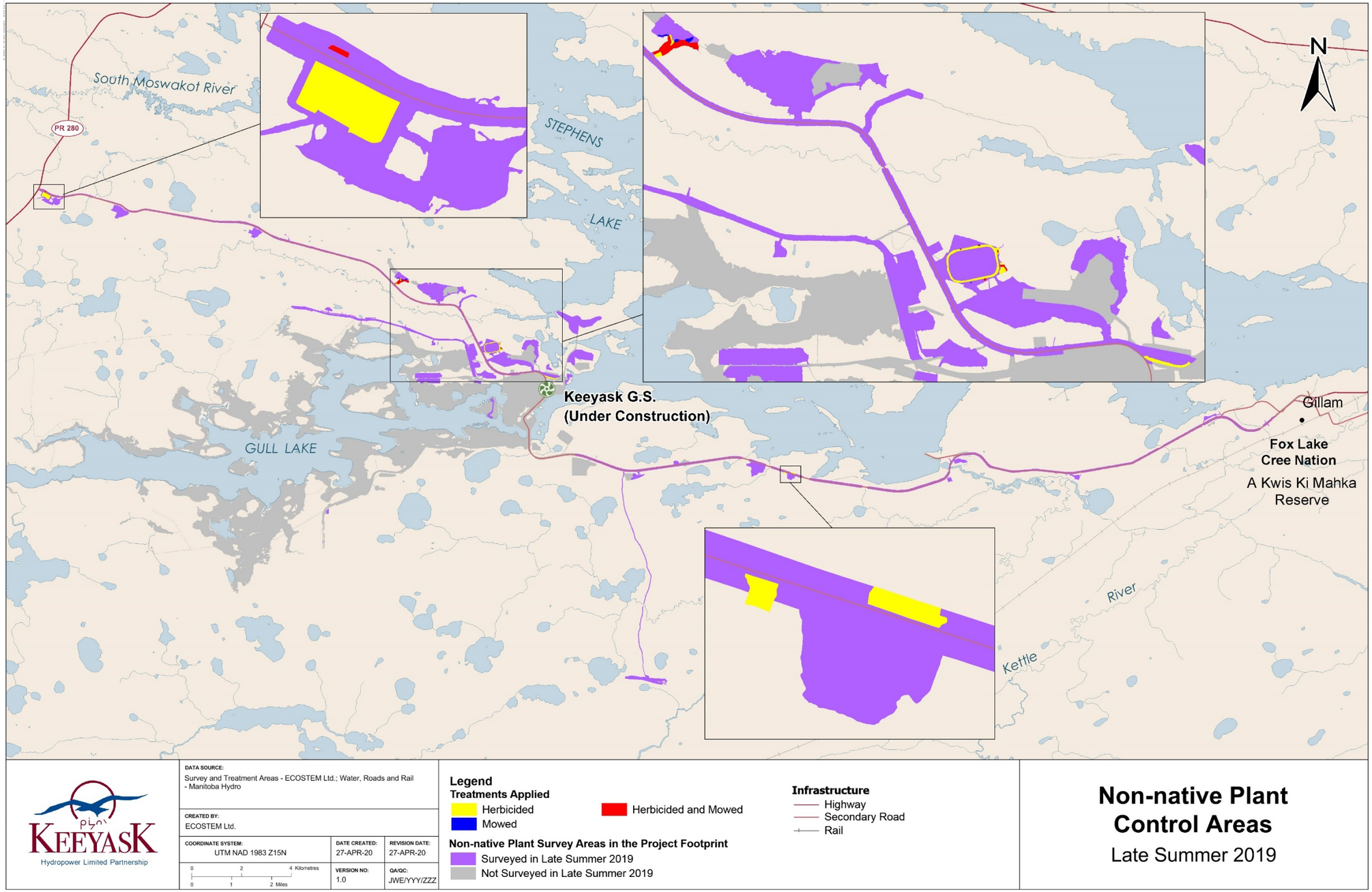
Borrow Area G-1 on August 22, 2019

B

Main Camp ring road ditch on July 3, 2019

Main Camp ring road ditch on August 22, 2019

Figure 4-1: Herbicide treatment sites in Borrow Area G-1 (A) that was treated; and in the Main Camp (B) recommended for herbicide treatment but not treated.



Map 4-1: Key areas selected for invasive plant herbicide control and mowing in 2019

5.0 DISCUSSION

5.1 OVERALL CHANGES TO NON-NATIVE PLANT DISTRIBUTION AND ABUNDANCE

Total non-native plant cover was still very low (0.9% of the total area surveyed) six years into construction. This was not surprising given that much of the Project footprint was only recently disturbed, construction was still severely disturbing some areas, and targeted eradication and control efforts had been undertaken (Section 3.4).

Even though total non-native plant cover was still low in 2019, existing small patches of non-native plants were still a concern as they could quickly become broad infestations if not managed. Reinforcing this concern was the fact that non-native plants were recorded in almost 10% of the surveyed area (note that this is an overestimate of non-native plant distribution within the entire Project footprint for the reasons described in Section 2.2).

How much of a concern the existing patches of non-native plants were for the Project site is partly determined by the magnitude of recent increases in distribution and abundance. As a percentage of area surveyed, total non-native plant cover and extent doubled between 2017 and 2018. In comparison, between 2018 and 2019, total non-native extent increased by only 3%, and total cover decreased slightly.

A possible explanation for a portion of the large decreases in the rates of cover and extent expansion between 2018 and 2019 is that some the areas surveyed in 2018 were inaccessible in 2019. However, the total non-native plant cover in the areas surveyed in 2018 but not 2019 was too low to account for the decreases. Additionally, some previously inaccessible areas were surveyed in 2019, which added to total cover in 2019.

The overall decreases in non-native plant cover between 2018 and 2019 may have resulted from competition with regenerating native vegetation. The largest decreases were seen in portions of the Project footprint components that were used by the KIP but not by the Project (e.g. Borrow Areas KM-4 and KM-9). These components had received rehabilitation efforts (tree planting), and natural regeneration of other native plants was occurring. Construction traffic in these areas was minimal, which limited transport of non-native plant seeds into the areas. Total cover in the newer footprint components used only by the Project increased between 2018 and 2019, but not to the degree seen in previous years.

Another possible factor that could have contributed to a decrease in total non-native plant cover was variability in growing conditions, natural life cycle patterns and/or natural population dynamics for different plant species. However, much of the decline in total non-native plant cover was from a few of the more abundant species (i.e. narrow-leaved hawks-beard, white sweet cover and common dandelion). Most other non-native species continued to increase in cover between 2018

and 2019 at a similar rate to previous years (e.g. lamb's quarters, yellow sweet clover and field sow-thistle). Non-native plant studies for other projects in northern Manitoba observed similar patterns and trends over a longer period of time (ECOSTEM 2018b).

In Borrow Areas G-3 and N-5, while non-native plant species have continued to slowly establish around the perimeters of the excavated areas, total cover remained very low. This was despite having several years of frequent vehicle traffic that could transport seeds into these areas. A possible explanation for the lower than typical expansion of non-native plants in these two borrow areas was that both of them were surrounded by taller trees, which reduced wind dispersal of seed into these borrow areas. The areas surrounding most other Project components on the north side of the Nelson River were burned in 2013. Another possible explanation is that these borrow areas are on previously undisturbed islands. The key factors that potentially lowered seed transport into these islands were less human activity before Project construction began and lower wind dispersal.

The largest increases in non-native plant cover and extent continued to occur Project footprint components where construction activity had recently decreased or stopped over the past one or two years. The North Dyke and South Access Road (SAR) were the most notable examples, with other examples including EMPAs D16, D17 and D12(1). The higher rate of non-native plant expansion in these areas occurred despite no ongoing excavation or construction activity and no newly exposed mineral substrates. As plants were already beginning to establish in these areas in 2018, they likely became seed sources for more rapid increases in cover. Along the SAR, regular vehicle traffic from and to the Town of Gillam, where non-native plants are well-established, was likely a continual seed source for that footprint component. It is expected that non-native plant cover will continue to increase and expand westward in the SAR ditches.

A potential trend emerging in 2018 was an apparent decrease in non-native plant cover in the footprint components that were primarily utilized for the KIP but not for the current Project (e.g., most of Borrow Areas KM-4 and KM-9). Results from the 2019 surveys appeared to support this observation. If this decrease actually becomes a trend, possible reasons for it are reduced traffic and increasing competition with regenerating native plants whose cover has been increasing in these areas. Monitoring in 2020 will help determine if this is a trend.

5.2 CHANGES IN SPECIES DISTRIBUTION AND ABUNDANCE

There were large changes in the relative abundances of some species. Only two of the five most abundant species increased in cover between 2018 and 2019 (lamb's quarters and field sow-thistle), while the other three decreased in cover. This was a change from previous years, as all five had been increasing in cover up to August 2018. In combination, these five species accounted for 91% of total non-native plant cover by the time of the 2019 surveys. The possible reasons for this change were described in the previous section.

The total number of non-native plant species recorded during the 2019 surveys (25) was higher than in 2018. Three species were recorded for the first time in 2019. These included shepherd's-purse, wormseed mustard and spotted lady's-thumb. It is possible that a few individuals of these species were present in previous years, but were missed because they were very scarce. In 2019, cover and extent for all three species was low, and limited to a few locations.

Because only a single plant of shepherd's purse was found in the Start-up Camp, it was possible it was only just introduced. Up to 2019, the Start-up Camp had a high amount of foot traffic, and personal vehicles were parked there, maintaining a constant potential external seed source.

In 2019, wormseed mustard had nearly 500 m^2 of cover. Much of the wormseed mustard cover was found in a portion of the EMPA D12 footprint that was not accessible until 2019, so it is possible that it had been spreading in the inaccessible area for one or more years prior to 2019. Wormseed mustard will be closely observed to determine if it will spread rapidly as was the case for narrow-leaved hawksbeard.

Narrow-leaved hawks-beard appeared later in construction, and rapidly increased in cover to become the third-most abundant non-native species in the Project footprint in 2018, over a period of only three years. This species was first recorded during the 2016 surveys, and had relatively low cover. Cover increased rapidly up to 2018 in areas that were utilized by both the Project and KIP. But between 2018 and 2019, rapid expansion appeared to stop, and cover declined slightly.

Narrow-leaved hawks-beard first became established in newer areas that were utilized only by the Project in 2017, then expanded very rapidly by 2018. Plants continued to expand up to 2019 in newer areas, namely the North Dyke, as well as EMPA D16. The largest declines in cover between 2018 and 2019 were in the borrow areas used only by the KIP, or by both the KIP and the Project. This pattern of establishment and cover expansion suggests that this species can rapidly colonize recently disturbed areas, but is then strongly influenced by negative factors (e.g., a poor competitor). On the positive side for this species, it is able to expand quickly because it is a prolific producer of wind-dispersed seeds. Counteracting this is a poor competitive ability with regenerating native plants. Support for this is the decline of hawksbeard cover in the regenerating footprints that were used only by KIP. An evaluation of the possible explanations for the changes will be undertaken by the construction synthesis report, which is when more data will be available to examine hypotheses.

5.3 NON-NATIVE PLANTS IN THE SHORE ZONE

Pre-operation baseline shore zone invasive plant surveys were conducted in 2019.

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. Plant cover was similar both upstream and downstream of the generating station over the shore segments surveyed.

Nine non-native plant species were recorded in the shore zone. Six of these occurred on the Nelson River, and three occurred only along Little Gull Lake. Of the three species that occurred

only along Little Gull Lake, narrow-leaved hawks-beard and curled dock, were becoming abundant on the North Dyke, the nearby portion of the Project footprint. Patches of these plants on the North Dyke area less than 300 m from the lake shoreline, and are at the end of a recently cleared cutline extending from the dyke to Little Gull Lake, where a monitoring station has been installed. It is possible that the North Dyke is acting as a seed source.

Four of the six species found in the Nelson River shore zone had also been noted during pre-construction surveys (the exceptions were field sow-thistle and tufted vetch). The most widespread of these four species, common plantain, had been previously found at 13 locations in the upstream hydraulic zone, and two locations downstream during pre-Project studies. It appears that non-native plant species have been spreading along the Nelson River shore long before the Project, which was expected. There is frequent traffic along the river, as it is central to the local communities. For example, several cabins are located along the shoreline. The large patch of alsike clover downstream of the generating station was beside a cabin.

Based on the 2019 survey results, no mitigation is recommended for non-native plants in the shore zone. Non-native plants in the shore zone will continue to be monitored in the operation phase.

5.4 EFFORTS TO MANAGE INVASIVE PLANTS

To date, the rapid manual removal appears to have been effective for the Level 1 species. In contrast, in most cases, manual removal has not been successful for Level 2 species. The most plausible explanations for the difference was plant root systems being already well-established, seeds from the seed bank germinating, and/or some plants in the area had already produced seed.

The overall effectiveness of the herbicide treatments was unknown. The 2016 treatment was completely ineffective likely because the herbiciding occurred in late August, which was after the plants produced seed. While the 2018 herbiciding considerably reduced total non-native plant cover over all of the treated areas (i.e., approximately 84%), the cover reduction for the target species was much lower (i.e., 1.6%) because the applicators missed treating the priority areas with largest amounts of the target species. A possible contributing factor was the roots of some of the herbicided plants were not killed. Herbicide treatments in 2019 did cover areas that were missed in 2018, however, heavy rains shortly after the herbicide application likely reduced the effectiveness of the treatment. The effectiveness of the mowing in early October 2019 will not be known until the areas are surveyed in 2020.

5.4.1 PREVENTION

The following provides some general considerations for future efforts to control invasive plants in the Project footprint. Specific control recommendations will be developed for the 2020 growing season based on the monitoring results to date.

It is difficult to prevent vehicles and people from inadvertently spreading non-native plant species into the Project footprint (Section 2.6.1). Therefore, recommendations in addition to the standard measures included in the EIS and EnvPPs focus on the plant species of highest invasive concern and on the situations where there are practical ways to eradicate these species or to prevent them from spreading further.

Of the non-native plant species recorded during monitoring, several falling into Levels 1 and 2 invasive concern were known to be present prior to the Project (KHLP 2009; KHLP 2012b). At least two such species (white sweet clover, ox-eye daisy) were likely already established in the Start-up Camp and Main Camp areas before KIP construction began (ECOSTEM 2014). Additionally, some Level 2 species (i.e., white and yellow sweet clover, Canada thistle, field sow-thistle) were found along PR 280 prior to development of the KIP (KHLP 2009; KHLP 2012b).

One strategy to prevent or reduce the spreading of invasive plants beyond their current locations is for equipment, machinery, vehicles and people to avoid or minimize travel through infested areas. A related strategy is to restrict travel to those periods when the spreading of seed or propagules is least likely (e.g., prior to seed development). Possible implementation of these strategies has become more feasible because the number of new construction areas have declined as the Project is approaching completion, and substantial additional Project clearing is not anticipated (Manitoba Hydro pers. comm. 2020).

Promoting native plant regeneration is another strategy to control and eradicate invasive plants. This can be accomplished in two ways: by implementing the already planned site regeneration as soon as is feasible after a construction area will no longer be used; and, by limiting traffic and other activity on sites where desired vegetation has established or is establishing.

5.4.2 ERADICATION AND CONTROL

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.

For sites with only one to a few plants, rapid manual removal has been effective to date for the Level 1 species (Section 4.1.1). Monitoring surveys in 2020 will determine if rapid manual removal continues to be effective for controlling these species.

Rapid manual removal has only been partially effective where it was applied to small patches of Level 2 species in 2016 (efficacy of the 2018 manual removals to be determined after 2019

surveys). As described in Section 4.1.2, the manual removal method will only be implemented in certain situations.

Rapid manual removal by monitoring field staff will continue to be employed for newly found sites with Level 1 and 2 species. For previously recorded sites, rapid manual removal will not be implemented for species that reproduce prolifically by rhizomes and where either the plants are mature or it appears the plants have already developed a root system (see Section 4.1.2). Herbicide application is being considered for these sites.

Additional herbicide applications and/or mowing are recommended to control or eradicate invasive plants at key sites. Key sites will be identified for treatment in summer 2020 using the same criteria as in previous years.

A general strategy to eradicate or control invasive plants involves promoting native plant regeneration. This can be accomplished in the same ways as described for prevention (Section 5.4.1).

Continued high vigilance is needed for Level 1 species because they are difficult to control (ISCM 2020). In addition, continued introductions by Project vehicles entering from outside of the Project footprint are quite possible. ISCM (2020) states that scentless chamomile, ox-eye daisy and common tansy are common along fence lines, roadways and fields in Manitoba, so vehicles and equipment coming to the Project site could easily transport them there.

6.0 SUMMARY AND CONCLUSIONS

While the combined extent of all non-native plants increased between the late summers of 2018 to 2019, total cover decreased slightly as a percentage of area surveyed. In August 2019, non-native plants still covered less than 1% of the surveyed area. As was the case in 2018, most of the non-native plant cover was within those cleared areas that were either there before the Project (e.g., cutlines, borrow areas and ditches along Butnau Road portion of the South Access Road), or were created by the Keeyask Infrastructure Project (KIP) and have been used by the Project.

