Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Long-Term Effects on Wetlands Monitoring Report

TEMP-2024-02

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2023 - 2024

KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2024-02

LONG-TERM EFFECTS ON WETLANDS MONITORING
YEAR 2 OPERATION
2023

Prepared for

Manitoba Hydro

By

ECOSTEM Ltd.

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SUMMARY

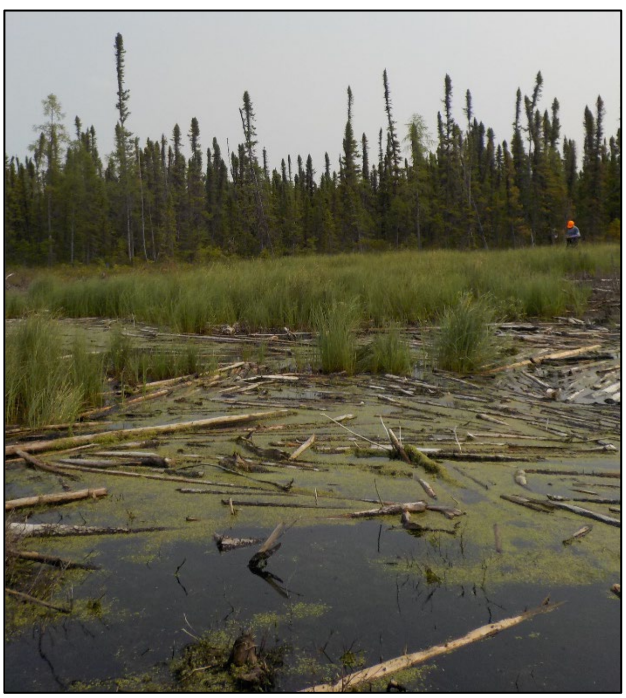
Background

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

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 Long-Term Effects on Wetlands monitoring study conducted in 2022 and 2023, which occurred during the first and second years of operation monitoring.

A wetland is a land ecosystem where periodic or prolonged water saturation at or near the soil surface is the dominant factor shaping soil attributes and vegetation distribution and composition. Wetlands include land covered by water that is up to 2 metres deep (e.g., shallow water along shorelines).



Shoreline wetland in the new reservoir

Wetland functions are the natural properties or processes that are associated with wetlands, stated in ways that describe what they do for the ecosystem. Wetlands typically make relatively high contributions to overall ecosystem function.

Why is the study being done?

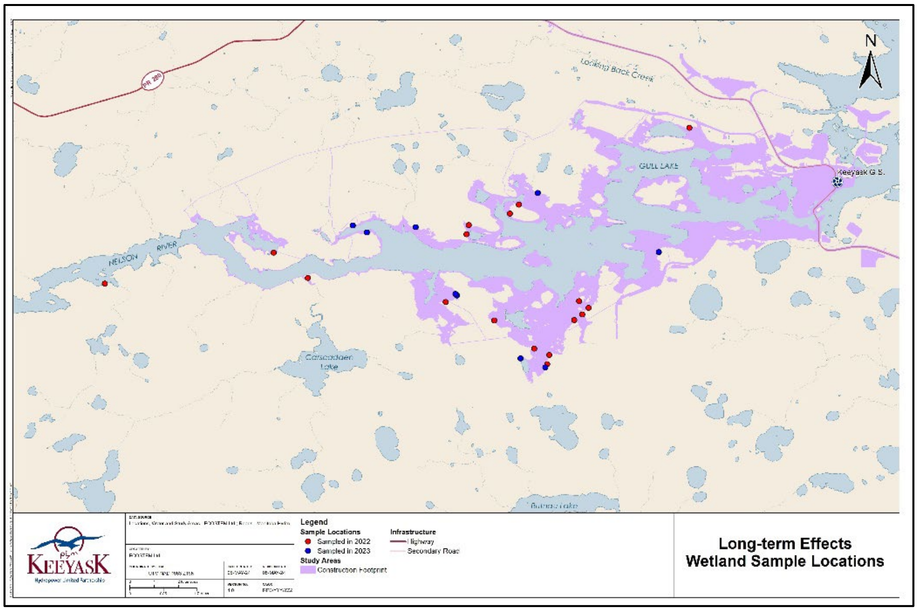
Project effects in areas next to the reservoir are very different from those around the rest of the Project Footprint primarily due to the flooding, water level fluctuations and wave action within the reservoir. The Project effects predictions for areas next to the reservoir had lower certainty than other wetland predictions due to the possibility that groundwater effects could extend a considerable distance inland of the shoreline. The EIS also predicted there could be some positive wetland effects from reduced water level fluctuations. For these reasons, and because the reservoir-affected area is relatively large, the Long-Term Effects on Wetlands study is determining the indirect effects of the reservoir on wetland function during Project operation.

This study is documenting indirect Project effects on shoreline and offshore wetlands in the reservoir. Shore zone wetlands are those that are found along the reservoir shoreline. This monitoring is being done to confirm that the Project effects predictions are accurate, and that no additional unexpected effects are occurring.

What was done?

The Long-Term Effects on Wetlands study has two components that begin at different times. Shore zone habitat monitoring began the first summer after most Project construction was complete and all generating units went online. Offshore wetland (peat island and offshore marsh) monitoring begins in year 5 of operation because the size, shape and location of these wetlands will be changing frequently during the first five years of operation. This report describes the methods used to establish the permanent sample locations in the shore zone and provides an overview of the habitat attributes at these locations.

Shore zone habitat monitoring includes periodic surveys of permanent shoreline transects. In 2022 and 2023, permanent transects were established and digital imagery was captured to collect baseline data at 26 locations, for a minimum of five replicates in each of the five shore zone habitat types. Ground surveys collected detailed vegetation, soil, and environment data within nested belt transects referred to as the environment, tree, tall shrub, and low vegetation belts. Each transect included a Project-disturbed and an undisturbed segment. Aerial surveys using drones also collected photos that were used to create digital orthographic images of a 140 m belt centered on the transects.



Map of sample locations established in 2022 and 2023

What was found?

Drone mapping found that a mixture of low and tall shrub vegetation types made up most of the undisturbed area. Patches of vegetation in standing water were present over 3.3% to 7.5% of the mapped disturbed area, depending on the environmental combination.

Drone image of the shoreline wetland in the new reservoir

Environmental conditions varied across the five sampled shore zone habitat types. The disturbed section of the transects ranged in length from 5 m to 100 m. Average slope and soil conditions for the locations generally corresponded to what was expected for the environmental combination.

The tree and tall shrub belts included five tree species and 21 tall shrub species. In the low vegetation belt, a total of 113 vascular plants, five mosses, four lichens, and 28 broader taxa were recorded. Thirty-four types of plants were widely distributed in the undisturbed portions of at least one of the environmental combinations, and 26 were widely distributed in the disturbed portions.

Evaluation of within transect and within location similarity determined that the selection criteria were met with one possible exception. Paired transects at two locations were substantially different with respect to a single attribute (thickness of surface organic substrate).

No plant species of very high conservation concern or high invasive concern were found during the surveys.

What does it mean?

This study is monitoring changes in shore zone habitat over many years, and the data collected in 2022 and 2023 represents the baseline for comparison with future monitoring years. The results of the baseline monitoring found that the location and transect selection criteria were met with respect to within transect and within location similarity, except for two locations.

What will be done next?

All 26 shore zone habitat locations will be re-sampled in 2024 to collect data for environmental conditions during the third year of Project operation. Prior to sampling, further evaluation of the two locations that were not similar with respect to one measured attribute will be conducted to determine if a transect at either of those locations need to be modified for 2024.

ACKNOWLEDGEMENTS

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We would also like to thank North/South Consultants Inc., in particular Ron Bretecher, Claire Hrenchuk, Rochelle Gnanapragasam and Shari Fournier, for their guidance, logistical support and other resources that made these studies possible.

STUDY TEAM

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

Fieldwork in 2023 was conducted by Brock Epp, Alanna Sutton, Owen Romanchuk, Candice Collette, Anoj Subedi, Lynnae Martin, Heidi Ahrenholtz, Saul Mayhem, Melvin Cook jr. and Tyler Kitchekeesik. Drone work was conducted by Owen Romanchuk and Alex Snitowski.

Data analysis and report writing in 2023 were completed by Alanna Sutton and Brock Epp. Brock Epp and James Ehnes reviewed the report. GIS analysis and cartography were completed by Alex Snitowski.

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1.0 INTRODUCTION

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

The *Keeyask Generation Project Response to EIS Guidelines* (the EIS), completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project (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 *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, including the focus of this report, which is long term effects on wetlands.

A wetland is a land ecosystem where periodic or prolonged water saturation at or near the soil surface is the dominant factor shaping soil attributes and vegetation distribution and composition. Wetlands include land covered by water that is up to 2 metres deep (e.g., shallow water along shorelines).

Wetland functions are the natural properties or processes that are associated with wetlands, stated in ways that describe what they do for the ecosystem. Wetlands typically make relatively high contributions to overall ecosystem function. The EIS studies concluded that off-system marsh is a particularly important wetland type in the Keeyask region. This is based on the contributions that off-system marsh makes to the range of wetland functions.

As described in the TEMP, two studies are monitoring Project effects on wetland function. During construction, the Wetland Loss and Disturbance study monitored direct Project effects on wetlands due to habitat loss and disturbance (now completed; see KHLP 2015, Section 2.5.2). During operation, the Long-Term Effects on Wetlands study is monitoring long-term direct and indirect Project effects on wetland function (see KHLP 2015, Section 2.5.3). A third study, Created Wetlands, will monitor the efficacy of mitigation efforts to create 12 ha of off-system marsh (see KHLP 2015, Section 8.1).

The goal of the Long-Term Effects on Wetlands study is to determine indirect Project effects on wetland function during operation. Its focus is on effects within the Project's hydraulic zone of influence. Due to the possibility that groundwater effects could extend a considerable distance inland of the shoreline, these predictions had lower certainty than other wetland predictions. The relevant wetland area is relatively large and effects in this zone are expected to be positive relative to pre-Project conditions.

Based on this goal, the objectives of this study are to:

- Determine the characteristics of shoreline and offshore wetlands developing within the Project's hydraulic zone of influence,
- Locate and quantify Project related changes to shoreline and offshore wetland composition in the Project's hydraulic zone of influence,
- Characterize the nature of Project-related groundwater and edge effects to inland habitat near the hydraulic zone of influence,
- Locate and quantify areas developing into native wetland types, and,
- Locate and quantify long-term Project effects on wetland function.

Monitoring for this study began in 2022 and 2023 when permanent sample locations were established adjacent to the reservoir clearing and post-impoundment terrestrial habitat shoreline, and the baseline data were collected. This report describes the methods used to establish these transects and provides an overview of wetland attributes at the locations established in 2022 and 2023.

2.0 METHODS

2.1 APPROACH

This study is documenting indirect Project effects on shoreline and offshore wetlands within the Project's hydraulic zone of influence.

Project effects are dramatically different in areas adjacent to the reservoir compared with the rest of the Project Footprint. Two factors are predominantly responsible for this. First, the main driver for terrestrial ecosystems affected by the Project reservoir is water level fluctuations, wave action and hydrology. Second, the stand "edge" (i.e., the new reservoir shoreline) will be shifting inland in response to wave action and hydrological effects. In other Project areas, the main impacts are clearing, physical disturbance, excavation, and excavated material placement. Also, the spatial extent of inland Project impacts (i.e., clearing and physical disturbance during construction) is predominantly static.

There are two components to this study. The first documents habitat attributes in affected shore zone and offshore wetlands, and how closely these attributes approximate those found in comparable native wetland types. The second component translates the periodically updated detailed terrestrial habitat mapping into effects on wetland function.

For the first component, the Long-Term effects on Wetlands study includes periodic surveys of permanent transects established during the early years of operation. Shore zone wetland monitoring began the first summer after most Project construction was complete and all generating units went online (i.e., the start of Project operation). Offshore wetland (peat island and offshore marsh) monitoring begins in year 5 of operation because patch boundaries will be highly dynamic during the first five years of operation.

Section 2.5.3 of the TEMP describes the approach for the Long-Term effects on Wetlands study. The following details the study methods for shore zone wetland monitoring, and describes the activities conducted during the initial years of this monitoring.

2.2 STUDY DESIGN

The Project's hydraulic zone of influence (Map 2-1) defined the spatial limits for monitoring long-term effects on shoreline and offshore wetland habitat. "Shore zone" wetlands are areas along the shoreline affected by Project operation such as initial flooding, water level fluctuations, groundwater changes and ice scouring. The shore zone begins in water up to 2m deep, continues through the beach, and ends in the inland area that remains unaffected over the long term.

An impact-trend by time design was employed to document changes to shore zone habitat over time. Data are being collected on permanent transects that are resampled periodically during Project operation.

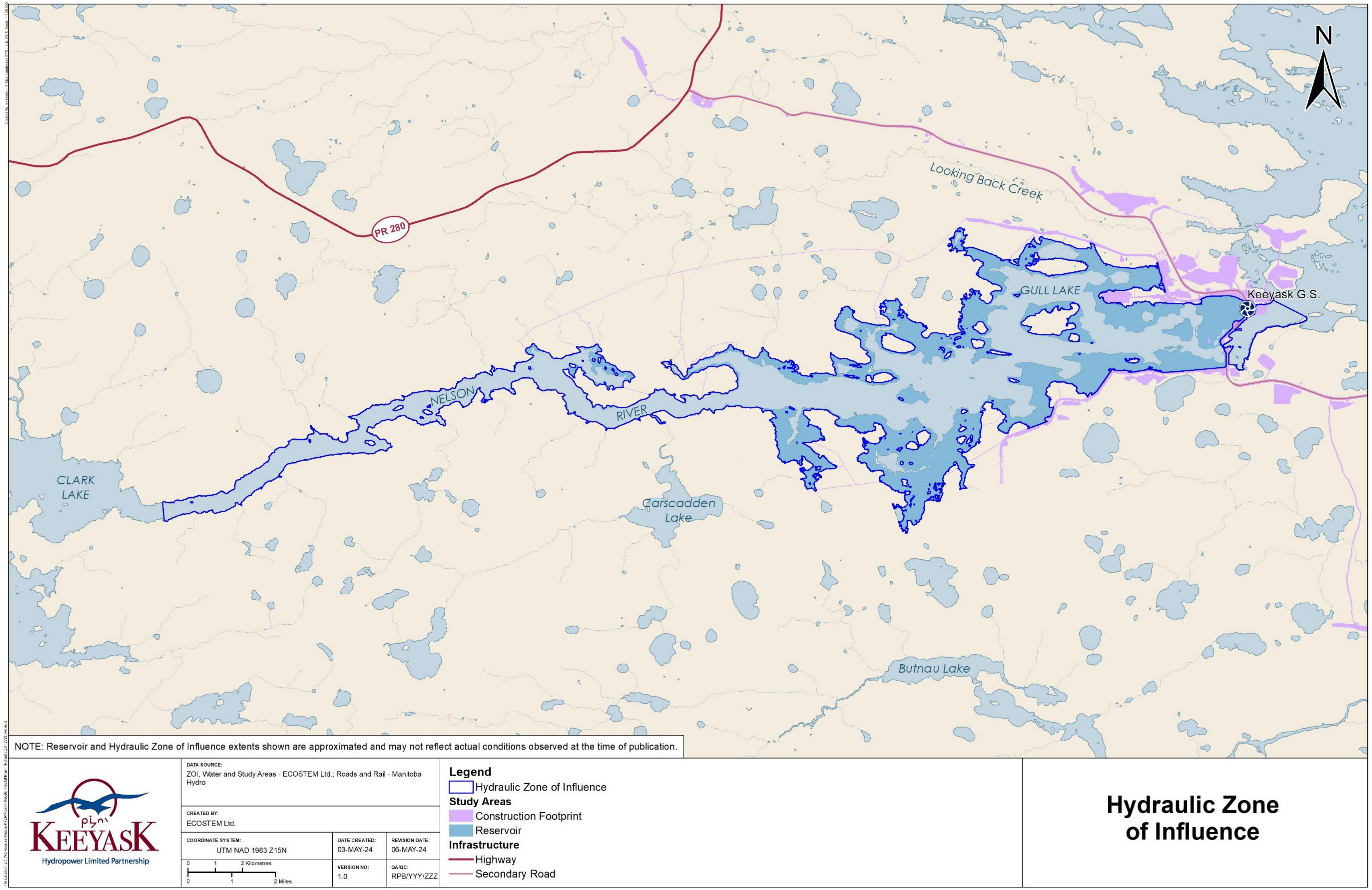
Permanent sample locations were a stratified, random sample of the shore zone habitat types. Shore zone habitat types were obtained from a preliminary mapping of the 2021 post-impoundment terrestrial habitat shoreline. The terrestrial habitat shoreline was segmented based on combinations of ecosite type, wave energy, water flow type (lacustrine or riverine), and bank height. The minimum shoreline segment length for a combination to be included in the sampling frame was 100 metres.

