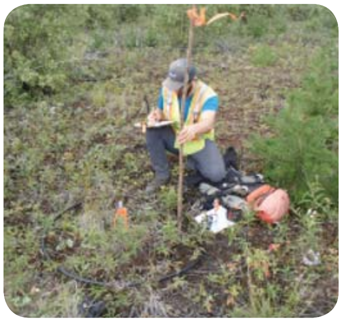
Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Road Dust on Vegetation Monitoring Report

TEMP-2019-07



KEEYASK

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KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2019-07

ROAD DUST ON VEGETATION MONITORING

Prepared for

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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 will affect the environment, and whether or not more needs to be done to reduce harmful effects.

This report describes the results of monitoring road dust on plants, conducted during the fifth summer of Project construction.

Why is the study being done?

Heavy dust accumulations on plants were observed more than 100 metres from the North Access Road while conducting terrestrial habitat fieldwork in 2016. If this was happening at many locations along the main Project access roads, then there is a small chance that Project effects on terrestrial habitat and ecosystems could be higher than predicted in the Environmental Impact Statement (EIS). Also, members of the partner First Nations had expressed concerns about road dust along the South Access Road during the early years of Project construction.

What was done?

Information is being collected at locations that are 100 metres or further from the North and South Access Roads to document how far dust is travelling from these roads, and to document possible effects on plants.

Some preliminary field studies looking at how dust information could be best collected was completed in July 2018 to help design this study. Between August 19 and 21, 2018, dust and plant information were collected at 47 sites at 12 locations along the North and South Access Roads.

What was found?

The 2018 monitoring recorded road dust on plants that were 100 m or further from the road at five of the eight locations sampled along the North Access Road. Road dust was not recorded 100 m or further from the roadbed at any of the four locations along the South Access Road.

The maximum distance from the road that dust accumulations on plants were recorded was 150 m.

What does it mean?

Road dust on plants further than 100 m from the road was found at enough locations to warrant additional field studies.

It is likely that road dust was not recorded on plants at any of the sites further than 100 m from the South Access Road due to a combination of the shorter length of time this road has been in use and the lower volume of construction traffic compared with the North Access Road. Other factors, such as plant cover and topography, may also play a role in the presence of road dust on plants, and will be looked at during future studies.

What will be done next?

Field methods for future sampling will be refined based on the information collected in 2018. Fieldwork for the road dust on plants monitoring will continue in 2020.

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STUDY TEAM

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

Fieldwork was conducted by Brock Epp, Nathan Ricard and Barry Flett (TCN).

Data analysis and report writing were completed by Brock Epp and James Ehnes. Cartography was completed by Nathan Ricard.

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1.0 INTRODUCTION

1.1 BACKGROUND

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; KHLP 2012a), completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project. 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 *Keeyask Generation Project Terrestrial Effects Monitoring Plan* (TEMP; KHLP 2015) was developed as part of the licensing process for the Project. Monitoring activities for various components of the terrestrial environment were described during the construction and operation phases.

High accumulations of road dust on vegetation were incidentally observed near the North Access Road (NAR) bridge while conducting the 2016 terrestrial habitat monitoring. The dust accumulations in this location extended more than 100 metres from the road, which is well beyond the distance predicted in the EIS. Several studies have found that road dust accumulations can have adverse effects on vegetation and soils. Based on this information, it is possible that actual Project effects on terrestrial habitat and ecosystems may be higher than predicted in the EIS, depending on how much area is affected by high accumulations of road dust.

In 2018, a new monitoring study was initiated to document the approximate spatial extent of road dust accumulations on vegetation, and to evaluate the degree to which this unanticipated impact could alter EIS conclusions regarding Project effects on terrestrial habitat and ecosystems. This report presents the results from the 2018 monitoring.

1.2 OBJECTIVES

The objectives of the Road Dust on Vegetation study are to:

- Document approximately how far road dust accumulations on vegetation extend from the Project access roads; and,

- Evaluate the degree to which road dust accumulations on vegetation could alter EIS conclusions regarding Project effects on terrestrial habitat and ecosystems.

1.3 LITERATURE OVERVIEW

Few studies regarding the effects of road dust on vegetation or soils have been conducted, and even fewer in ecosystems that are comparable to those found in the Keeyask region. Findings from studies relevant for Keeyask ecosystems were generally similar in terms of the outlined effects of road dust on vegetation and soils.

All of the studies conducted in the ecosystems most comparable to those in the Keeyask region were located in the Alaskan tundra (Auerbach *et al.* 1997; Myers-Smith *et al.* 2006; Walker and Everett 1987). Other studies that examined the effects of road and/or industrial dust focused on very different ecosystem types (Matsuki *et al.* 2016; Supe and Gawande 2015), and/or in industrialized areas. The studies that looked at the effect of dust on the growth and function of specific plant species (Farmer 1993; Wijayratne *et al.* 2009; Zia-khan *et al.* 2015) did not include any of the species found within the Keeyask region. Farmer (1993) and Spellerberg and Morrison (1998) reviewed the literature regarding road dust effects on vegetation and soils. Table 1-1 summarizes literature findings relevant for the types of vegetation and soils found in the Keeyask region.