A total of 25 non-native plant species were found during the 2019 surveys. Three new species (wormseed mustard, spotted lady's-thumb and shepherd's purse) were recorded in 2019, and four previously recorded species (wormwood, black medick, rye and wheat) were not observed.

The 2019 monitoring found sites with plants for each of three species at the highest level of invasive concern for the Project area. These species were ox-eye daisy, scentless chamomile, and common tansy. ECOSTEM field staff manually removed these plants immediately after discovery.

Shore zone surveys in 2019 found that non-native plant cover was low in the Project's hydraulic zone of influence (the future reservoir area). Non-native plant cover ranged from 1.3 m^2/km to 2.3 m^2/km in the different hydraulic zones. A total of nine non-native plant species were recorded, with six occurring along the Nelson River, and three occurring along the Little Gull Lake shoreline. Of the three species of higher concern, field sow-thistle was the most abundant, but total cover was still low at only 12 m^2 in total.

Monitoring to 2019 has indicated that manual removal of plants from the species of highest concern was generally effective, as new plants have not returned to those sites. The exception was for species that have the ability to proliferate from roots left in the ground. Manual removal will be continued in 2020 except for selected situations of plants from species that can proliferate from roots left in the ground. Other control measures, such has herbicide applications, will be considered for plants that are not manually removed.

Four key locations with target species of higher concern in the Project footprint were treated with herbicides in early August 2019, and then mowed in early October. Monitoring in August 2019 found that the herbicide treatments reduced non-native plant cover in the treated areas by approximately 54%. The effectiveness of this treatment may have been reduced by heavy rain shortly after application. Surveys in 2020 will determine if the herbicide treatment and subsequent mowing is expected to continue to reduce or slow the spread of invasive plant cover in these sites.

Additional invasive plant control recommendations are being developed for the 2020 growing season based on the monitoring results to date. Monitoring fieldwork for invasive and other non-native plants will continue in 2020.

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APPENDIX 1:
NON-NATIVE PLANT INDIVIDUAL AREAS

Table 7-1: Estimated radius and derived area for individual plant species

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

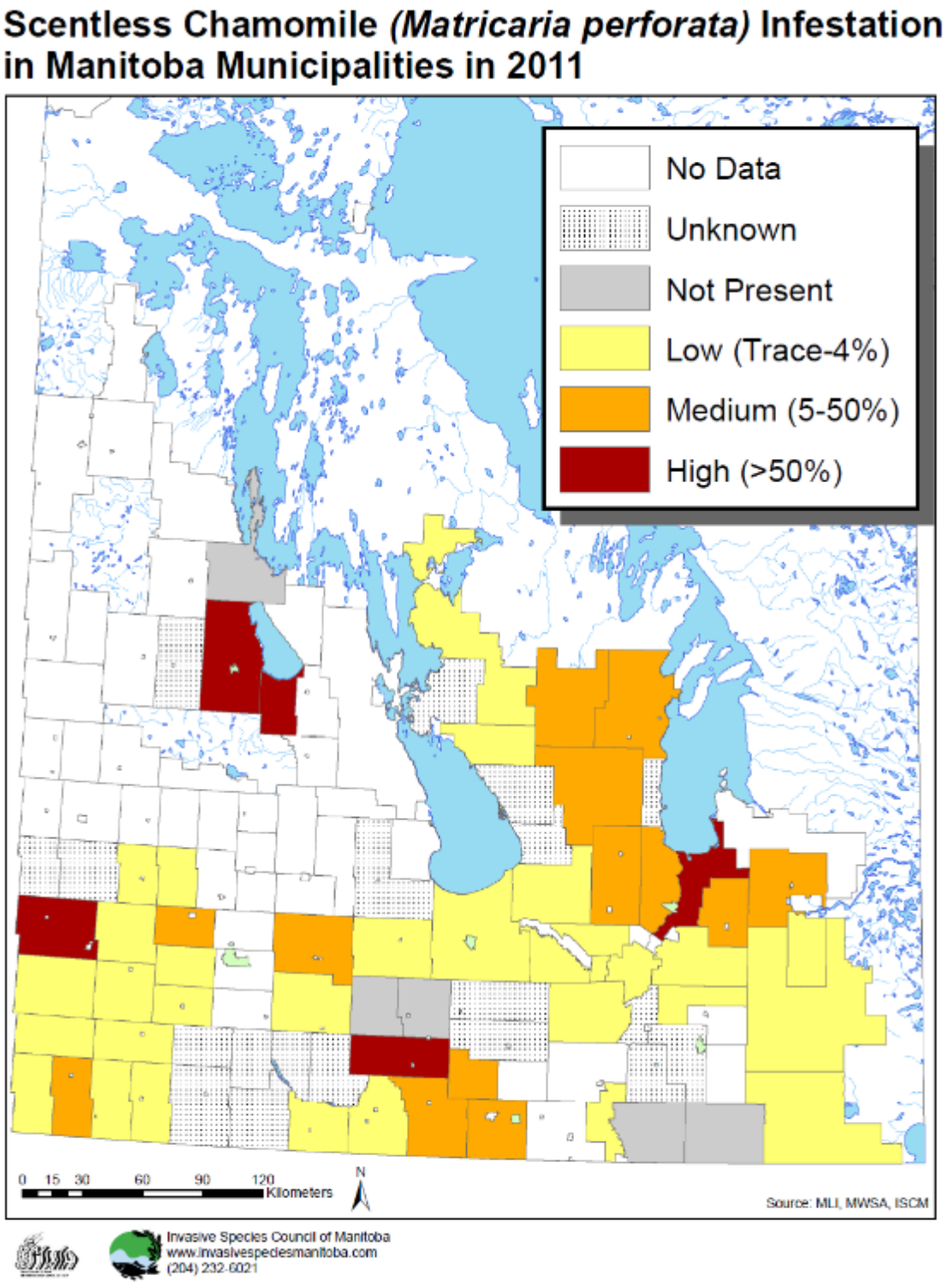
APPENDIX 2:
INVASIVENESS RANKINGS AND MANAGEMENT STRATEGIES

7.1.1 BACKGROUND

This monitoring study provides additional control or eradication recommendations during construction 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 locations and establish in new locations.

Many of the non-native species recorded during Project monitoring are commonly found in disturbed areas throughout the Province (e.g., field sow-thistle, white clover), 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 7-1 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.



Source: Invasive Species Council of Manitoba.

Figure 7-1. 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 (2020), 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 (2018) 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.

7.1.2 INVASIVE CONCERN CLASSIFICATION

As noted above, ISCM 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 7-2 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 7-2. ISCM invasive plant categories, criteria for inclusion and minimum management criteria

Categories and Criteria for Inclusion	Minimum Management Criteria
Category 1 Species	
• These invasive plants are not present in Manitoba, but may be present in cultivation[1] 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.	• 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	
• These invasive plants are present in Manitoba and • Capable of further spread and • Pathways for spread are present and • Easily identifiable with available resources.	• 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	
• Other terrestrial invasive plants	• Not specified in the ISCM website.

Source: ISCM (2020).

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 2-6). 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 2-7 shows how the invasive concern classification was applied to the non-native plant species recorded in the Project footprint to date.

Table 7-3 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 (2020).

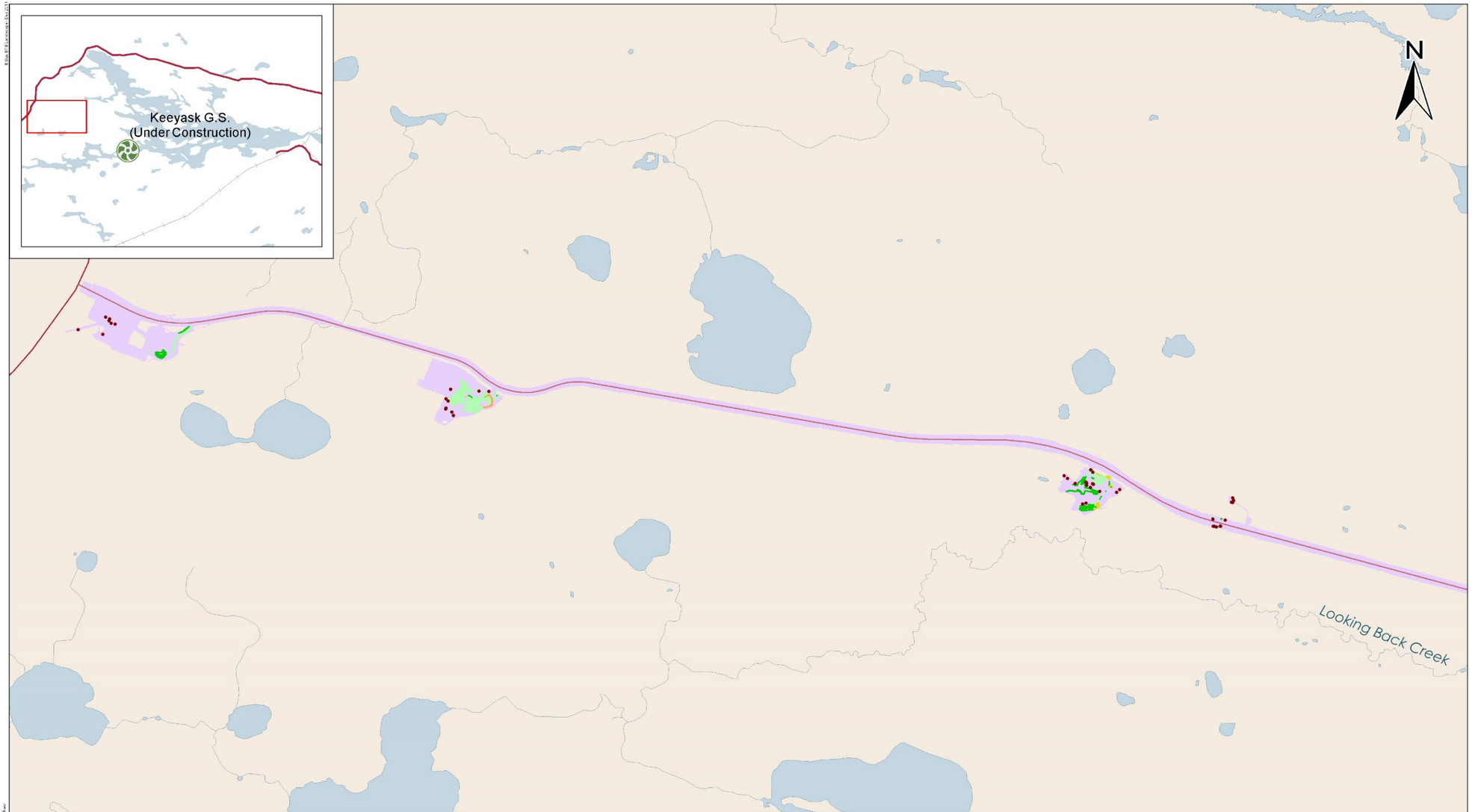
Table 7-3: Invasive concern classifications for non-native plant species that could potentially occur in the Project footprint

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

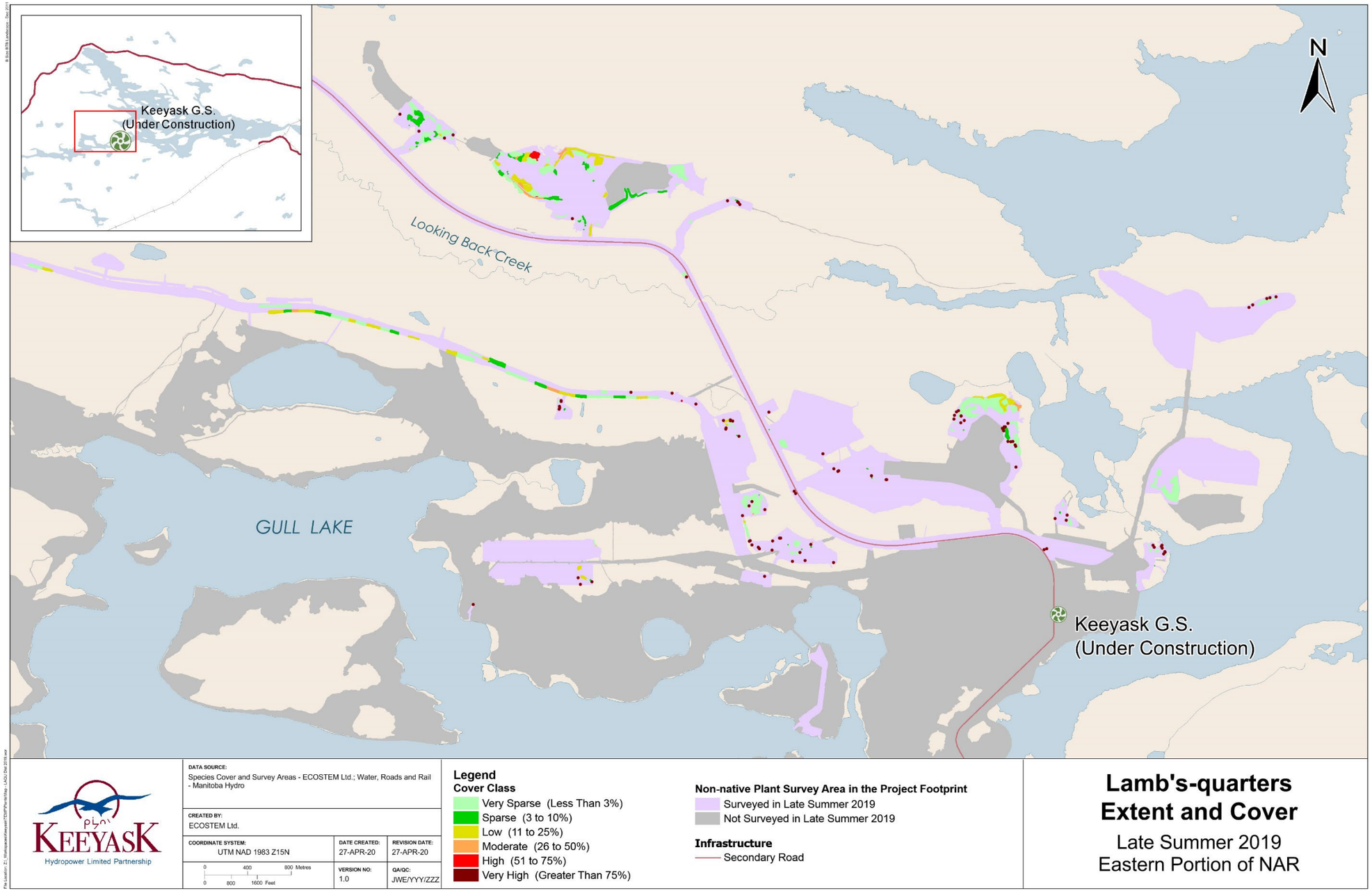
Invasive Concern[1]	Common Name[2]	Scientific Name	ISCM Category[3]	White *et al.* Category[4]	Noxious weed[5]	Weed Seed[6]
	Japanese Knotweed	*Fallopia japonica*	Other			
	Giant hogweed	*Heracleum mantegazzianam*	Other			
	Dame's-rocket	*Hesperis matronalis*	Other	Minor		
	Tansy Ragwort	*Jacobaea vulgaris*	Other			Primary
	Scotch Thistle	*Onopordum acanthium*	Other			
	Orange Hawkweed	*Pilosella aurantiaca*	Other			
	Common Buttercup	*Ranunculus acris*	Other			
	Cockle, white	*Silene latifolia*	Other		Tier 3	Primary
	Puncture Vine	*Tribulus terrestris*	Other			
	Cow-cockle	*Vaccaria hispanica*	Other			Secondary

Notes: [1] See Table 2-6 for the invasive concern classification. [2] In decreasing order of concern for the Project area. [3] Invasive Species Council of Manitoba (2020). [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).