The preliminary shore zone habitat mapping was produced from a combination of digital stereo photos acquired in October 2021 and helicopter-based aerial surveys and photography. These data were collected by the Terrestrial Habitat Clearing, Disturbance and Indirect Effects monitoring study (see TEMP Section 2.1).

The shore zone habitat types selected for sampling were those that: i) comprised the most common combinations of environmental conditions; ii) were well distributed throughout the reservoir shoreline; and iii) were represented by at least 5 potential replicates. The environmental conditions used to select stands were ecosite type, wave energy, water flow type, and bank height. Table 2-1 provides the five combinations of environmental type conditions selected for sampling. Only one bank height class met the selection criteria.

Table 2-1: Shore zone habitat types sampled and description based on wave energy, water flow, ecosite and bank height

Habitat Type	Wave Energy ($Watts/m^2$)	Water Flow	Ecosite	Bank Height
1	3,000	Lacustrine	Deep Dry Mineral	None
2	3,000	Lacustrine	Veneer Bog on Slope	None
3	3,000	Lacustrine	Veneer Bog	None
4	3,000	Lacustrine	Blanket bog	None
5	3,000	Riverine	Veneer Bog on Slope	None



Map 2-1: The Project's hydraulic zone of influence

2.3 DATA COLLECTION

2.3.1 DIGITAL ORTHORECTIFIED IMAGES

A drone acquired photos of the wetland and inland habitat that included a 140 m wide band centred on each ground transect. From these photos, a digital orthorectified image (DOI) of the area covered by the imagery was created (i.e., the transect DOI).

Photos of each transect were captured twice, at two elevations above ground level: 40 m to provide more detailed imagery used to identify smaller features and vegetation, and another set at 70 m to provide a wider overview, and imagery that can more accurately be georectified for mapping. Photos were acquired with forward and side overlap to produce a DOI for a 140 m wide band centred on each transect, extending 30 m offshore and 100m inland from either end.

The photos were acquired using an Autel EVO II Pro drone equipped with a 20 MP RGB camera.

Drone photos were acquired between August 19 to 25, 2022, and on August 21 and 22, 2023.

The imagery was used to confirm the post-impoundment inland flooding extent along the segment of the shoreline sampled, and to confirm conditions were similar between the pair of transects. The imagery was also used to monitor:

- Environmental conditions surrounding the transect;
- Overstorey canopy closure; and,
- Trees and snags in the flooded portion of the transects.

2.3.2 BELT TRANSECTS

2.3.2.1 UNDISTURBED TRANSECT SEGMENT

At each of the selected shoreline segments, the sample location was positioned where: i) the shoreline was relatively straight (so transects would not approach each other); ii) at least 60 m long (to include two belt transects separated by 20 m); and, iii) had relatively homogenous environmental conditions.

At each sample location, two roughly parallel transects were established 20m apart. The transect origin was located at the edge of visible Project disturbance (e.g., reservoir clearing, flooding, ice scouring; Photo 2-1). The origin was either at the edge of the Project clearing (Figure 2-1A), or where evidence of previous reservoir inundation was obvious (Figure 2-1B), whichever was further inland. Each transect was oriented perpendicular to the overall orientation of the disturbance edge (Figure 2-1).

Each transect was subdivided into two sections: Project-disturbed and undisturbed by the Project. At all sample locations, the undisturbed section of the transect was 30 m long. The disturbed section of the transect extended from the disturbed edge into the water, either to a depth of 1 m or to the end of the emergent vegetation, whichever was further.

For the undisturbed section of the belt transect, data were collected in four nested belts (Figure 2-1) referred to as the environment, tree, tall shrub and low vegetation belts. The nesting reflected finding a balance between the larger area needed to adequately represent the different vegetation components and minimizing sampling effort.

The attributes recorded in each belt were the following:

1. Environment belt
    - For vegetation structure and environment attributes.
    - 10 m wide belt with three consecutive 10 m X 10 m quadrats.
    - Attributes for each quadrat included structure class (Table 2-2), average canopy height, average percent slope and aspect, slope position (Figure 2-2), slope shape, and disturbance.
2. Tree belt
    - For trees and snags (dead standing trees).
    - Stem tallies within a 4 m wide belt transect along the 30m transect.
    - Attributes for both trees and snags included distance along transect, perpendicular offset distance and direction (left or right), circumference at breast height (CBH, 1.3 m), and species.
    - Additional attributes for trees included condition (Table 2-3), and canopy position (Table 2-4).
    - Additional attributes for snags included condition (Table 2-5) and decay stage (Table 2-6).
3. Tall shrub belt
    - For tree recruitment and tall shrubs
    - Tree “pseudospecies”, i.e.: tree seedlings (height < 0.5m), tree saplings (height ≥ 0.5m), and tall shrub species (Table 2-7).
    - Tallies for each species within a 2 m wide belt transect for contiguous 2 m X 5 m quadrats.
4. Low vegetation belt
    - For plant species composition.
    - Presence by species within a 1 m wide belt transect for contiguous 25 cm X 100 cm quadrats.

2.3.2.2 DISTURBED TRANSECT SEGMENT

For the disturbed section of the transect, the extent of data collection depended on whether some of the transect was above water (Figure 2-1A). For transects that had an initial portion above water, environment and vegetation attributes were generally recorded in the same way as for the undisturbed section. The exception was that a tree and snag belt were not included because these stems had been predominantly removed by reservoir clearing.

For the portion of the transect under water, the attributes were recorded in two nested belts, including a 2 m wide belt for tree recruitment and tall shrubs emerging from the water, and a 1 m wide belt for the remaining attributes (Figure 2-1):

1. Environment
   - Water depth, recorded wherever a slope change was perceived, or every 5m.
   - Surface substrate within contiguous 25 cm X 100 cm quadrats.
2. Tree recruitment and tall shrubs
   - Tree seedlings (height <0.5m), tree saplings (height ≥0.5m), and tall shrub species (Table 2-7). Only living stems emerging from the water were counted.
   - Tallies for each species within a 2 m wide belt transect for contiguous 2 m X 5 m quadrats.
3. Plant species composition
   - Presence by species within a 1 m wide belt transect for contiguous 25 cm X 100 cm quadrats.

Photo 2-1: Transcect setup (Disturbed portion) at LTESKNO3B on August 5, 2023

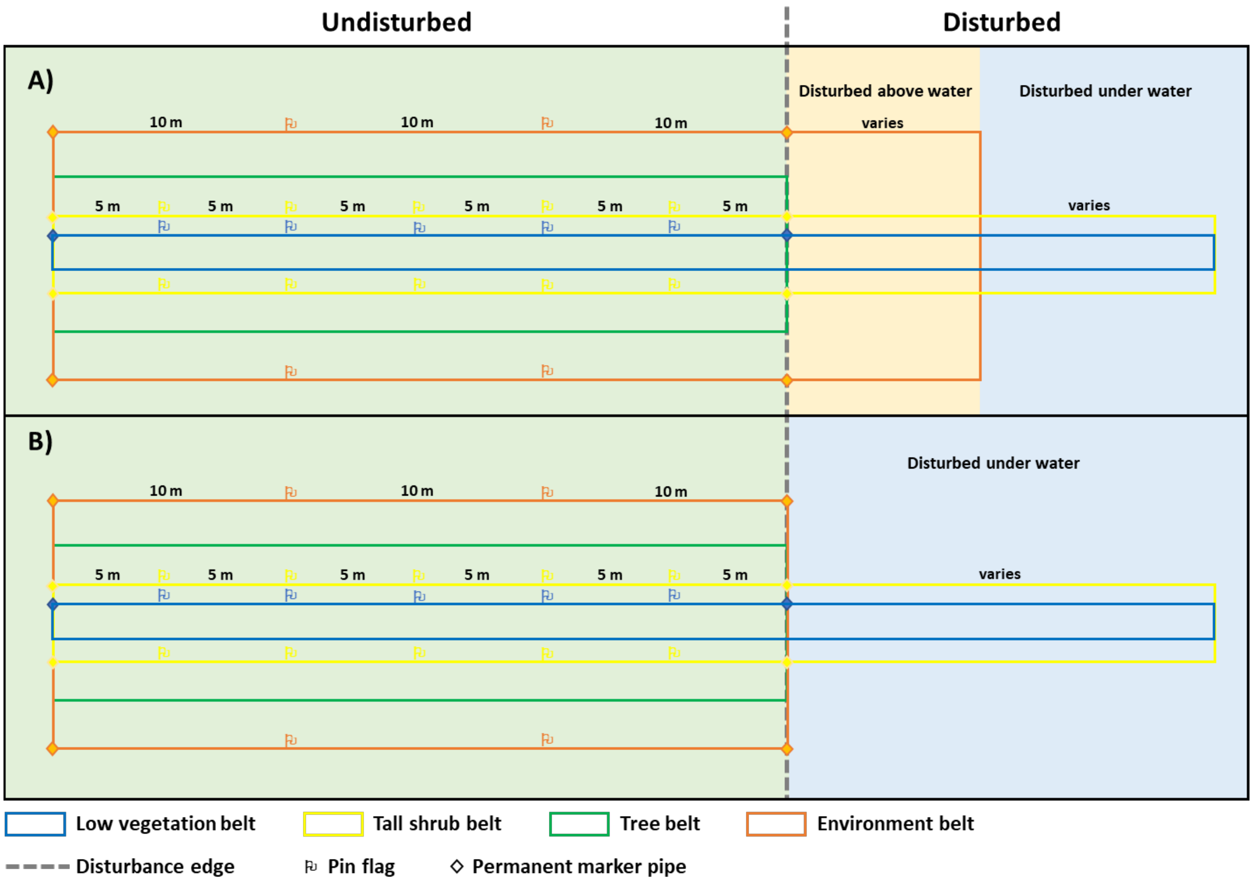


Figure 2-1: Shore zone belt transect layout for locations with A) a portion of the disturbed transect above water, and B) all of the disturbed transect under water

Table 2-2: Vegetation structure classes

Code	Type	Criteria
F	Forest	Dominated by trees (i.e., tree species with stems that have CBH >0) that have ≥75% canopy closure.
W	Woodland	Trees (i.e., tree species with stems that have CBH > 0) form the canopy and those trees have ≥25% and <75% canopy closure.
T	Shrubland - Tall	Tall shrubs (shrub species whose height ≥ 0.5m) and/ or saplings (tree species >0.5m < CBH) form the canopy and have at least 25% cover
L	Shrubland - Low	Low shrubs (shrub species whose height <0.5m) or tree seedlings (tree species <0.5m tall) form the canopy and have at least 25% cover.
G	Grassland / Herbland	Grasses and/ or sedges and/ or herbs form the canopy and have at least 25% cover
B	Bryoid	Mosses, hepatics and/ or lichens are the tallest vegetation with at least 25% cover.
S	Sparse	All vegetation combined has ≥25% cover if all of the strata are combined but no one stratum has at least 25% cover.
N	Barren	All vegetation combined has <25% cover.
E	Edge	Used to identify the location of a hard edge.

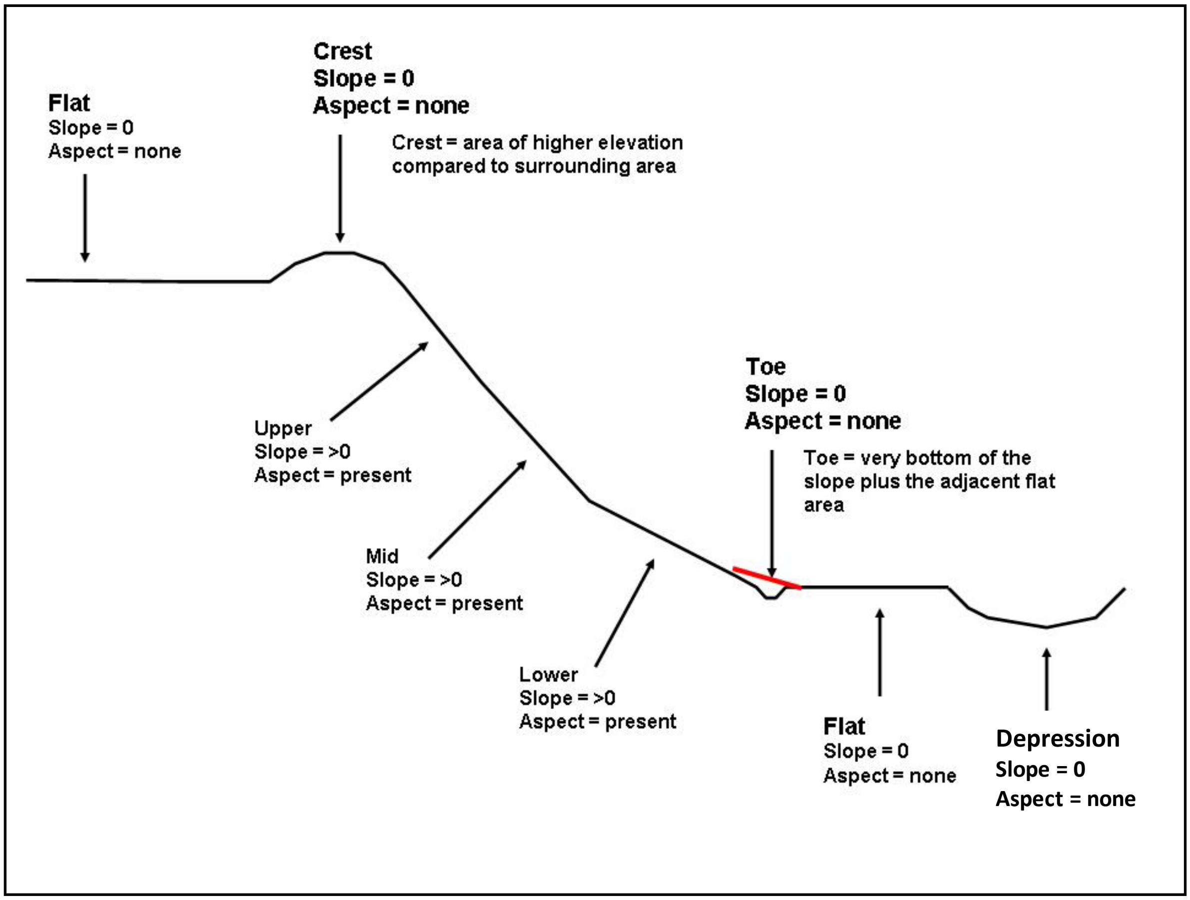


Figure 2-2: Slope positions

Table 2-3: Tree condition

Code	Condition	Description
1	Intact	Tree has not sustained any damage (i.e., canopy and bole are intact)
2	Broken canopy	Majority of the branches in upper portion of tree are missing
3	Broken bole	Bole broken below canopy
4	Windfall	Tree uprooted by wind
5	Heart rot	Tree with evidence of heart rot
6	Disease	Evidence of other type of disease (e.g., conk)
7	Insect	Evidence of insect attack
8	Knocked down	Tree pushed over by forwarder/harvester as seen by bark scarring
9	Stump	Tree that was cut during reservoir clearing
10	Forked canopy	Canopy is forked
11	Browsed	Tree browsed by animals, damaged by birds (e.g., sapsuckers)
12	Dead top	Upper portion of tree canopy is dead