The most comprehensive, and incidentally also the most comparable, studies took place in the Alaskan tundra. These studies (Auerbach *et al.* 1997; Myers-Smith *et al.* 2006; Walker and Everett 1987), recorded the cumulative effects of dust deposition on vegetation and soils in the same area along an unpaved highway over approximately 25 years. These studies generally found that road dust affected both vegetation and soils.

For vegetation, the Alaskan studies found that increasing dust accumulation was associated with a decrease in plant biomass, and/or a change in vegetation composition. As dust accumulations increased, sphagnum mosses, feather mosses and lichens and were the first species groups to be affected, followed by conifers and ericaceous shrubs (Auerbach *et al.* 1997; Myers-Smith *et al.* 2006; Walker and Everett 1987). Myers-Smith *et al.* (2006) found that moss, evergreen shrub, lichen and forb cover declined while cloudberry (*Rubus chamaemorous*) and graminoid biomass increased with proximity to the road over the long-term (~25 years).

For soils, the Alaskan studies found that effects included an increase in the alkalinity of the fibric soil horizon, lower nutrient levels, and a change in organic horizon thickness (Auerbach *et al.* 1997; Myers-Smith *et al.* 2006). Myers-Smith *et al.* (2006) found that fibric horizon pH continued to rise over the long-term (~25 years). Studies in the northern hardwood forests also found that soil pH increased with proximity to a road (Brown 2009; Neher *et al.* 2013).

Two studies examined the effect of road dust on vegetation and soils in the hardwood forests of the northeastern US (Brown 2009; Neher *et al.* 2013). These studies found that road dust accumulation or proximity to roads increased the presence of some invasive species and altered roadside soil chemistry.

Two literature reviews regarding the effects of road dust and development on adjacent vegetation communities (Farmer 1993; Spellerberg and Morrison 1998) highlighted that northern arctic ecosystems, particularly bryoid and lichen dominated vegetation communities, were particularly sensitive to dust accumulation. Farmer (1993) observed that trees, shrubs and sedges appeared to be more tolerant to dust, compared to sphagnum and feather mosses, and lichens (particularly epiphytic lichens). For their study location, Neher *et al.* (2013) observed that the effects of road dust did not extend beyond the forest edge, presumably due to a vegetation barrier effect.

Table 1-1: Findings relevant for Keeyask region ecosystems from the literature

Source	Habitat	Findings Relevant for Keeyask Ecosystems
Walker & Everett 1987	Alaskan taiga and tundra	Effects of dust: Early snowmelt (lower albedo), decrease in sphagnum mosses (increase in minerotrophic mosses) and lichens. Few effects on vascular plant abundance, except for ericaceous shrubs and conifers where dust accumulation is very high.
Auerbach *et al.* 1997	Alaska tundra	Effect of gravel road dust over 15 years: Soils were more basic due to calcareous road dust, lower nutrient levels, lower moisture, altered OM depth. Vegetation biomass reduced nearer the road. Veg composition altered most in acidic tundras, sphagnum mosses nearly eliminated nearer road.
Myers-Smith *et al.* 2006	Alaska tundra	Effect of road dust over 25 years (update to Auerbach *et al.* 1997): Fibric horizon pH continued to rise, community adjacent to road higher *Rubus chamaemorous* and graminoid biomass, lower moss, evergreen shrub, lichen and forb biomass.
Brown 2009	Pennsylvania hardwood forest	Effect of road dust on forest organic soils and vegetation: Road dust altered roadside soil chemistry, especially limestone dust (increased pH), possibly aiding establishment of invasive species.
Neher *et al.* 2013	Vermont hardwood forest	Effect of road dust: Cleared area determined distance road pollutants travelled. Increased alkalinity with proximity to roads. Effects did not extend beyond forest edge, presumably due to vegetation barrier.
Farmer 1993 (lit. review)	Variety	Of the ecosystems studied, the most sensitive to dust were bryophyte-dominated plant communities (e.g. sphagnum) of the north. Trees, shrubs and sedges more tolerant, sphagnum, feather mosses and lichens (especially epiphytes) least tolerant.
Spellerberg & Morrison 1998 (lit. review)	Variety, New Zealand	Cited sensitivity of arctic bryophyte and lichen communities (Farmer 1993).

2.0 METHODS

2.1 OVERVIEW

This study is being designed in stages for two reasons. First, virtually no existing information was available regarding the spatial extent of road dust accumulation on vegetation in the vicinity of the Project access roads. Second, very little relevant information was available for the length of time it would take to collect data at each sample location. Thus, the 2018 fieldwork was focused on obtaining: data on how frequently road dust was accumulating on vegetation at distances of 100 m or further; and, information needed to refine the sampling protocol for subsequent sampling.