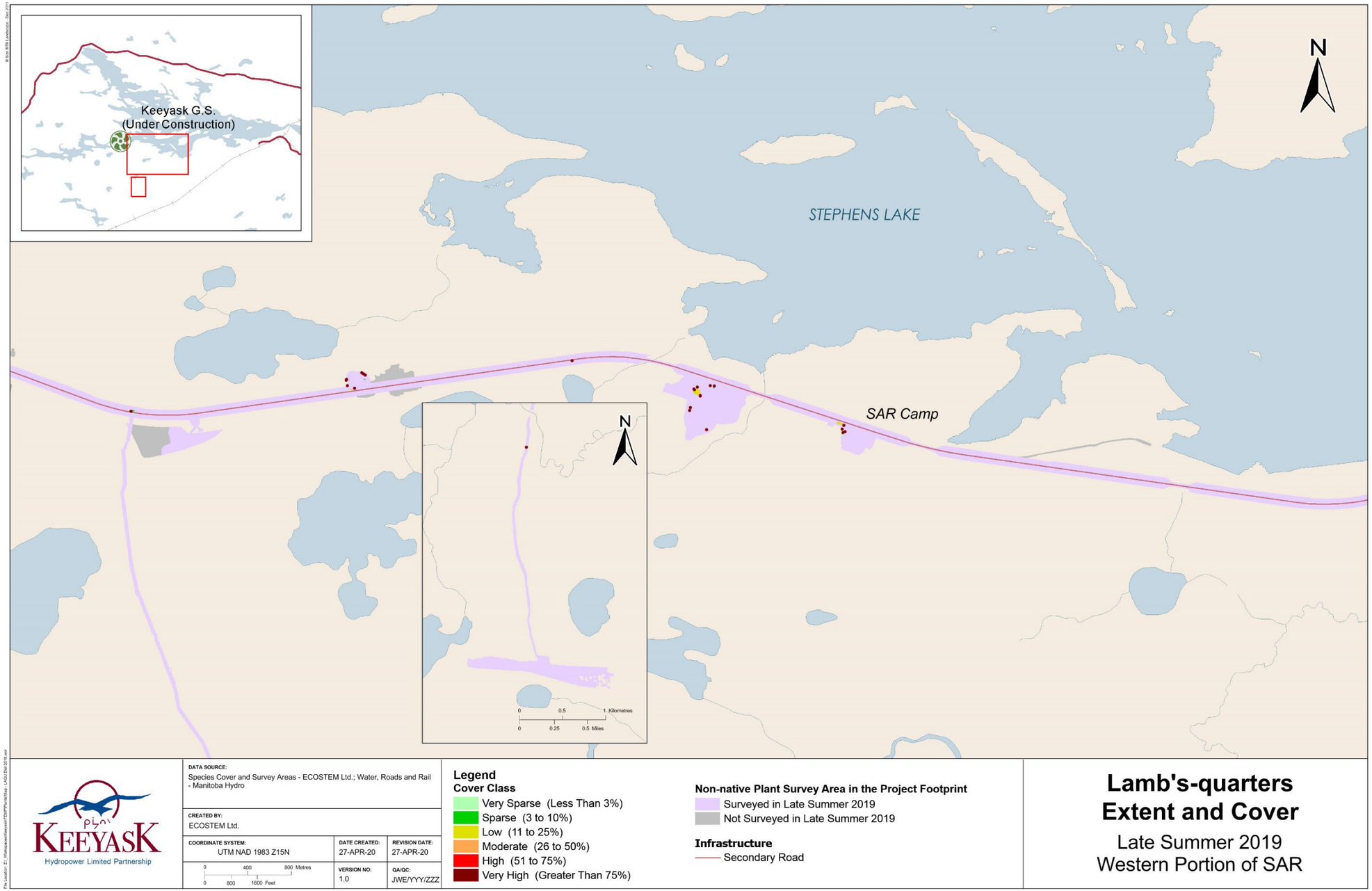
APPENDIX 3:
NON-NATIVE PLANT DISTRIBUTION MAPS



Map 7-1: The distribution and abundance (cover class) of lamb's quarters in the Project footprint along the western portion of the North Access Road in late summer, 2019

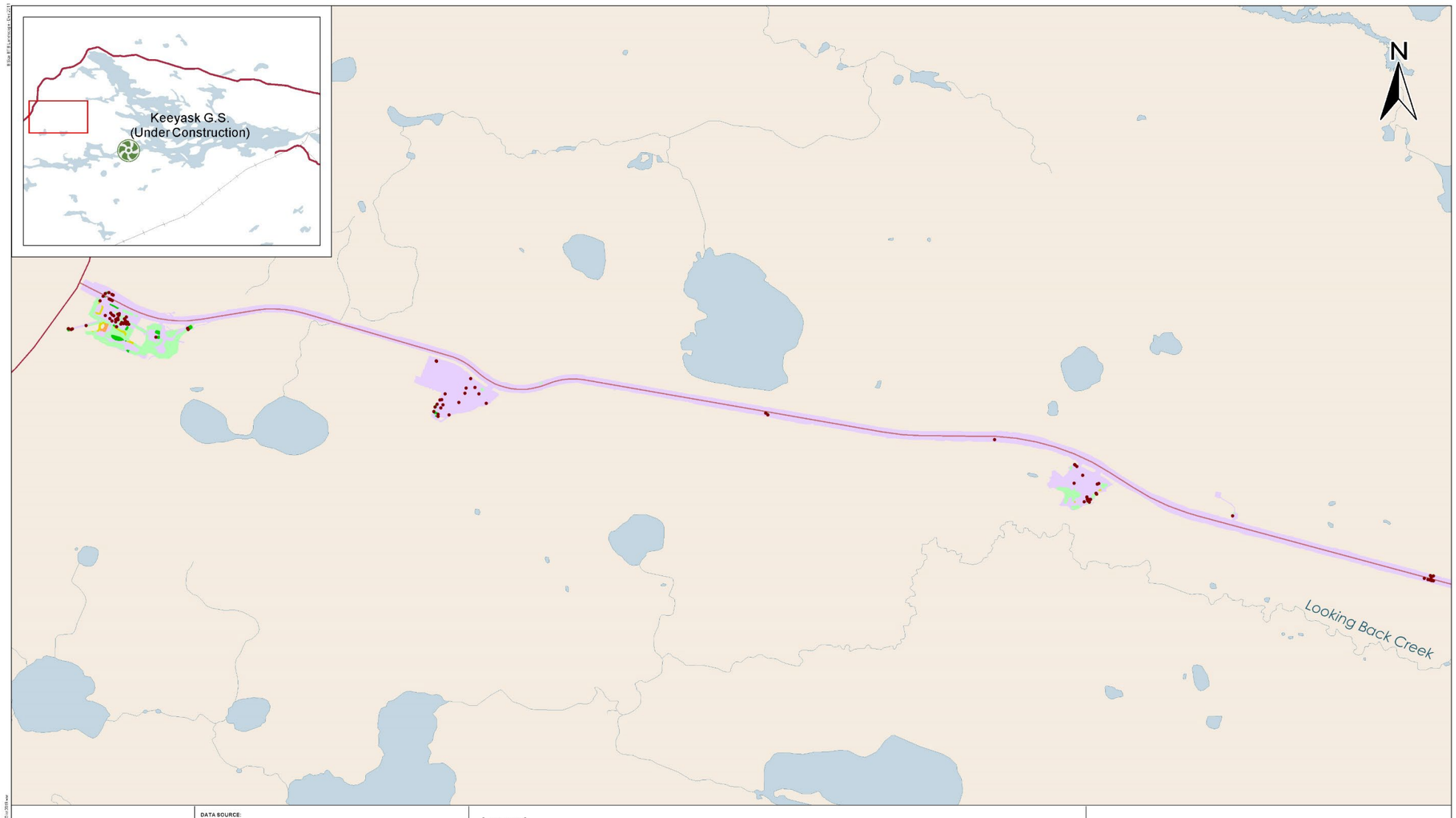


Map 7-2: The distribution and abundance (cover class) of lamb's quarters in the Project footprint along the eastern portion of the North Access Road in late summer, 2019

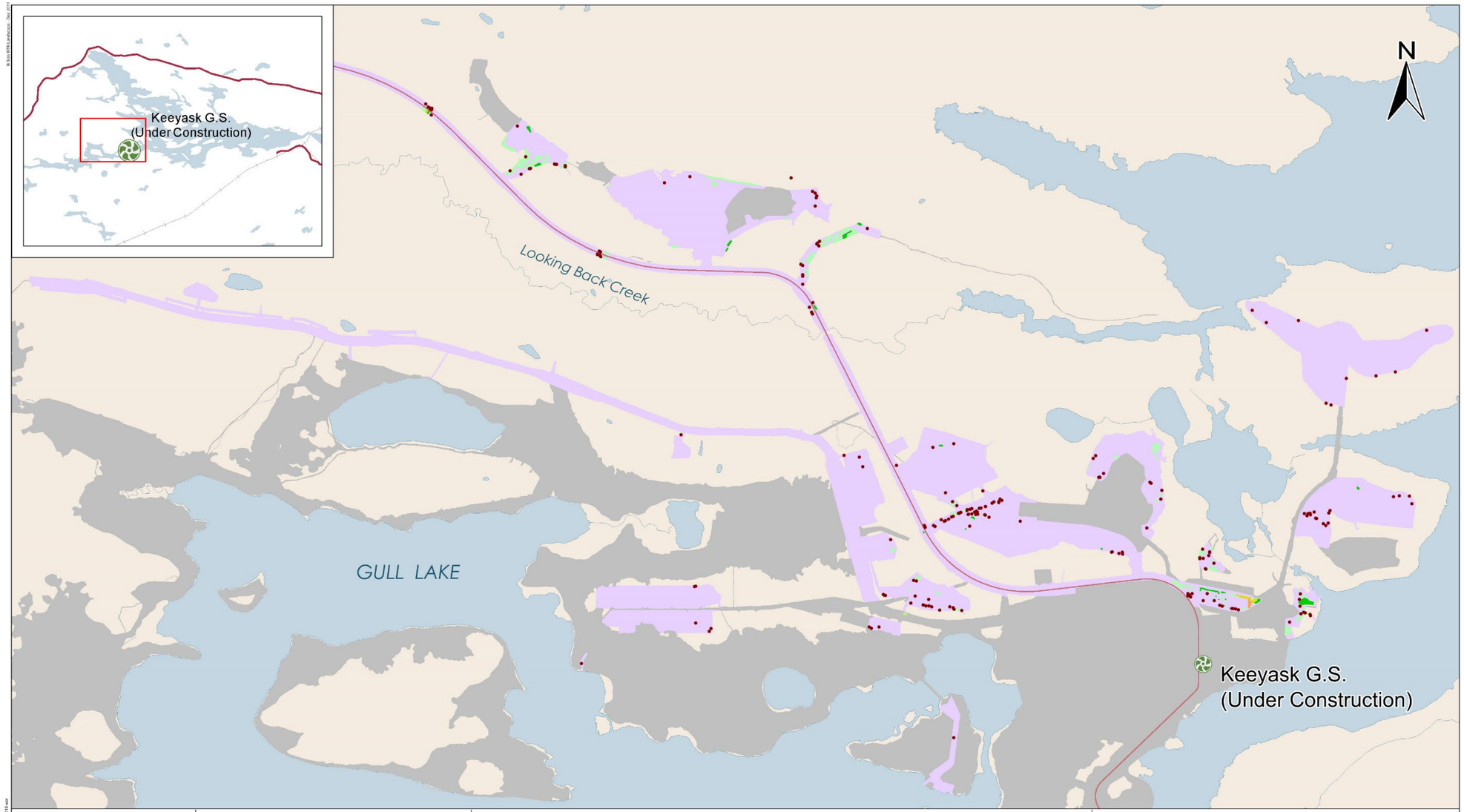


Map 7-3: The distribution and abundance (cover class) of lamb's quarters in the Project footprint along the western portion of the South Access Road in late summer, 2019

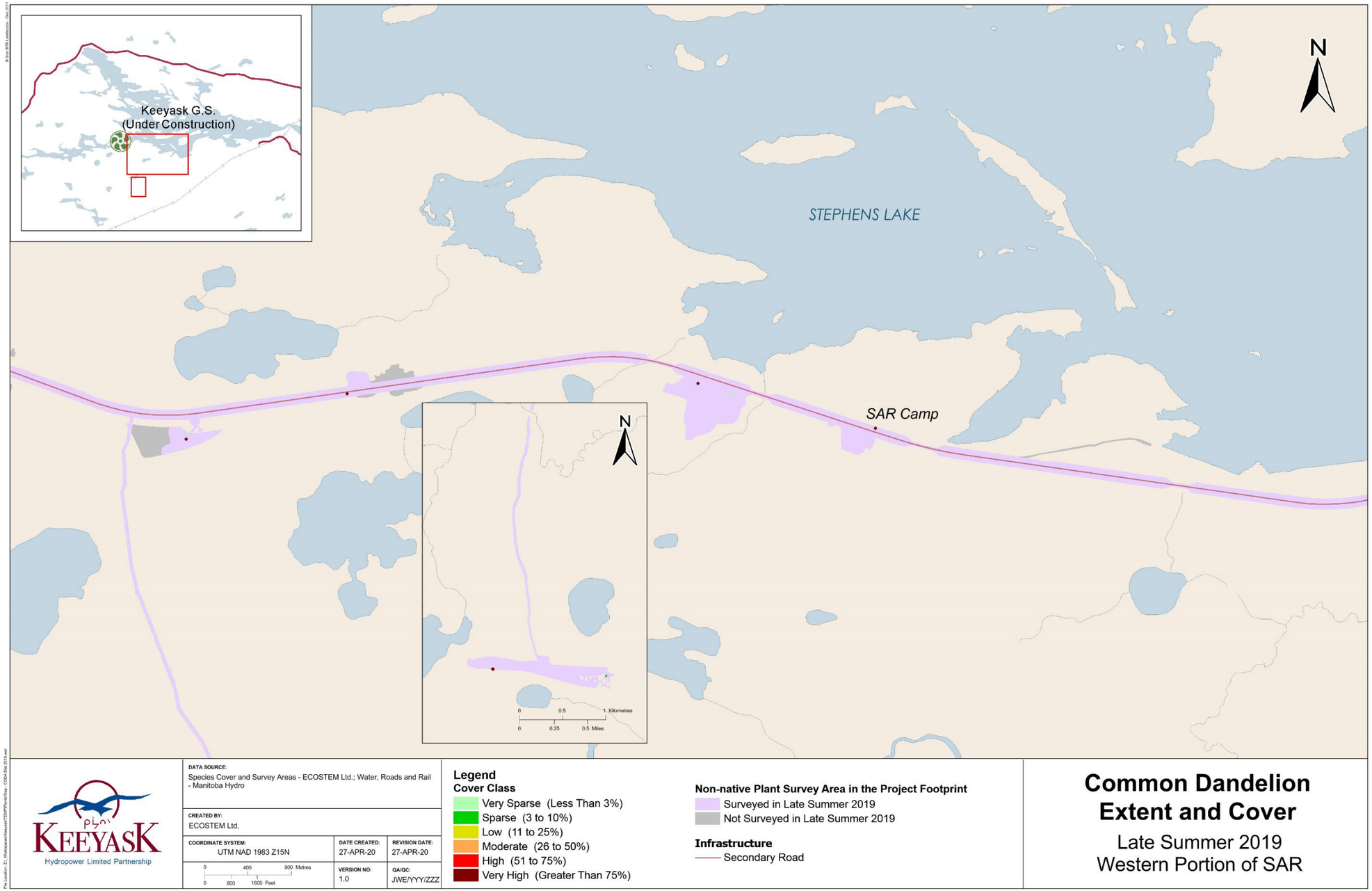
Map 7-4: The distribution and abundance (cover class) of lamb's quarters in the Project footprint along the eastern portion of the South Access Road in late summer, 2019



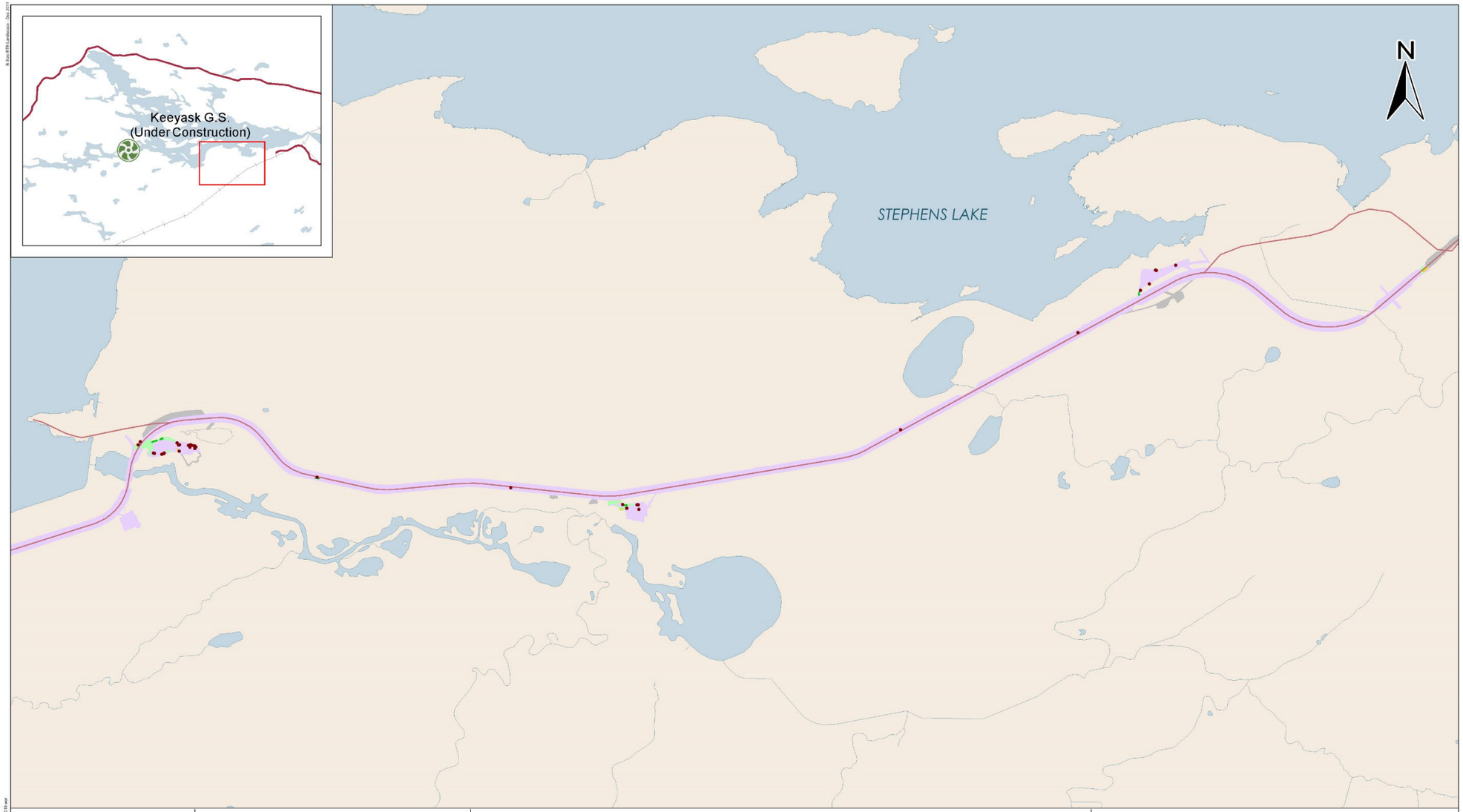
Map 7-5: The distribution and abundance (cover class) of common dandelion in the Project footprint along the western portion of the North Access Road in late summer, 2019



