Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Habitat Rehabilitation Implementation and Success Monitoring Report

TEMP-2018-07

KEEYASK

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KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2018-07

HABITAT REHABILITATION IMPLEMENTATION AND SUCCESS MONITORING

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.

This report describes the results of the terrestrial habitat rehabilitation monitoring conducted during the fourth summer of Project construction.

Why is the study being done?

Terrestrial habitat rehabilitation mitigates adverse Project effects on terrestrial habitat and plants (e.g., habitat loss, erosion, invasive plant spread), restores wildlife habitat and improves aesthetics, among other benefits. Terrestrial habitat will be rehabilitated in areas not required for Project operation and in some permanent Project areas (e.g., along access roads).

The Project's Vegetation Rehabilitation Plan, which is part of the overall Environmental Protection Program, provides the framework for rehabilitating terrestrial habitat in areas impacted by the Keeyask Infrastructure Project (KIP) and the Project.

Monitoring is verifying that terrestrial habitat rehabilitation measures are being done in accordance with the Vegetation Rehabilitation Plan, and whether access on certain trails that lead into the Project site has been blocked. Monitoring is also verifying whether each trail or rehabilitated site has already regenerated to the desired habitat type, or is on a pathway to achieving that.

What was done?

The KHLP carried out the first rehabilitation efforts in 2016 at five locations, including three borrow areas developed by the KIP, one cleared area near the Start-Up Camp and one cleared area near the Main Camp. Rehabilitation measures included grading to reduce steep slopes in the borrow areas, using a discer to loosen compacted mineral substrates and tree planting in all locations. Approximately 231,360 jack pine and 19,720 black spruce seedlings were planted.

Monitoring in 2017 focused on documenting the rehabilitation efforts that were carried out in 2016, and on recording the extent to which pre-existing access trails that meet up with the Project footprint had been blocked or if they were revegetating. Tree regeneration surveys were conducted in the five locations noted above. The 47 trails being monitored by this study were

surveyed for evidence of recent human use, vegetation regeneration and features constructed to block access.

What was found?

Monitoring in 2017 recorded approximately 23.2 ha of planted area. The actual area planted was 1.6 ha more than planned due to factors such as substrate suitability and the actual total number of seedlings received.

Tree regeneration surveys found that the recorded number of live tree seedlings per hectare was higher than the rehabilitation target in every treatment area. In most cases, the number of seedlings was considerably higher than the target (i.e., more than 20% higher). This was partly because additional tree seedlings had sprouted from seeds blown in from nearby uncleared areas, or tree seedlings had been able to survive after the original vegetation clearing because the topsoil was not stripped. In most of the cases where there were a large number of recently sprouted seedlings, it was thought that seed came from cones on nearby jack pine or black spruce trees that were killed in the 2013 wildfire.

All of the planted black spruce seedlings along the surveyed transects were alive. Over all of the treatment areas, planted jack pine seedling survival averaged 97.4% of the total planted stem density, and ranged from 89.9% to 100% by treatment area.

For the 47 existing trails that meet the Project footprint, recent human use was apparent in only two of them. These two exceptions were entirely within a cleared portion of Borrow Area G-1, and this was within the approved Project footprint. Sparse to dense naturally regenerating trees and/or tall shrubs were present in 36 of the 47 surveyed trails. Nearly one-quarter of the trails visited were no longer distinct from the surrounding area because they had been filled in by naturally regenerating vegetation, or because the surrounding area had been recently burned in the 2013 fire.

What does it mean?

For the areas where habitat rehabilitation efforts were implemented in 2016, the stem densities recorded in 2017 were sufficiently high to indicate that each treated area was presently on track to achieve the target densities over time. If natural regeneration and survival rates remain similar to what they were in 2017, then natural regeneration should at least somewhat offset future tree mortality.

Most of the existing trails that meet the Project footprint appeared to be on track to effectively block access, due to regenerating vegetation and/or a constructed barrier. While it is too soon to evaluate whether these trails will regenerate to a habitat type similar to what they pass through, no major concerns were identified for any of these trails.

What will be done next?

The next tree regeneration surveys in the locations that received rehabilitation treatments in 2016 will be conducted in 2020. The first tree regeneration surveys in other locations yet to

receive rehabilitation treatments will be conducted one year after the location is planted. Surveys for access on trails that meet the Project footprint will continue in 2020.

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STUDY TEAM

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

Fieldwork in 2017 was conducted by Brock Epp, Nathan Ricard and Barry Flett.

Data analysis and report writing in 2017 were completed by Brock Epp and James Ehnes. GIS analysis and cartography was completed by Nathan Ricard.

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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 2015a). Monitoring activities for various components of the terrestrial environment were described, including the focus of this report, habitat rehabilitation, during the construction and operation phases.

Monitoring for the Terrestrial Habitat Rehabilitation study was conducted for the first time in 2017. The following presents the results of monitoring conducted that year.

1.1 BACKGROUND

Terrestrial habitat rehabilitation mitigates adverse Project effects on terrestrial habitat and plants (e.g., habitat loss, erosion, invasive plant spread), restores wildlife habitat and improves aesthetics, among other benefits. Terrestrial habitat will be rehabilitated in areas not required for Project operation and in some areas that are required for Project operation (e.g., along access roads). Some of the planned rehabilitation addresses potential adverse Project effects on intactness by blocking or hindering access from Project areas to surrounding areas.

The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan for rehabilitating terrestrial habitat. The *Keeyask Generation Project Vegetation Rehabilitation Plan* (KHLP 2015b), which is part of the overall Environmental Protection Program, provides the framework for rehabilitating terrestrial habitat in areas impacted by Keeyask Infrastructure Project (KIP) and the Project. Areas that were temporarily required for construction but are not required for operation of the generating station or long-term maintenance of the associated infrastructure (e.g., borrow areas), will be rehabilitated based on the framework outlined in this plan. Best efforts will be made to re-establish the habitat types that existed prior to construction. Preference will be given to rehabilitating the most affected priority habitat types. Plant species that are important to the partner First Nations will be incorporated into habitat restoration, where feasible. Permanent Project features that require sight lines for safety purposes will be

revegetated with plant species that are appropriate for the site. A rehabilitation "target" will be determined for areas based on the above criteria.

Monitoring is needed to verify the implementation and effectiveness of terrestrial habitat rehabilitation measures. The overall goal of this study (Habitat Rehabilitation Implementation and Success) is to verify whether each site has achieved, or is on a pathway to achieving, its rehabilitation targets. The study will initially focus on verifying adequate implementation of rehabilitation efforts. As sufficient time elapses for habitat recovery, the monitoring will increasingly focus on evaluating the ultimate success of the rehabilitation efforts.

1.2 OBJECTIVES

The objectives of this study are to:

- Confirm that trails intersecting the Project Footprint (except for existing resource-use trails and those required for operation) are blocked and initial revegetation efforts are adequate;
- Verify the implementation of rehabilitation prescriptions set out in the Vegetation Rehabilitation Plan;
- Confirm that the revegetated portions of the blocked trails are regenerating successfully and are expected to restore a habitat type similar to adjacent areas; and,
- Verify the effectiveness of rehabilitation efforts at restoring native habitat where this is the target prescription, and at restoring ecologically appropriate vegetation in the remaining areas.

1.3 REHABILITATION EFFORTS

As described above, the planned approach for habitat rehabilitation is described in the Project's Vegetation Rehabilitation Plan (KHLP 2015b). Manitoba Hydro provides information on the actual rehabilitation treatments carried out at specific locations on an annual basis to help plan subsequent monitoring efforts.

The KHLP implemented the first habitat rehabilitation efforts in 2016 at five locations along the North Access Road (NAR). This included one location near the Main Camp that was added at the time that the seedlings were being planted to use up surplus seedlings. A recently burned area near the cemetery site along the NAR was also planted with surplus seedlings, but as this is not an area disturbed by the Project, follow-up monitoring under this study is not being done for this site.

The target habitat type is a woodland or forest type for all of the planted areas. This was predefined for the borrow areas. While a specific target habitat type was not predefined for the

planting areas located near the Main Camp (as this was an impromptu addition to use up surplus seedlings), a woodland or forest type is appropriate for the site conditions.

Tree planting is a key measure for facilitating the development of a target habitat type. Trees are typically planted at a predetermined spacing within an area to achieve an initial tree density target. It is anticipated that some planted seedlings will die, predominantly in the first few years, and also that natural tree regeneration will at least somewhat offset planted tree mortality. Natural tree regeneration includes additional tree seedlings that sprout from seeds blown in from nearby areas, or trees that are able to survive after the original vegetation clearing (usually because the topsoil was not stripped).

Based on the target habitat type, rehabilitation treatments in 2016 consisted of tree planting in all sites and one or more other measures in some sites. Grading to reduce slopes greater than 4:1 occurred where needed in borrow areas. In some sites, a Rome TRCW16 discer (Photo 1-1) pulled behind a tractor loosened compacted surface material. Site preparation generally occurred on exposed mineral substrates. Areas where the original surface organic layer was intact were not treated.