2.2 INFLUENTIAL FACTORS

Key factors potentially influencing road dust accumulation on vegetation along the access roads identified in the relevant literature included:

- Proximity of the site to the road;
- Vegetation structure and extent of cleared vegetation between the road and the site;
- Increasing vegetation height and density was expected to trap more dust and limit how far it spreads from the road;
- Amount of recent rainfall. While rain may partially wash leaves clean of deposited dust, the resulting wet surfaces may then experience higher accumulation rates;
- Dust chemistry, including characteristics such as pH and presence of toxic elements;
- Plant type, which is relevant for reasons such as sensitivity and ability to trap dust; and,
- Trends in the local prevailing wind direction. Dust cover may be more extensive in the downwind direction.

2.3 EXISTING DATA

There were no existing data for this study. Incidental observations from 2016 identified one site off the North Access Road, near Looking-Back Creek, with high accumulations of road dust more than 100 m from the road.

2.4 DESIGN

2.4.1 PRELIMINARY FIELDWORK

Preliminary fieldwork was conducted in July, 2018. On July 2, possible data collection methods were tested and observations on the distances from the access roads with dust accumulations were made at 10 sites. These dust searches occurred at road locations with visible high dust accumulations, and entailed walking perpendicular from the roadbed until it was obvious that the maximum distance of dust accumulation had been reached. Additionally, over the subsequent seven days, staff occasionally stopped along the North Access Road while conducting other plant monitoring to take photos of the dust accumulation and record how far dust accumulations were present away from the road.

Information from the July fieldwork was used to develop the sampling design and methods employed in August, 2018. The following details the methods used for the August, 2018 sampling. Methods for sampling in future years will be refined based on the results and experience from the August sampling.

2.4.2 SAMPLE LOCATIONS

To control for the potential confounding effect that vegetation structure (e.g., forest versus low vegetation) has on dust accumulations relative to distance from road, bands of vegetation having relatively homogenous vegetation structure (i.e., height and density) extending between 100 m and 400 m perpendicular from the north or south access roads were identified as potential locations for sample transects. The potential vegetation bands to sample were identified from the terrestrial habitat mapping, 2013 burn mapping and high-resolution digital orthoimages (DOIs). It was recognized that some locations within these bands would have a different vegetation structure than the overall band due to localized variability in soils and/or topography.

Sampling occurred when there had been less than 5 mm of total rainfall over the preceding seven days, since visible dust accumulations on shrub and herb foliage are influenced by the amount of recent rainfall. Daily precipitation data were obtained from two weather stations: a Manitoba Hydro station on the north arm of Stephens Lake; and, a NAVCAN station at the Gillam airport. While the Stephens Lake data were more spatially relevant, the quality of these data were unknown. A review of the weather data found some large differences in the daily amounts of precipitation recorded at the two stations. However, these differences could be due to localized variations in weather given that the stations were approximately 36 km apart.

The selected transects were geographically distributed within the higher construction traffic areas. Eight transects were sampled along the North Access Road (NAR) and four along the

South Access Road (SAR). Map 2-1 shows the locations of the potential vegetation bands and those that were sampled on August 19 to 21, 2018.

One straight-line transect was established in the center of each of the selected vegetation bands (Map 2-1). Each transect was oriented perpendicular from the road, with the origin positioned 100 m from the roadbed edge. The length of the transect that was sampled depended on the observed dust accumulations (see below). Waypoints for the transect start and end points were recorded from a handheld GPS.

Sample locations were positioned systematically along each straight-line transect. The first sample location was located at the transect origin (i.e., 100 m from the roadbed edge). Subsequent sample locations were spaced 25 m apart until the maximum distance was reached. The maximum distance occurred once three sample locations in a row had no visible dust accumulation on foliage.

2.5 DATA COLLECTION

Data were collected in a 1 m diameter, or 0.785 m^2, cylindrical quadrat that was vertically subdivided into four height strata, including tall, moderate, short and ground (see Table 2-1 for height stratum definitions).

The cylindrical quadrat used for data recording (see below) was centered on the transect at the sample distance. If a quadrat at the required distance had more than one mapping-level habitat type within 10 m of the point, the quadrat center was moved perpendicularly to the transect into the closest homogenous habitat patch.

A permanent stake and flagging tape were left at the center of each sampled quadrat. A waypoint was recorded for the quadrat location with a handheld GPS.

A 1 m diameter, or 0.785 m^2, circular hoop made from flexible HDPE pipe was used to delineate the sample area for the cylindrical quadrat. The circular hoop was placed on the ground to sample the ground stratum, and at the lowest height of each of the remaining strata.

Data recorded at each sample location are detailed below. Rare or non-native plant species were also recorded if incidentally observed while moving between sample locations.

2.5.1 CYLINDRICAL QUADRAT DATA

Table 2-2 provides the attributes recorded for the entire cylindrical quadrat.

Vegetation structure (Table 2-3) identified the tallest vegetation layer that had at least 25% foliage cover. The tallest vegetation structure class took precedence over the lower classes. For example, a forest or woodland could still have a tall shrub and/ or low shrub understorey.