Table 2-4: Tree canopy position

Code	Position	Description
1	Veteran	Tree that survived last stand-replacing disturbance
2	Dominant	Top of crown is not shaded by other trees
3	Sub-Dominant	Crown is in upper canopy but slightly below the crowns of dominant trees
4	Secondary	In second tier, if one exists
5	Understorey	Crown below the secondary and upper canopies
9	Not applicable	Stump or windfall

Table 2-5: Snag condition

Code	Condition	Description
1	Intact	Main stem and branches in canopy are unbroken
2	Broken canopy	Majority of the branches in upper portion of snag are missing
3	Broken bole	Entire canopy and upper portion of main stem axis broken off

Table 2-6: Snag decay stage

Code	Stage
1	Recently killed
2	Twigs and leaves lost; bark intact
3	Small branches lost; bark beginning to peel; wood hard
4	Only major branches remaining; >20% bark lost; wood condition soft to hard
5	Canopy broken; bark condition variable; wood conditions variable
6	Decomposing stump; wood soft; bark peeling

Table 2-7: Species considered as tall shrubs

Species Name	Common Name
Alnus incana	Speckled alder
Alnus alnobetula	Green alder
Amelanchier alnifolia	Saskatoon
Betula pumila	Bog birch
Cornus sericea	Red-osier dogwood
Corylus cornuta	Beaked hazelnut
Endotropis alnifolia	Alder-leaved buckthorn
Prunus pensylvanica	Pin cherry
Rosa acicularis	Prickly rose
Rubus idaeus	Red raspberry
Salix arbusculoides	Shrubby willow
Salix bebbiana	Bebb's willow
Salix glauca	Smooth willow
Salix pellita	Satin willow
Salix planifolia	Plane-leaved willow
Salix pseudomonticola	False mountain willow
Salix pseudomyrsinites	Myrtle-leaved willow
Salix spp.	Other willow species
Shepherdia canadensis	Soapberry
Viburnum edule	Mooseberry

The soil sampling method was intended to be sufficient to detect moisture regime changes in the rooting zone. Soils were sampled in pits (Photo 2-2) and from soil cores obtained using a Dutch auger. The soil pits collected detailed soil information while the soil cores focused on moisture regime (Figure 2-3). Soil pits were dug at 1m and 10m along the undisturbed portion of the transect. Soil cores was completed at 5m, 15m, 20m and 30m on the undisturbed section of the transect, and at 1m and 5m on the disturbed section unless those distances were under water.

Data recorded at soil pits included:

- LFH and/or organic matter depth.
- Depth to prominent mottling, gleying, ice, water table and bedrock.
- Soil horizon information, such as depth, texture and stoniness.

Data was collected at 1m and 10m on the undisturbed section of the transect.

Photo 2-2: Soil pit data being collected

Portion of Transect	Distance (m)	Pit Type
Undisturbed	30	Moisture Regime
	20	Moisture Regime
	15	Moisture Regime
	10	Full
	5	Moisture Regime
	1	Full
Disturbed - above water	1	Moisture Regime
	varies	Moisture Regime
Disturbed - under water		

Figure 2-3: Schematic representation of soil sampling locations and type

2.3.2.3 PLANT TAXA

Plant nomenclature followed the Manitoba Conservation Data Centre (MBCDC 2021) species and plant community database standards.

Plants recorded in the belt transects were identified to species if it was a taxon for which this was generally feasible in the field and to a taxon otherwise. Trees were recorded as pseudospecies based on growth form (Section 2.3.1). In this report, the singular "taxon" and plural "taxa" are used to refer to species, broader taxa, and pseudospecies collectively.

Additionally, plants of ecological concern (see Section 2.4.3) were recorded between sampling locations and included as incidentals in their respective studies (ECOSTEM 2023a, b).

2.4 DATA ANALYSIS

The objective of the data analysis for the permanent transect establishment (i.e. the data collected in 2022 and 2023) was to:

- Confirm the extent of reservoir flooding and water effects on vegetation along the shoreline sampled;
- Confirm that environmental conditions across the pair of transects sampled at each location were homogeneous; and,
- Describe overall characteristics of the undisturbed and disturbed portions of each the sampled locations, which will form the baseline for the evaluation of Project effects during operation.

2.4.1 HABITAT MAPPING

Habitat mapping from the DOIs focused on attributes in the coverage area, refining the location of the terrestrial habitat shoreline (inland extent of reservoir flooding), and refining the limit of pre-impoundment vegetation clearing.

Distinct patches of vegetation structure were heads-up digitized over the transect DOI (Section 2.3.1). A minimum polygon size of 200 m^2 was used, which was small enough to capture localized differences in structure and disturbances that may be associated with possible variations in environmental conditions such as soil moisture regime.

The attributes that were interpreted included:

- Vegetation structure (Table 2-8)
- Upper canopy closure estimated to the nearest 10% class (1=10%, 2=20%, …, 10=100%)
- Recent disturbance type (e.g., windthrow, clearing)
- Recent tree mortality estimated to the nearest 10% class (1=10%, 2=20%, …, 10=100%)
- Precise location of the clearing edge and the terrestrial habitat shoreline

The mapped vegetation structure classes differed slightly from the vegetation structure class determined from the ground in the transects (see Section 2.3.2). This is because of the different criteria used to classify vegetation cover from above rather than below and using photo interpretation.

Table 2-8: Mapped vegetation structure classes and interpretation criteria

Division (based on dominant life form)	Code	Class	Criteria if the Dominant Stratum
Treed	F	Forest	61 - 100% cover with crowns overlapping.
	D	Woodland	26 - 60% cover with crowns generally not touching.
	S	Sparsely Treed	10 - 25% cover with crowns generally not touching.
Shrub	TS	Tall Shrub	Taller than 0.5m and cover > 25% with Trees < 10%; Cover can be less than 25% when the cover of each of the other life forms < 25% and shrub cover exceeds others.
	LS	Low Shrub	Up to 0.5m tall and cover > 25% with Trees < 10% and Tall Shrubs < 25%; Cover can be less than 25% when the cover of each of the other life forms < 25% and shrub cover exceeds others.
Herb	LG	Graminoid	Cover > 25% with Trees < 10% and Tall Shrubs < 25%; Can be less than 25% when the cover of each of the other life forms < 25% and graminoid cover exceeds others.
	LF	Forb	Cover > 25% with Trees < 10% and Tall Shrubs < 25%; Can be less than 25% when the cover of each of the other life forms < 25% and forb cover exceeds others.
Non-vascular	LB	Bryoid	Cover > 25% with Trees < 10% and Tall Shrubs < 25%; Can be less than 25% when the cover of each of the other life forms < 25% and bryoid cover exceeds others.
Bare ground	B	Sparse/Barren	All vegetation cover < 25%.

2.4.2 TRANSECT CHARACTERISTICS FROM GROUND SURVEYS

2.4.2.1 ENVIRONMENTAL ATTRIBUTES

Environment attributes and soil data from both transects were pooled for each sample location. Descriptive statistics generated included average slope, total quadrat occurrences for each slope position category, and total soil profile occurrences for each moisture regime and drainage regime category.

2.4.2.2 VEGETATION

Tree, snag, and tall shrub tallies were pooled for both transects for each sample location. Descriptive statistics included percent occurrence for each species.

Descriptive statistics generated for species distributions were based on species data collected in the low vegetation belt. As this was the first year of data collection, all species occurring in at least 1 quadrat in one of the transects were retained for analysis.

Species meeting the criterion for inclusion were classified into the distribution classes shown in Table 2-9 based on the percentage of locations they were found in.

Table 2-9: Distribution Class Names and Ranges as a percentage of locations surveyed

Distribution Class	Percentage range	Generalized Distribution
Very Widespread	90% ≤ D ≤ 100%	Widely
Widespread	75% ≤ D < 90%	
Scattered	25% ≤ D < 75%	Narrowly
Localized	0% < D < 25%	
Absent	0%	Absent

2.4.3 TRANSECT HOMOGENEITY

Transect homogeneity was evaluated for each of the sample locations based on information derived from the transect data. In order to evaluate homogeneity within and between belt transects at each location, environment, vegetation, and soil data were considered separately for each transect. Each transect was divided three 10m segments, with the first segment being adjacent to the disturbed edge (0 – 10 m into the undisturbed habitat), and the third segment being the furthest from the disturbed edge. Variables were compared for a total of six segments from two transects in each sampled stand. The transect data used to evaluate homogeneity included:

1. Number of different vegetation structure types across the segments
2. Tree species composition (as a percentage of tallied stems)
3. Number of different site types across the segments
4. Average thickness of the surface organic layer across the segments

2.4.4 PLANTS OF ECOLOGICAL CONCERN

Plant species of ecological concern were given additional consideration. These included priority and non-native plants.

Priority plants included species listed under the Manitoba Endangered Species Act (MESA), the Species at Risk Act (SARA) or the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), as well as species ranked provincially critically imperiled to vulnerable (S1 to S3 ranked).

Non-native plants included species that were categorized based on their concern level (Table 2-10 for classification criteria). Species in the level 1 and 2 concern levels were considered for immediate management within the Study Area where possible (ECOSTEM 2023a).

Table 2-10: 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 species[1]
Level 4	All remaining non-native plant species

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

3.0 RESULTS

3.1 SAMPLE LOCATIONS

Sampling occurred from July 11 to 21, August 3 to 10, and August 19 to 24, 2022; and July 31 to August 10, 2023.

Of the 25 planned locations, 17 were sampled in 2022 (Table 3-1). Sampling the remaining eight locations was deferred to 2023 because they were inaccessible (due to debris, peatland disintegration, and/or low water levels), and/or the shoreline position was not yet well defined one year after reservoir impoundment. In the latter case, this was because some flooded peatlands were still in the process of resurfacing inland of the water's edge.

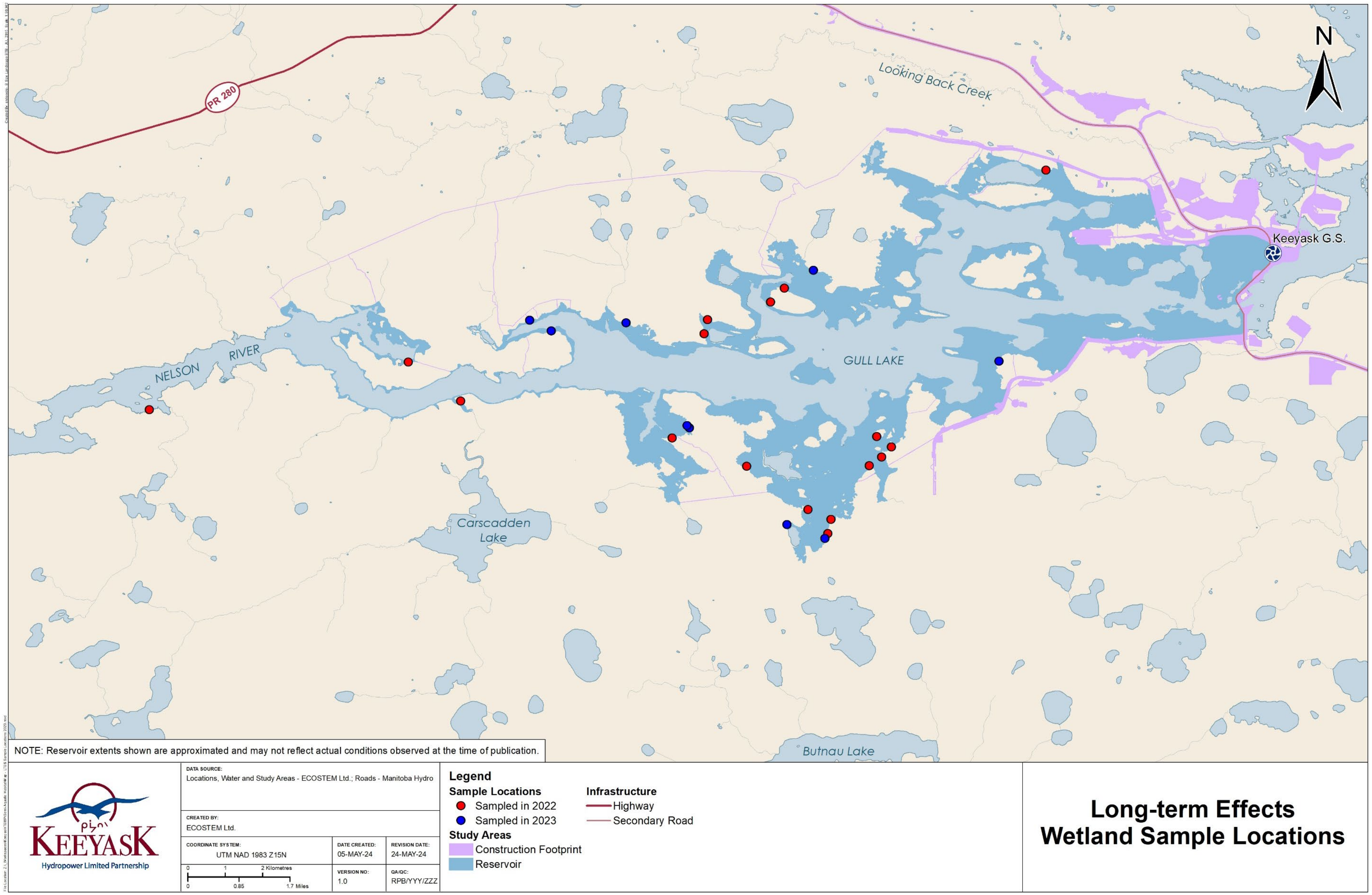
In 2023, a total of nine locations were sampled, bringing the total sample size to 26 (Map 3-1). Sample locations were established in all five different environmental combinations across the four geographic zones (Table 3-1), all of which had five replicates or more in 2023.

Of the 52 transects sampled (two at each location), 11 had at least 5m of cleared area inland of water inundation. The cleared portion was sampled similarly to the undisturbed section of the transect but without the tree belt (Section 2.3.1).

Table 3-1: Number of locations sampled by environmental combination by year

Environmental Combination[1]	Locations sampled in 2022	Locations sampled in 2023[2]	Total locations sampled
Lacustrine, Deep Dry Mineral	5	0	5
Lacustrine, Veneer Bog on Slope	5	0	5
Lacustrine, Veneer Bog	3	3	6
Lacustrine, Blanket Bog	0	5	5
Riverine, Veneer Bog on Slope	4	1	5

Notes: [1] All sampled combinations were low wave energy and had no bank. [2] A sample location includes a pair of parallel transects.