Photo source: Manitoba Hydro

Photo 1-1: Discer used for site preparation

The rehabilitation locations were subdivided into “treatment areas” for the monitoring. A treatment area refers to a spatial extent that differed in at least one important way from an adjacent area. The key considerations were the tree species planted, the degree of construction disturbance (e.g., vegetation removal only, vegetation and surface organic layer removal,

overburden excavation) and any site preparation. These treatment areas were delineated, in part, based on results from the field surveys conducted in 2017 (see Section 1.0).

Using the target habitat and rehabilitation prescriptions, the five rehabilitation locations included 17 treatment areas. Table 1-1 summarizes the specific treatments applied within each treatment area.

Table 1-1: Rehabilitation treatment areas in 2016, by location

Location	Treatment Area	Planned Planting Area (ha)	Site Treatment for Planting[1]	Target Species
Planned Areas				
Borrow Area KM-1	01	0.3	Discer	Black spruce
	02	4.0	Discer	Jack pine
	03	0.7	Discer	Black spruce
Borrow Area KM-4	04	0.3	Discer	Jack pine & black spruce
	05	0.4	Discer	Jack pine & black spruce
	06	8.1	Discer	Jack pine
Borrow Area KM-9	07	1.9	Discer	Black spruce
	08	1.5	Discer	Jack pine
	09	2.0	Discer	Black spruce
	10	0.9	Discer	Black spruce
	11	0.2	Discer	Black spruce
Near Start-Up Camp	12	0.1	None	Jack pine
	13	0.4	None	Jack pine
	14	0.2	None	Jack pine
	15	0.5	None	Jack pine
Total		**21.6**		
Additional Unplanned Area				
Main Camp Entrance	16	0.4	None	Jack pine
	17	0.4	None	Jack pine
Total Area for All		**22.4**		

Notes: [1] Additionally, all slopes in borrow areas would have been graded to a slope of 4:1.

Tree planting was planned for approximately 21.6 ha in total (Table 1-1), at the locations shown in Map 1-1 to Map 1-3. In actuality, the total area planted was determined by substrate suitability, the actual total number of seedlings received, and other factors such as logistics (e.g., temporary standing water, worker availability). Typically, some of the areas planned for planting are found to be unsuitable, while other sites outside of the planned planting area are added because they are more suitable, or to utilize surplus seedlings.

Surplus seedlings were available after the planned planting areas were fully planted in 2016. Therefore, two additional areas were planted (Table 1-1), including the Main Camp entrance (two treatment areas) and the cemetery site (one treatment area).

For the black spruce planting areas, seedlings were planted at a spacing of 2 m by 2 m, which equates to an initial tree density target of 2,500 stems/ha. For the jack pine planting areas, seedlings were planted at a spacing of 1 m by 1 m, which equates to a tree density target of 10,000 stems/ha. Both species of seedlings were also planted at a spacing of 1 m by 1 m in areas targeted for a 60% jack pine and 40% black spruce mix. The Vegetation Rehabilitation Plan anticipates that natural regeneration will contribute to achieving the tree density targets.

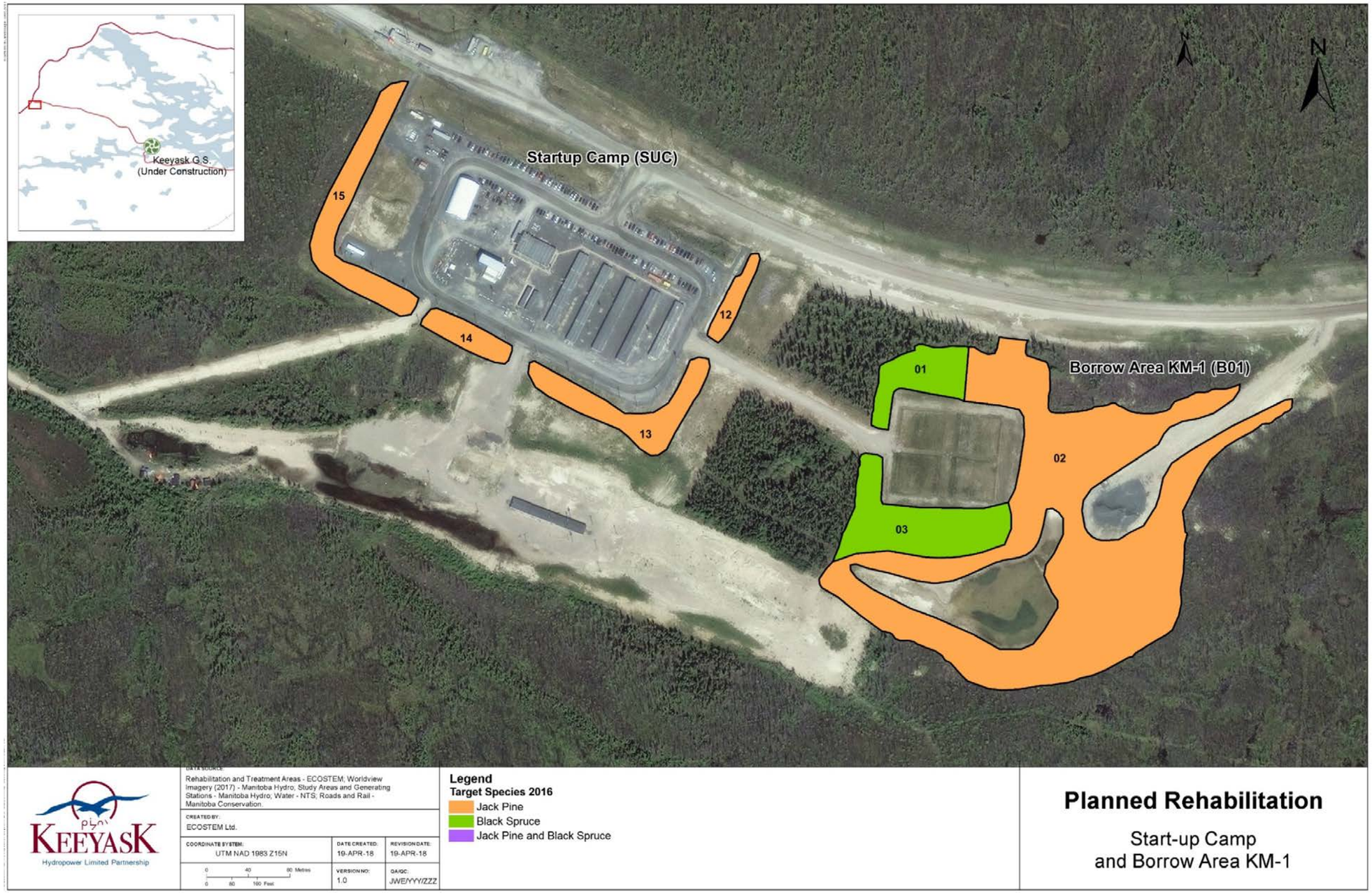
Table 1-2 provides the estimated number of jack pine and black spruce seedlings planted within each rehabilitation location in 2016. Jack pine and black spruce were planted in distinct portions of each of the borrow areas. Only jack pine was planted near the Start-up Camp, at the Main Camp entrance and at the cemetery site. Borrow Area KM-4 received more than half of the jack pine seedlings, which was more than any other location by far. Borrow Area KM-9 received most of the black spruce seedlings.

Planted tree stem densities were calculated using the estimated number of seedlings planted as provided by Manitoba Hydro and the approximate actual area planted. On this basis, overall black spruce planting density ranged from 1,542 to 3,970 stems/ha while overall jack pine planting density ranged from 9,253 to 13,310 stems/ha.