Trees taller than 1.3 m that were present in the quadrat were recorded in descending order of abundance. The total percentage of understorey foliage cover and bare ground were recorded. Bare ground included any non-living cover in the ground stratum (e.g. mineral soil, litter, water). The average thickness of the surface organic layer in the quadrat was also recorded using a survey pin. The surface organic layer included any litter (LFH) layer and organic soil layers on top of mineral material. If the depth of the surface organic layer was thicker than the length of the survey pin, a depth ">30 cm" was recorded.

2.5.2 STRATUM DATA

Additional data were collected separately for each of the height strata (Table 2-1) within the vertically subdivided cylindrical quadrat. Therefore, each sample location had four measurements for each stratum attribute (i.e., one for each stratum). Table 2-4 provides the attributes recorded for each of the stratum quadrats.

Dust accumulation on the foliage was recorded using three variables, including the percentage of foliage covered by dust, the average thickness of dust cover, and the variability of dust thickness (see Table 2-4 for definitions).

Total plant foliage cover for all species was estimated as the percentage of the circular quadrat area. Plant species covering 25% or more of the quadrat area in a stratum, or 10% or more for narrow-leaved species such as grasses, were recorded in descending order of abundance. Tree growth forms were recorded separately as pseudo-species, including tree (>1.3m tall), sapling (0.5-1.3m tall), or seedling (<0.5m tall). Broader taxonomic groups were used for species that would be difficult to identify quickly (e.g., *Cladonia* spp, *Sphagnum* spp, *Peltigera* spp). Additionally, species mixtures were recorded when more than one species of the same type grew intermingled together to the degree that it made estimating the 25% minimum cover very time consuming (this was usually employed for moss species or mixtures of tree pseudospecies).

Percent foliage mortality was estimated for each of the recorded species based on a visual estimate of the percent of dead leaf tissue in the total foliage cover of the species in the stratum.

Any rare or non-native plant species present in the quadrat were also recorded.

Table 2-1: Height strata

Code	Stratum	Description
T	Tall	The volume within the cylindrical quadrat that is between the heights of 81 cm and 150 cm. Typically includes tall shrubs and lower branches of trees.
M	Moderate	The volume within the cylindrical quadrat that is between the heights of 41 cm and 80 cm. Typically includes low shrubs, foliage of tall herbs and lower foliage of tall shrubs.
S	Short	The volume within the cylindrical quadrat that is between the heights of 6 cm and 80 cm. Typically includes herbs, lower foliage of low shrubs.
G	Ground	The volume within the cylindrical quadrat that is below 5 cm in height. Includes ground mosses and lichens, foliage of prostrate herbs or woody species (e.g., *Vaccinium oxycoccus, Linnea borealis*).

Table 2-2: Attributes and Definitions for variables recorded for the entire cylindrical quadrat

Attribute	Definition
Transect	Transect ID, which is a combination of the Protocol (D); Study Area (N=North Access Road; S=South Access Road); and Location Number (Number of the transect starting at 01 for each of the two roads and then incrementing by one).
Date and Time	The month, day and time (24h format) of sampling.
Distance	Distance of plot from roadbed edge in 25 m increments.
Coordinates	The UTM Easting and Northing at the plot origin.
Vegetation Structure	See Table 2-3.
Tree Cover	Percent cover for tree foliage if present.
Dominant Tree Species	Tree species (>1.3 m tall) in descending order of abundance.
Recent Burn	Identifies if the plot burned in the past 10 years. Y=yes, N=no and P= partially burned.
Percent Bare Ground	Percentage of the quadrat that has bare ground (non-living ground cover).
Total Organic Material Thickness	Total thickness of surface organic material, including LFH.
LFH Thickness	Total thickness of the LFH layer.

Table 2-3: Vegetation Structure Classes

Type	Class	Definition
Treed (T)	Forest	Trees (i.e., tree species with stems that have Diameter at Breast Height (DBH) > 0) formed the canopy and those trees have >=75% canopy closure. Only trees were included in the canopy closure estimate; shrubs not included in estimate.
	Woodland	Trees (i.e., tree species with stems that have DBH > 0) formed the canopy and those trees had =>25% and < 75% canopy closure. Only trees were included in the canopy closure estimate; shrubs not included in estimate.
Tall Shrub (S)	Shrubland- Tall	Tall shrubs (shrub species whose height >= 0.5m) and/ or saplings (tree species >0.5m < DBH) formed the canopy and had at least 25% cover.
Low (L)	Shrubland- Low	Low shrubs (shrub species whose height < 0.5m) or tree seedlings (tree species < 0.5m tall) formed the canopy and had at least 25% cover.
	Grassland/ Herbland	Grasses and/ or sedges and/ or herbs formed the canopy and had at least 25% cover.
	Bryoid	Mosses, hepatics and/ or lichens were the tallest vegetation with at least 25% cover.
	Sparse	All vegetation combined has >= 25% cover if all of the strata were combined but no one stratum had at least 25% cover.
	Barren	All vegetation combined had < 25% cover.