Map 3-1: Long-term Effects on Wetland Function sample locations in 2022 and 2023

3.2 HABITAT MAPPING

The total area covered by the DOIs (Figure 3-1) for the 26 locations sampled was 101.6 ha, 63% of which was in undisturbed habitat (Table 3-2). The area covered for each location ranged from 2.9 ha to 6.1 ha, depending on the nature of the surrounding habitat and the length of the disturbed portion of the transect. Imagery was typically collected deeper inland for low-lying peatland habitat. The total combined area mapped for locations by environmental combinations ranged from 8.7 ha for Lacustrine, Deep Dry Mineral locations, to 17.4 ha for Lacustrine, Blanket Bog Locations (Table 3-2). For the disturbed portion, the largest combined area mapped was for the Lacustrine, Blanket Bog locations.

A total of eight vegetation structure types were identified across the undisturbed area mapped for the locations (Table 3-3). Overall, most of the mapped area was comprised of an even mixture of Low Shrub and Tall Shrub structure types (74.9% combined). Treed structure types made up most of the remaining undisturbed area with Sparse Treed structure being most abundant (10.4%). In all environmental combinations, Tall Shrub and/or Low Shrub was the dominant structure type (Table 3-3). Treed structure was most abundant at the Lacustrine, Veneer Bog locations where a mixture of Forest, Woodland, and Sparse Treed structure made up 40.3% of the mapped area.

In the 37.8 ha of disturbed areas mapped, 98.3% was inundated from reservoir impoundment and 1.7% was pre-impoundment reservoir clearing (Table 3-4). Non-inundated reservoir clearing area was absent at all locations in the Lacustrine, Veneer Bog on Slope, and Riverine, Veneer Bog on Slope environmental combinations (Table 3-4). Between three and four locations at each of the remaining environmental combinations had small areas with non-inundated reservoir clearing.

Patches of emergent vegetation was mapped in the inundated areas at 14 (54%) of the 26 sample locations in 2022 and 2023. The total area of mapped emergent vegetation was 2.1 ha (Table 3-5). It was present in all environmental combinations in relatively similar amounts, ranging from 3.3% to 7.5% of the disturbed area mapped. The most common emergent vegetation type was graminoid marsh.

Map 3-2 to Map 3-3 show vegetation structure of the mapped area around each of the sample locations.

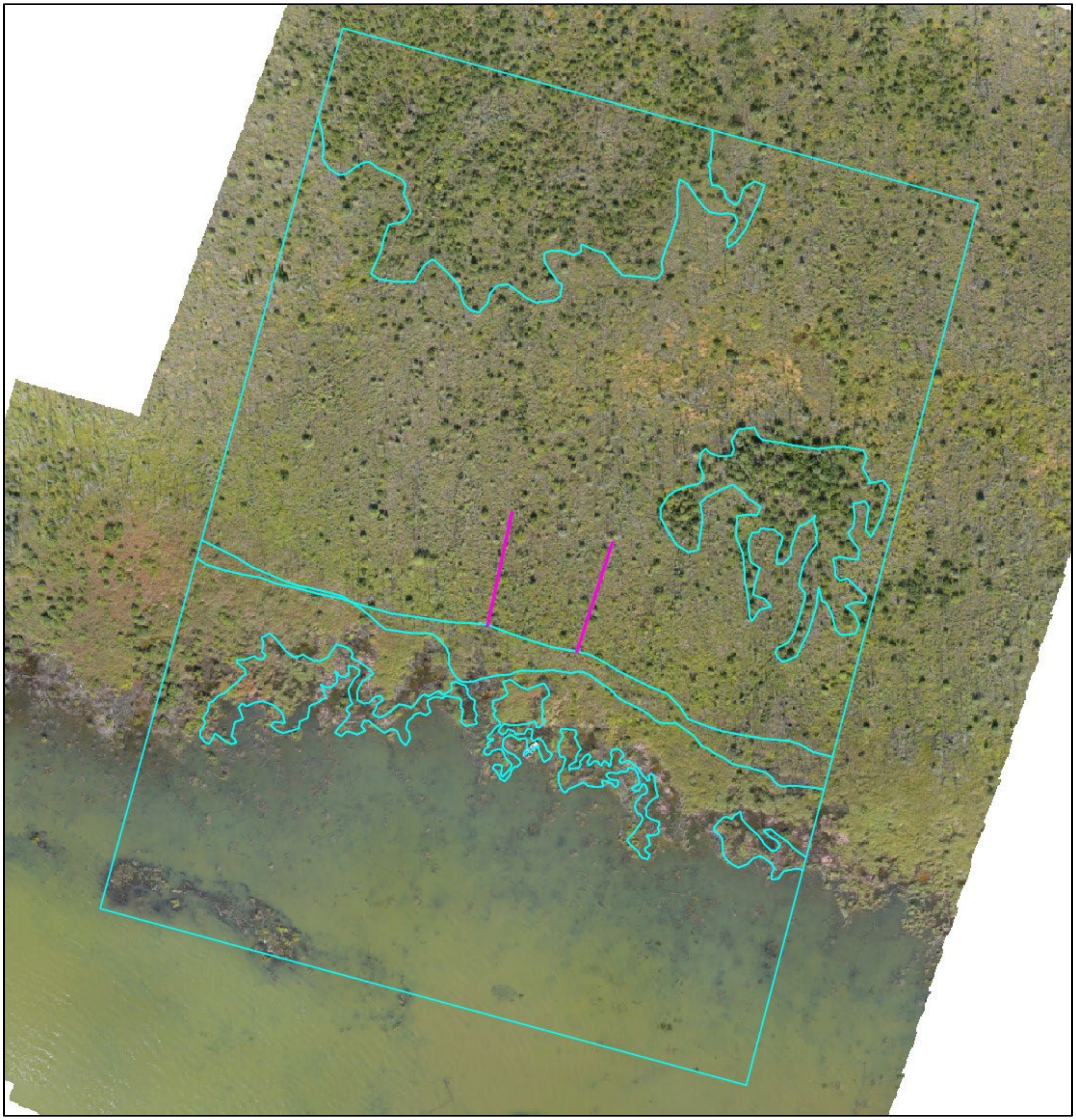


Figure 3-1: Example of DOI created for location LTESKNO5C with interpreted fine-scale habitat polygons overlain. Blue outlined area is the habitat mapped, and pink lines show the transect positions

Table 3-2: Total area mapped from the DOIs for the undisturbed and disturbed portions of locations grouped by environmental combination in 2022 and 2023

Environmental Combination	Area Mapped (ha)		
	Undisturbed	Disturbed	Both
Lacustrine, Deep Dry Mineral	8.7	6.3	15.0
Lacustrine, Veneer Bog on Slope	11.5	6.2	17.7
Lacustrine, Veneer Bog	14.4	8.5	22.9
Lacustrine, Blanket Bog	17.4	10.1	27.6
Riverine, Veneer Bog on Slope	11.7	6.6	18.3
Total area mapped (ha)	*63.8*	*37.8*	*101.6*

Table 3-3: Vegetation structure composition of the undisturbed portions of environmental combinations covered by the DOIs in 2022 and 2023

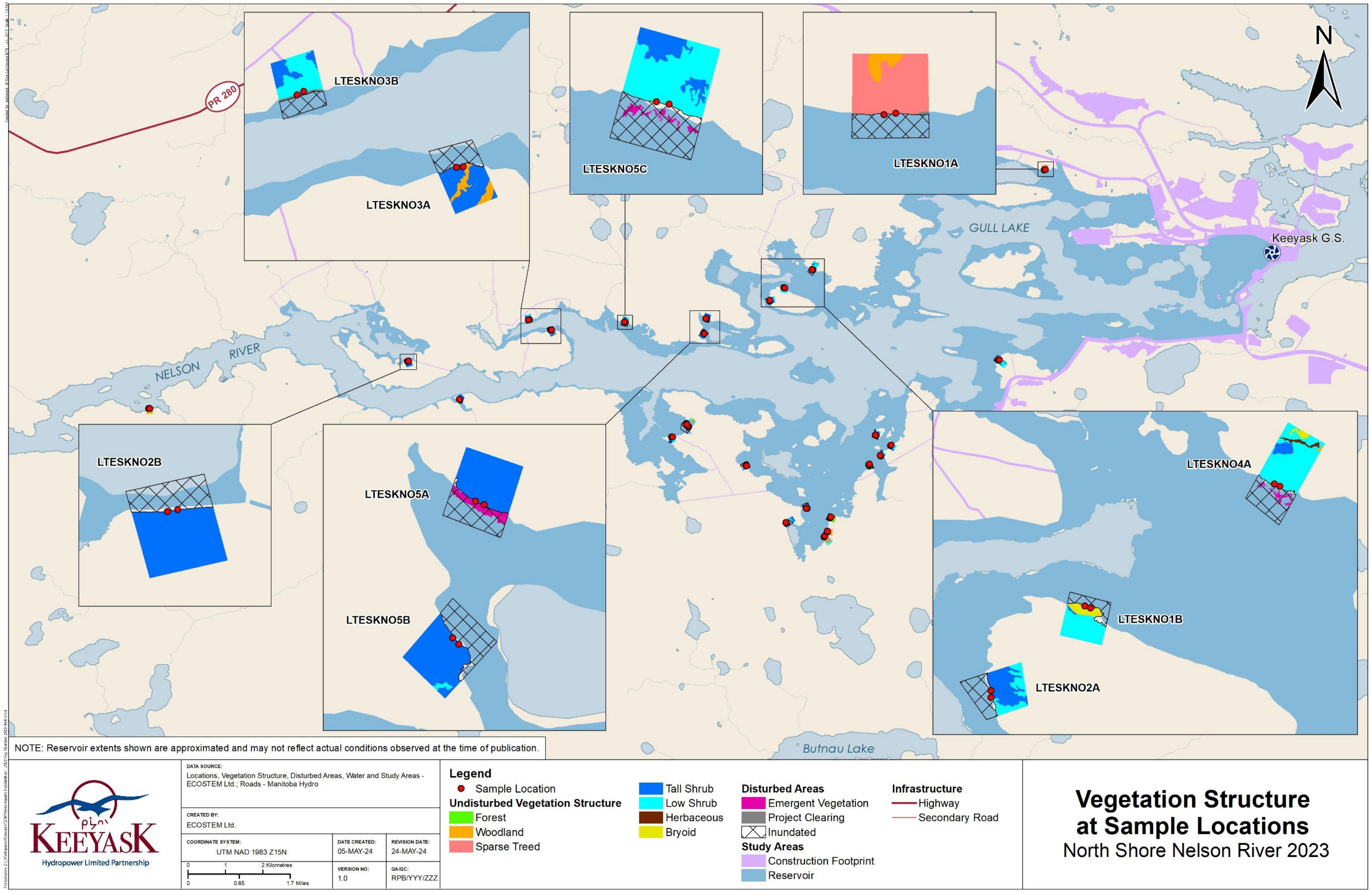
Structure Type	All	Percent of Undisturbed Area in Environmental Combination				
		Lacustrine Deep Dry Mineral	Lacustrine Veneer Bog on Slope	Lacustrine Veneer Bog	Lacustrine Blanket Bog	Riverine Veneer Bog on Slope
Forest	5.3	-	-	10.5	7.5	4.7
Woodland	7.7	2.7	2.0	18.4	1.8	12.7
Sparse Treed	10.4	21.8	1.5	11.4	14.7	2.9
Tall Shrub	35.8	12.2	68.7	28.2	14.7	61.8
Low Shrub	39.1	58.1	27.8	29.5	59.0	17.9
Herbaceous	0.4	-	-	0.4	1.1	-
Bryoid	1.4	5.1	-	1.6	1.2	-
Total area (ha)	*63.8*	*8.7*	*11.5*	*14.4*	*17.4*	*11.7*

Table 3-4: Percent of mapped disturbed area inundated and cleared by environmental combination in 2022 and 2023

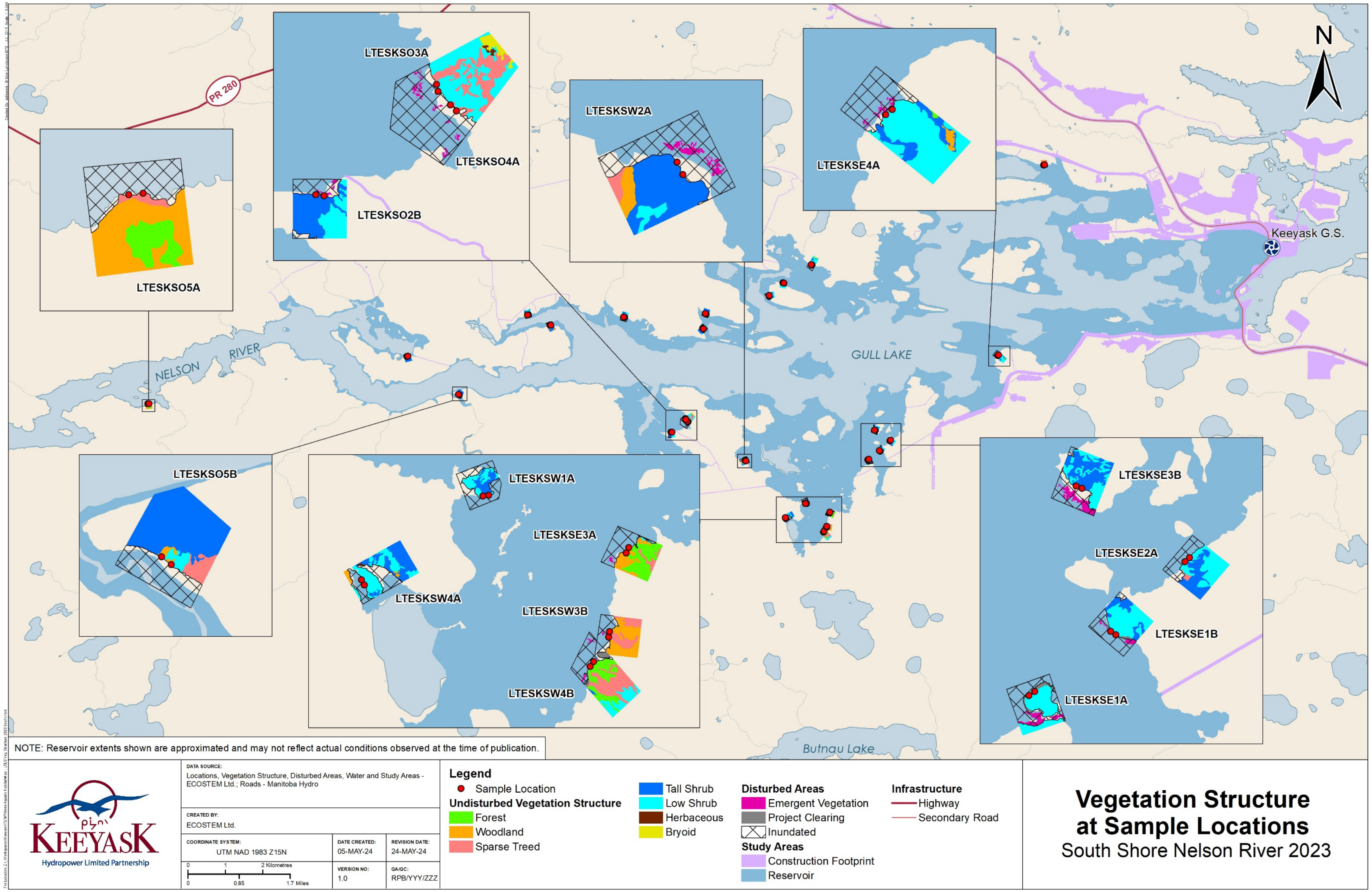
Environmental Combination	Total Disturbed Area (ha)	Percent of Area Inundated	Percent of Area Cleared
Lacustrine, Deep Dry Mineral	6.3	97.1	2.9
Lacustrine, Veneer Bog on Slope	6.2	100.0	0.0
Lacustrine, Veneer Bog	8.5	97.7	2.3
Lacustrine, Blanket Bog	10.1	97.5	2.5
Riverine, Veneer Bog on Slope	6.6	100.0	0.0
All	*37.8*	*98.3*	*1.7*

Table 3-5: Percent of mapped disturbed area with emergent vegetation cover in 2022 and 2023 by environmental combination

Environmental Combination	Total Disturbed Area (ha)	Percent with Emergent Vegetation
Lacustrine, Deep Dry Mineral	6.3	6.0
Lacustrine, Veneer Bog on Slope	6.2	3.3
Lacustrine, Veneer Bog	8.5	6.4
Lacustrine, Blanket Bog	10.1	4.4
Riverine, Veneer Bog on Slope	6.6	7.5
All	*37.8*	*5.5*



Map 3-2: **Vegetation structure of habitat surrounding the undisturbed portions of sample locations in 2022 and 2023 for northern portions of the hydraulic zone of influence**



Map 3-3: Vegetation structure of habitat surrounding the undisturbed portions of sample locations in 2022 and 2023 for southern portions of the hydraulic zone of influence

3.3 TRANSECT CHARACTERISTICS FROM GROUND SURVEYS

3.3.1 ENVIRONMENT AND SOILS

3.3.1.1 UNDISTURBED SECTION OF TRANSECTS

Over the 52 transects, 156 10 m X 10 m environment quadrats were sampled.