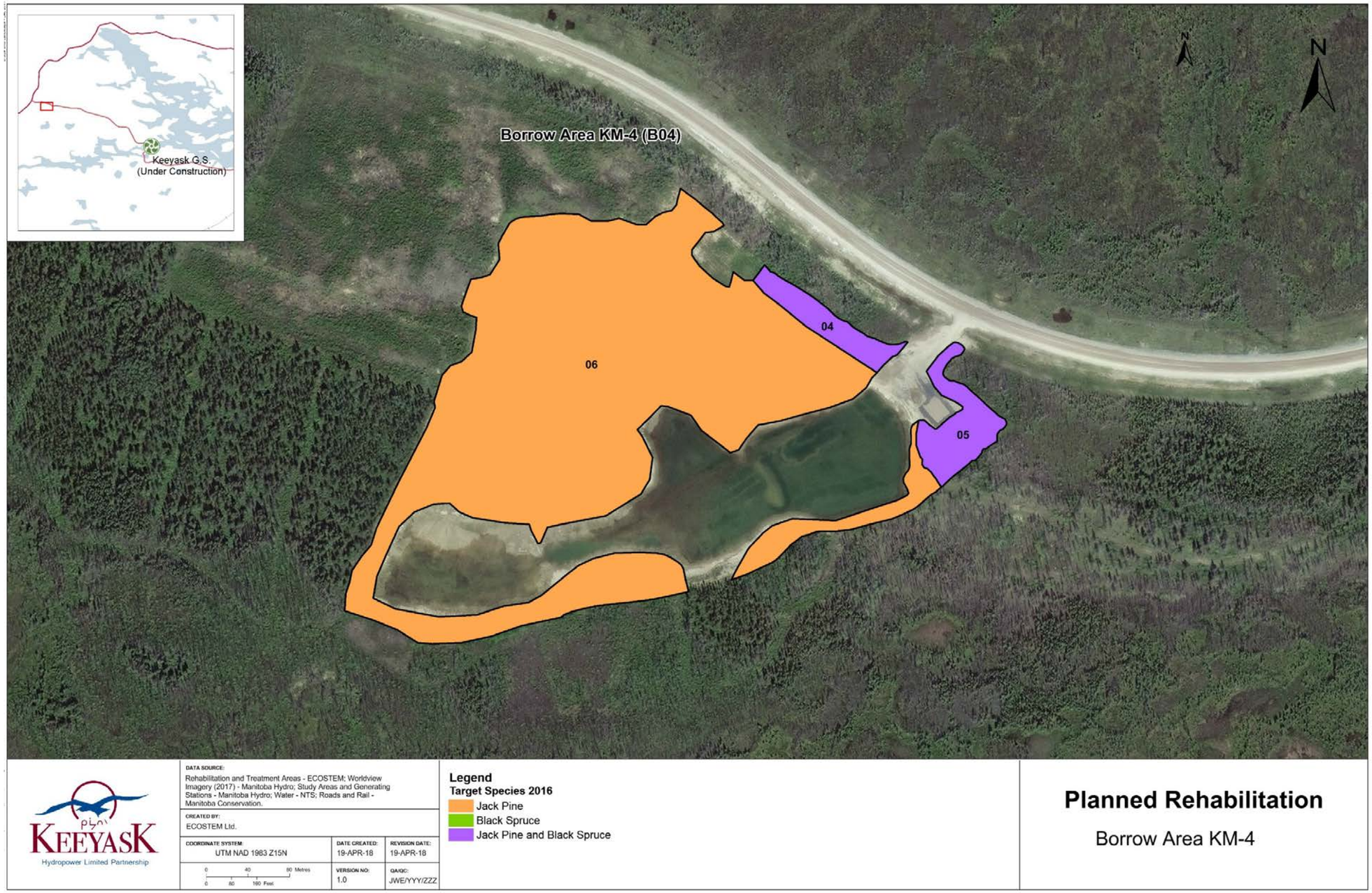
Table 1-2: Approximate area planted and number of seedlings planted by location in 2016

Location	Species	Area Planted (ha)	Number of Seedlings	Overall Density (stems/ha)
Borrow Area KM-1	Black spruce	1	1,577	1,542
	Jack pine	3.5	40,258	11,366
Borrow Area KM-4	Black spruce	0.7	2,760	3,970
	Jack pine	9	120,307	13,310
Borrow Area KM-9	Black spruce	4.5	15,383	3,397
	Jack pine	3.4	23,136	6,709
Near Start-up Camp	Jack pine	2.7	34,704	12,720
Main Camp Entrance	Jack pine	0.8	9,254	11,632
Cemetery[1]	Jack pine	0.41	3,701	9,253
Total	Black spruce	6.2	19,720	3,157
	Jack pine	20	231,360	11,595

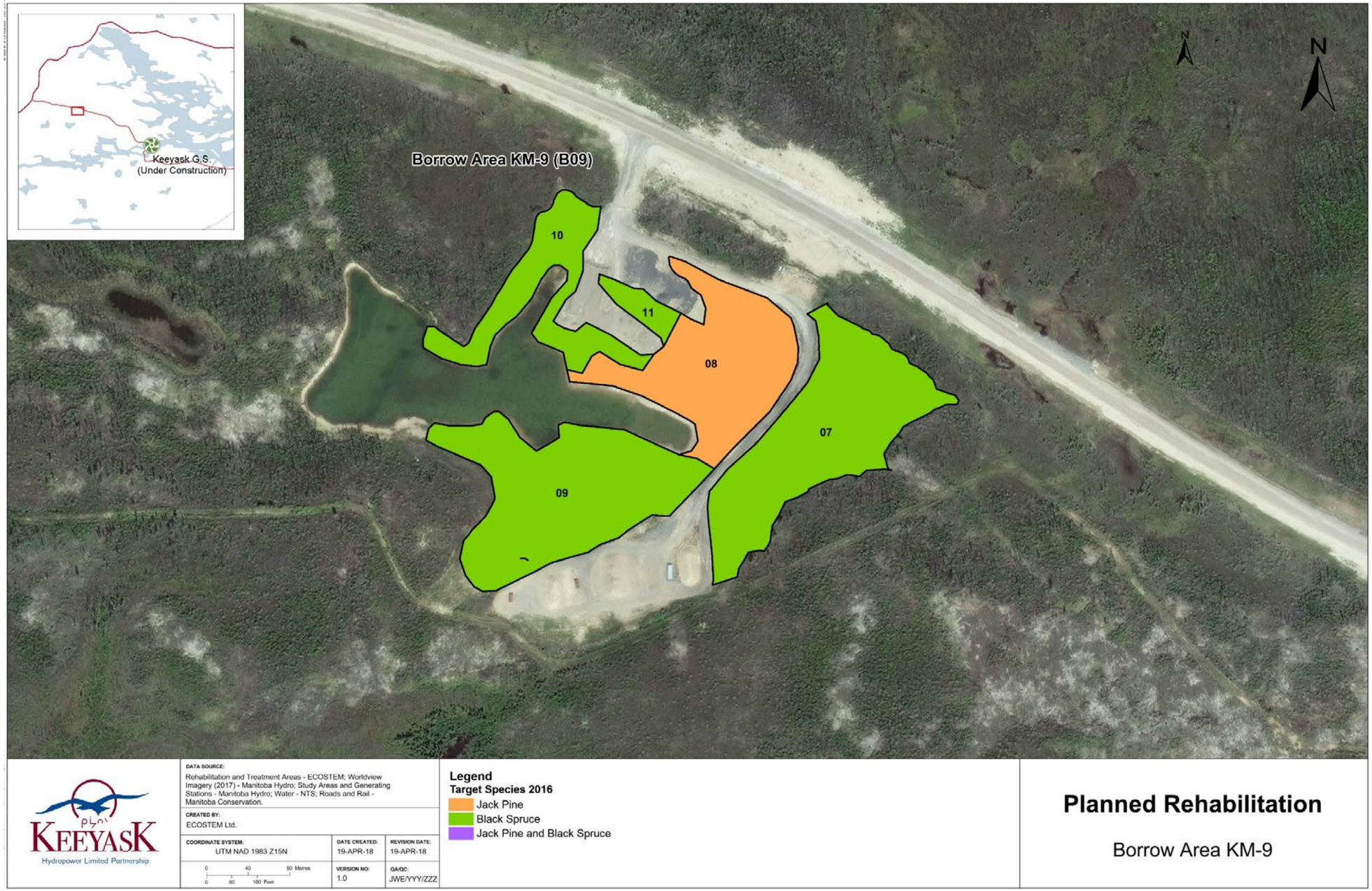
Notes: [1] Number of seedlings planted and estimated area planted at cemetery provided by Manitoba Hydro.



Map 1-1: Planned rehabilitation locations and treatment areas at the Start-up Camp and Borrow Area KM-1 in 2016



Map 1-2: Planned rehabilitation locations and treatment areas at Borrow Area KM-4 in 2016.



DATA SOURCE:
Rehabilitation and Treatment Areas - ECOSTEM; Worldview Imagery (2017) - Manitoba Hydro; Study Areas and Generating Stations - Manitoba Hydro; Water - NTS; Roads and Rail - Manitoba Conservation.

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Legend
Target Species 2016
- Jack Pine
- Black Spruce
- Jack Pine and Black Spruce

Planned Rehabilitation

Borrow Area KM-9

Map 1-3: Planned rehabilitation locations and treatment areas at Borrow Area KM-9 in 2016

2.0 METHODS

Section 2.2.2 of the TEMP details the methods for the Habitat Rehabilitation Implementation and Success monitoring study, which began in 2017. This study monitors habitat regeneration in areas that receive some form of rehabilitation. During the construction phase, the primary focus of this study is on the implementation of the rehabilitation prescriptions since several years are required before it can be determined whether vegetation and soil targets are on the desired recovery pathway. The spatial extent and degree of habitat regeneration success are ultimately documented through high resolution remote sensing (i.e., data about objects or areas obtained from a distance) and/or field surveys. As it takes some years for vegetative cover to develop after rehabilitation treatments, this mapping is generally undertaken after rehabilitation is completed.

This study also monitors the efficacy of efforts to block access to trails intersecting the Project footprint that are not existing resource-use trails and are not required for operation.

The following summarizes the activities conducted in 2017.

2.1 HABITAT REHABILITATION

Locations that received rehabilitation treatments in 2016 were visited in 2017 to complete tree regeneration surveys and document general site conditions. This included sampling transects in areas near the Start-up Camp, at the entrance to the Main Camp and three borrow areas off the NAR, including Borrow Area KM-1, Borrow Area KM-4 and Borrow Area KM-9. Regeneration surveys were not conducted in the cemetery location as the planted seedlings were in the previously burned area surrounding the site and not within the cleared portion of the cemetery site.

As described in Section 1.3, the rehabilitation locations were subdivided into 17 treatment areas (Table 1-1). The subdivisions were initially made in the field based on the tree species planted, as well as the degree of construction disturbance, extending progressively from vegetation removal only, to vegetation and surface organic layer removal, to overburden excavation (which includes vegetation and surface organic layer removal). Following the fieldwork, four additional subdivisions were made to reflect the observed locations of site preparation. The field data were collected in a manner that facilitated the subsequent subdivisions.