Table 2-4: Attributes and Definitions for each 1m Diameter Stratum Quadrat

Attribute	Definition
Dust Coverage	Percentage of the foliage in the stratum with dust on it.
Dust Thickness	Average dust thickness on foliage with dust cover using the classes in Table 2-5.
Dust Variability	How variable the dust thickness is on foliage with dust cover using the classes in Table 2-6.
Vegetation Cover	Percentage cover of all foliage in the stratum.
Plants	Every species meeting the minimum percent cover in the quadrat area. 25% for all species except for narrow-leaved ones, which is 10%.
Plant Mortality	Estimate of the percent foliage mortality for each of the recorded species.

Table 2-5: Dust Thickness Classes

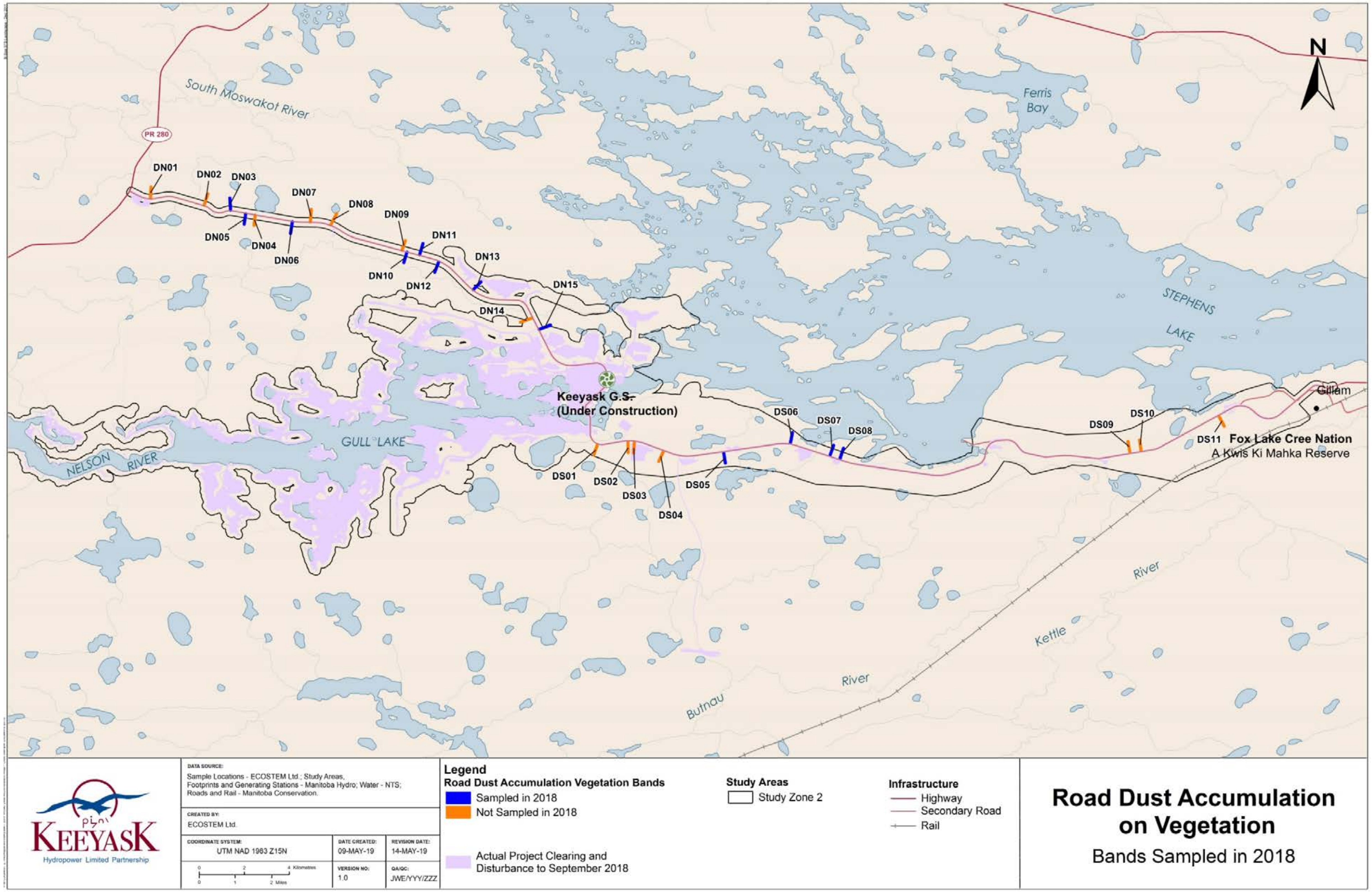
Class	Definition
None	No diminution of the natural foliage cover by road dust. Occurs if there is no dust in addition to what would be there from natural airborne dust deposition.
Thin	Slight opaqueness to the natural foliage cover.
Moderate	Moderate opaqueness to the natural foliage cover OR Foliage not visible in less than 25% of the leaf area and mildly obscured in most of the rest of the area.
Thick	High opaqueness to the natural foliage cover OR Foliage not visible in between 25% and 75% of the leaf area.
Very Thick	Foliage surface not visible through the dust.