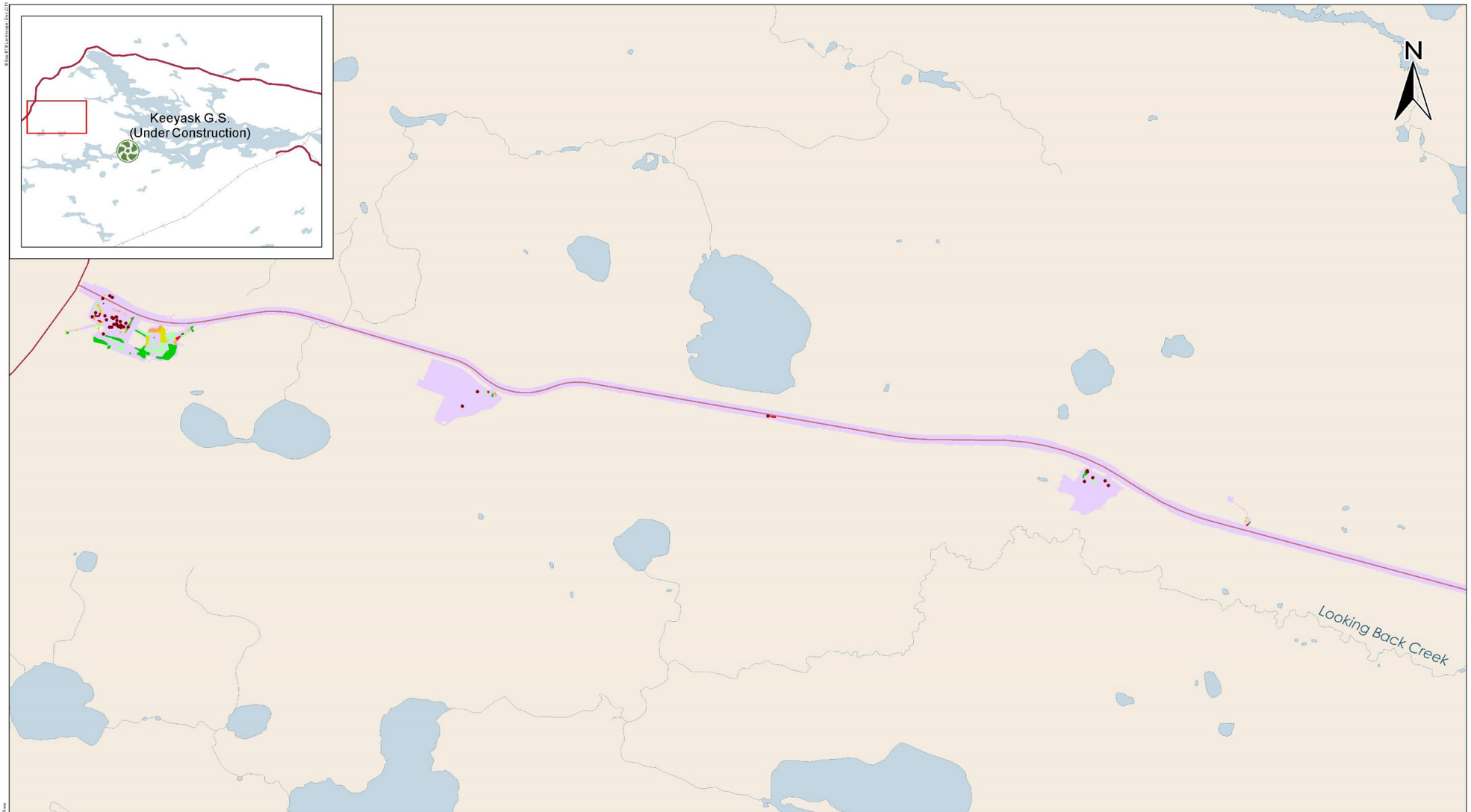
Map 7-6: The distribution and abundance (cover class) of common dandelion in the Project footprint along the eastern portion of the North Access Road in late summer, 2019



Map 7-7: The distribution and abundance (cover class) of common dandelion in the Project footprint along the western portion of the South Access Road in late summer, 2019

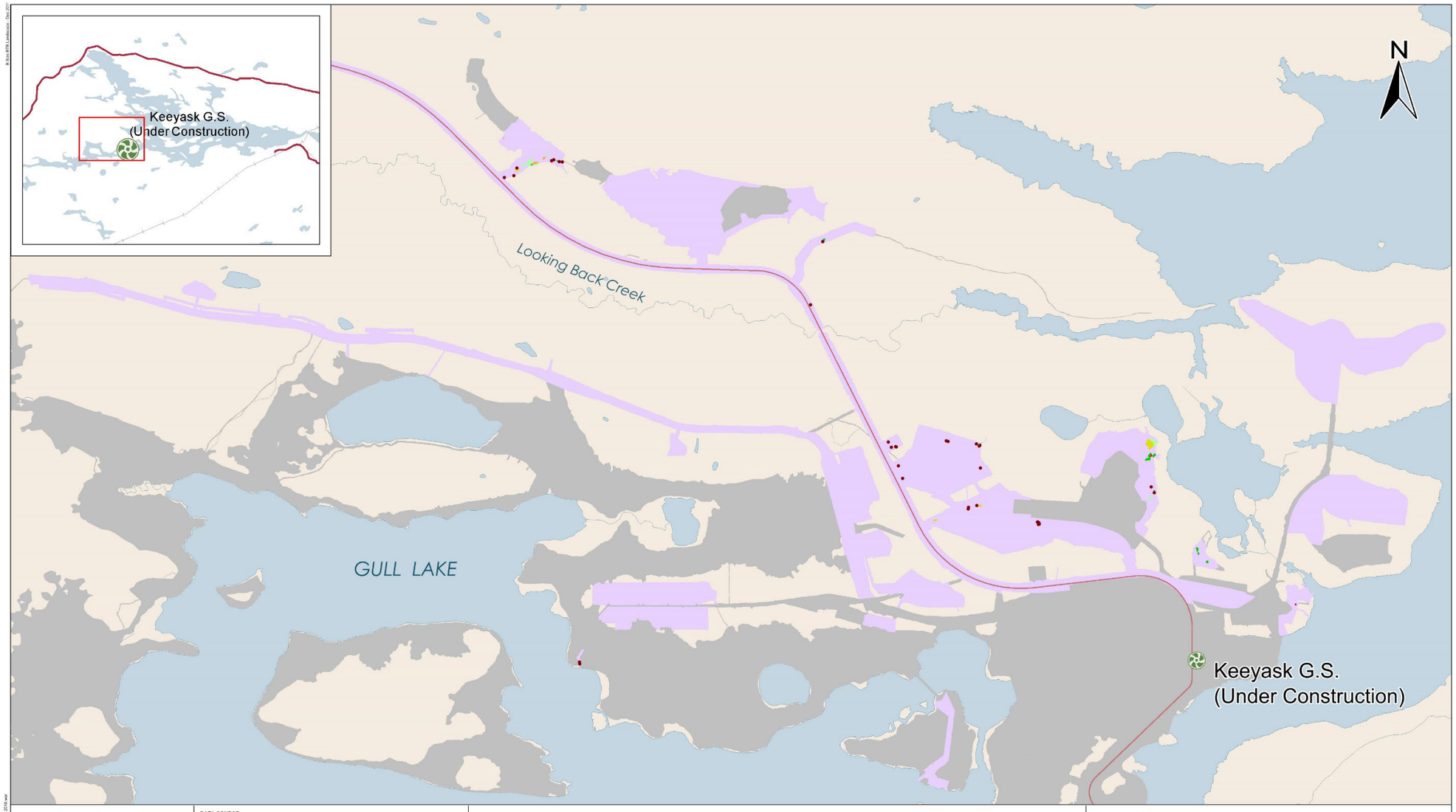


Map 7-8: The distribution and abundance (cover class) of common dandelion in the Project footprint along the eastern portion of the South Access Road in late summer, 2019



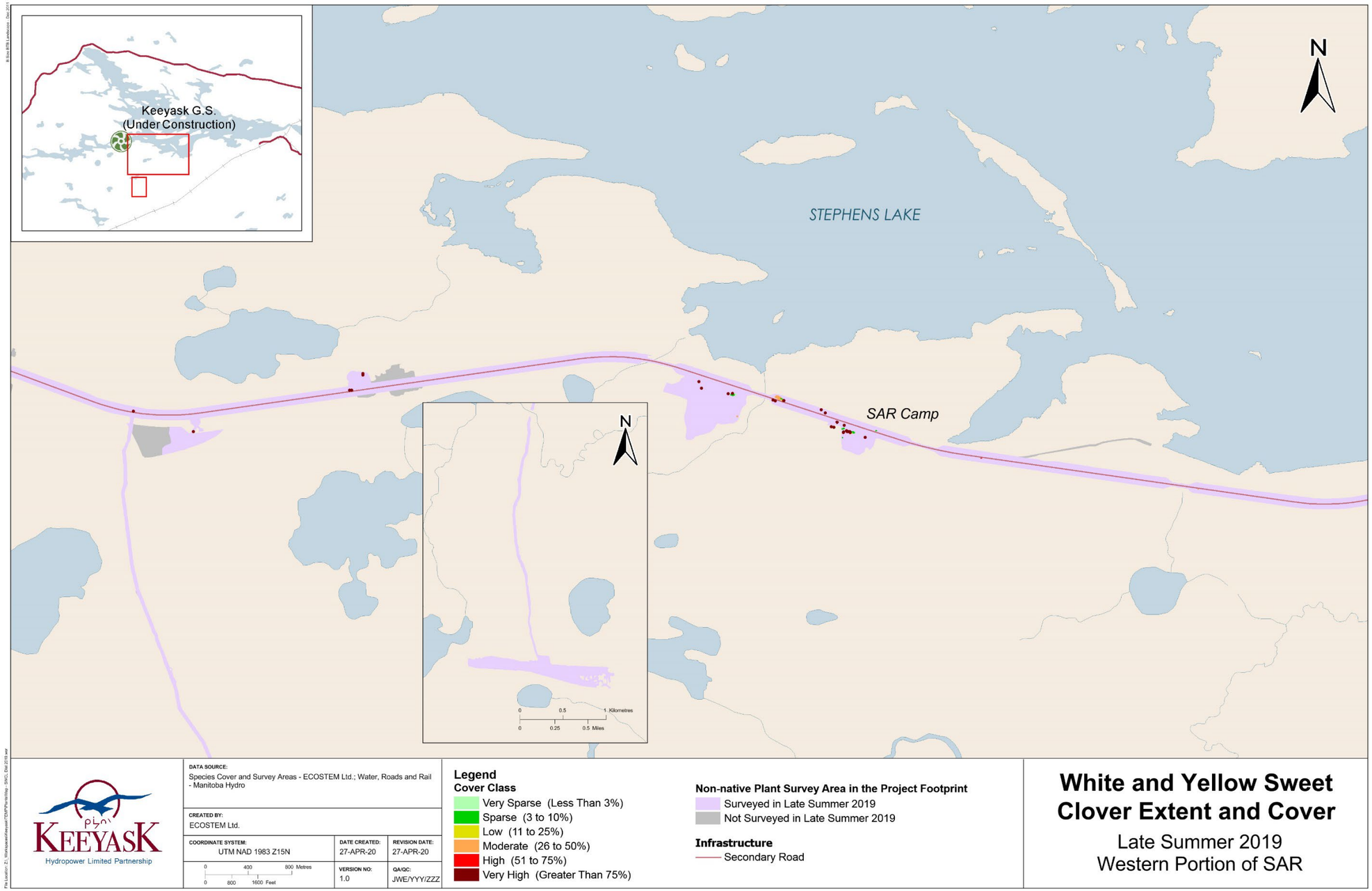
[1] Includes locations with unidentified white or yellow sweet clover due to lack of flowers.

Map 7-9: The distribution and abundance (cover class) of white sweet clover[1] in the Project footprint along the western portion of the North Access Road in late summer, 2019



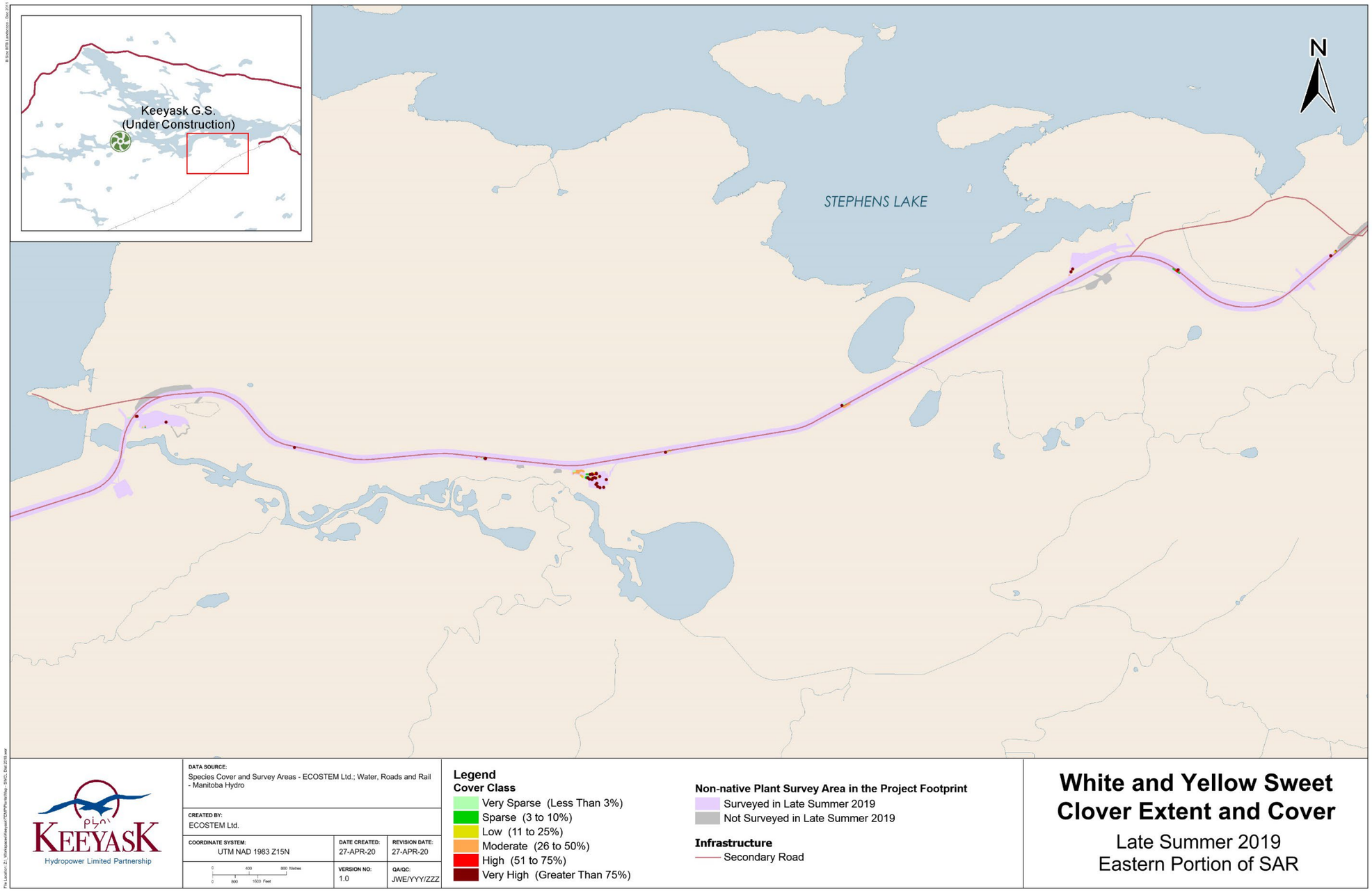
[1] Includes locations with unidentified white or yellow sweet clover due to lack of flowers.