Quadrat slope varied from 0% to 19%, with 68% of the quadrats having a slope of 3% or less. On average, slope was highest in the Lacustrine, Blanket Bog environmental combination, followed by the Lacustrine, Veneer Bog environmental combinations (Table 3-6). For slope position (Figure 2-2), lower slopes made up the largest proportion of position in all the environmental combinations except for Lacustrine, Veneer Bog on Slope, where mid-slopes were the most frequent (Table 3-7). The Lacustrine, Blanket Bog locations were the only locations where the flat position did not occur in any of the undisturbed quadrats.

Table 3-6: Average of sample location slope in the undisturbed portion of transects by environmental combination, 2022 and 2023

Environmental Combination	N	Average Slope (%)	Standard Error
Lacustrine, Deep Dry Mineral	5	1.8	0.6
Lacustrine, Veneer Bog on Slope	5	3.2	0.7
Lacustrine, Veneer Bog	6	3.9	1.6
Lacustrine, Blanket Bog	5	4.5	1.4
Riverine, Veneer Bog on Slope	5	2.0	0.8
All	26	3.1	0.5

Table 3-7: Slope position of environment quadrats in 2022 and 2023

Position	Percent of quadrats				
	Lacustrine Deep Dry Mineral	Lacustrine Veneer Bog on Slope	Lacustrine Veneer Bog	Lacustrine Blanket Bog	Riverine Veneer Bog on Slope
Crest	13.3	3.3	-	6.7	-
Upper	13.3	13.3	11.1	3.3	6.7
Mid	6.7	43.3	30.6	20.0	20.0
Lower	50.0	36.7	33.3	70.0	43.3
Flat	16.7	3.3	25.0	-	23.3
Depression	-	-	-	-	6.7
Total number of quadrats	*30*	*30*	*36*	*30*	*30*

Soil data collection included 104 full soil pits (two at each transect) and 218 auger pits, for a total of 322 soil profiles. Average surface organic matter thickness ranged from 4.8 cm to 69.2 cm across the locations. The environmental combination with the lowest organic matter thickness was Lacustrine, Deep Dry Mineral at 6.4 cm on average across the locations, and the thickest was Lacustrine, Blanket Bog at 54.5 cm on average (Table 3-8).

Moisture regime differed for the soil profiles depending on the environmental combination. For Lacustrine, Deep Dry Mineral locations, Fresh moisture regimes were the most frequent (Table 3-9) with moderately well to well drained soils (Table 3-10). Locations in that environmental combination had the widest variety of moisture regimes, from Dry to Moderately Wet. All soil profiles in the Lacustrine, Blanket Bog environmental combination had Very Poorly drained, Moderately Wet to Very Wet moisture regimes. The combinations with veneer bog or veneer bog on slope all had soil profiles with predominantly Moderately Wet to Very Wet moisture regimes, but where organic substrates were thin enough, some Fresh or Moderately Fresh moisture regimes were present (Table 3-9).

Table 3-8: Average of sample location surface organic matter thickness by environmental combination in 2022 and 2023

Environmental Combination	N	Average Surface Organic Matter Thickness (cm)	Standard Error
Lacustrine, Deep Dry Mineral	5	6.4	0.8
Lacustrine, Veneer Bog on Slope	5	32.7	7.5
Lacustrine, Veneer Bog	6	42.8	5.5
Lacustrine, Blanket Bog	5	54.5	4.6
Riverine, Veneer Bog on Slope	5	39.1	4.2
All	26	35.4	3.8

Table 3-9: Soil moisture regime during the first year of Project operation in 2022 and 2023

Moisture Regime	Percent of soil profiles				
	Lacustrine Deep Dry Mineral	Lacustrine Veneer Bog on Slope	Lacustrine Veneer Bog	Lacustrine Blanket Bog	Riverine Veneer Bog on Slope
Dry	3.2	-	-	-	-
Moderately dry	1.6	-	-	-	-
Moderately fresh	19.0	-	-	-	1.7
Fresh	69.8	36.5	7.9	-	1.7
Moderately moist	3.2	-	-	-	-
Very moist	1.6	-	-	-	-
Moderately wet to very wet	1.6	63.5	92.1	100.0	96.7
Total number of soil profiles	*63*	*63*	*76*	*60*	*60*

Table 3-10: Soil drainage regime during the first year of Project Operation in 2022 and 2023

Drainage regime	Percent of soil profiles				
	Lacustrine Deep Dry Mineral	Lacustrine Veneer Bog on Slope	Lacustrine Veneer Bog	Lacustrine Blanket Bog	Riverine Veneer Bog on Slope
Very rapid	3.2	-	-	-	-
Well	27.0	9.5	-	-	-
Moderately well	68.3	27.0	7.9	-	3.3
Very poor	1.6	63.5	92.1	100.0	96.7
Total number of soil profiles	*63*	*63*	*76*	*60*	*60*

3.3.1.2 DISTURBED SECTION OF TRANSECTS

The disturbed section of the transects varied in length from 5 m to 100 m. On average, transects were longest in the Lacustrine, Veneer Bog environmental combination (53.9 m), followed by Lacustrine, Blanket Bog (48.6 m).

Transect slope varied depending on the location and environmental combination. On average, the overall percent slope of the disturbed section of transects was highest (7.5%) for Lacustrine, Deep Dry Mineral locations (Table 3-11). Slope was lowest on average for the Lacustrine, Blanket Bog locations (3.3%).

As a percentage of transect length where present, the most abundant surface substrate type along the disturbed section of the transects for all environmental combinations was organic material (Table 3-12). Mineral substrates were most abundant at the Lacustrine, Deep Dry Mineral locations, mostly comprised of clay (34.2%), and less frequently sand (7.6%).

Table 3-11: Average of sample location slope in the disturbed portion of transects by environmental combination in 2022 and 2023

Environmental Combination	N	Average Percent Slope	Standard Error
Lacustrine, Deep Dry Mineral	5	7.5	3.1
Lacustrine, Veneer Bog on Slope	5	3.9	1.5
Lacustrine, Veneer Bog	6	3.5	1.5
Lacustrine, Blanket Bog	5	3.3	2.2
Riverine, Veneer Bog on Slope	5	4.0	0.9
All locations	*26*	*4.4*	*0.9*

Table 3-12: Surface substrate material type presence along disturbed sections of transects by environmental combination as a percentage of total transect length in 2022 and 2023

Environmental Combination	Total Transect Length (m)	Percent of Transects with Substrate Type[1]			
		Organic	Clay	Sand	Stone
Lacustrine, Deep Dry Mineral	238.8	87.1	34.2	7.6	-
Lacustrine, Veneer Bog on Slope	419.0	100.0	-	-	-
Lacustrine, Veneer Bog	647.4	94.2	8.1	-	0.4
Lacustrine, Blanket Bog	486.0	100.0	-	-	-
Riverine, Veneer Bog on Slope	348.8	100.0	2.3	-	-

Notes: [1] The sum of rows may exceed 100% because more than one substrate type may be present in the same quadrat.

3.3.2 VEGETATION

Taxa recorded in the low vegetation belt included 113 vascular plants, five mosses, four lichens, and 28 broader taxa (see Appendix1, Table 6-2 for full species list).

3.3.2.1 UNDISTURBED SECTION OF TRANSECTS

Five tree species were recorded within the tree belt across all sample locations (Table 3-13). Black spruce (*Picea mariana*) trees made up approximately 68% of the live stems tallied. Black spruce accounted for 83% to 98% of the stems tallied in each of the environmental combinations except for the Lacustrine, Deep Dry Mineral locations, where it accounted for 6% of the stems. There, 91% of the stems were trembling aspen (*Populus tremuloides*), with white birch (*Betula papyrifera*) and balsam poplar (*Populus balsamifera*) making up the remaining stems. Tamarack (*Larix laricina*) made up 6% to 12% of the total stems at all environmental combinations except Lacustrine, Deep Dry Mineral and Riverine, Veneer Bog on Slope, where the species was absent. Average tree height ranged from 1.5 m to 7.4 m across all sampled locations.

Black spruce was also the most abundant snag species by far, making up over 75% of the snags in all environmental combinations, except Lacustrine, Blanket Bog, where 68% of the snags could not be identified to species (Table 3-13).

Black spruce saplings and seedlings made up more than 90% of total tree recruitment in all environmental combinations (Table 3-14). Trembling aspen was the only other species that made up part of the tree recruitment in all the environmental combinations. Tamarack made up 1% to 3% of the recruitment in all environmental combinations except Lacustrine, Deep Dry Mineral and Riverine, Veneer Bog on Slope.

Table 3-13: Tree and snag species within the tree belt at locations sampled in 2022 and 2023 by environmental combination

Species	Percent of stems									
	Lacustrine Deep Dry Mineral		Lacustrine Veneer Bog on Slope		Lacustrine Veneer Bog		Lacustrine Blanket Bog		Riverine Veneer Bog on Slope	
	Tree	Snag	Tree	Snag	Tree	Snag	Tree	Snag	Tree	Snag
Paper birch	2.5	-	2.7	-	-	-	-	-	-	-
Tamarack	-	2.6	12.0	3.7	5.9	4.8	8.5	1.8	-	-
Black spruce	5.9	92.3	82.7	96.3	93.8	76.2	91.5	29.8	98.5	89.8
Balsam poplar	1.0	-	-	-	-	-	-	-	1.5	-
Trembling aspen	90.7	-	2.7	-	0.3	-	-	-	-	-
Unknown	-	5.1	-	-	-	19.0	-	68.4	-	10.2
Total stems	*526*	*39*	*75*	*54*	*676*	*42*	*448*	*57*	*133*	*59*

Table 3-14: Tree recruitment species counts within the undisturbed portion of the shrub belt over all transects sampled as a percentage of total stems tallied by environmental combination in 2022 and 2023

Species and Growth Stage	Percent of Stems				
	Lacustrine Deep Dry Mineral	Lacustrine Veneer Bog on Slope	Lacustrine Veneer Bog	Lacustrine Blanket Bog	Riverine Veneer Bog on Slope
White birch sapling	0.4	0.6	-	-	0.1
White birch seedling	0.7	-	-	-	0.1
Tamarack sapling	-	0.2	0.1	0.2	-
Tamarack seedling	-	1.6	3.3	0.9	-
Black spruce sapling	21.0	21.4	20.8	10.9	8.9
Black spruce seedling	69.9	75.0	75.6	87.4	89.3
Jack pine sapling	1.2	-	0.1	0.0	-
Jack pine seedling	1.9	-	-	-	-
Balsam poplar sapling	-	0.1	-	-	0.3
Balsam poplar seedling	0.9	-	-	-	0.2
Trembling aspen sapling	0.3	0.7	-	0.1	0.3
Trembling aspen seedling	3.6	0.2	0.1	0.5	0.8
Total stems	*667*	*804*	*1,600*	*3,444*	*1,817*

Twenty-one tall shrub species were recorded in the tall shrub belt of the undisturbed section across all locations (Table 3-15). Depending on the environmental combination, Prickly rose (*Rosa acicularis*), green alder (*Alnus alnobetula*), and plane-leaved willow (*Salix planifolia*) were the most abundant species. Prickly rose was the most abundant in the Lacustrine Deep Dry Mineral and Veneer Bog on Slope combinations, while green alder was one of the two most abundant species in all the combinations except Lacustrine, Blanket Bog. Plane-leaved willow was the most abundant species in the Lacustrine, Blanket Bog and Riverine, Veneer Bog on Slope combinations.

Table 3-15: Tall shrub stem counts within the tall shrub belt on the undisturbed portion of the transects sampled in 2022 and 2023 by environmental combination

Species	Common name	Percent of stems				
		Lacustrine Deep Dry Mineral	Lacustrine Veneer Bog on Slope	Lacustrine Veneer Bog	Lacustrine Blanket Bog	Riverine Veneer Bog on Slope
Alnus incana	Speckled alder	-	-	1.5	3.5	7.0
Alnus viridis	Green alder	22.1	30.2	29.2	0.7	23.4
Betula pumila	Bog birch	-	9.3	3.3	9.3	12.0
Cornus sericea	Dogwood	-	-	-	-	4.7
Juniper communis	Common juniper	0.3	-	-	-	-
Rhamnus alnifolia	Alder-leaved buckthorn	0.5	0.4	-	-	-
Ribes americanum	Wild black currant	-	0.1	-	-	0.3
Ribes oxyacanthoides	Canada wild gooseberry	-	0.6	-	-	-
Ribes triste	Wild red currant	0.1	-	-	-	-
Rosa acicularis	Prickly rose	59.4	31.9	20.4	-	7.6
Rubus idaeus	Red raspberry	0.5	-	-	-	-
Salix arbusculoides	Shrubby willow	-	3.4	-	-	-
Salix bebbiana	Bebb's willow	4.2	15.4	6.3	5.8	8.3
Salix candida	Hoary willow	-	-	-	-	0.7
Salix glauca	Smooth willow	-	-	4.7	-	6.5
Salix pellita	Satin willow	-	-	-	-	2.5
Salix planifolia	Plane-leaved willow	-	2.7	24.1	80.7	24.7
Salix pseudomonticola	False Mountain Willow	-	-	-	-	1.8
Salix pseudomyrsinites	Myrtle-leaved willow	-	-	-	-	-
Shepherdia canadensis	Soapberry	8.0	-	10.2	-	-
Viburnum edule	Mooseberry	4.8	5.9	0.4	-	0.6
Total stems		*3,327*	*1,359*	*1,687*	*548*	*1,696*

In the undisturbed section of the transects, 34 taxa (Table 3-16) were found to be widely distributed in at least one of the environmental combinations (see Table 2-9 for class definitions).

Black spruce was the only species that was very widespread in all the combinations. Four species were at least widespread in all four of the combinations sampled in 2022 and 2023.

The taxa that were widely distributed in all of the environmental combinations included black spruce sapling and seedling (Photo 3-1), Labrador-tea (*Rhododendron groenlandicum*) (Photo 3-2), bog whortleberry (*Vaccinium uliginosum*; Photo 3-3), and bog cranberry (*Vaccinium vitis-idaea*; Table 3-16).

The environmental combination with the largest number of widely distributed taxa was the Riverine Veneer Bog on Slope type (Table 3-16).