Table 2-6: Dust Thickness Variability Classes

Class	Definition
None	Dust thickness is highly similar throughout the stratum.
Low	Dust thickness varies to a low degree throughout the stratum.
Moderate	Dust thickness varies to a moderate degree throughout the stratum.
High	Dust thickness is highly variable throughout the stratum.

2.6 ANALYSIS

The analysis of the 2018 data was limited to descriptive statistics. Too few replicates (i.e., 12 transects) have been sampled to date to evaluate associations between dust accumulations and factors such as vegetation structure, traffic volume, topography, prevailing wind direction) and if the dust is adversely affecting the vegetation. This was expected because one of the purposes of the 2018 fieldwork was to test the effectiveness and efficiency of possible sampling methods. Possible associations between dust accumulations and influential factors will be examined after additional data become available.



Map 2-1: Vegetation bands sampled in August, 2018

3.0 RESULTS

During the preliminary fieldwork in early July, 10 locations along the NAR were surveyed for dust accumulations. Dust was not observed on foliage further than approximately 80 m from the roadbed during these searches.

Anecdotal observations from the preliminary fieldwork and incidental observations suggested that dust accumulations were highly influenced by recent rainfalls, which was consistent with the literature. At one site within 30 metres of the NAR, substantial dust accumulation was observed on the foliage over several days in early July. Following several days of rain, the foliage had been almost entirely washed clean of dust.

The following provides results from the formal monitoring fieldwork conducted in August, 2018.

Figure 3-1 shows the vegetation structure for each of the 47 cylindrical quadrats sampled. As expected, only two of the 12 transects (i.e., DN10, DS08) had the same vegetation structure in every quadrat (Table 3-1). Two predominantly low vegetation transects (DN12, DN13) had a single treed quadrat, but in both of these cases the trees were sparse, which created a minor barrier to dust moving to more distant locations.

A majority (71%) of the 35 cylindrical quadrats sampled along the NAR transects had a low vegetation structure type (i.e., herbaceous, bryoid or low shrub) or were sparsely vegetated if they were treed. This was because much of the area along the NAR had been burned in 1999 and/or 2001, and then again in 2013.

Of the 12 quadrats sampled along the four SAR transects, 67% had treed structure, 25% had low vegetation structure, and one quadrat had tall shrub structure.

Dust on foliage was recorded 100 m or further from the access roads at five of the 12 (42%), transects sampled (Table 3-2). All five of these transects were along the NAR. The maximum recorded distance for dust accumulation was 150 m, and this occurred on two transects (Figure 3-1).

Dust accumulations were present in only the first quadrat on transects DN05 and DN12 (80% and 30% of foliage covered, respectively).

The transects with the highest total number of quadrats with dust covered foliage included DN06, DN13 and DN11 (Table 3-2). The maximum recorded dust cover within a cylindrical quadrat along each of these transects was 100%, 95% and 60%, respectively.

At both transects where dust extended 150 m from the road (DN06 and DN13), the vegetation structure of the quadrats was predominantly low vegetation (Table 3-1), including the quadrats at 150 m from the road (Table 3-3).

The spatial pattern of dust accumulation differed on the two transects where dust was recorded up to 150 m from the roadbed (DN06, DN13). Percent dust cover followed the expected pattern at DN06, decreasing as distance from the road increased. At DN13, dust cover declined from

95% to 5% at 125 m, but then rose to 60% at 150 m before declining to 0%. Compared with the second quadrat (i.e., at 125 m), the first and third quadrats had a higher percentage of larger-leaved foliage and higher overall foliage cover.

Dust cover was classified as generally thin in all strata where it was present. However, variability of dust thickness varied both between transects, and among the strata within the cylindrical quadrats (Table 3-4). Variability of dust thickness ranged from none to moderate.

Table 3-1: Number of quadrats by vegetation structure sampled at the 12 transects

Transect	Overall Type	Vegetation Structure Type[1]			All
		Low	Tall Shrub	Treed	
DN03	Low	3	1	-	4
DN05	Treed	1	-	3	4
DN06	Low	4	2	-	6
DN10	Low	3	-	-	3
DN11	Low	4	1	-	5
DN12	Low	3	-	1	4
DN13	Low	5	-	1	6
DN15	Low/tall shrub	2	1	-	3
DS05	Mixture	1	1	1	3
DS06	Treed/low	1	-	2	3
DS07	Treed/low	1	-	2	3
DS08	Treed	-	-	3	3
All Transects		28	6	13	47

Notes: [1] "Low" structure includes the Shrubland- Low, Grassland/ Herbland, Bryoid, Sparse and Barren vegetation structure classes; and "Treed" includes the Forest and Woodland classes (see Table 2-3).