Map 7-10: The distribution and abundance (cover class) of white sweet clover[1] in the Project footprint along the eastern portion of the North Access Road in late summer, 2019



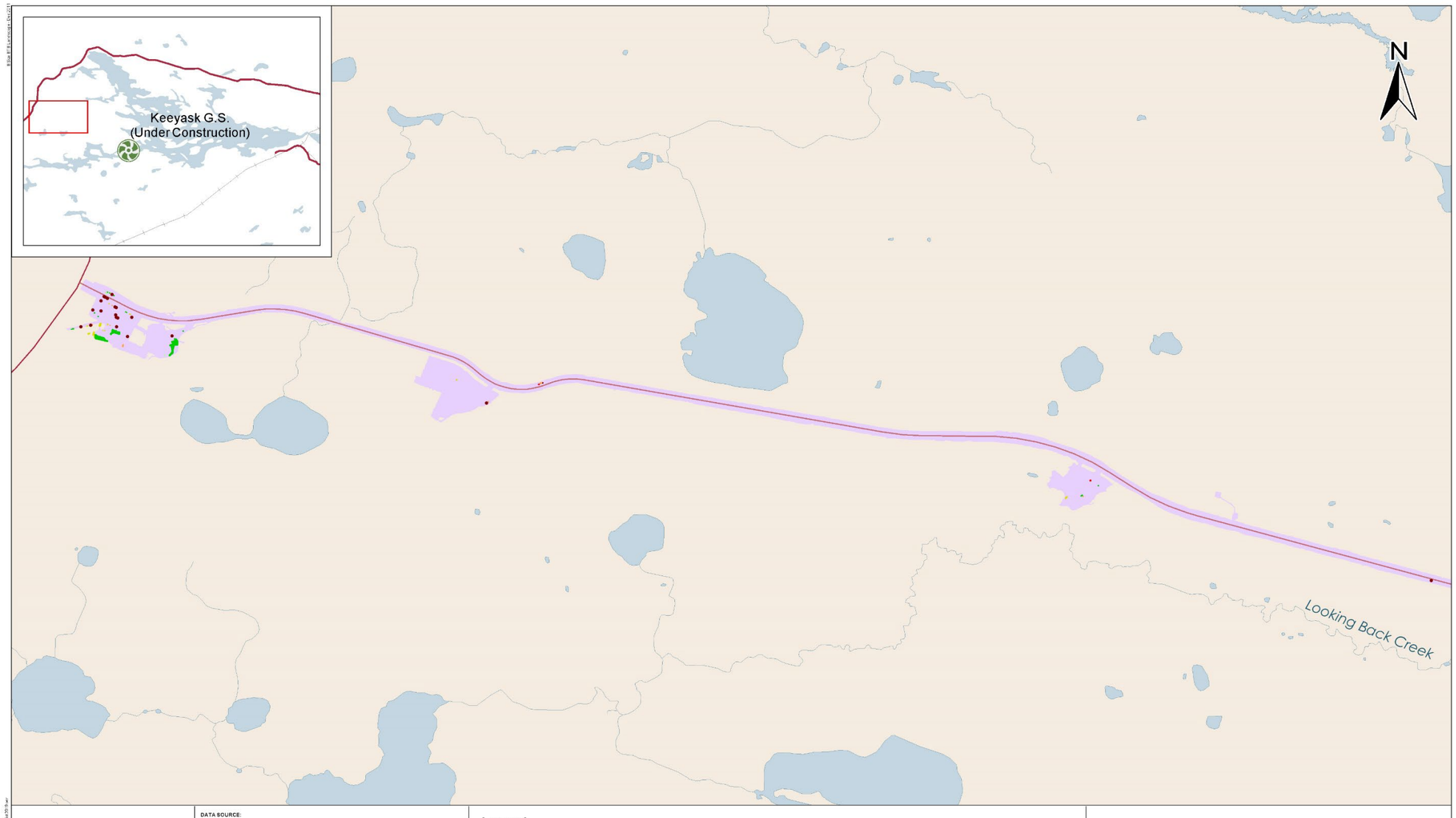
[1] Includes locations with unidentified white or yellow sweet clover due to lack of flowers.

Map 7-11: The distribution and abundance (cover class) of white sweet clover[1] in the Project footprint along the western portion of the South Access Road in late summer, 2019

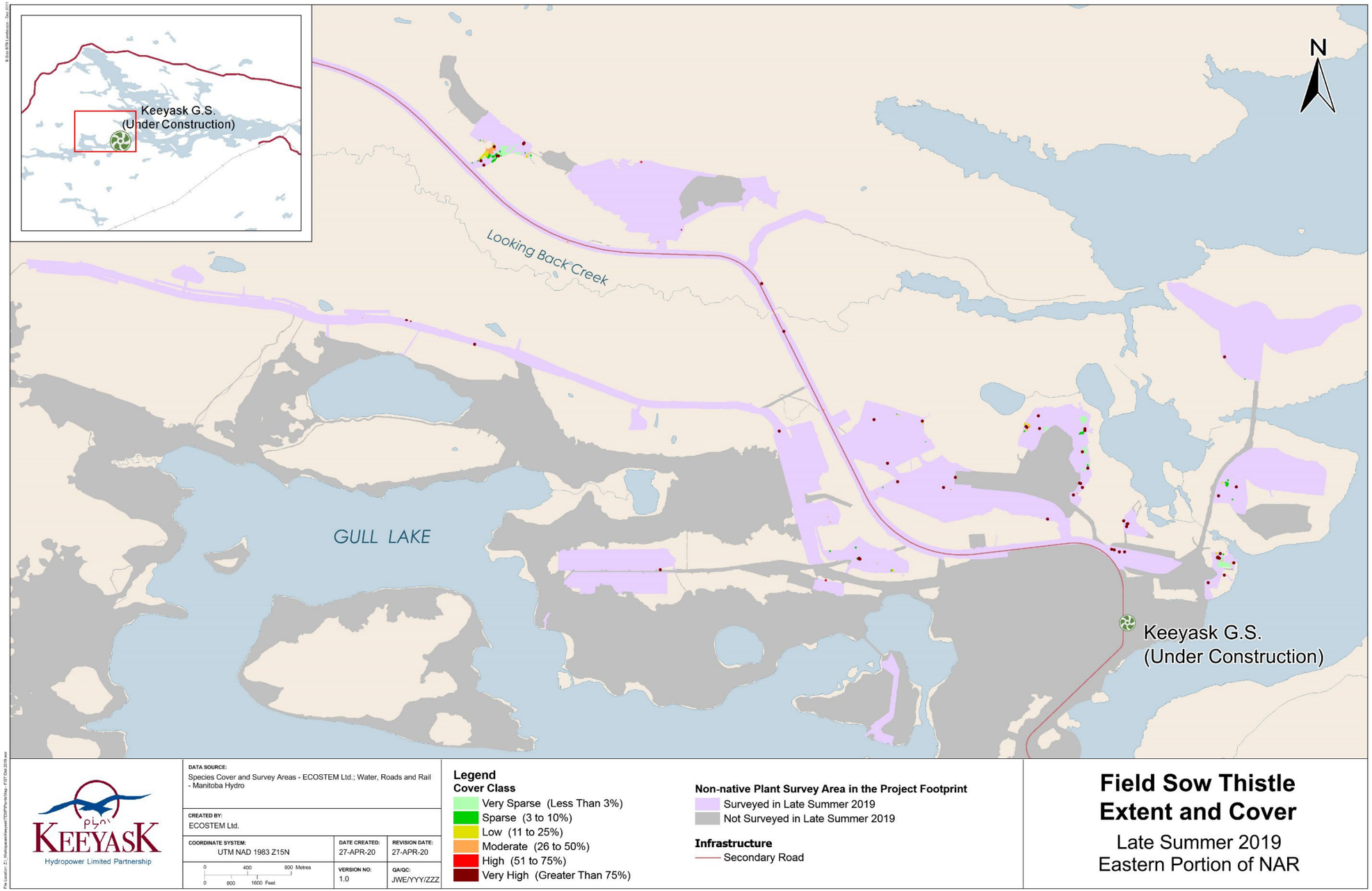


[1] Includes locations with unidentified white or yellow sweet clover due to lack of flowers.

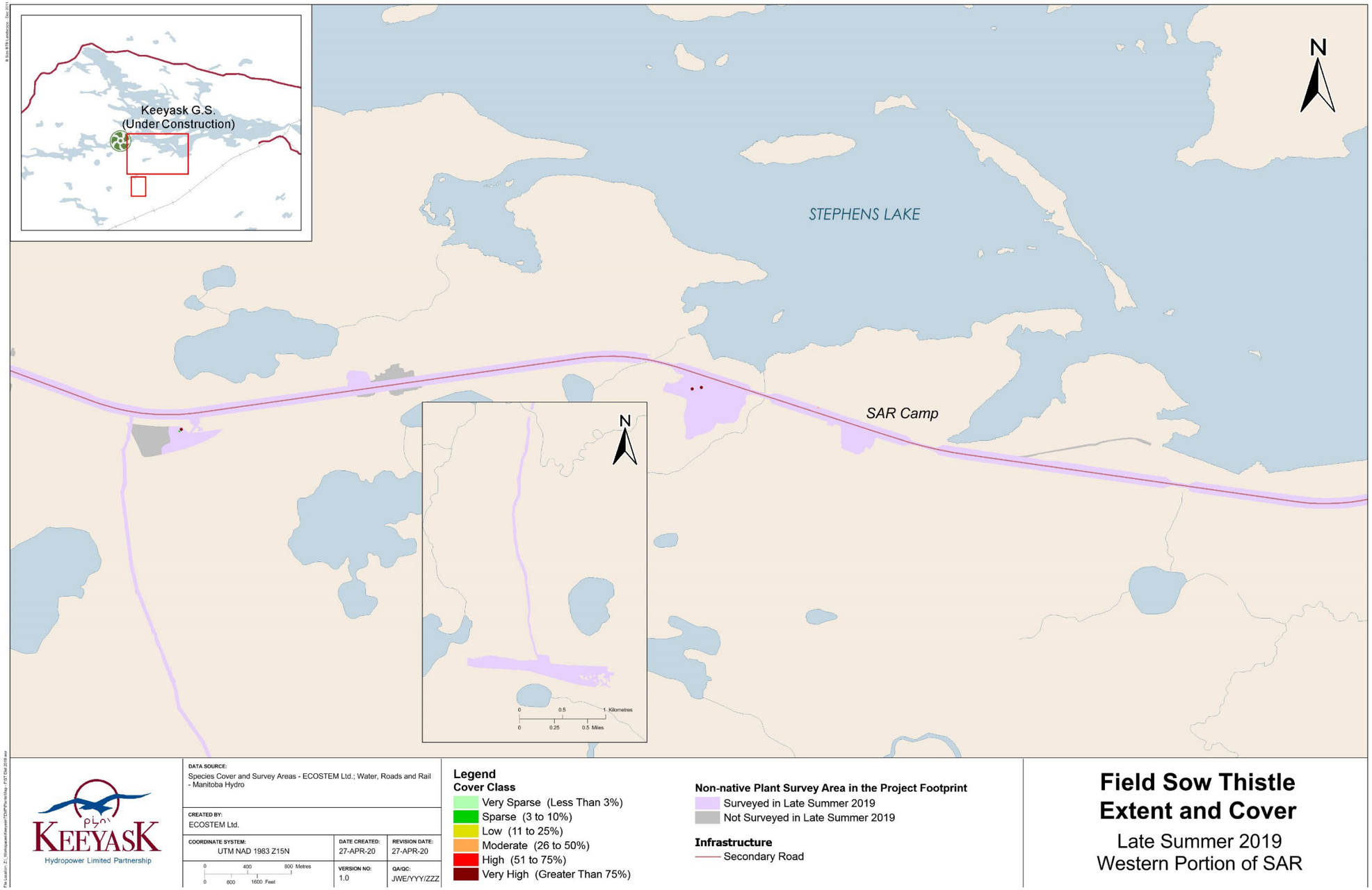
Map 7-12: The distribution and abundance (cover class) of white sweet clover[1] in the Project footprint along the eastern portion of the South Access Road in late summer, 2019



Map 7-13: 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, 2019

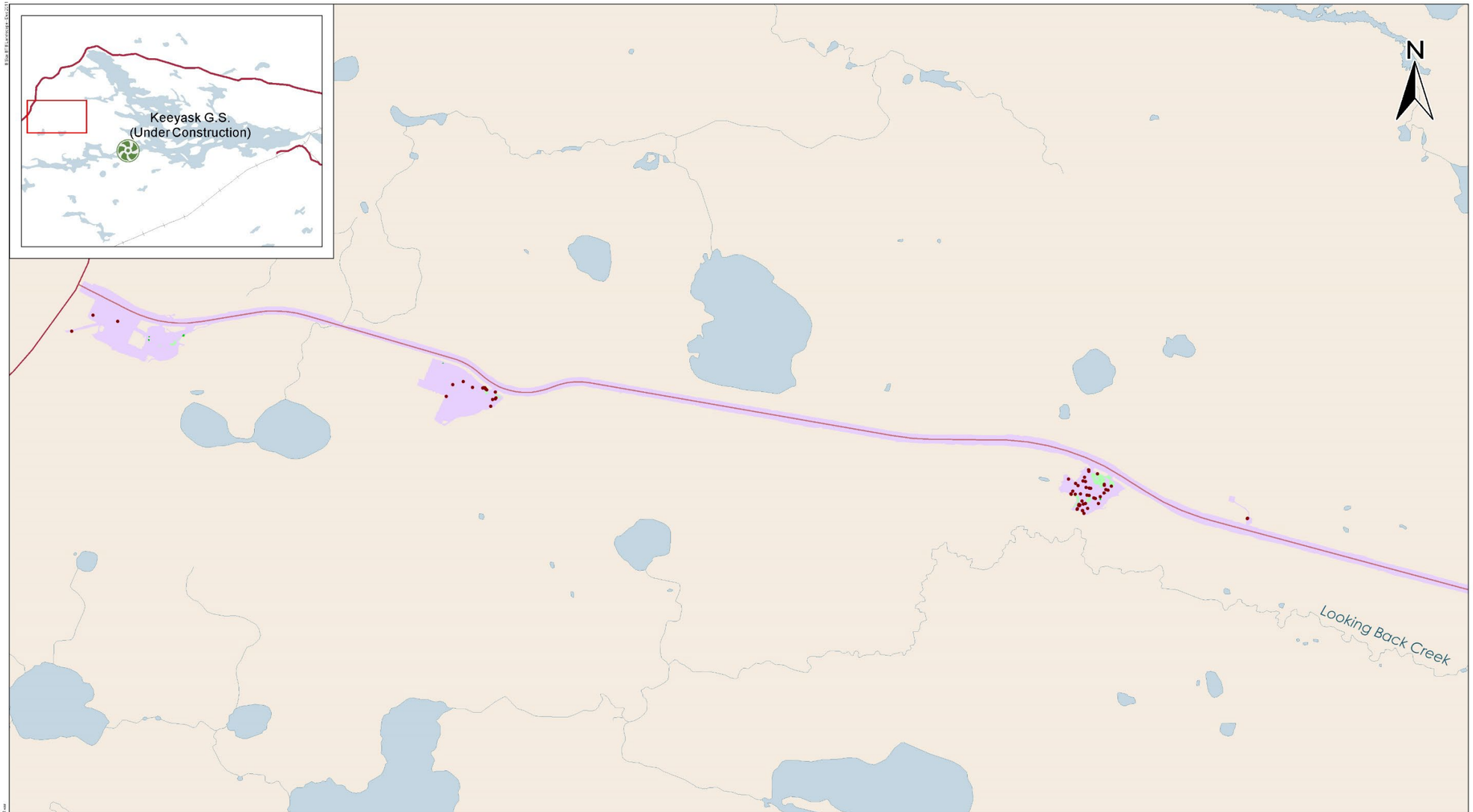


Map 7-14: The distribution and abundance (cover class) of field sow-thistle in the Project footprint along the eastern portion of the North Access Road in late summer, 2019