On September 12 to 16, 2017, tree regeneration surveys were conducted along pre-determined belt transects within the treatment areas. Transect lengths and locations were tailored to the shape of the treatment area. The goal was to have at least two belt transects within each treatment area. In wide treatment areas, such as the centre of a borrow pit, sample transects were spaced approximately 50 metres apart. In narrow treatment areas (<50 m wide), usually perimeter areas, where 2 parallel transects were required, a formula ([mean area width in meters minus 4]/2) was used to determine the spacing. In very narrow planted strips (<16 m

wide), a single transect was sampled along the middle of the area. Map 2-1 to Map 2-4 show the treatment areas and transect locations sampled in 2017.

Plastic (PVC) pipes and pin flags were inserted into the ground as markers at the beginning, end, and inflection points of each transect so the same locations could be re-sampled in the future. A hand-held GPS recorded a waypoint at each marker.

Live and dead tree seedlings were counted within a 1 m wide belt centered on the transect. Information recorded for each seedling included species, height class (seedling or sapling), vigor class (Table 2-1), natural regeneration class (Table 2-2), damage class (Table 2-3), the distance along the transect in 25 m classes, and the average organic substrate depth for the 25 m segment. Additional notes regarding transect environmental conditions (other regenerating vegetation, and general comments) were recorded. Reference photos were taken at the beginning and end points of each transect.

Table 2-1: Tree seedling vigor class

Class Code	Class Name	Description
0	Older dead	Appears to have been dead for at least one year
1	Dead	Appears to have died within the past year
2	Almost dead	Appears dead except a few needles still green
3	Dead leader	The top of the main stem appears dead
4	Dead lower branches	Most of the lower branches appear dead, but rest of plant appears healthy
5	Mostly living	Mostly healthy; a few dead needles
6	Alive	No signs of mortality

Table 2-2: Natural regeneration class

Class code	Class name
D	Definitely natural regeneration
P	Possibly natural regeneration
N	Not natural regeneration (planted)
U	Could not be determined due to herbivory or some other form of damage

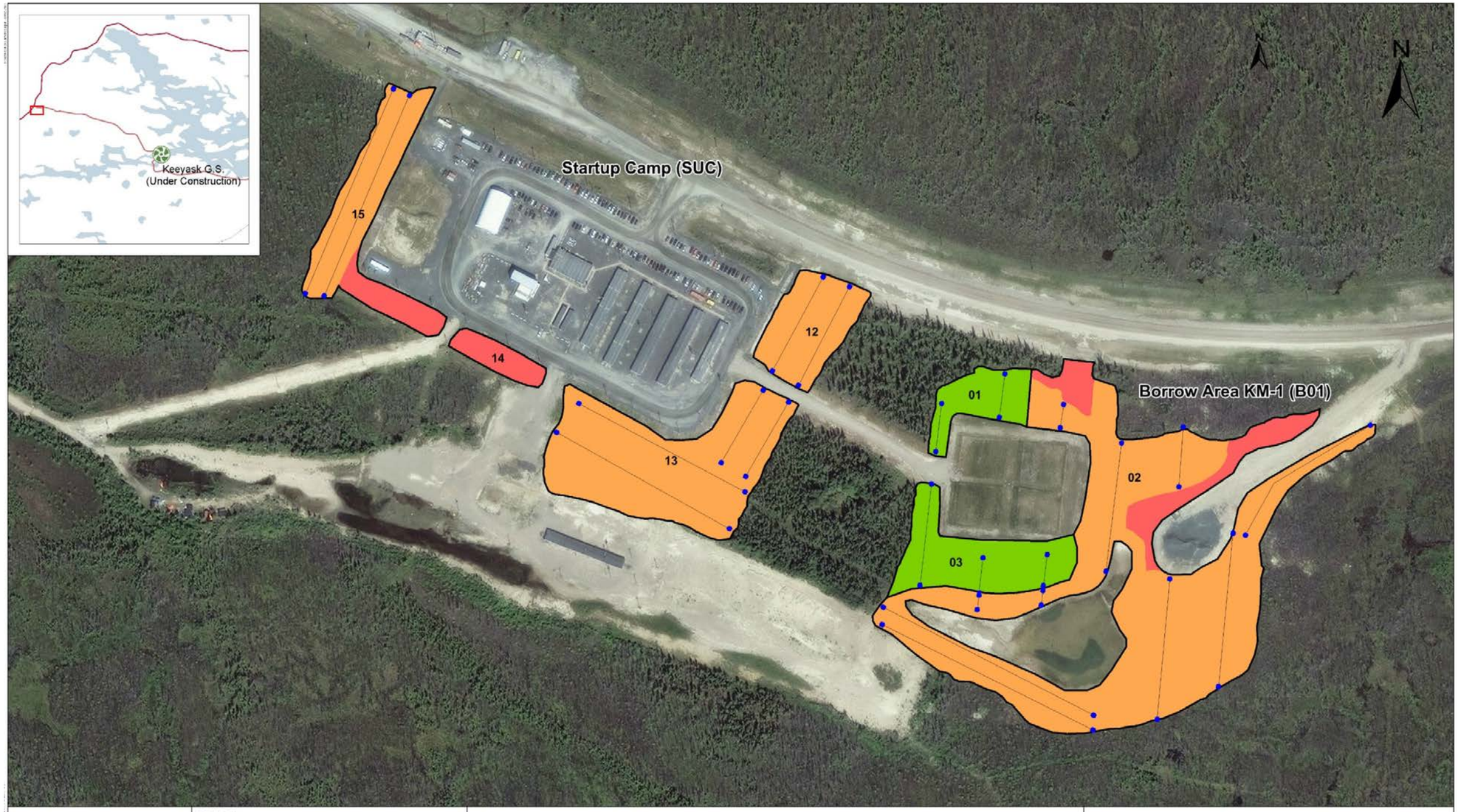
Table 2-3: Damage class

Class code	Class name
M	Mechanical damage
H	Herbivory
E	Undermined or washed over by erosion and/or sediment deposition
N	None

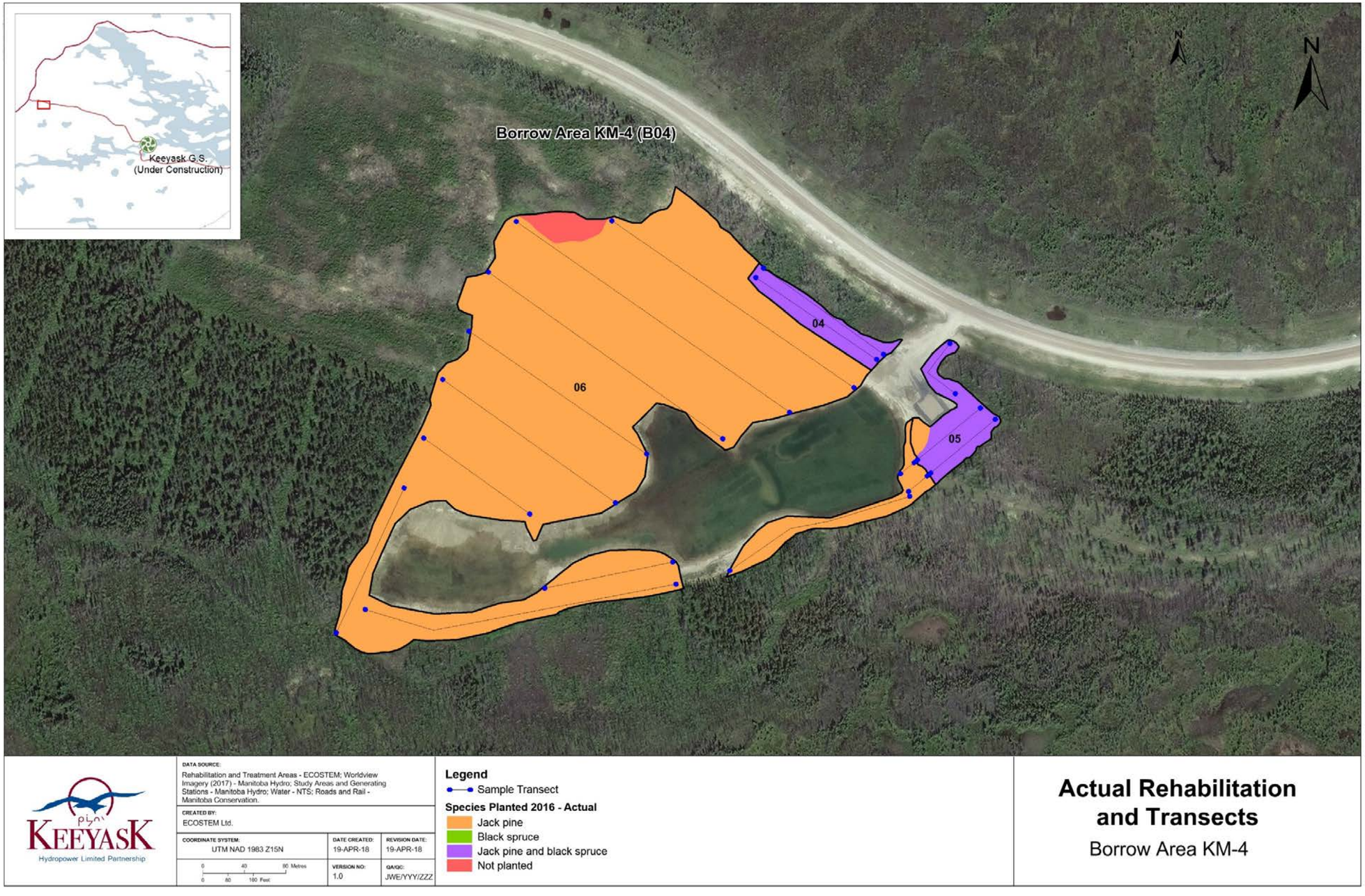
2.2 TRAIL BLOCKING AND REHABILITATION

The 47 distinct trails intersecting the Project footprint (Map 2-5) were surveyed for trail blocking and regeneration on August 20, 21 and 23, 2017. Each of the trails were surveyed by foot at the locations where they entered the Project footprint, and as far along the trail as needed to determine if access had been blocked, and if any rehabilitation (e.g., tree planting) had been implemented. For each trail, the following information was recorded:

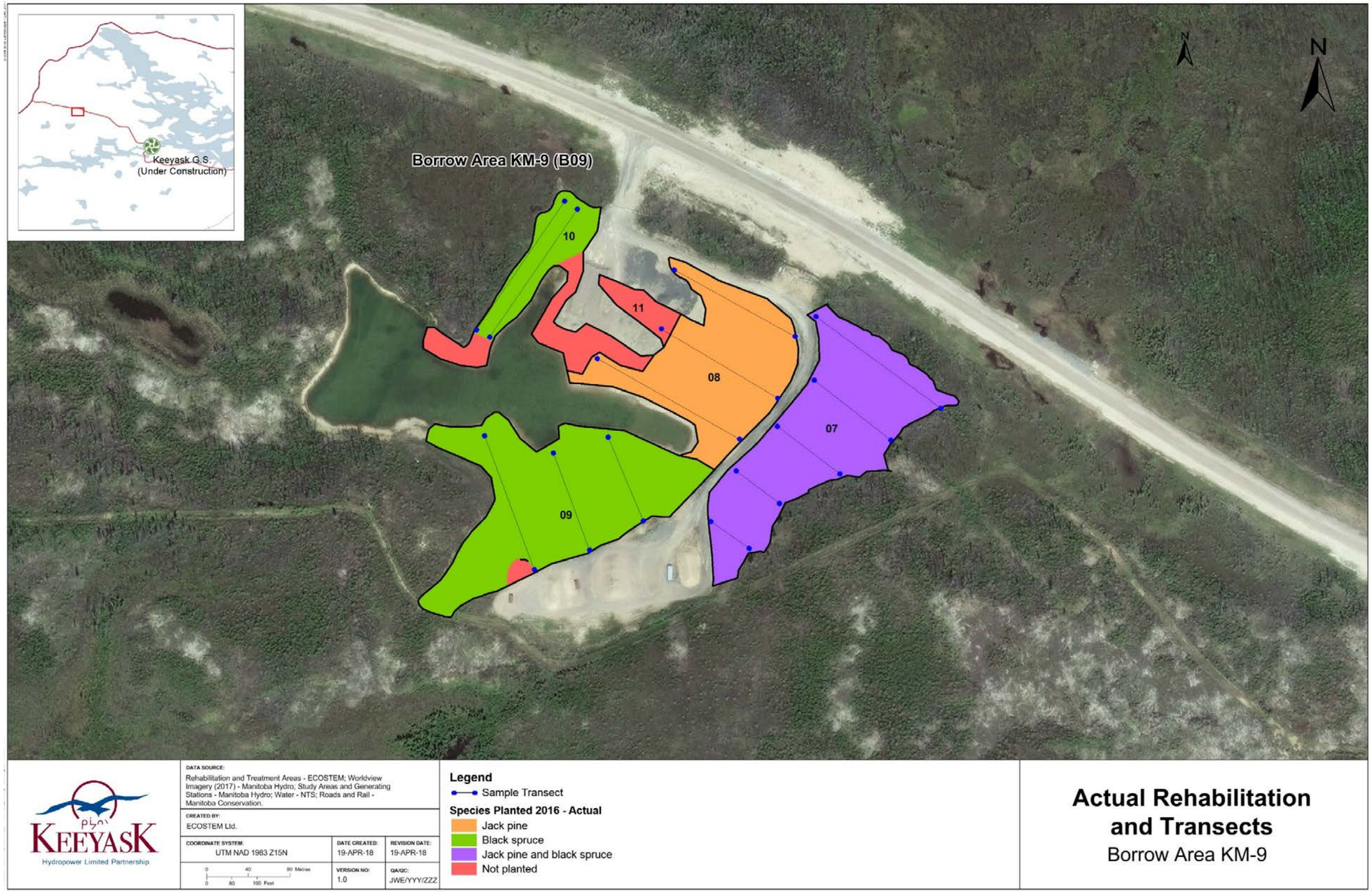
- The presence and nature of blocking of trail access.
- Any evidence of continued or recent human use of trail (e.g. fresh ATV tracks, footprints).
- Degree and composition of natural regeneration along the trail.
- Substrate type (peatland [bog or fen] or mineral).
- If tree planting was conducted in the trail, including species planted, extent of planting, and spacing of seedlings.



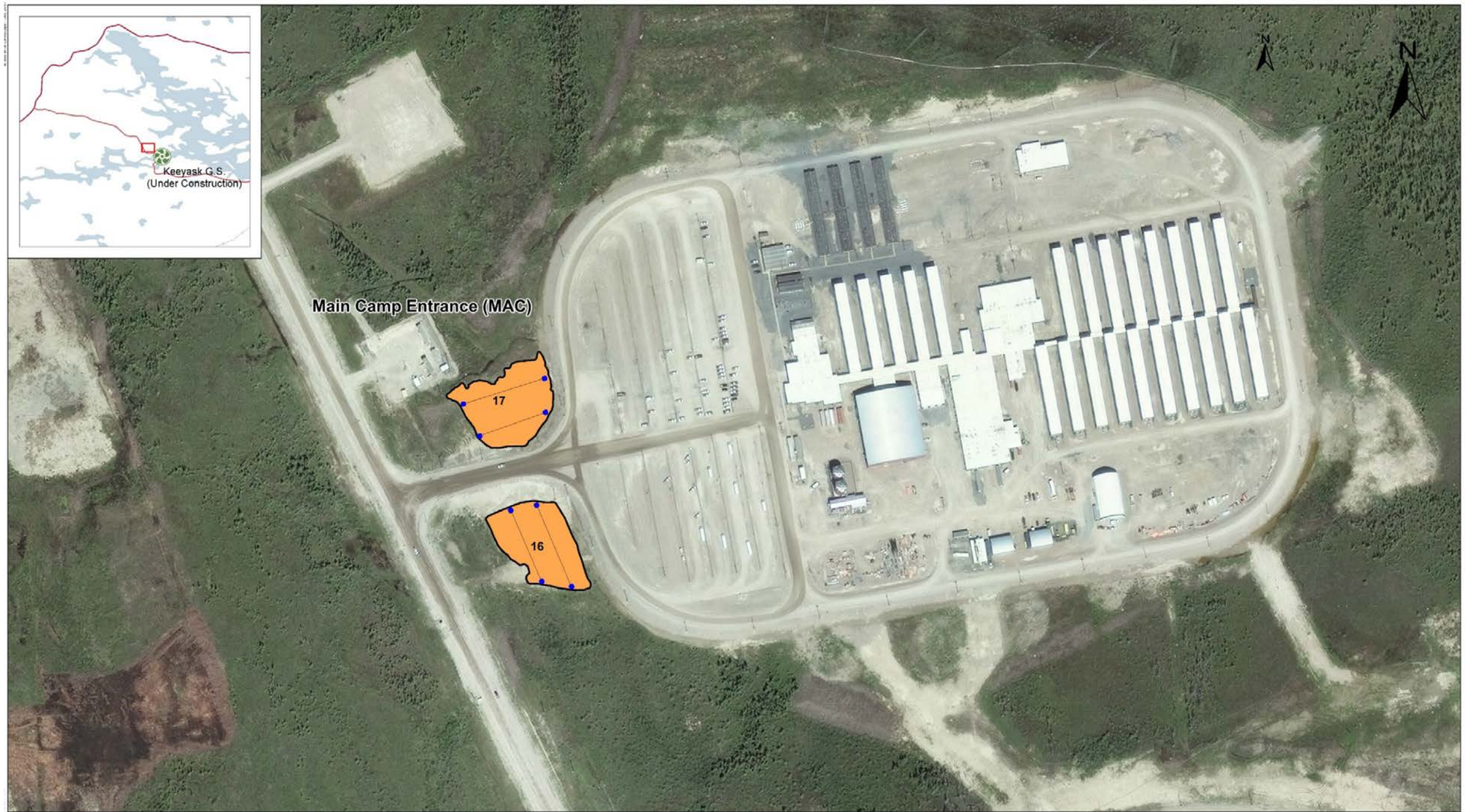
Map 2-1: Locations of rehabilitation treatment areas and transects for 2017 sampling near Start-up Camp and Borrow Area KM-1