Table 3-2: Transects where dust accumulation occurred at least 100 m from the roadbed, and maximum percent of foliage covered by dust at each distance by transect and structure type

Transect	Distance From Roadbed (m) Vegetation Structure1 in Brackets		
	100	125	150
DN05	80 (L)	-	-
DN06	100 (L)	80 (S)	75 (L)
DN11	60 (L)	30 (S)	-
DN12	30 (L)	-	-
DN13	95 (T)	5 (L)	60 (L)

Notes: [1] "Low" structure includes the Shrubland- Low, Grassland/ Herbland, Bryoid, Sparse and Barren vegetation structure classes; and "Treed" includes the Forest and Woodland classes (see Table 2-3).

Table 3-3: Number of quadrats by vegetation structure and distance where dust accumulation was present at least 100 m from the roadbed

Vegetation Structure Type[1]	Distance From Roadbed (m)			All
	100	125	150	
Low	4	1	2	7
Tall Shrub	-	2	-	2
Treed	1	-	-	1
All Structure Types	5	3	2	10

Notes: [1] "Low" structure includes the Shrubland- Low, Grassland/ Herbland, Bryoid, Sparse and Barren vegetation structure classes; and "Treed" includes the Forest and Woodland classes (see Table 2-3).

Table 3-4: Number of quadrats by stratum and dust thickness variability class for transects where dust accumulation was present at least 100 m from the roadbed

Transect	Stratum	Dust Thickness Variability Class		
		None	Low	Moderate
DN05	Moderate	-	1	-
	Short	-	1	-
	Ground	-	-	1
DN06	Tall	2	-	1
	Moderate	2	1	-
	Short	1	2	-
	Ground	-	2	-
DN11	Moderate	-	2	-
	Short	-	2	-
	Ground	-	1	-
DN12	Tall	1	-	-
	Moderate	1	-	-
	Short	1	-	-
	Ground	1	-	-
DN13	Tall	-	1	-
	Moderate	1	2	-
	Short	-	2	1
	Ground	2	-	1

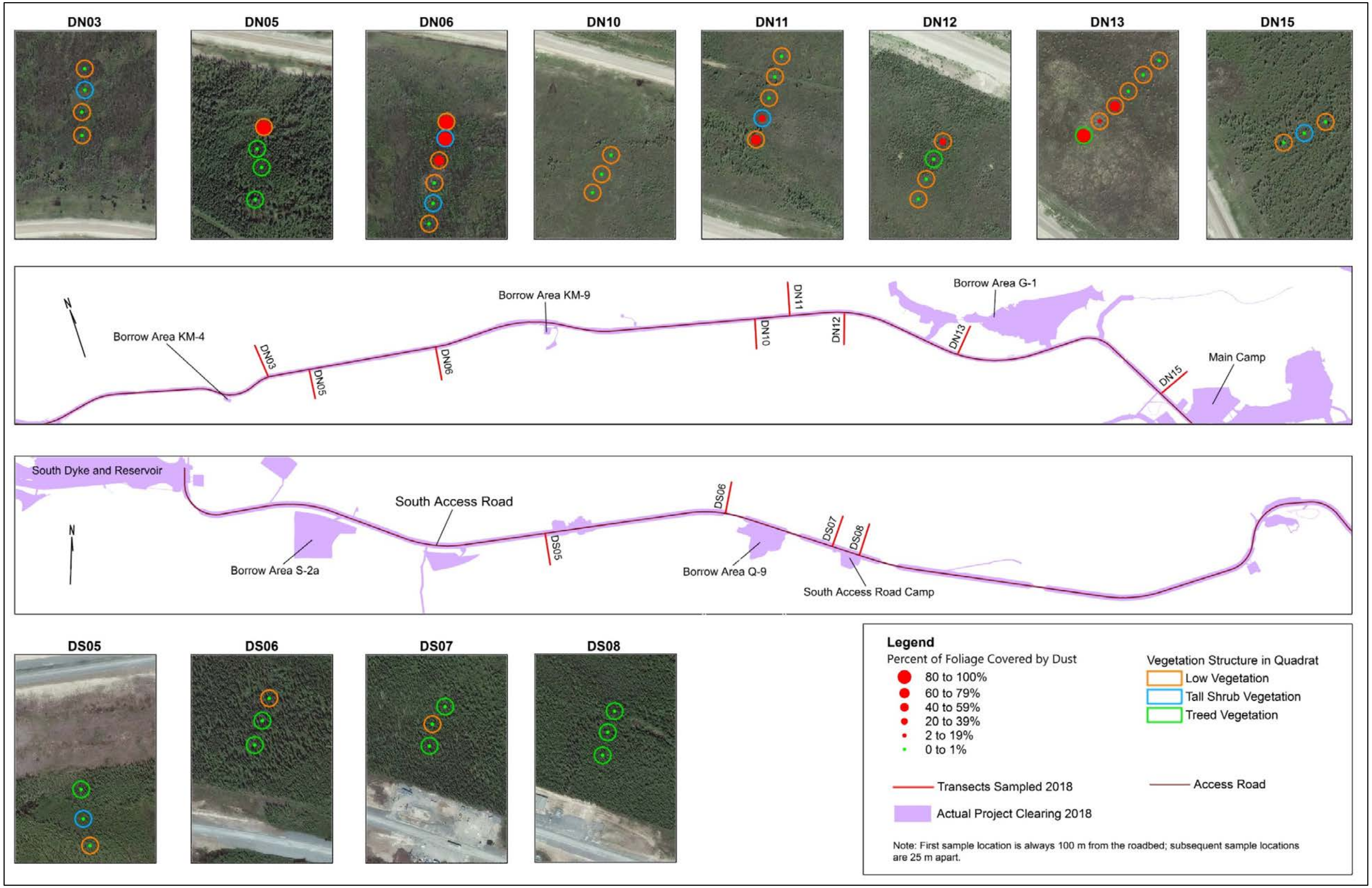


Figure 3-1: Dust accumulation in quadrats sampled on transects along the North and South Access Roads