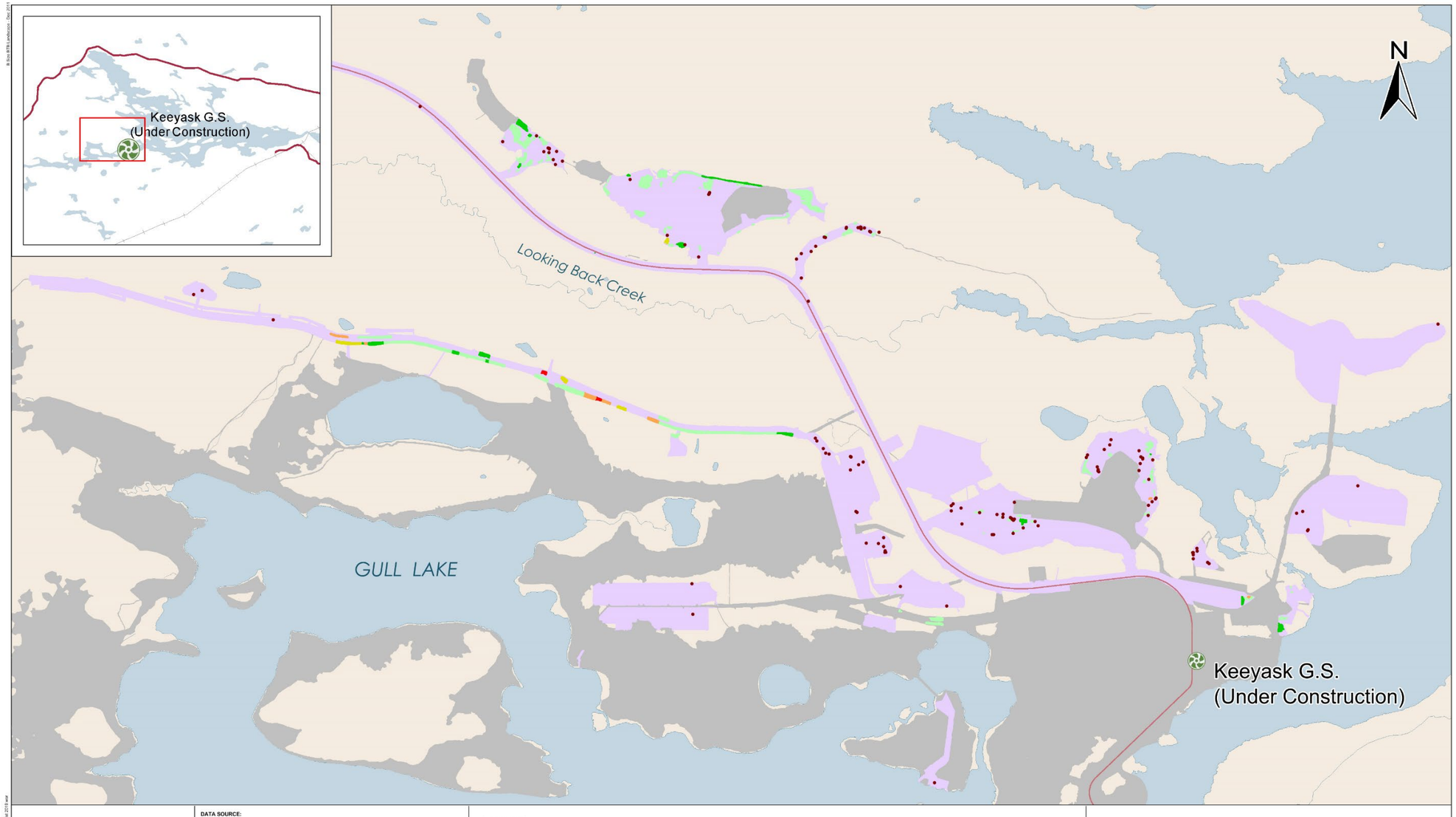


Map 7-15: The distribution and abundance (cover class) of field sow-thistle in the Project footprint along the western portion of the South Access Road in late summer, 2019

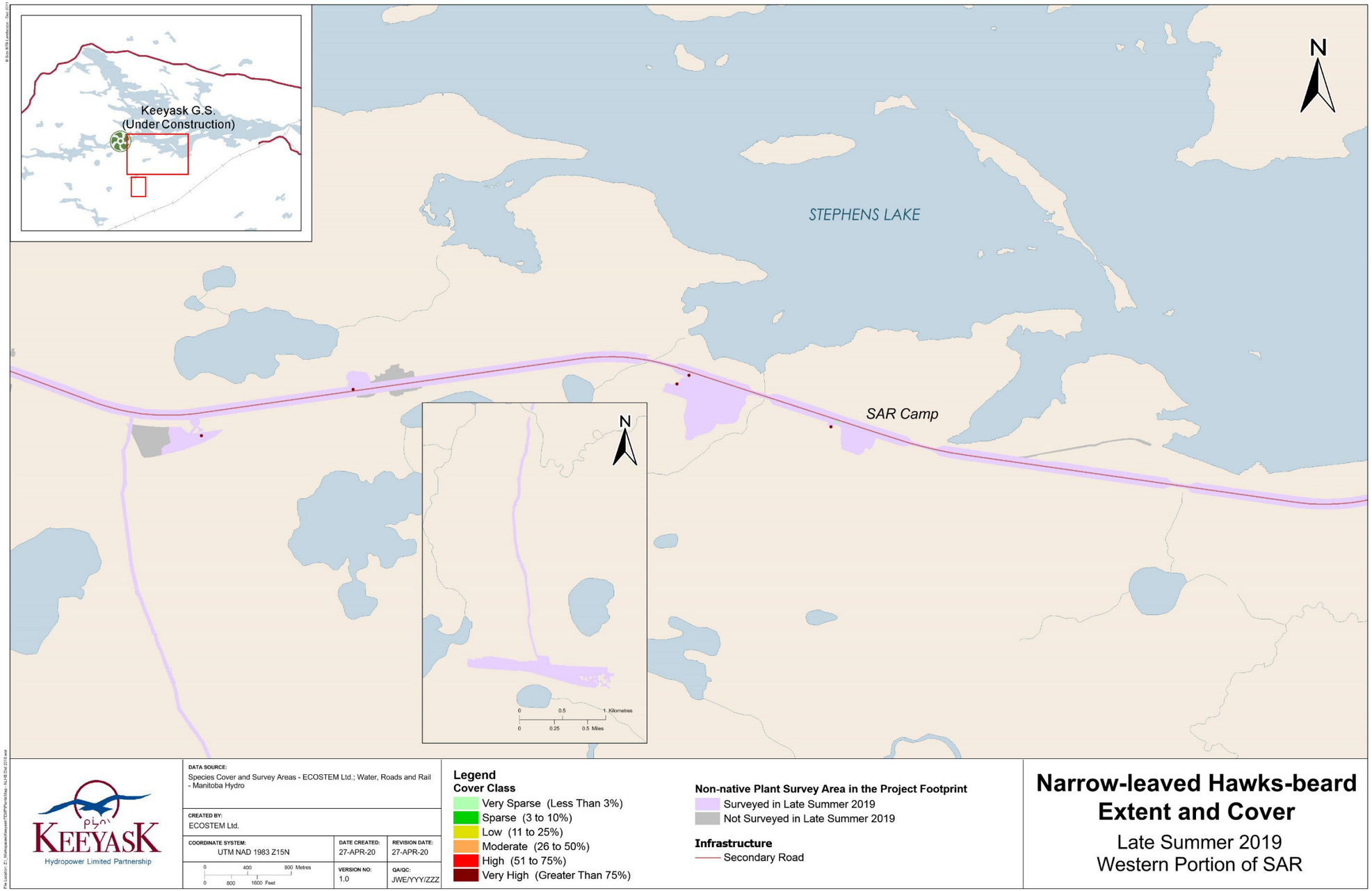
Map 7-16: The distribution and abundance (cover class) of field sow-thistle in the Project footprint along the eastern portion of the South Access Road in late summer, 2019



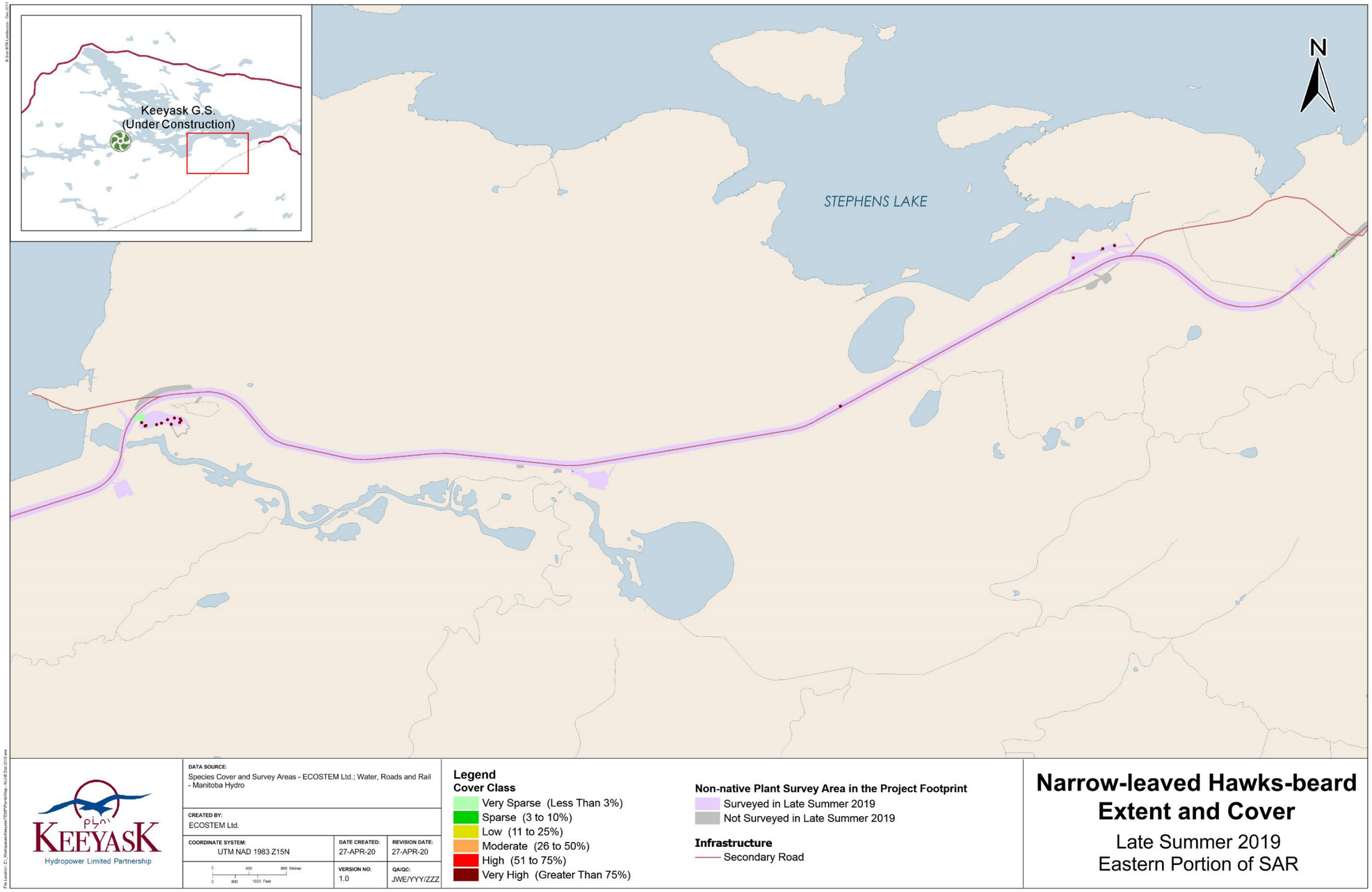
Map 7-17: The distribution and abundance (cover class) of narrow-leaved hawks-beard in the Project footprint along the western portion of the North Access Road in late summer, 2019



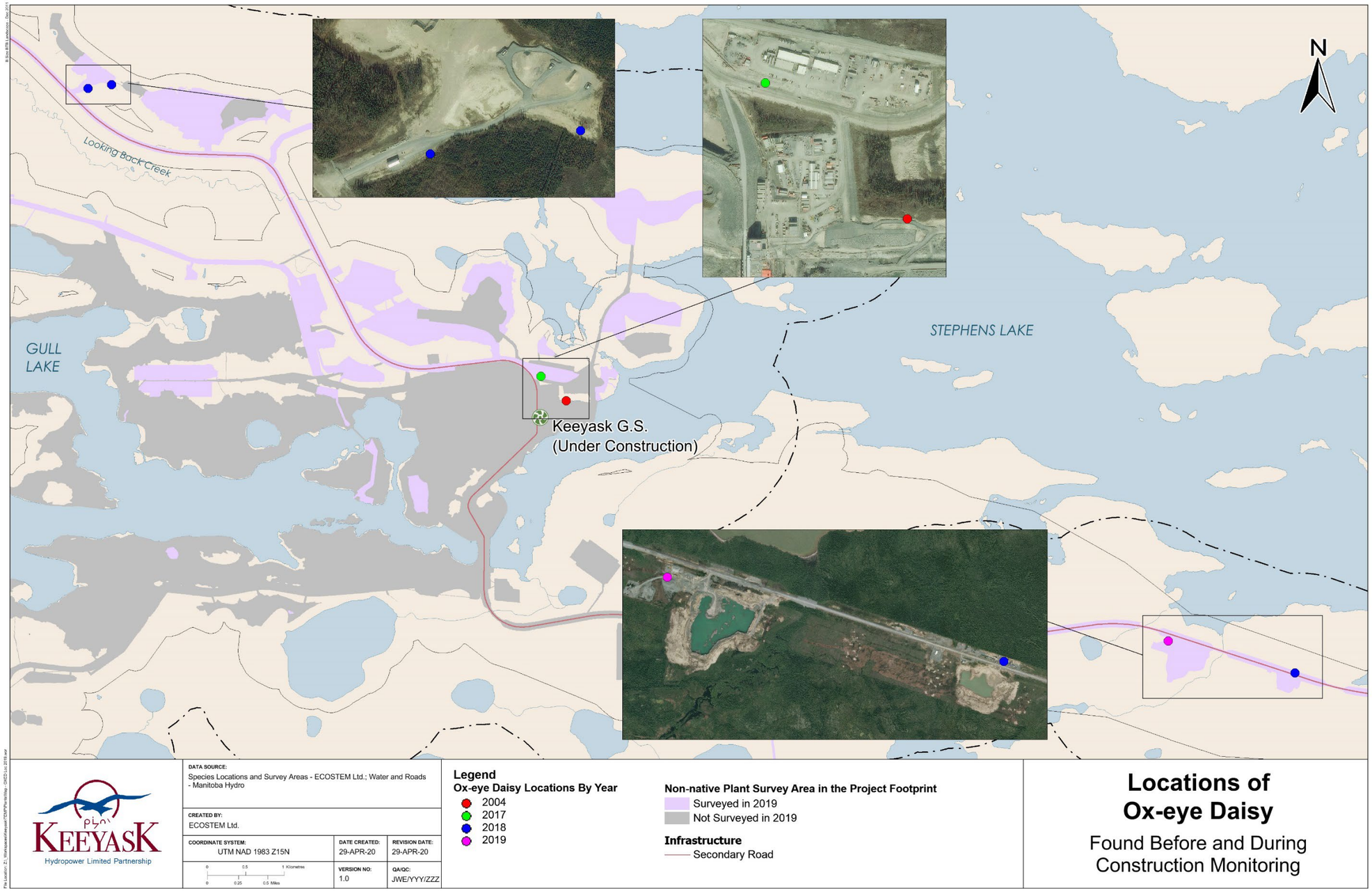
Map 7-18: The distribution and abundance (cover class) of narrow-leaved hawks-beard in the Project footprint along the eastern portion of the North Access Road in late summer, 2019