Table 3-16: Widely distributed taxa by environmental combination for the undisturbed portions of locations sampled in 2022 and 2023

Distribution	Lacustrine Deep Dry Mineral	Lacustrine Veneer Bog on Slope	Lacustrine Veneer Bog	Lacustrine Blanket Bog	Riverine Veneer Bog on Slope
Very Widespread	Fireweed Bunchberry Black Spruce Prickly Rose	Dwarf Scouring-rush Ground mosses Black Spruce Labrador-tea Myrtle-leaved Willow Bog Whortleberry Bog Cranberry	Cup lichens Ground mosses Frog's pelt species Black Spruce Labrador-tea Bog Whortleberry Bog Cranberry	Green Reindeer Lichen Cup lichens Woodland Horsetail Bog-laurel Gound mosses Black Spruce Labrador-tea Sphagnum moss Small Cranberry Bog Cranberry	Sheathed Sedge Green Reindeer Lichen Ground mosses Black Spruce Labrador-tea Bebb's or Beaked Willow Myrtle-leaved Willow Plane-leaved Willow Sphagnum moss Bog Whortleberry
Widespread	Aster species Grasses Tall Lungwort Ground mosses Palmate-leaved Colt's-foot Trembling Aspen Labrador-tea Red Raspberry Bebb's or Beaked Willow Bog Whortleberry Bog Cranberry	Fireweed Green Reindeer Lichen Cup lichens Bunchberry Field Horsetail Northern Comandra Sphagnum moss	Green Reindeer Lichen Round-leaved Sundew Woodland Horsetail Grasses Bog-laurel Cloudberry Sphagnum moss Small Cranberry	Water Sedge Three-leaved Solomon's-seal Cloudberry Bog Whortleberry	Bluejoint Reedgrass Fireweed Cup lichen Litter Stemless raspberry Small cranberry Bog cranberry

Photo 3-1: Black spruce seedlings growing at LTESKNO4A on August 6, 2023

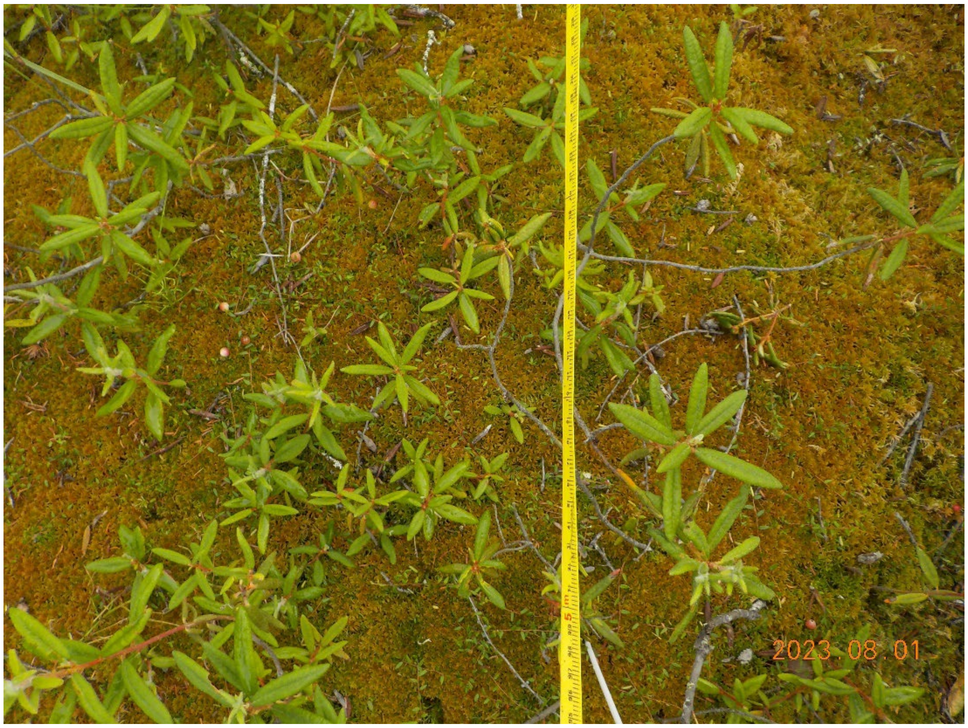


Photo 3-2: Labrador-tea growing at LTESKSO4A on August 1, 2023

Photo 3-3: Bog whortleberry growing on July 29, 2023

3.3.2.2 DISTURBED SECTION OF TRANSECTS

In the disturbed section of the transects (Table 3-17), tree recruitment (seedlings and saplings) included the same six pseudospecies as in the undisturbed portion. Black spruce seedlings and saplings were the most abundant pseudospecies in the tree recruitment layer by far, making up more than 93% of the stems in all but the Lacustrine Deep Dry Mineral environmental combination. In the Lacustrine Deep Dry Mineral combination locations, recruitment from all the other species except tamarack accounted for 3% or more of the stems.

Table 3-17: Tree recruitment species counts within the disturbed portion of the shrub belt over all transects sampled as a percentage of total stems tallied by environmental combination in 2022 and 2023

Species and Growth Stage	Percent of Stems				
	Lacustrine Deep Dry Mineral	Lacustrine Veneer Bog on Slope	Lacustrine Veneer Bog	Lacustrine Blanket Bog	Riverine Veneer Bog on Slope
White birch sapling	3.2	-	-	-	4.4
Tamarack sapling	-	0.7	-	0.7	-
Tamarack seedling	-	1.4	0.9	0.2	-
Black spruce sapling	14.9	46.9	28.1	3.8	-
Black spruce seedling	62.8	50.5	67.6	95.3	93.4
Jack pine sapling	4.3	-	-	-	-
Balsam poplar sapling	3.2	-	1.1	-	-
Balsam poplar seedling	-	-	0.9	-	-
Trembling aspen sapling	5.3	0.4	0.2	-	0.7
Trembling aspen seedling	6.4	-	1.1	-	1.5
Total stems	*94*	*277*	*448*	*548*	*137*

Fifteen tall shrub taxa were recorded in the tall shrub belt of the disturbed section across all locations (Table 3-18). Plane-leaved willow was the most abundant tall shrub in the Lacustrine Veneer Bog on Slope, Veneer Bog, and Blanket Bog combinations in the disturbed sections. Prickly rose was the most abundant in the Lacustrine, Deep Dry Mineral combination, and red osier dogwood (*Cornus sericea*) was the most abundant in the Riverine Veneer Bog on Slope combination. Bebb's willow (*Salix bebbiana*) was the second most abundant tall shrub in the Lacustrine, Deep Dry Mineral and Lacustrine, Veneer Bog on Slope combinations.

Table 3-18: Tall shrub stem counts within the tall shrub belt on the undisturbed portion of the transects sampled in 2022 and 2023 by environmental combination

Species	Common name	Percent of stems				
		Lacustrine Deep Dry Mineral	Lacustrine Veneer Bog on Slope	Lacustrine Veneer Bog	Lacustrine Blanket Bog	Riverine Veneer Bog on Slope
Alnus incana	Speckled alder	-	6.7	4.5	-	0.5
Alnus viridis	Green alder	12.8	11.7	9.4	-	6.2
Betula pumila	Bog birch	-	11.7	2.9	13.4	4.6
Cornus sericea	Dogwood	-	-	-	-	36.2
Rhamnus alnifolia	Alder-leaved buckthorn	7.5	-	-	-	2.5
Ribes americanum	Wild black currant	-	-	-	-	1.2
Rosa acicularis	Prickly rose	41.5	6.1	16.3	-	7.9
Salix bebbiana	Bebb's willow	30.1	24.4	8.0	3.0	4.3
Salix candida	Hoary willow	-	-	-	-	-
Salix glauca	Smooth willow	-	-	5.3	-	2.0
Salix planifolia	Plane-leaved willow	0.1	39.5	50.7	83.5	18.9
Salix pseudomyrsinites	Myrtle-leaved willow	-	-	-	-	15.6
Salix spp	Unidentified willow	0.3	-	-	-	-
Shepherdia canadensis	Soapberry	6.3	-	2.9	-	-
Viburnum edule	Smooth willow	1.5	-	-	-	-
Total stems		*750*	*660*	*935*	*231*	*834*

In the disturbed section of the transects, 26 taxa were widely distributed in at least one of the environmental combinations (Table 3-19). None of the taxa were widely distributed in all five environmental combinations, and only three taxa were widely distributed across four of the combinations.

The taxa that were widely distributed in four of the combinations included black spruce, Labrador-tea and bog whortleberry. Unidentified moss species were also widely distributed in four environmental combinations, but that includes multiple different species. In the Lacustrine Deep Dry Mineral type, the only very widespread species was fireweed (*Chamaenerion angustifolium*).

The environmental combination with the largest number of widely spread taxa was Lacustrine Blanket Bog (Table 3-19).

Table 3-19: Widely distributed taxa by environmental combination for the disturbed portions of locations sampled in 2022 and 2023

Distribution	Lacustrine Deep Dry Mineral	Lacustrine Veneer Bog on Slope	Lacustrine Veneer Bog	Lacustrine Blanket Bog	Riverine Veneer Bog on Slope
Very Widespread	Fireweed	Duckweed Ground mosses Labrador-tea Bog Whortleberry	Ground mosses Black Spruce Labrador-tea	Green Reindeer Lichen Cup lichens Gound mosses Black Spruce Labrador-tea Sphagnum moss Bog Cranberry	Bluejoint Reedgrass Gound mosses Plane-leaved Willow Bog Whortleberry
Widespread	Duckweed Twinflower Palmate-leaved Colt's-foot Black Spruce Prickly Rose Bebb's or Beaked Willow	Sheathed Sedge Fireweed Green Reindeer Lichen Cup lichens Black Spruce Bog Cranberry	Round-leaved Sundew Dwarf Scouring-rush Plane-leaved Willow Sphagnum moss Small Cranberry Bog Whortleberry Bog Cranberry	Water Sedge Hoary Sedge Marsh Willowherb Woodland Horsetail Small Bedstraw Cloudberry Small Cranberry Bog Whortleberry	Labrador-tea Sphagnum moss

3.4 TRANSECT HOMOGENEITY

Overall vegetation structure was patchy at the sample locations, largely because the areas sampled were regenerating from recent wildfires in 2013 and 2005. For segments at each transect, the number of structure types was either one or two (Appendix 2, Table 6-3). The variability appeared to reflect the patchy nature of regeneration at the transect scale at the locations. Where more than one structure type occurred, it was due to the relative foliage cover for different vegetation types falling close to the threshold to classify that type.

Tree species composition was similar in segments at the transects in each location, with respect to both overstorey trees (Appendix 2, Table 6-4) and tree recruitment (Appendix 2, Table 6-5). Overstorey tree cover was variable, as many of the locations had been burned within the past ten years (i.e., 2013). Where it was present, black spruce was the leading overstorey tree species at all locations. The exceptions were one location in the Lacustrine, Deep Dry Mineral environmental combination (NO1A), where a mixture of broadleaf species formed the overstorey cover in all segments of both transects, and one location in the Lacustrine, Veneer Bog on Slope combination, where the few tree stems present were either tamarack or trembling aspen. There was no substantive difference between segments within transects at each location with respect to the composition and abundance of tree recruitment (Appendix 2, Table 6-5).

Average organic substrate thickness was variable in segments within and between the two transects at each of the locations (Appendix 2,Table 6-6 and Figure 6-1). In general, between segment variability was greater at locations that generally had thicker organic substrates, however this variability was characteristic of natural conditions for those ecosite types. At most of the locations, average organic substrate thickness was similar both within and between the paired transects and fell within the range expected for the environmental combination. There were two exceptions to this. The first was location SO2B in the Lacustrine, Veneer Bog on Slope combination, where the average organic substrate thickness was under 9.3 cm for transect one, and more than 35.3 cm for transect two. Similarly, at location SE3B in the Lacustrine, Veneer Bog combination, average organic substrate thickness was 10.7 cm and 26.5 cm for transects one and two, respectively. Despite the differences in organic substrate thickness, the vegetation composition was almost identical between transects at both locations.

With respect to site type, 38 of the 52 transect sampled had identical site types for all soil profiles (Appendix 2, Table 6-7). All transects at locations within the Lacustrine, Veneer Bog and Blanket Bog combinations had a single site type, and only one location in the former combination (SE3B) had transects with different site types, which was due to the difference in organic substrate thickness. In the remaining environmental combinations, site type differences were generally due to differences in mineral soil depth (over bedrock), and slight difference in moisture regime or organic substrate thicknesses, and the majority of soil profiles fell within a single site type.

3.5 PLANTS OF ECOLOGICAL CONCERN

No MESA, SARA or COSEWIC listed plant species (see Appendix 1, Table 6-1 for potential species) or provincially critically imperiled or imperiled (S1 or S2 rank) plant species were found along any of the shore zone sample transects in 2022 or 2023. Additionally, none of these species were incidentally found during the fieldwork.

One American milkvetch (*Astragalus americanus*) plant and one shrubby willow (*Salix arbusculoides;* Photo 3-4), both provincially imperiled to vulnerable species (S2S3), as well as two rock willow (*Salix vestita*; Photo 3-5) plants, a provincially vulnerable species (S3), were found at or near sample transects. None of the remaining provincially critically imperiled to vulnerable species that had been identified in the EIS (KHLP 2012a) were found along the transects, or incidentally during the 2022 or 2023 surveys.

Photo 3-4: Shrubby willow growing at LRK22SS21 on August 24, 2022

Photo 3-5: Rock willow growing at LRK22SS21 on August 24, 2022

No Level 1 or 2 (highest concern) non-native invasive species were recorded along any of the Long-Term Effects on Wetland Habitat transects, or incidentally during surveys in 2022 and 2023. Two non-native species were recorded on the transects. Dandelion (*Taraxacum officinale*; concern level 3) and common plantain (*Plantago major*; concern level 4) were recorded at one location each.

4.0 DISCUSSION

The purposes of the Long-Term Effects on Wetland Habitat monitoring in 2022 and 2023 were to establish permanent sample locations and to collect the baseline data needed to evaluate long-term effects in subsequent surveys.

To identify potential Project effects in the analysis of change over time, it was important that conditions within a transect and across transects within a sample location were similar. Between-transect heterogeneity would either reduce the statistical power of change analysis or initiate a more complex analysis method.

Based on mapping from the drone imagery and transect data, variation in vegetation structure, substrate conditions and vegetation composition within and between the transects, as well as within environmental combinations were generally small. Also, conditions at the locations within the different environmental combinations were reflective of what was expected for the ecosite type.

There were two possible exceptions to the above. First, all the locations in the Lacustrine, Blanket Bog environmental combination had an average organic substrate thickness and slope that differed substantially from what was expected for a blanket bog. The second exception was that at two locations, the paired transects differed substantially with respect to average organic substrate thickness.

With respect to the first exception, the blanket bog ecosite is characterized as having a level, featureless surface, with a surface organic layer thickness typically between 100 cm and 200 cm with discontinuous ground ice. Transect data found that the locations in this environmental combination had the highest slope on average (although still a low slope at 4.5%). And while the average organic layer thickness for that environmental combination was the highest, it was well below 100 cm at 54.5 cm. Despite the difference, the maximum thickness was below 40 cm at both locations, and the vegetation cover at both locations did not differ in any substantive way. In the next annual report, the species composition of the vegetation layers will be compared to what typically occurs for the ecosite type.

Although the ecosite conditions differ from the criteria used to create the pre-impoundment habitat map, they were not surprising given that the scale of the habitat map allows for some considerable small patch variations within a given map polygon. That is, it is understood that a blanket bog map polygon can include localized patches of discordant ecosites such as deep, dry mineral, veneer bog or bedrock outcrop. Additionally, due to the deep organic substrate, water from the reservoir impoundment will permeate through the peat until it reaches an impermeable barrier, usually the mineral substrate. In blanket bogs, this will typically be near the edge of the mapped ecosite boundary, where the ecosite is transitioning to one of shallower peat, and the underlying mineral layer has risen to the new water elevation. The undisturbed portions of the subject transects are occurring in this transitional area of the map polygon. These locations will be reclassified to the Lacustrine, Veneer Bog on Slope combination for future analyses.