4.0 DISCUSSION

All of the transects with dust covered foliage occurring more than 100 m from the roadbed were located along the NAR. It was expected that the NAR would have higher dust accumulations than the SAR due to the longer time that the NAR has been in use (i.e., three and five years, respectively) and expected higher construction traffic volumes due to the main camp and the majority of the work areas and borrow areas being accessed off of the NAR. While recent traffic volume data was not available for the SAR, an average of 125 vehicles per day travelled on the NAR between April 2017 and March 2018 (Manitoba Hydro 2018).

At both transects where dust extended up to 150 m from the roadbed (DN06, DN13), the sampled quadrats predominantly had low vegetation. While this apparent association between vegetation structure and dust accumulation was consistent with the literature (Section 1.3), it could also be the result of other factors such as topography, traffic volume, road material and prevailing winds. With only 12 replicate transects sampled to date, the amount of data is insufficient to test possible explanations. Possible explanations will be examined when data from future fieldwork become available.

Data collected to date could suggest that construction traffic on the SAR may have been too low to generate dust more than 100 m from the roadbed. However, it is quite possible that the lack of dust at the higher distances recorded for the NAR could be due to other factors such as generally denser vegetation along the sampled transects, topography or localized heavier rainfall. With only four replicate transects sampled along the SAR to date, the amount of data is insufficient to evaluate any explanations. Possible explanations will be explored when data from future fieldwork become available.

The anecdotal field observations that suggested dust accumulations were highly influenced by recent rainfalls were consistent with the literature.

5.0 SUMMARY AND CONCLUSIONS

Heavy road dust accumulations were unexpectedly discovered more than 100 m from the NAR while conducting terrestrial habitat fieldwork in 2016. This new monitoring study was initiated in 2018 to document the extent to which road dust has been accumulating at distances of 100 m or further from the north and south access roads. If this study determines that road dust has accumulated 100 m or further from the access roads in many locations, it will evaluate how this finding would alter EIS conclusions regarding Project effects on terrestrial habitat and ecosystems.

Preliminary data to help design this study were collected in July, 2018. In August, 2018, data were collected at 47 sites on 12 transects along the main access roads. Eight transects were located along the NAR and four transects were along the SAR.

The 2018 road dust monitoring confirmed that road dust on vegetation was present 100 m or further from the access roads in at least five locations. Dust on foliage was recorded 100 m or further from roadbed at 63% of the eight transects sampled along the NAR. The maximum recorded distance for dust accumulation was 150 m.

Road dust was not recorded 100 m or further from the roadbed at the four transects along the SAR. This was likely due to a combination of the shorter length of time the SAR has been in use and the lower volume of construction traffic compared with the NAR. However, other factors such as terrain and generally denser vegetation along the sampled transects, may be at least partially responsible. Possible explanations will be examined when more data from future sampling become available.

A number of factors can influence how far road dust travels from the roadbed (e.g., recent rainfall, terrain, traffic volume, road material, prevailing winds) and if the dust is adversely affecting the vegetation. It is too soon to evaluate how much these factors are influencing how far dust travels given the relatively small number of replicates (i.e., 12 transects) that have been sampled to date. A small number of transects were sampled in 2018 because one of the purposes of the fieldwork was to test the effectiveness and efficiency of possible sampling methods.

The sampling methods will be refined for future sampling based on information obtained from the 2018 fieldwork. The primary focus of the refinements will be on maximizing the data available to document the spatial extent of dust accumulation. Secondary considerations will be collecting some data to evaluate the factors that affect the distance that the dust travels and how the dust has affected vegetation.

5.1 NEXT STEPS

Field methods for future sampling will be refined based on the information that is now available. Fieldwork for the road dust monitoring will continue in 2020.

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APPENDIX 1:
FIELD OBSERVATIONS FROM JULY 2018

Table 6-1: Field observations from preliminary fieldwork conducted in early July

Date	Notes
July 2, 2018	Stopped at 10 locations along the North Access Road. Dust accumulation did not extend 100 m from road at any of the locations.
July 4, 2018	Following two days of dry weather there was noticeable dust accumulation. The fresh coating of dust was highest near the road, and diminished to undetectable after 70-80m from the road bed.
July 9, 2018	Several days of heavy rain have washed much of the dust off leaves where it had accumulated before. More textured leaves appeared to have held on to some dust, but most leaves were washed clean.