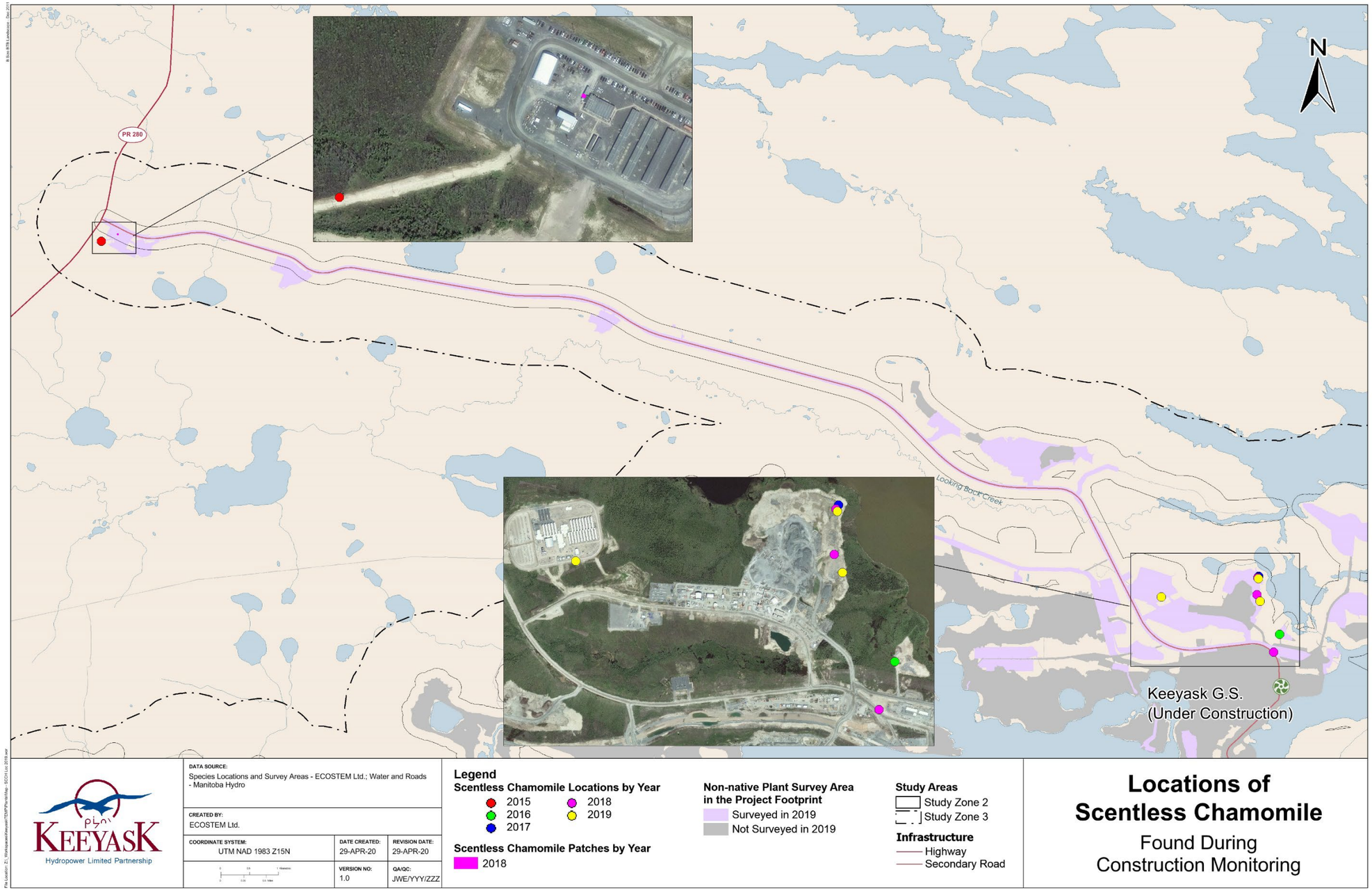
Map 7-19: The distribution and abundance (cover class) of narrow-leaved hawks-beard in the Project footprint along the western portion of the South Access Road in late summer, 2019



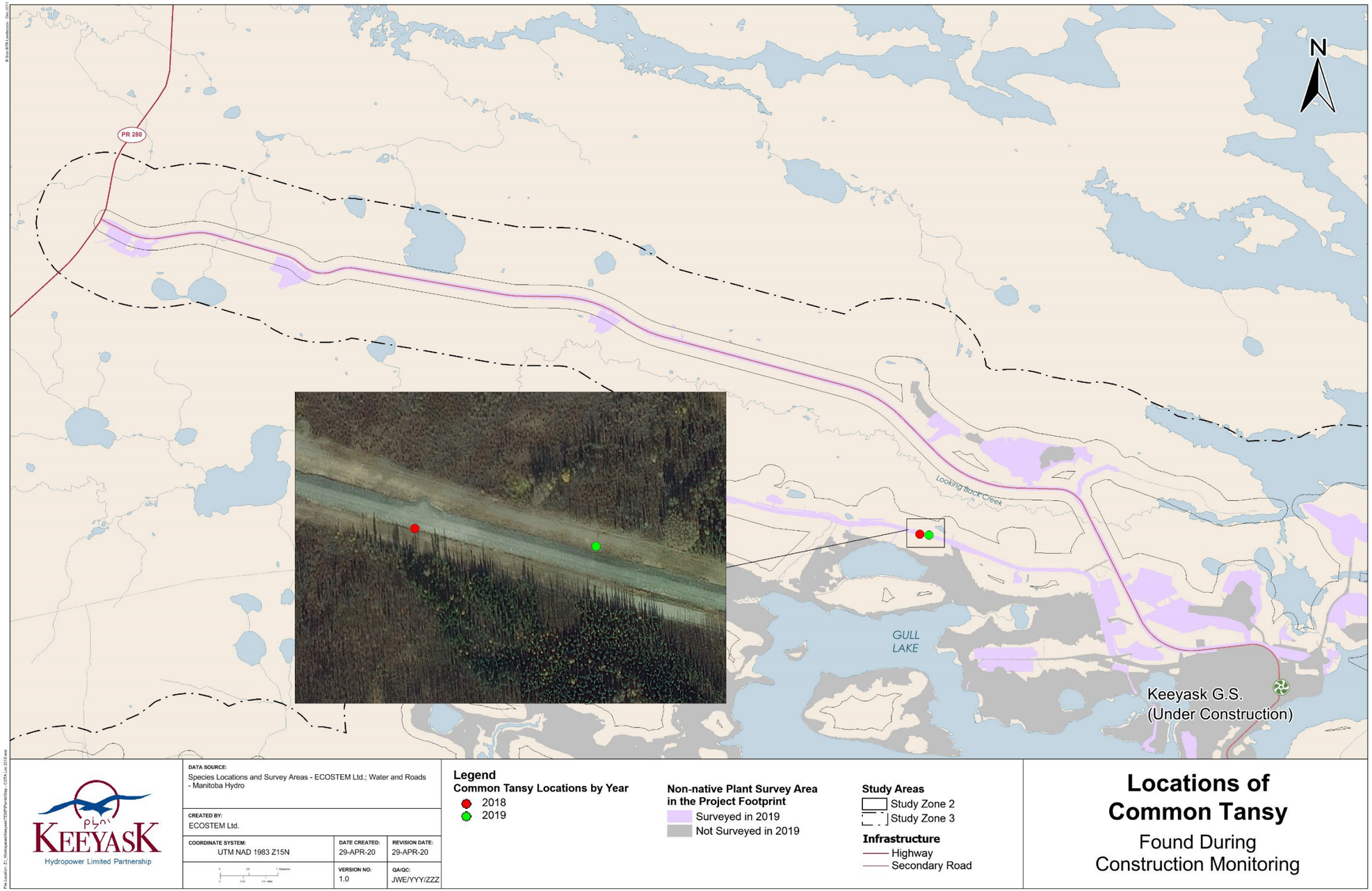
Map 7-20: The distribution and abundance (cover class) of narrow-leaved hawks-beard in the Project footprint along the eastern portion of the South Access Road in late summer, 2019



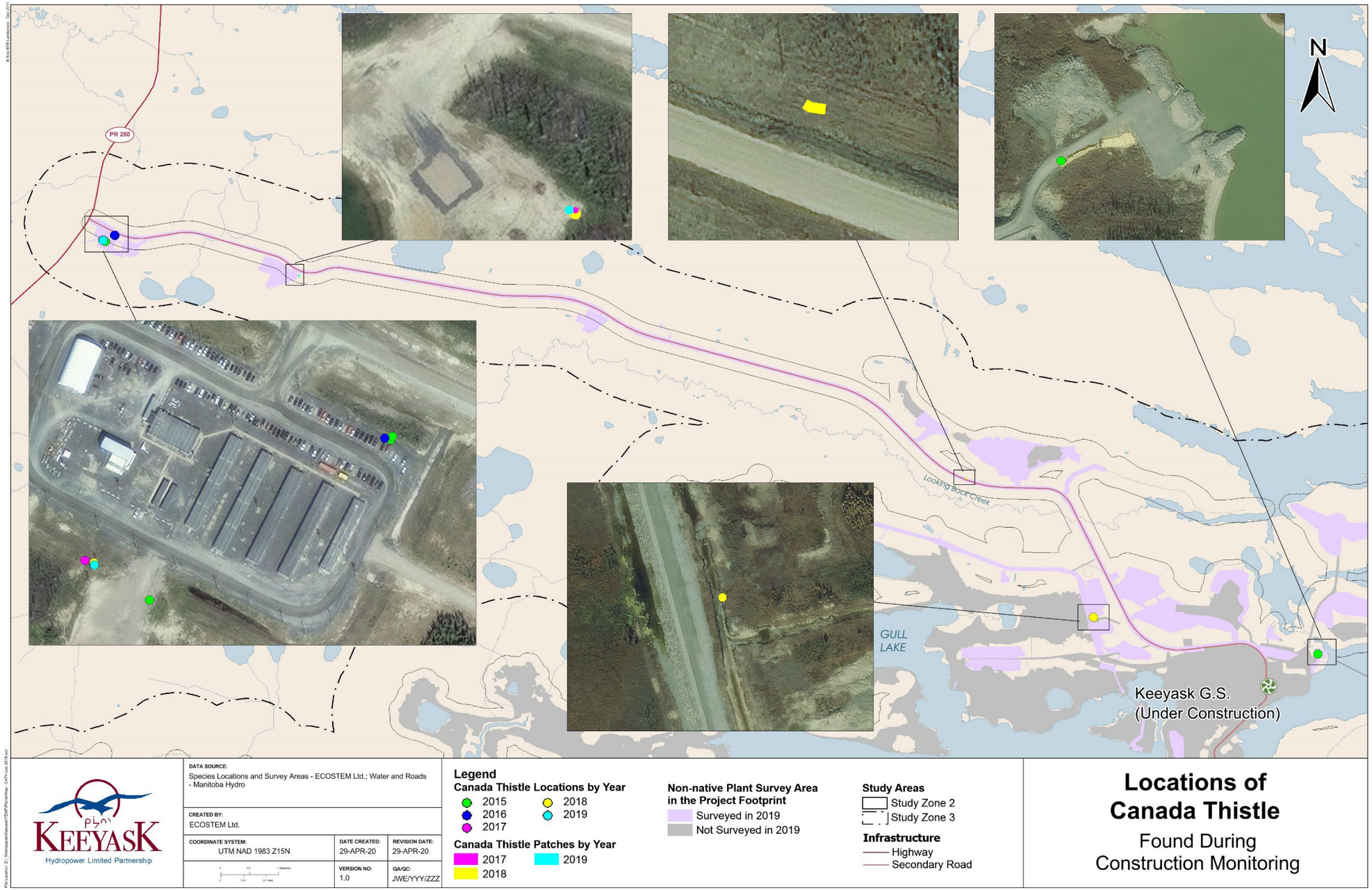
Map 7-21: Locations of ox-eye daisy found before and during Project construction monitoring



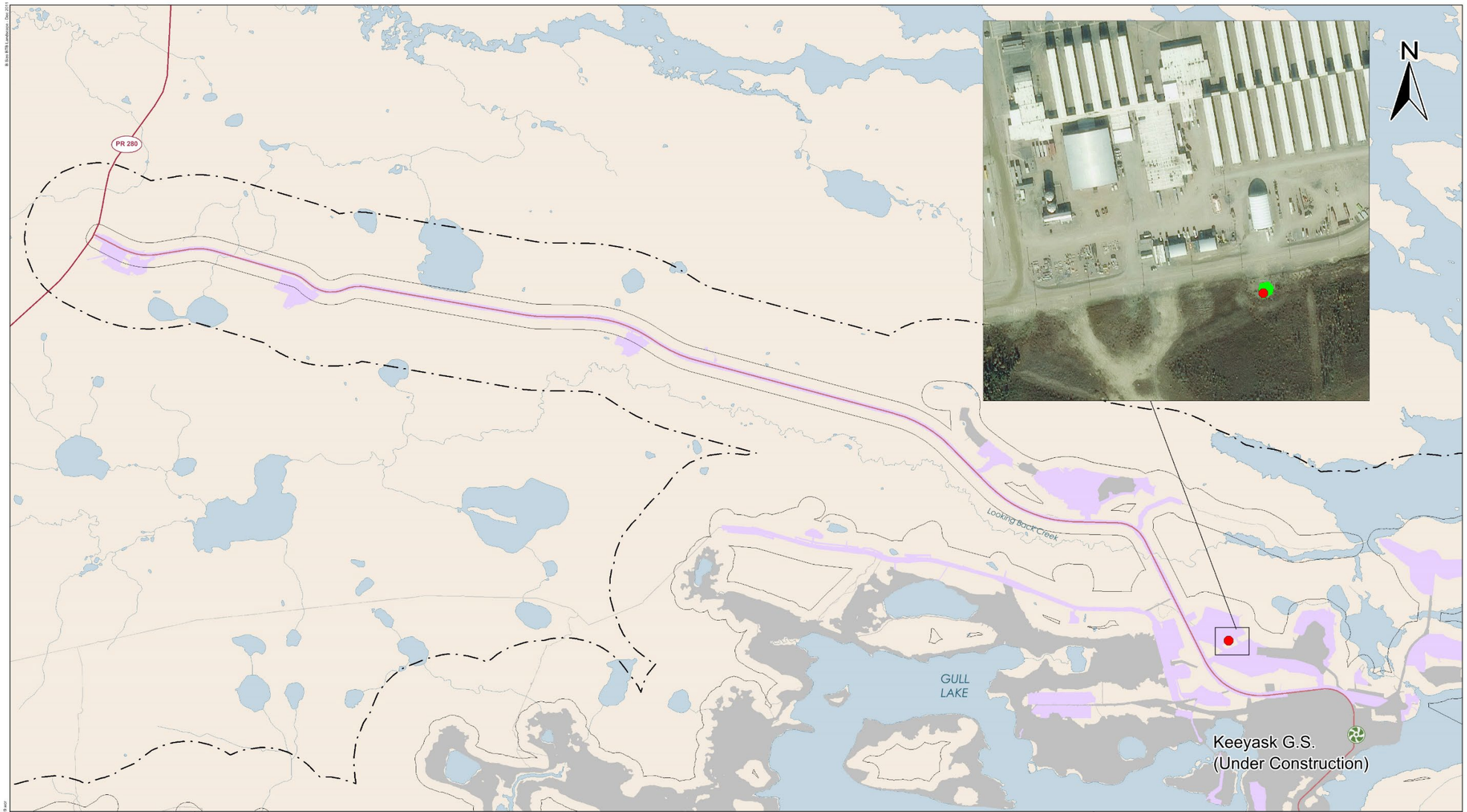
Map 7-22: Locations of scentless chamomile identified during Project construction monitoring



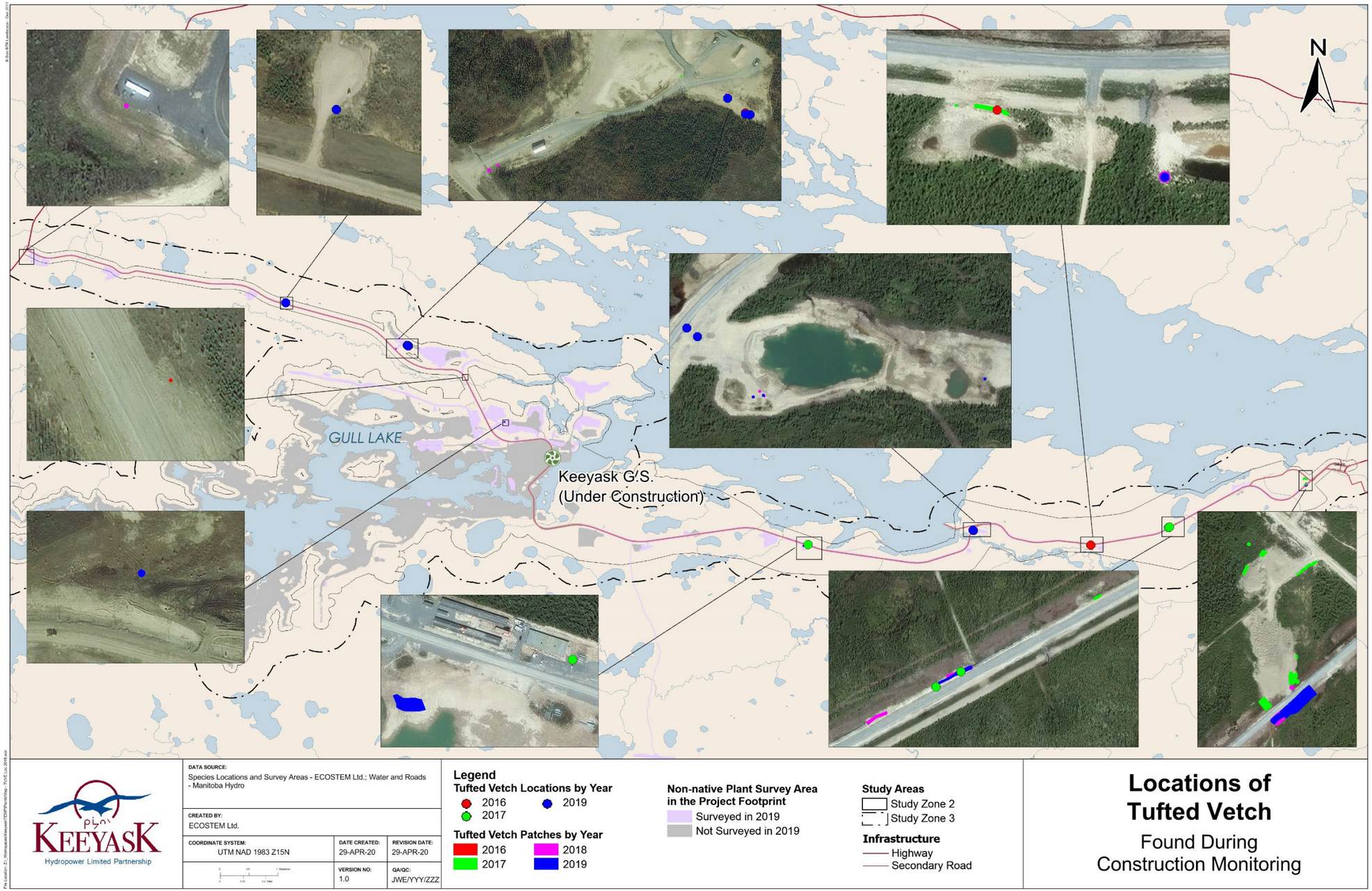
Map 7-23: Location of common tansy identified during Project construction monitoring