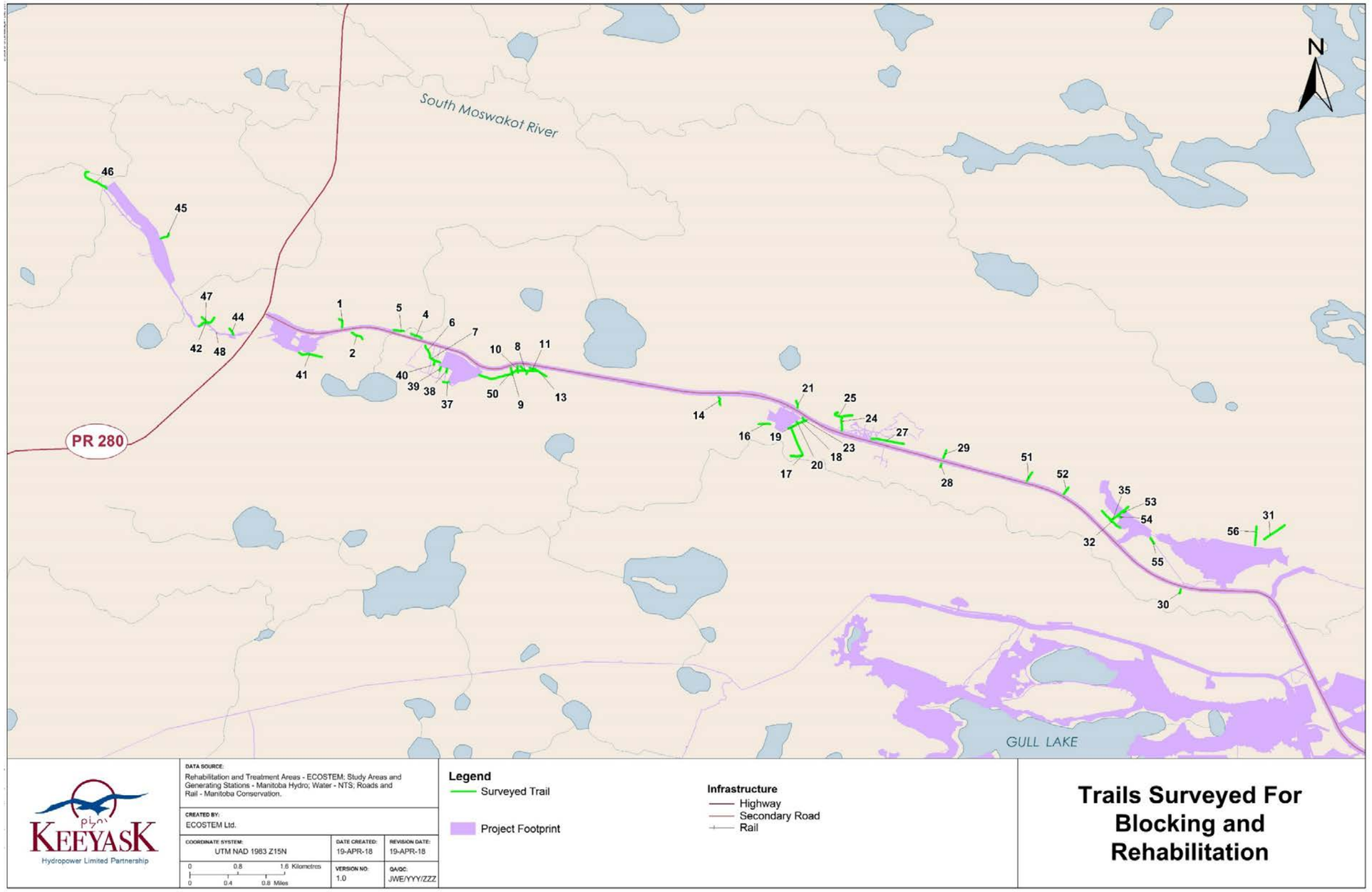
Map 2-2: Locations of rehabilitation treatment areas and transects for 2017 sampling in Borrow Area KM-4.



Map 2-3: Locations of rehabilitation treatment areas and transects for 2017 sampling in Borrow Area KM-9.



Map 2-4: Locations of rehabilitation treatment areas and transects for 2017 sampling at the Main Camp entrance.



Note: The number labels on the trails go higher than the 47 surveyed because some trails are subdivided into segments, and field surveys confirmed that some trails did not intersect the Project footprint.

Map 2-5: Trails surveyed by foot in 2017 for blocking and rehabilitation condition

3.0 RESULTS

3.1 HABITAT REHABILITATION

Tree regeneration surveys were conducted along 57 belt transects, in 17 distinct planting areas at the five locations along the NAR (Table 3-1; Map 2-1 to Map 2-4). The number of transects in each planting area ranged from two to twelve. Total surveyed transect length was approximately 6.5 km.

The planned site preparation was observed to have been implemented in each applicable treatment area.

Monitoring surveys recorded approximately 22.8 ha of planted area (Table 3-1), which differed somewhat from what was planned due to the factors discussed in Section 1.3. The planned Treatment Area 11 (TA-11) in Borrow Area KM-9, and TA-14 near the Start-up Camp, were not planted in 2016. Conversely, actual planted area at several treatment areas, particularly near the Start-up Camp, was substantially larger than planned (Table 1-2; Table 3-1). Map 2-1 to Map 2-4 shows areas that were actually planted in 2016, based on 2017 field surveys.

The total area planted included 0.8 ha at the Main Camp entrance, which was not included in planned planting, but was added to use up surplus tree seedlings.

The target tree species had been planted in all of the 2016 locations. An additional species, jack pine, was planted in TA-07 in Borrow Area KM-9. While this area had initially been targeted for black spruce only, jack pine was likely planted to use some of the surplus seedlings.

Ten of the 57 transects had a surface organic layer that was at least 1 cm thick along some portion of their length (Appendix Table 5-1). The percentage of total transect length for each treatment area with surface organic substrate ranged from 0% to 60% (Table 3-1).

Table 3-1: Species planted, area planted, and number and length of transects surveyed by treatment area in 2017

Location	Treatment Area	Planted Species[1]	Area Planted (ha)	Transects Sampled		
				Number	Length (km)	Surface OM (%)[2]
Borrow Area KM-1	01	Black spruce	0.3	2	0.08	0
	02	Jack pine	3.5	10	1.01	5
	03	Black spruce	0.7	3	0.15	0
Borrow Area KM-4	04	Both	0.3	2	0.26	13
	05	Both	0.4	3	0.22	0
	06	Jack pine	8.3	12	2.08	2
Borrow Area KM-9	07	Both	1.9	5	0.40	24
	08	Jack pine	1.5	3	0.39	0
	09	Black spruce	2.1	3	0.31	0
	10	Black spruce	0.5	2	0.28	0
	11	None	0.0	0	-	-
Near Start-up Camp	12	Jack pine	0.5	2	0.19	0
	13	Jack pine	1.6	4	0.47	0
	14	None	0.0	0	-	-
	15	Jack pine	0.6	2	0.37	60
Main Camp Entrance	16	Jack pine	0.4	2	0.14	0
	17	Jack pine	0.4	2	0.14	0
All[3]			22.8	57	6.34	8

Notes: [1] Actual planted species based on species identified during field surveys not including natural regeneration.
[2] OM=Surface organic material. Value is percentage of total combined transect length with surface OM of all transects in the planting area.
[3] Numbers in a column may not add to the total shown due to rounding.

Flagged sampling transect in Main Camp entrance

Sampling a transect in Borrow Area KM-1

Figure 3-1: Tree regeneration sampling in 2017

Photo 3-1: Treatment area 09 in Borrow Area KM-9 that was prepared with a discer

Surface organic material between 1 and 5 cm thick

Surface organic material between 10 and 15 cm thick

Figure 3-2: Examples of surface organic material along transects in 2017

Live stem density for planted and naturally regenerating jack pine in treatment areas targeted for jack pine or jack pine and black spruce forest ranged from 9,154 to 14,998 stems/ha (Table

3-2). The highest stem densities were in TA-15 (Main Camp entrance), TA-06 (in Borrow Area KM-4), TA-08 (in Borrow Area KM-9), and TA-02 (in Borrow Area KM-1).

Table 3-2: Live stem average density, standard deviation and coefficient of variation by treatment area in 2017

Location	Treatment Area	Number of Transects	Species[1]	Average density (stems/ha)	Standard deviation	Coefficient of variation
Borrow Area KM-1	01	2	**Black spruce**	3,534	1,109	31
	02	10	Black spruce	64	135	211
			Jack pine	13,933	3,592	26
	03	3	**Black spruce**	3,754	602	16
Borrow Area KM-4	04	2	**Black spruce**	3,346	4,732	141
			Jack pine	11,946	2,646	22
	05	3	**Black spruce**	2,806	1,607	57
			Jack pine	9,154	2,291	25
	06	12	Black spruce	660	2,242	340
			Jack pine	14,021	2,868	20
Borrow Area KM-9	07	5	**Black spruce**	7,483	9,607	128
			Jack pine	1,644	2,967	180
	08	3	Black spruce	27	47	173
			Jack pine	13,959	1,135	8
	09	3	**Black spruce**	4,017	1,221	30
			Jack pine	435	558	128
	10	2	**Black spruce**	3,440	287	8
			Jack pine	144	203	141
Near Start-up Camp	12	2	Black spruce	632	893	141
			Jack pine	12,031	105	1
	13	4	Black spruce	247	373	151
			Jack pine	13,058	1,594	12
	15	2	Black spruce	6,669	7,886	118
			Jack pine	10,878	1,772	16
Main Camp Entrance	16	2	**Jack pine**	14,998	742	5
	17	2	**Jack pine**	11,611	1,895	16

Notes: [1]Species in bold font are species that were planted in the treatment area, other species were natural regeneration.