Given the above conditions, it was expected that the substrate slope will be much lower in the disturbed inundated portions of the transects for the Lacustrine, Blanket Bog environmental combination compared to other combinations. Slope data from the transects confirmed this to be the case, as the average disturbed transect slope was lowest for the blanket bog locations (3.3%). Average slope was even lower (1.2%) when excluding one location (SW4A), which was an apparent outlier. The inundated area at that location appeared to coincide with a narrow channel that was present prior to inundation.

Results from the baseline data collection did not identify any reasons to modify the study design or any of the sample locations with the two possible exceptions. For locations SO2B and SE3B, there was a substantial between-transect difference for a single attribute. For the remaining attributes, there were no substantive differences. The implications of this difference will be further evaluated prior to the 2024 field sampling to determine if any of the transects should be moved and re-sampled. Overall, the descriptive analysis results confirmed that the locations selected for monitoring long-term effects on inland wetland habitat met the study design criteria.

5.0 SUMMARY AND CONCLUSIONS

The Long-Term Effects on Wetland Habitat study is monitoring the nature of long-term Project effects on wetland function during operation. This study is documenting indirect Project effects on shoreline and offshore wetlands within the Project's hydraulic zone of influence. This report describes the methods used to establish the permanent sample locations in the shore zone, and provides an overview of the habitat attributes at these locations.

The shore zone component of this study conducts periodic surveys at permanent sample locations along the shoreline in the Project's hydraulic zone of influence. Permanent sample locations are a stratified, random sample of the shore zone habitat types based on preliminary mapping of the 2021 post-impoundment terrestrial habitat shoreline. Twenty-six permanent sample locations were established, and baseline data were collected in 2022 and 2023. A total of 56 transects (two per location) were sampled in five different combinations of environmental conditions, resulting in a minimum of five replicates for each combination. The sampled environmental combinations were Lacustrine, Deep Dry Mineral; Lacustrine Veneer Bog on Slope; Lacustrine, Veneer Bog; Lacustrine, Blanket Bog; and Riverine, Veneer Bog on Slope.

Drone-based mapping of habitat in a 140 m wide band along the transects found that a mixture of low and tall shrub structure types made up most of the undisturbed area. The majority (98%) of the disturbed area at the locations was inundated by the reservoir, with the remaining disturbed area being cleared, as part of the reservoir clearing prior to inundation. Patches of emergent vegetation were present over 3.3% to 7.5% of the mapped disturbed area, depending on the environmental combination.

Across the locations and environmental combinations, average slope variation in the undisturbed portion of the transects was generally low, ranging from 1.8% to 4.5% on average. Slope in the disturbed portion of the transects ranged from 3.3% to 7.5%. Average organic substrate thickness varied, reflecting the shoreline ecosite type for the location.

To identify potential Project effects in the analysis of change over time, high within transect or between transect homogeneity would either reduce the statistical power of change analysis or initiate a more complex analysis method. Evaluation of within transect and within location homogeneity determined that the selection criteria were met with one possible exception. Paired transects at two locations were substantially different with respect to a single attribute (thickness of organic substrate). These locations will be further evaluated prior to 2024 sampling to determine if a new transect should be established. Results from the baseline data collection did not identify any reasons to modify the study design or any of the sample locations.

Black spruce was by far the most recorded species for trees and snags. Also, black spruce seedlings and saplings accounted for most of the tree recruitment. Depending on environmental combination, the most abundant tall shrub species were green alder, prickly rose and plane-leaved willow in the undisturbed section of the transects, and plane-leaved willow or Bebb's willow in the disturbed sections.

A total of 34 plant taxa were found to be very widely or widely distributed in at least one environmental combination in the undisturbed section of the transects. The most widespread taxa were black spruce, Labrador-tea, bog whortleberry, and bog cranberry. In the disturbed section of the transects, 26 taxa were widely distributed in at least one environmental combination. The most widespread taxa were black spruce, Labrador-tea, and bog whortleberry.

No plant species of very high conservation concern (i.e., MBCDC ranked S1 or S2) were recorded either on the transects or incidentally during fieldwork.

None of the non-native species of highest invasive concern were recorded along any of the transects, or incidentally during surveys.

The second year of sampling for the Long-term Effects on Wetland Habitat study will take place in summer, 2024, to document conditions during the third year of Project operation. All of the baseline locations will be re-sampled.

6.0 LITERATURE CITED

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APPENDIX 1:
SPECIES LISTS

Table 6-1: SARA, COSEWIC and MESA Listed endangered species which occur in Manitoba

Species	Common Name	SARA	COSEWIC	MESA
Endangered				
Agalinis aspera	Rough agalinis	X	X	X
Agalinis gattingeri	Gattinger's agalinis	X	X	X
Chenopodium subglabrum	Smooth goosefoot			X
Cypripedium candidum	Small white lady's-slipper	X		X
Pellaea gastonyi	Gastony's cliffbrake			X
Platanthera praeclara	Western prairie fringed-orchid	X	X	X
Spiranthes magnicamporum	Great Plains lady's tresses			X
Vernonian fasciculata	Fascicled ironweed	X	X	X
Threatened				
*Bouteloua dactyloides**	Buffalograss			X
Celtis occidentalis	Common hackberry			X
Chenopodium subglabrum	Smooth goosefoot	X	X	
Cypripedium candidum	Small white lady's-slipper		X	
*Dalea villosa**	Prairie clover	X		X
Solidago riddellii	Riddell's goldenrod			X
Symphyotrichum sericeum	Western silvery aster	X	X	X
Tradescantia occidentalis	Western spiderwort	X	X	X
Veronicastrum virginicum	Culver's-root			X
Leptogium rivulare[1]	Flooded jellyskin			

Notes: [1] *Leptogium rivulare* was rated as threatened at the time of the EIS (KHLP 2012b), but has since been adjusted to "special concern".

Table 6-2: List of species and taxa identified on Long Term Effects on Wetland Habitat study transects, including their common name, MBCDC S-rank and the number of transect occurrences in 2022 and 2023

Scientific Name	Common Name	S-Rank	1st survey
Achillea millefolium	Common Yarrow	SNA	3
Agrostis scabra	Rough Bentgrass	S5	2
Alnus alnobetula	Green Alder	S5	20
Alnus incana	Speckled Alder	S5	9
Andromeda polifolia	Bog rosemary	S5	1
Anemonastrum canadense	Canada Anemone	S5	1
Arctostaphylos uva-ursi	Common Bearberry	S5	5
Arctous alpina	Alpine Bearberry	S3S4	17
Aster spp	NA	NA	14
Astragalus americanus	American Milkvetch	S2S3	1
Betula papyrifera	Paper Birch	S5	10
Betula pumila	Bog Birch	S5	23
Bidens cernua	Nodding Beggarticks	S5	5
Calamagrostis canadensis	Bluejoint Reedgrass	S5	36
Calla palustris	Wild Calla	S5	11
Caltha palustris	Marsh Marigold	S5	1
Campanula aparinoides	Marsh Bellflower	S5	1
Carex aquatilis	Water Sedge	S5	27
Carex bebbii	Bebb's Sedge	S5	1
Carex canescens	Hoary Sedge	S5	13
Carex chordorrhiza	Creeping Sedge	S4S5	3
Carex concinna	Northern Elegant Sedge	S4S5	6
Carex foenea	Bronze Sedge	S5	2
Carex gynocrates	Northern Bog Sedge	S5	1
Carex scirpoidea	Single-spike Sedge	S4S5	14
Carex spp	NA	NA	13
Carex utriculata	Northern Beaked Sedge	S5	1
Carex vaginata	Sheathed Sedge	S5	23
Chamaedaphne calyculata	Leather-leaf	S5	4
Chamaenerion angustifolium	Fireweed	S5	37
Cicuta bulbifera	Bulb-bearing Water-hemlock	S5	11
Cicuta maculata	Spotted Water-hemlock	S4S5	3
Cladonia arbuscula ssp. mitis	Green Reindeer Lichen	S4	39
Cladonia rangiferina	Gray Reindeer Lichen	S5	12
Cladonia spp	NA	NA	42
Cladonia stellaris	Star-tipped Reindeer Lichen	S5	6
Comarum palustre	Marsh Cinquefoil	S5	10

Scientific Name	Common Name	S-Rank	1st survey
Cornus canadensis	Bunchberry	S5	26
Cornus sericea	Red-osier Dogwood	S5	2
Deschampsia cespitosa	Tufted Hairgrass	S4S5	1
Diphasiastrum complanatum	Northern Ground-cedar	S3S4	2
Drosera rotundifolia	Round-leaved Sundew	S4S5	16
Eleocharis palustris	Creeping Spikerush	S5	1
Empetrum nigrum	Black Crowberry	S5	9
Endotropis alnifolia	Alder-leaved Buckthorn	S5	3
Epilobium ciliatum	Hairy Willow-herb	S5	2
Epilobium palustre	Marsh Willowherb	S5	16
Equisetum arvense	Field Horsetail	S5	21
Equisetum scirpoides	Dwarf Scouring-rush	S4S5	31
Equisetum spp	NA	NA	1
Equisetum sylvaticum	Woodland Horsetail	S5	33
Fragaria virginiana	Smooth Wild Strawberry	S5	6
Galium trifidum	Small Bedstraw	S5	10
Galium triflorum	Sweet-scented Bedstraw	S5	1
Gentiana spp	NA	NA	1
Geocaulon lividum	Northern Comandra	S5	21
Glyceria spp	NA	NA	1
Grass spp	NA	NA	23
Hylocomium splendens	Stairstep Moss	S4S5	10
Icmadophila ericetorum	Candy Lichen	S5	5
Impatiens capensis	Spotted Jewelweed	S5	1
Iris versicolor	Harlequin Blue Flag	S3S4	2
Juniperus communis	Common Juniper	S5	4
Kalmia polifolia	Bog-laurel	S5	28
Larix laricina	Tamarack	S5	17
Lathyrus ochroleucus	Pale Vetchling	S5	3
Lathyrus palustris	Marsh Vetchling	S5	3
Lemna spp	NA	NA	23
Lichen spp	NA	NA	6
Linnaea borealis	Twinflower	S5	14
Lonicera spp	NA	NA	1
Lonicera villosa	Mountain-fly-honeysuckle	S5	4
Lycopus spp	NA	NA	2
Lysimachia thyrsiflora	Tufted Loosestrife	S5	1
Maianthemum trifolium	Three-leaved Solomon's-seal	S5	15
Marchantia polymorpha	Green-tongue Liverwort	S3	4
Menyanthes trifoliata	Bogbean	S5	3

Scientific Name	Common Name	S-Rank	1st survey
Mertensia paniculata	Tall Lungwort	S5	7
Mitella nuda	Mitrewort	S5	8
Moss spp	NA	NA	49
Orthilia secunda	One-sided Wintergreen	S5	2
Oryzopsis asperifolia	White-grained Mountain-ricegrass	S5	4
Packera paupercula	Balsam Groundsel	S5	2
Parnassia palustris	Marsh Grass of Parnassus	S5	4
Peltigera spp	NA	NA	24
Persicaria amphibia	Water Smartweed	S5	2
Petasites frigidus var. palmatus	Palmate-leaved Colt's-foot	S5	17
Picea mariana	Black Spruce	S5	52
Pinus banksiana	Jack Pine	S5	3
Plantago major	Common Plantain	SNA	1
Platanthera spp	NA	NA	1
Pleurozium schreberi	Red-stemmed Feather Moss	S4S5	17
Polytrichum juniperinum	Juniper Haircap Moss	S4S5	10
Polytrichum strictum	Bog Haircap Moss	S4S5	2
Populus balsamifera	Balsam Poplar	S5	3
Populus tremuloides	Trembling Aspen	S5	16
Potentilla anserina	Silverweed	S5	1
Potentilla norvegica	Rough Cinquefoil	S5	9
Pyrola spp	NA	NA	9
Ranunculus gmelinii	Small Yellow Water Buttercup	S5	2
Ranunculus spp	NA	NA	4
Rhododendron groenlandicum	Labrador-tea	S5	50
Ribes americanum	Wild Black Currant	S5	2
Ribes glandulosum	Skunk Currant	S5	2
Ribes oxyacanthoides	Canada Wild Gooseberry	S5	2
Ribes triste	Wild Red Currant	S5	5
Rorippa palustris	Bog Yellowcress	S4S5	4
Rosa acicularis	Prickly Rose	S5	24
Rubus arcticus	Stemless Raspberry	S5	17
Rubus chamaemorus	Cloudberry	S5	24
Rubus idaeus	Red Raspberry	S5	8
Rubus pubescens	Dewberry	S5	4
Rumex fueginus	Golden Dock	S4S5	2
Salix arbusculoides	Shrubby Willow	S2S3	1
Salix bebbiana	Bebb's or Beaked Willow	S5	36
Salix candida	Hoary Willow	S5	3
Salix glauca	Smooth Willow	S4	7

Scientific Name	Common Name	S-Rank	1st survey
Salix myrtillifolia	Myrtle-leaved Willow	S5	26
Salix pellita	Satin Willow	S3S4	1
Salix planifolia	Plane-leaved Willow	S5	33
Salix pseudomonticola	False Mountain Willow	S4S5	3
Salix pseudomyrsinites	Myrtle-leaved Willow	S3S5	3
Salix spp	Unidentified Willow	NA	2
Salix vestita	Rock Willow	S3	2
Scutellaria galericulata	Hooded Skullcap	S5	4
Shepherdia canadensis	Soapberry	S5	6
Sium suave	Water-parsnip	S5	4
Solidago hispida	Hairy Goldenrod	S5	3
Solidago spp	Goldenrod	NA	4
Sparganium spp	Burreed	NA	5
Sphagnum spp	Peat moss	NA	37
Spiranthes romanzoffiana	Hooded Ladies'-tresses	S5	2
Symphyotrichum boreale	Boreal Aster	S4S5	1
Symphyotrichum ciliolatum	Lindley's Aster	S5	4
Symphyotrichum laeve	Smooth Aster	S5	1
Taraxacum officinale	Common Dandelion	SNA	1
Utricularia spp	NA	NA	2
Vaccinium myrtilloides	Velvet-leaf Blueberry	S5	1
Vaccinium oxycoccos	Small Cranberry	S5	32
Vaccinium uliginosum	Bog Whortleberry	S5	48
Vaccinium vitis-idaea	Bog Cranberry	S5	47
Viburnum edule	Mooseberry	S5	4
Vicia americana	American Purple Vetch	S5	3
Viola spp	Violet	NA	3

APPENDIX 2: HOMOGENEITY RESULTS

Table 6-3: Number of 10m segment recorded for each vegetation structure in the undisturbed portions of each transect

Environmental Combination	Location	Transect	Forest	Woodland	Tall Shrub	Low Shrub	Bryoid
1	LTESKNO1A	1		2	1		
		2	1		2		
	LTESKNO1B	1			3		
		2			2	1	
	LTESKSE1A	1			1	2	
		2			2	1	
	LTESKSE1B	1			3		
		2			3		
	LTESKSW1A	1			2	1	
		2			2	1	
2	LTESKNO2A	1				3	
		2		2		1	
	LTESKNO2B	1			3		
		2			3		
	LTESKSE2A	1			3		
		2			1	2	
	LTESKSO2B	1			1	2	
		2			2	1	
	LTESKSW2A	1			2	1	
		2			1	2	
3	LTESKNO3A	1			1	2	
		2		1		2	
	LTESKNO3B	1				3	
		2				3	
	LTESKSE3A	1		3			
		2		3			
	LTESKSE3B	1			3		
		2			2	1	
	LTESKSO3A	1				1	2
		2				2	1
	LTESKSW3B	1		3			
		2		3			
4	LTESKNO4A	1				3	
		2				3	
	LTESKSE4A	1				3	
		2				3	
	LTESKSO4A	1				3	