Map 7-24: Canada thistle locations identified during Project construction monitoring



Map 7-25: Common burdock locations identified during Project construction monitoring



Map 7-26: Tufted vetch locations identified during Project construction monitoring

June 2020

APPENDIX 4:
ADDITIONAL NON-NATIVE PLANT RESULTS

June 2020

Table 7-4: Total early and late summer non-native plant extent as a percentage of total area surveyed by year and Project component

Project Component	2014		2015		2016		2017[2]	2018[2]	2019[2]
	ES	LS	ES	LS	ES	LS	LS	LS	LS
North Access Road	0.00	0.32	0.32	0.89	0.01	3.5	4.4	7.6	4.9
South Access Road	-	-	-	-	-	0.2	2.8	7.9	7.7
Camp & Work Areas	0.56	3.24	3.59	4.66	1.26	4.0	5.9	12.8	13.1
Borrow Area	0.02	0.33	0.64	3.09	0.85	2.1	5.1	8.9	8.0
North Dyke	-	-	-	-	-	0.1	0.3	7.6	11.5
South Dyke[1]	-	-	-	-	0.00	0.0	0.1	0.2	0.2
Generating Station Area	-	-	-	-	-	0.5	0.2	-	-
Reservoir Clearing Area	-	-	-	-	-	-	-	-	-
All	0.30	1.83	1.98	3.70	0.72	2.4	4.3	9.6	9.9
Total non-native plant extent (ha)	*0.7*	*4.9*	*4.7*	*9.3*	*4.8*	*14.8*	*28.9*	*64.0*	*69.4*
Total area surveyed (ha)	*247*	*269*	*237*	*251*	*669*	*620*	*671*	*668*	*703*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".ES="Early Summer"; LS="Late Summer".
[1] Proportion of non-native cover in south dyke area is likely an overestimate of the proportion for entire footprint. See Section 2.1.
[2] Full early summer survey not undertaken in 2017, 2018 and 2019.

June 2020

Table 7-5: Total early and late summer non-native plant cover as a percentage of total area surveyed by year and Project component

Project Component	2014		2015		2016		2017[2]	2018[2]	2019[2]
	ES	LS	ES	LS	ES	LS	LS	LS	LS
North Access Road	0.00	0.01	0.02	0.07	0.00	0.25	0.38	0.62	0.45
South Access Road	-	-	-	-	-	0.01	0.36	1.21	2.17
Camp & Work Areas	0.06	0.34	0.46	0.77	0.18	0.58	0.73	1.20	1.05
Borrow Area	0.00	0.05	0.05	0.48	0.04	0.24	0.46	0.74	0.64
North Dyke	-	-	-	-	-	0.00	0.01	0.79	1.10
South Dyke1	-	-	-	-	0.00	0.00	0.02	0.02	0.00
Generating Station Area	-	-	-	-	-	0.03	0.00	-	-
Reservoir Clearing Area	-	-	-	-	-	-	-	-	-
All	0.03	0.20	0.24	0.59	0.06	0.31	0.44	0.88	0.86
Total non-native plant cover (ha)	*0.08*	*0.53*	*0.57*	*1.49*	*0.43*	*1.89*	*2.98*	*5.85*	*6.02*
Total area surveyed (ha)	*247*	*269*	*237*	*251*	*669*	*620*	*671*	*668*	*703*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".ES="Early Summer"; LS="Late Summer".
[1] Proportion of non-native cover in south dyke area is likely an overestimate of the proportion for entire footprint. See Section 2.1.
[2] Full early summer survey not undertaken in 2017, 2018 and 2019.

June 2020

Table 7-6: Total approximate non-native species cover (m^2) and number of species in the Project footprint, by year and season

Common Name	2014		2015		2016		2017		2018		2019	
	ES	LS	ES	LS	ES	LS	ES[1]	LS	ES[1]	LS	ES[1]	LS
Common Burdock	-	-	-	-	-	0	-	-	2	5	-	5
Wormwood	-	-	0	0	0	1	0	1	-	1	-	-
Shepherd's-Purse											-	0
Lamb's-quarters	89	2,903	1,115	8,844	990	6,342	131	15,229	-	19,709	0	25,817
Canada Thistle	-	-	0	0	-	0	-	1	1	2	-	1
Narrow-leaved Hawks-beard	-	-	-	-	-	586	191	1,314	-	11,040	0	10,808
Wormseed Mustard											-	495
Ox-eye Daisy	-	-	-	-	-	-	0	-	-	0	-	0
Bird's-foot Trefoil	-	-	-	-	0	0	-	0	-	-	-	0
Pineappleweed	-	-	7	18	0	29	-	325	-	74	-	32
Black Medick	-	0	-	1	-	-	-	0	-	-	-	-
Alfalfa	119	124	0	11	4	14	4	40	-	98	-	102
White Sweet Clover	-	532	1,742	2,252	900	3,015	11	4,949	-	11,508	-	7,839
Yellow Sweet Clover	-	0	-	2	7	109	-	254	-	543	0	1,235
Unidentified Sweet Clover	387	72	-	-	565	1,838	1,372	67	-	307	0	851
Spotted Lady's-Thumb											-	77
Common Timothy	-	-	-	-	-	0	101	0	-	0	0	0
Common Plantain	27	80	56	121	68	268	97	246	-	741	0	674
Curly Dock	-	-	-	-	-	100	19	19	-	148	0	204
Rye	-	0	-	-	-	-	-	-	-	-	-	-
Smooth Catchfly	-	-	0	5	16	26	1	32	-	294	-	338
Field Sow-thistle	38	252	301	972	52	1,111	420	1,656	14	2,543	0	3,338
Common Tansy	-	-	-	-	-	-	-	-	-	0	-	0
Common Dandelion	143	1,291	2,316	2,422	1,654	5,268	1,465	5,521	-	10,199	0	6,792
Alsike Clover	-	25	145	242	43	190	2	91	-	833	0	1,021
Red Clover	-	0	-	0	-	-	0	1	-	0	-	0
White Clover	-	0	-	0	0	0	-	-	-	-	-	0
Scentless chamomile	-	-	-	0	-	0	-	0	-	1	-	0
Wheat	-	-	-	-	-	30	-	21	0	-	-	-
Tufted Vetch	-	-	-	-	0	0	2	38	2	170	0	563
Number of non-native species	7	12	11	16	13	21	16	21	5	21	10	25

Notes: Numbers that round to zero shown as "0"; absences shown as "-". ES="Early Summer"; LS="Late Summer".
[1] Full early summer survey not undertaken in 2017, 2018 and 2019. Cover only includes patches mapped using full method.
[2] Species difficult to distinguish until they flower are combined into a broader taxon. Unidentified sweet clover includes white sweet clover and yellow sweet clover.

Table 7-7: Total late summer non-native plant extent by project and year as a percentage of area surveyed

Footprint Use	2014	2015	2016	2017	2018	2019
Keeyask Infrastructure Project	0.5	3.7	7.5	29.4	23.2	21.0
Both Keeyask Infrastructure and Keeyask Generation Projects	2.4	3.7	4.2	6.9	15.1	16.2
Keeyask Generation Project	-	-	0.3	0.4	4.1	5.2

Notes: Numbers that round to zero shown as "0"; absences shown as "-".

Table 7-8: Total late summer non-native plant cover by project and year as a percentage of area surveyed

Footprint Use	2014	2015	2016	2017	2018	2019
Keeyask Infrastructure Project	0.1	0.6	1.1	2.3	1.1	0.8
Both Keeyask Infrastructure and Keeyask Generation Projects	0.2	0.6	0.5	0.8	1.5	1.4
Keeyask Generation Project	-	-	0.06	0.03	0.4	0.5

Notes: Numbers that round to zero shown as "0"; absences shown as "-".

Table 7-9: Percentage of total non-native plant cover with mortality by treatment area

Treatment area	Total cover (m^2)	Percent of Cover Treated[1]
Borrow Area G-1	3,125	94
Start-up Camp	932	8
NAR Gate Staging Area	31	44
Main Camp	46	72
Work Area B	142	0
SAR Camp	2	0
All areas	*4,277*	*72*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".

[1] Patches with mortality characteristic of herbicide application.

Table 7-10: Percentage of total non-native plant cover with mortality by species

Common Name	Total cover (m^2)	Percent of Cover Treated[1]
Common Burdock	5	100
Shepherd's-Purse	0	0
Lamb's-quarters	236	72
Narrow-leaved Hawks-beard	145	77
Pineappleweed	21	0
Alfalfa	1	50
Field Sow-thistle	1,254	98
White and yellow sweet clover	1,791	61
Common Plantain	127	96
Yellow or Curled Dock	65	99
Smooth Catchfly	56	63
Common Dandelion	536	39
Alsike Clover	40	72
White Clover	0	0
Tufted Vetch	0	100
All species	*4,277*	*72*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".

[1] Patches with mortality characteristic of herbicide application.

Table 7-11: Non-native species cover in herbicide-treated patches before and after treatment in 2019

Common Name	Pre-treatment cover (m^2)	Post-treatment cover (m^2)	Percent change
Common Burdock	5	0	-100
Lamb's-quarters	169	18	-89
Narrow-leaved Hawks-beard	111	51	-54
Alfalfa	0	0	-30
Field Sow-thistle	1,226	703	-43
White and Yellow Sweet Clover	1,096	238	-78
Common Plantain	122	89	-27
Yellow or Curled Dock	65	44	-33
Smooth Catchfly	35	4	-89
Common Dandelion	207	105	-49
Alsike Clover	29	3	-89
Tufted Vetch	0	0	-93
All Species	*3,066*	*1,256*	*-59*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".

[1] Percent change; A negative sign means that cover decreased.

Table 7-12: Changes in the overall cover[1] of the species at Levels 1 and 2 of invasive concern that were in the treatment areas before and after treatment in 2019

Common Name[2]	Overall Live Cover Before Herbicide Treatment (m^2)	Overall Live Cover After Herbicide Treatment (m^2)	Percent Change[3]
Common Burdock	4.7	0.0	-100.0
Field Sow-thistle	3,337.8	2,806.3	-15.9
White and yellow sweet clover	9,924.6	9,063.2	-8.7
Tufted Vetch	562.4	562.1	-0.1
All Level 1 and 2 species	13,829.5	12,431.6	-10.1
Percent of total area surveyed	*0.20*	*0.18*	

Notes: Numbers that round to zero shown as "0"; absences shown as "-".

[1] Overall cover includes treated and untreated surveyed areas.

[2] Underlined species were targeted for herbicide application

[3] Percent change; A negative sign means that cover decreased.

APPENDIX 5:
REED CANARYGRASS RESULTS

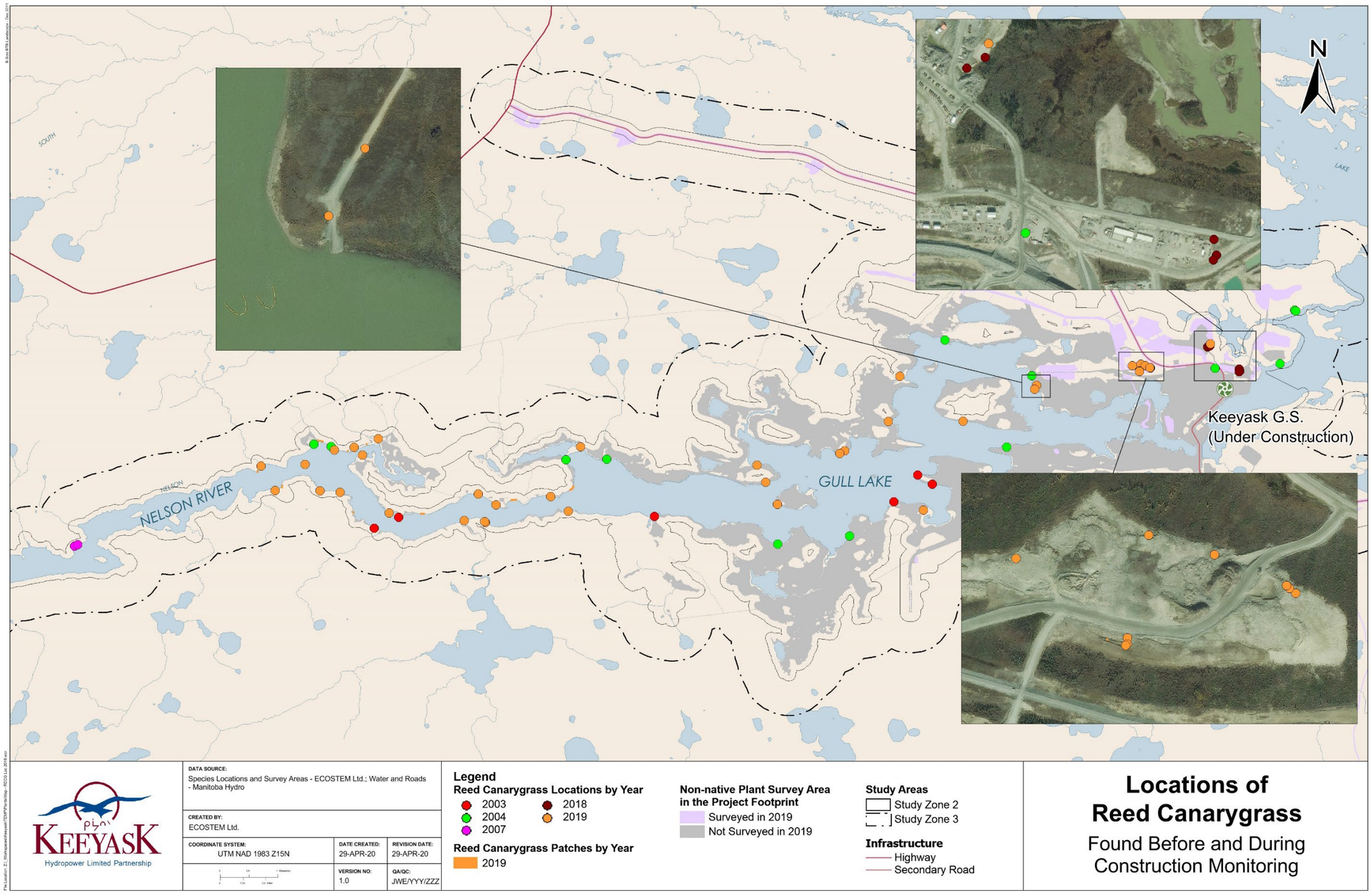
Reed Canarygrass

In 2019, reed canarygrass (*Phalaris arundinacea*; Photo 7-1) was recorded in three components of the Project footprint (Map 7-27). Plants were found at 10 sites scattered in EMPA D12, at two sites in EMPA D16, and at one site near the upstream boat launch. During the shore zone non-native plant surveys, patches of reed canarygrass were found growing at 42 sites along the shoreline upstream of the Keeyask Generating Station.

The plant has previously been found at 26 locations near and along the Nelson River shoreline between Clark and Stephens Lakes during plant surveys in 2003, 2004 and 2007, and at five locations in the Project footprint in 2018. It is uncertain whether the plant was introduced by Project construction activity, or if it spread to this location from a pre-existing population outside of the Project footprint.

Due to the reasons stated in Section 2.6, reed canarygrass found during the monitoring is not being included as a non-native species. Manual removal will continue at sites with one to a few plants. Recorded plant locations will be monitored, however, and mitigation options will be considered in the future if the plant appears to become invasive.

Photo 7-1: Reed canarygrass growing in Work Area B on August 26, 2018



Map 7-27: Reed canarygrass locations identified before and during Project construction monitoring