Jack pine was also planted in some portions of TA-07 in Borrow Area KM-9. This area was targeted for black spruce, but some of the excess jack pine seedlings were planted in this area after other suitable areas were filled. Natural regeneration was the source of the jack pine found in other areas targeted for black spruce only in Borrow Area KM-9.

Live stem density for planted and naturally regenerating black spruce in areas targeted for black spruce treatment ranged from approximately 2,806 to 7,483 stems/ha (Table 3-2). The highest stem densities were in TA-07 and TA-09 of Borrow Area KM-9, and in TA-03 of Borrow Area KM-1. The second-highest black spruce stem density (6,669 stems/ha) was in TA-13 of the

Start-up Camp, which was targeted for jack pine treatment only, and consisted entirely of naturally regenerating black spruce.

All of the observed planted black spruce seedlings were alive, as were all of the naturally regenerating black spruce stems.

Table 3-3: Planted jack pine average percent stem mortality, standard deviation and coefficient of variation by treatment area in 2017, where jack pine was planted

Location	Treatment Area	Number of transects	Average Percent Mortality[1]	Standard Deviation	Coefficient of Variation
Borrow Area KM-1	02	10	1.2	1.7	143
Borrow Area KM-4	04	2	0.0	0.0	-
	05	3	2.7	3.5	130
	06	12	3.7	4.1	112
Borrow Area KM-9	07	3	0.0	0.0	-
	08	3	1.4	2.5	173
Near Start-up Camp	12	2	1.8	1.3	72
	13	4	2.4	1.5	61
	15	2	1.5	0.2	15
Main Camp Entrance	16	2	6.2	2.6	42
	17	2	11.1	8.9	80
All Areas		45	2.6	3.7	138

Notes: [1] Percent mortality of each transect averaged over total number of transects in treatment area.

Over all of the treatment areas, planted jack pine seedling mortality averaged 2.6% of the total planted stem density, and ranged from 0% to 11.1% by treatment area (Table 3-3). The corresponding survival rates were 97.6%, and ranged from 89.9% to 100%. The lowest survival rate was in the two treatment areas at the Main Camp entrance. Jack pine survival was above 96% at the remaining seven jack pine planting areas.

Natural regeneration comprised a very small proportion of the total live jack pine stem density in treatment areas targeted for jack pine regeneration (Table 3-4). TA-02 had the highest percentage of naturally regenerating stems, averaging only 0.5% of the total live stem density.

Naturally regenerating jack pine was present in three areas that were targeted for black spruce planting, all of which were in Borrow Area KM-9 (Table 3-4). Approximately 41.6% of the jack pine stem density occurring in TA-07 was natural regeneration.

Table 3-4: Average percent naturally regenerating jack pine and black spruce stems in transects where the species was present, by treatment area in 2017

Location	Treatment Area	Number of Transects	Species[2]	Percent of Stems from Natural Regeneration[1]	Standard Deviation	Coefficient of Variation
Borrow Area KM-1	01	2	**Black spruce**	0.0	0.0	-
	02	2	Black spruce	83.3	23.6	28
		10	**Jack pine**	0.5	1.2	214
	03	3	**Black spruce**	0.0	0.0	-
Borrow Area KM-4	04	1	**Black spruce**	0.0	-	-
		2	**Jack pine**	0.0	0.0	-
	05	3	**Black spruce**	0.0	0.0	-
		3	**Jack pine**	0.0	0.0	-
	06	3	Black spruce	66.7	57.7	87
		12	**Jack pine**	0.3	0.8	283
Borrow Area KM-9	07	5	**Black spruce**	30.1	40.6	135
		4	Jack pine	41.6	47.4	114
	08	1	Black spruce	0.0	-	-
		3	**Jack pine**	0.0	0.0	-
	09	3	**Black spruce**	9.9	17.1	173
		2	Jack pine	100.0	0.0	0
	10	2	**Black spruce**	2.2	3.1	141
		1	Jack pine	100.0	-	-
Near Start-up Camp	12	1	Black spruce	100.0	-	-
		2	**Jack pine**	0.0	0.0	-
	13	3	Black spruce	100.0	0.0	0
		4	**Jack pine**	0.1	0.3	200
	15	2	Black spruce	100.0	0.0	0
		2	**Jack pine**	0.0	0.0	-
Main Camp Entrance	16	2	**Jack pine**	0.0	0.0	-
	17	2	**Jack pine**	0.0	0.0	-

Notes: [1]Percent natural regeneration of each transect averaged over total number of transects in treatment area.
[2]Species in bold font are target species.

In areas targeted for black spruce regeneration, naturally regenerating black spruce trees made up a portion of the total black spruce live stem density in three treatment areas, all of which were in Borrow Area KM-9 (Table 3-4). The highest average proportion of naturally regenerating stems in black spruce targeted areas occurred in TA-07, averaging 30% of the total live stem density.

Naturally regenerating black spruce occurred in all locations except the Main Camp entrance, and in five treatment areas that were targeted for jack pine treatment only. This included all three treatment areas near the Start-up Camp, one area in Borrow Area KM-1, and one area in Borrow Area KM-4. All black spruce stems in the Start-up Camp consisted of natural

regeneration. In TA-13, black spruce stem density was approximately 6,669 stems/ha, which was just over 2.5 times the target density for where black spruce was to be planted.

Planted jack pine in Borrow Area KM-4

Mixture of naturally regenerating (foreground) and planted (background) jack pine in Borrow Area KM-4

Black spruce planting area in Borrow Area KM-1

Naturally regenerating black spruce with planted jack pine in Borrow Area KM-4

Figure 3-3: Examples of different types of regeneration observed in treatment areas in 2017

3.2 TRAIL BLOCKING AND REHABILITATION

Of the 47 trails surveyed, two had some form of access blocking at their entrances (Table 3-5). In both cases, excavated material from Borrow Area G-5 was mounded in front of the trail entrance (Figure 3-4). None of the other trails surveyed were deliberately blocked.

Tree planting was not observed in any of the surveyed trails. Natural regeneration was present within many of the trails, and ranged from herbaceous and low shrub cover, to regenerating trees and/or tall shrubs. Thirty-six of the 47 surveyed trails (77%) had naturally regenerating tree and/or tall shrub regeneration (Table 3-5). Of these, 28 had sparse to dense tree regeneration, and 28 had tall shrub regeneration.

Only two trails had any signs of recent human activity in 2017. These trails fell entirely within a cleared portion of Borrow Area G-1, within the approved Project footprint (ECOSTEM 2018). These trails will not be surveyed in subsequent years, as they no longer exist and are now part of a cleared Project area.

At four of the trails, natural vegetation regeneration had advanced to the point that the trails were no longer distinct from the surrounding area (Table 3-6; Figure 3-5). At an additional seven locations, trails could not easily be located because the general area had burned in 2013 (Figure 3-6). These situations tended to occur on mineral substrates.

More than half (55%) of the trails surveyed had been entirely or partially burned in 2013. While many of them remained visible, there was no distinct difference in vegetation structure between the trail and the surrounding area.

Table 3-5: Condition of surveyed trails in 2017

Trail Condition	Number of Trails	Percent of Trails
Blocked	2	4
Tree planting	0	0
Signs of recent activity1	0	0
Natural tree and/or tall shrub regeneration	36	77
Natural tree regeneration	28	60
Natural tall shrub regeneration	28	60
Burned in 2013	26	55
Total trails surveyed	**47**	**-**

[1] Recent activity other than Project clearing or disturbance.

Table 3-6: Visibility of surveyed trails in 2017

Trail Condition	Number of Trails Visible	Number of Trails Not Visible[1]	All
Not burned in 2013	17	4	21
Burned in 2013	17	6	23
Partially burned in 2013	2	1	3
Total trails surveyed	**36**	**11**	**47**

[1] Includes trails barely discernable from surroundings

Trail 45

Trail 44 (Truck is in borrow area on opposite side of berm)

Figure 3-4: Piled materials from Borrow Area G-5 blocking entrance to trails in August 2017

Trail 35

Trail 29 (Regenerating from 1999 burn)

Figure 3-5: Trails no longer distinct due to advanced regeneration in August 2017

Trail 25

Trail 27

Figure 3-6: Trails no longer distinct in August 2017 following 2013 burn

4.0 SUMMARY AND CONCLUSIONS

Terrestrial habitat rehabilitation mitigates adverse Project effects on terrestrial habitat and plants (e.g., habitat loss, erosion, invasive plant spread), restores wildlife habitat and improves aesthetics, among other benefits. Terrestrial habitat will be rehabilitated in areas not required for Project operation and in some permanent Project areas (e.g., ditches). Some of the planned rehabilitation addresses potential adverse Project effects on intactness by blocking or hindering access from Project areas to surrounding areas.

4.1 HABITAT REHABILITATION EFFORTS

The first habitat rehabilitation efforts occurred in 2016 at five locations along the North Access Road (NAR). This included four planned locations, which were three borrow areas and an area near the Start-up Camp. An area near the Main Camp and a recently burned area near the cemetery site were also planted to use up surplus seedlings. A woodland or forest type is the target habitat type for all but the cemetery locations. The area near the cemetery site has no target habitat type as it is not part of the Project footprint and is within a recently burned area.

In the borrow areas, steep slopes were graded to a maximum slope of 4:1 and a discer loosened the top layer in compacted mineral areas. Trees were planted in the five Project locations and in the area near the cemetery site.

Approximately 231,360 jack pine and 19,720 black spruce seedlings were received for planting. For the black spruce planting areas, the seedlings were planted at a spacing of 2 m by 2 m, which equates to a density of 2,500 stems/ha. For jack pine planting areas, the seedlings were planted at a spacing of 1 m by 1 m, which equates to a density of 10,000 stems/ha. Seedlings were planted at a spacing of 1 m by 1 m in areas targeted for a 60% jack pine and 40% black spruce mix.

Areas where rehabilitation efforts had occurred in 2016 were visited in 2017 to complete tree regeneration surveys. The rehabilitation locations were subdivided into 17 treatment areas based on the tree species planted, the degree of construction disturbance (e.g., vegetation removal only, overburden excavation) and site preparation treatments.

Monitoring in 2017 recorded approximately 23.2 ha of planted area. Tree regeneration surveys found that all of planted black spruce seedlings observed during the surveys were alive, as were all of the naturally regenerating black spruce stems. Over all of the treatment areas, planted jack pine seedling survival averaged 97.4% of the total planted stem density, and ranged from 89.9% to 100% by treatment area.

Tree regeneration surveys also found that live stem density for the target tree species, including planted and naturally regenerating stems, was higher than the target. In the treatment areas targeted for black spruce forest or woodland, black spruce density ranged from approximately 2,806 to 7,483 stems/ha, compared with a target density of 2,500 stems/ha. Recorded live stem

density for planted and naturally regenerating jack pine in treatment areas targeted for either jack pine or jack pine/black spruce vegetation ranged from approximately 9,154 to 14,998 stems/ha compared with a target density of 10,000 stems/ha. Combined jack pine and black spruce densities in jack pine/black spruce mixture treatment areas ranged from approximately 11,960 to 15,292 stems/ha compared with a target density of 10,000 stems/ha.

Natural jack pine or black spruce regeneration was contributing a substantial number of stems in some treatment areas. There appeared to be two sources for this natural regeneration. Seeds blown in from nearby burned areas had sprouted and survived. Additionally, some tree seedlings or saplings present prior to Project clearing had been able to survive clearing because the topsoil and ground vegetation were not stripped.

In all of the treatment areas, the observed stem densities for the target species were sufficiently high to indicate that these areas were on track to achieve their targets over time. If additional natural regeneration continues for a few years, it should offset future low mortality in some if not most of the treated areas.

Given the observed tree densities, mortality rates and natural regeneration rates in the areas treated in 2016, it is recommended that the next tree regeneration surveys in these particular treatment areas next occur in 2020.

4.2 TRAIL BLOCKING AND REHABILITATION

The 47 distinct trails being monitored by this study were surveyed for evidence of tree regeneration, blocking, or recent activity in 2017.

Recent human use was apparent in only two of the surveyed trails. These two exceptions were entirely within a cleared portion of Borrow Area G-1, which was also within the approved Project footprint. These trails will not be surveyed in future years as they no longer exist.

At two other trails, access had been blocked by mounds of excavated material that had been piled where the two trails enter the Project footprint at Borrow Area G-5.

Sparse to dense naturally regenerating trees and/or tall shrubs were present in 36 of the 47 surveyed trails. Tree planting had not been undertaken in any of the monitored trails at the time of the surveys.

Nearly one-quarter of the trails visited were no longer distinct from the surrounding area because they had been filled in by regenerating vegetation, or because they had been recently burned in the 2013 fire. More than half of the trails being monitored fell within the 2013 burn, and as a result are currently blending in with the surrounding regenerating area. As they continue to regenerate with the surrounding area, most of these trails may disappear within a few years, provided they are not used or that previous use has not somehow limited future regeneration (e.g., through soil compaction).

Travel on many of the smaller unburned trails intersecting the Project footprint would be difficult because they were situated in larger areas skipped over by the 2013 wildfire. Access would be inhibited by deadfall across these trails or when the trail meets a burned area.

Most of the access trails appeared to be on track to have access effectively blocked due to a constructed barrier and/or regenerating vegetation. While it is too soon to evaluate whether these trails will regenerate to the adjacent habitat type, no major concerns were identified for any of the trails.

Of the 47 existing trails that meet the Project footprint, some are existing resource use trails or will be required for Project operation. These trails do not need to be monitored for restrictions to access. A future workshop will determine which of the trails are resource use trails. Near the end of construction, the KHLP will identify which trails are required for Project operation.

Given the observed conditions of these trails and the need to identify which ones require access impediments, it is recommended that the trail blocking surveys next occur in 2020.

4.3 NEXT STEPS

The next tree regeneration surveys in the locations receiving rehabilitation treatments in 2016 will be conducted in 2020. The first tree regeneration surveys in other locations yet to receive rehabilitation treatments will be conducted one year after the location is planted. Monitoring fieldwork for access trails will continue in 2020. No major changes to field methods are anticipated.

5.0 LITERATURE CITED

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APPENDIX 1:
DETAILED RESULTS

Table 5-1: Individual sampling transect characteristics including live and dead stem densities

Location	Treatment Area	Transect	Transect Length (m)	Surface Organic Material		Stem Density (stems/ha)		
				Percent of Transect Length	Average Thickness Where Present (cm)	Live Black Spruce	Live Jack Pine	Dead Jack Pine
Borrow Area KM-1	01	50	44	-	-	4,318	-	-
		51	40	-	-	2,750	-	-
	02	09	197	13	2	305	9,746	51
		10	198	-	-	-	14,192	202
		11	145	-	-	-	13,172	-
		12	110	-	-	-	8,909	91
		18	23	-	-	-	11,304	-
		21	120	-	-	333	12,833	83
		43	131	-	-	-	14,198	763
		52	53	-	-	-	16,226	-
		58	16	-	-	-	19,375	-
		59	16	-	-	-	19,375	625
	03	19	88	-	-	3,068	-	-
		20	31	-	-	4,194	-	-
		57	30	-	-	4,000	-	-
Borrow Area KM-4	04	22	133	19	5	6,692	10,075	-
		23	131	-	-	-	13,817	-
	05	16	75	-	-	3,200	6,533	-
		17	67	-	-	4,179	10,149	149
		29	77	-	-	1,039	10,779	779
	06	13	144	13	25	7,778	14,861	278
Borrow Area KM-4	06	14	282	-	-	-	11,596	35
		15	118	-	-	85	15,085	932
		24	261	-	-	-	13,142	77
		25	296	-	-	-	12,872	338
		26	256	-	-	-	12,305	508

Location	Treatment Area	Transect	Transect Length (m)	Surface Organic Material		Stem Density (stems/ha)		
				Percent of Transect Length	Average Thickness Where Present (cm)	Live Black Spruce	Live Jack Pine	Dead Jack Pine
		27	189	-	-	53	11,534	265
		28	193	-	-	-	14,456	259
		30	177	-	-	-	14,915	508
		44	118	-	-	-	11,780	847
		60	25	-	-	-	13,600	2,400
		61	19	-	-	-	22,105	-
Borrow Area KM-9	07	31	139	10	6	4,820	6,906	-
		32	89	28	14	2,697	112	-
		33	72	31	10	1,389	-	-
		34	51	49	25	24,510	980	-
		46	45	44	15	4,000	222	-
	08	35	124	-	-	-	12,984	-
		36	122	-	-	82	13,689	-
		45	146	-	-	-	15,205	685
	09	37	129	-	-	3,876	-	-
		38	94	-	-	2,872	1,064	-
		39	83	-	-	5,301	241	-
Borrow Area KM-9	10	41	140	-	-	3,643	-	-
		42	139	-	-	3,237	288	-
Near Start-up Camp	12	07	92	-	-	-	11,957	326
		08	95	-	-	1,263	12,105	105
	13	05	158	-	-	127	11,899	443
		06	167	-	-	60	11,796	60
		48	73	-	-	-	15,205	548
		49	75	-	-	800	13,333	267
	15	03	187	67	9	12,246	9,626	160
		04	183	59	7	1,093	12,131	164
Main Camp	16	53	76	-	-	-	14,474	658

Location	Treatment Area	Transect	Transect Length (m)	Surface Organic Material		Stem Density (stems/ha)		
				Percent of Transect Length	Average Thickness Where Present (cm)	Live Black Spruce	Live Jack Pine	Dead Jack Pine
Entrance	17	54	67	-	-	-	15,522	1,343
		55	74	-	-	-	10,270	2,162
		56	61	-	-	-	12,951	656