Environmental Combination	Location	Transect	Forest	Woodland	Tall Shrub	Low Shrub	Bryoid
		2				3	
	LTESKSW4A	1				3	
		2				3	
	LTESKSW4B	1		3			
		2		3			
5	LTESKNO5C	1				3	
		2				3	
	LTESKNO5A	1			3		
		2			3		
	LTESKNO5B	1			3		
		2			3		
	LTESKSO5A	1		1	2		
		2		1	2		
	LTESKSO5B	1		1	2		
		2		2	1		

Table 6-4: Overstorey tree composition as percent of the total number of stems tallied by segment for the undisturbed portions of each stand

Environmental Combination	Location	Transect	Seg 1					Seg 2					Seg 3				
			Perc_BA	Perc_BP	Perc_PT	Perc_PM	Perc_LL	Perc_BA	Perc_BP	Perc_PT	Perc_PM	Perc_LL	Perc_BA	Perc_BP	Perc_PT	Perc_PM	Perc_LL
1	LTESKNO1A	1	11	-	89	-	-	-	100	-	-	-	-	-	100	-	-
		2	25	50	25	-	-	-	-	-	-	-	-	-	100	-	-
	LTESKNO1B	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LTESKSE1A	1	-	-	-	-	-	-	-	-	100	-	-	-	-	100	-
		2	-	-	-	100	-	-	-	-	100	-	-	-	-	-	-
	LTESKSE1B	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-
	LTESKSW1A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2	-	-	-	-	-	-	-	-	-	-	-	-	-	100	-
2	LTESKNO2A	1	-	-	-	100	-	-	-	-	100	-	-	-	-	100	-
		2	-	-	-	92	8	-	-	-	-	-	-	-	-	67	33
	LTESKNO2B	1	-	-	-	50	50	-	-	-	-	-	-	-	-	-	-
		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LTESKSE2A	1	-	-	100	-	-	-	-	-	-	100	-	-	25	-	75
		2															
	LTESKSO2B	1	-	-	-	-	-	-	100	-	-	-	-	-	-	-	-
		2	-	-	-	100	-	-	-	-	100	-	-	-	-	100	-
	LTESKSW2A	1	-	8	-	92	-	-	-	-	100	-	-	-	-	100	-
		2	-	-	-	100	-	-	-	-	100	-	-	-	-	100	-
3	LTESKNO3A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2	-	-	-	100	-	-	-	-	100	-	-	-	-	100	-
	LTESKNO3B	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LTESKSE3A	1	-	-	-	80	20	-	-	-	83	17	-	-	-	100	-
		2	-	-	-	84	16	-	-	-	97	3	-	-	-	90	10
	LTESKSE3B	1	-	-	-	100	-	-	-	6	94	-	-	-	4	96	-
		2	-	-	-	-	-	-	-	-	100	-	-	-	-	100	-
	LTESKSO3A	1	-	-	-	93	7	-	-	-	91	9	-	-	-	100	-
		2	-	-	-	40	60	-	-	-	-	-	-	-	-	33	67
	LTESKSW3B	1	-	-	-	96	4	-	-	-	98	2	-	-	-	98	2
		2	-	-	-	95	5	-	-	-	98	2	-	-	-	90	10
4	LTESKNO4A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LTESKSE4A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	100	-
		2	-	-	-	-	-	-	-	-	-	-	-	-	-	33	67
	LTESKSO4A	1	-	-	-	55	45	-	-	-	40	60	-	-	-	-	-

Environmental Combination	Location	Transect	Seg 1					Seg 2					Seg 3				
			Perc_BA	Perc_BP	Perc_PT	Perc_PM	Perc_LL	Perc_BA	Perc_BP	Perc_PT	Perc_PM	Perc_LL	Perc_BA	Perc_BP	Perc_PT	Perc_PM	Perc_LL
		2	-	-	-	100	-	-	-	-	-	100	-	-	-	-	-
	LTESKSW4A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LTESKSW4B	1	-	-	-	96	4	-	-	-	95	5	-	-	-	97	3
		2	-	-	-	100	-	-	-	-	85	15	-	-	-	92	8
5	LTESKNO5C	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LTESKNO5A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LTESKNO5B	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LTESKSO5A	1	50	-	-	50	-	-	-	-	100	-	-	-	-	100	-
		2	6	-	-	94	-	-	-	-	100	-	-	-	-	100	-
	LTESKSO5B		-	-	-	100	-	-	-	-	100	-	-	-	-	100	-
			-	-	-	100	-	-	-	-	100	-	-	-	-	100	-

Table 6-5: Tree recruitment composition as total number of stems tallied by transect for the undisturbed portions of each location

Environmental Combination	Location	Transect	Betula papyrifera sapling	Betula papyrifera seedling	Larix laricina sapling	Larix laricina seedling	Picea mariana sapling	Picea mariana seedling	Pinus banksiana sapling	Pinus banksiana seedling	Populus balsamifera sapling	Populus balsamifera seedling	Populus tremuloides sapling	Populus tremuloides seedling
1	LTESKNO1A	1	3					50	3	8		3		9
		2		5			4	78	5	5		3		12
	LTESKNO1B	1					23	63						
		2					24	52					2	
	LTESKSE1A	1					17	44						
		2					29	43						
	LTESKSE1B	1					3	55						
		2					18	32					0	2
	LTESKSW1A	1					12	23						1
		2					10	26						
2	LTESKNO2A	1					3	11						
		2				3	3	40						
	LTESKNO2B	1	4			1	11	89						1
		2	1		1	1		20						
	LTESKSE2A	1			1	6	29	114					6	1
		2				2	4	43			1		0	
	LTESKSO2B	1					31	160						
		2					20	38						
	LTESKSW2A	1					45	60						
		2					26	28						
3	LTESKNO3A	1					3	221	1				0	1
		2					18	12						
	LTESKNO3B	1					3	20			0	0		1
		2					0	11						
	LTESKSE3A	1				0	40	89						
		2					51	72						
	LTESKSE3B	1					32	29						
		2					4	114						
	LTESKSO3A	1			1	37	22	79						
		2				14	3	459						

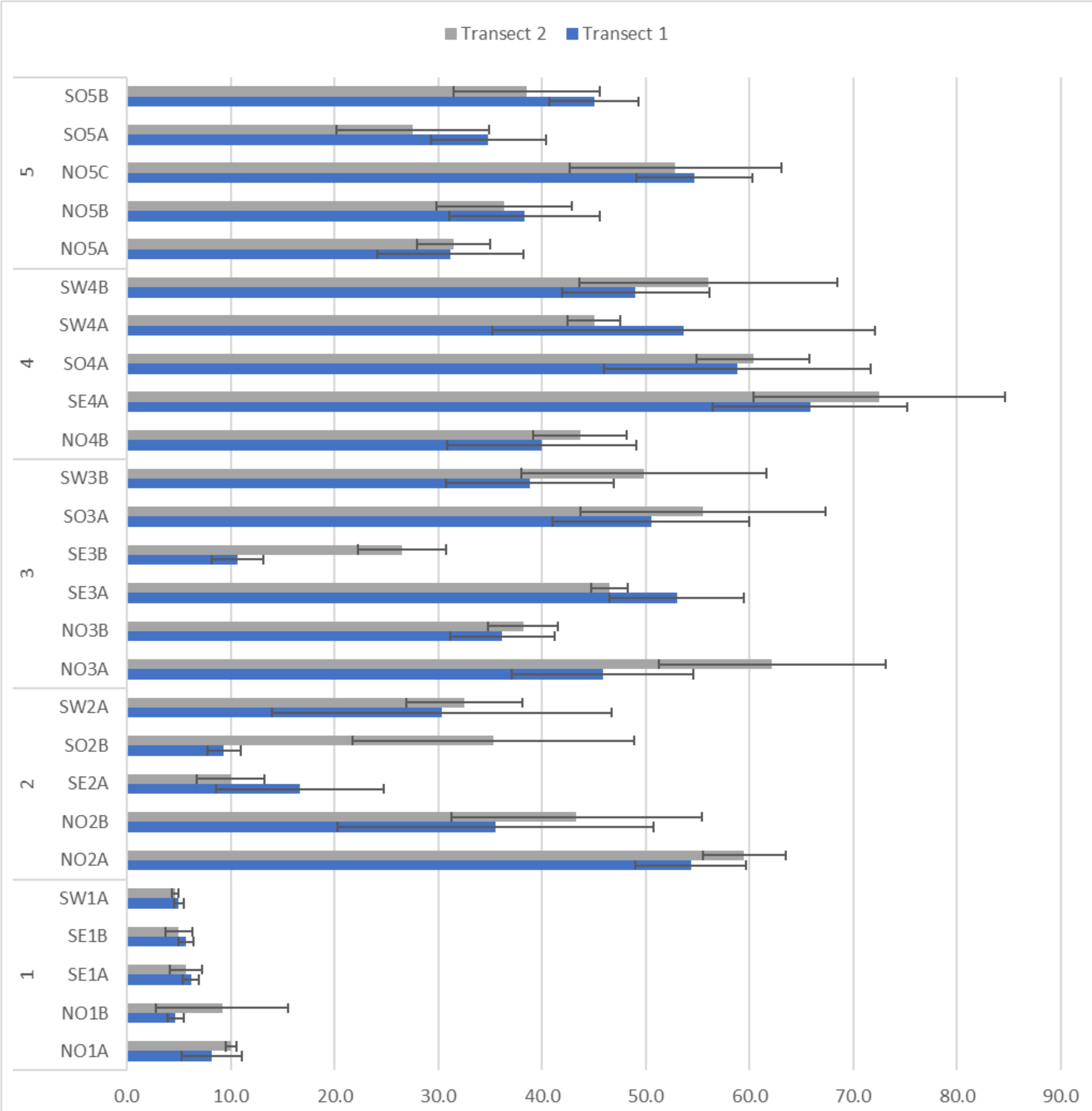
Environ-mental Combination	Location	Transect	Betula papyrifera sapling	Betula papyrifera seedling	Larix laricina sapling	Larix laricina seedling	Picea mariana sapling	Picea mariana seedling	Pinus banksiana sapling	Pinus banksiana seedling	Populus balsamifera sapling	Populus balsamifera seedling	Populus tremuloides sapling	Populus tremuloides seedling
	LTESKSW3B	1			1	2	84	40						
		2				0	73	63						
4	LTESKNO4A	1					76	262					1	16
		2					69	682	1				1	2
	LTESKSE4A	1			0	5	2	738						
		2				1	3	637						
	LTESKSO4A	1			2	19	12	94						
		2			3	3	5	140						
	LTESKSW4A	1			1	1	10	55						
		2				3		259						
	LTESKSW4B	1					82	109						
		2			1		115	34						
5	LTESKNO5C	1		2			67	185			6		2	3
		2					77	299					4	
	LTESKNO5A	1					4	186						
		2					1	122						
	LTESKNO5B	1	1					559						5
		2	1				10	255						6
	LTESKSO5A	1										3		
	LTESKSO5B	1					1	14						
		2					1	3						

Table 6-6: Average organic substrate thickness by segment and overall for each transect

Environ-mental Combination	Location	Transect	Segment Average			Transect Average	SE
			1	2	3		
1	LTESKNO1A	1	6.5	11.5	6.5	8.2	1.7
		2	9.5	10.5	10.0	10.0	0.3
	LTESKNO1B	1	5.5	4.5	4.0	4.7	0.4
		2	6.0	5.0	16.5	9.2	3.7
	LTESKSE1A	1	6.0	5.5	7.0	6.2	0.4
		2	4.0	7.0	6.0	5.7	0.9

Environ-mental Combination	Location	Transect	Segment Average			Transect Average	SE
			1	2	3		
	LTESKSE1B	1	6.5	5.0	5.5	5.7	0.4
		2	6.0	3.5	5.5	5.0	0.8
	LTESKSW1A	1	5.0	5.5	4.5	5.0	0.3
		2	5.0	4.5	4.5	4.7	0.2
2	LTESKNO2A	1	49.5	53.5	60.0	54.3	3.1
		2	59.5	63.5	55.5	59.5	2.3
	LTESKNO2B	1	42.5	46.0	18.0	35.5	8.8
		2	54.5	45.0	30.5	43.3	7.0
	LTESKSE2A	1	12.0	26.0	12.0	16.7	4.7
		2	13.5	7.0	9.5	10.0	1.9
	LTESKSO2B	1	10.5	10.0	7.5	9.3	0.9
		2	37.0	48.0	21.0	35.3	7.8
	LTESKSW2A	1	49.0	18.5	23.5	30.3	9.4
		2	37.5	33.5	26.5	32.5	3.2
3	LTESKNO3A	1	43.5	55.5	38.5	45.8	5.0
		2	52.5	74.0	60.0	62.2	6.3
	LTESKNO3B	1	40.0	38.0	30.5	36.2	2.9
		2	34.5	41.0	39.0	38.2	1.9
	LTESKSE3A	1	56.5	57.0	45.5	53.0	3.8
		2	44.5	47.0	48.0	46.5	1.0
	LTESKSE3B	1	9.5	9.0	13.5	10.7	1.4
		2	31.0	26.0	22.5	26.5	2.5
	LTESKSO3A	1	60.0	41.0	50.5	50.5	5.5
		2	68.5	45.5	52.5	55.5	6.8
	LTESKSW3B	1	35.5	33.0	48.0	38.8	4.6
		2	54.0	59.0	36.5	49.8	6.8
4	LTESKNO4A	1	35.5	34.0	50.5	40.0	5.3
		2	38.5	47.0	45.5	43.7	2.6
	LTESKSE4A	1	71.0	71.5	55.0	65.8	5.4
		2	58.5	79.5	79.5	72.5	7.0
	LTESKSO4A	1	70.5	61.0	45.0	58.8	7.4
		2	63.5	63.5	54.0	60.3	3.2
	LTESKSW4A	1	32.5	66.5	62.0	53.7	10.7
		2	45.0	47.5	42.5	45.0	1.4
	LTESKSW4B	1	54.5	41.0	51.5	49.0	4.1
		2	58.5	42.5	67.0	56.0	7.2
5	LTESKNO5C	1	61.0	52.5	50.5	54.7	3.2
		2	64.5	48.5	45.5	52.8	5.9

Environ-mental Combination	Location	Transect	Segment Average 1	Segment Average 2	Segment Average 3	Transect Average	SE
	LTESKNO5A	1	38.0	31.5	24.0	31.2	4.0
		2	34.0	33.0	27.5	31.5	2.0
	LTESKNO5B	1	45.5	31.0	38.5	38.3	4.2
		2	43.0	36.0	30.0	36.3	3.8
	LTESKSO5A	1	37.5	28.5	38.5	34.8	3.2
		2	19.0	32.0	31.5	27.5	4.3
	LTESKSO5B	1	45.5	40.5	49.0	45.0	2.5
		2	32.0	46.0	37.5	38.5	4.1



Error bars represent standard deviations.

Figure 6-1: Average organic soil thickness from soil profiles at each transect.

Table 6-7: Number of soil profiles by site type in the undisturbed portions of each transect

Environ-mental Combination	Location	Transect	Site type						
			1	3	4	5	6	8	9
1	LTESKNO1A	1			5	1			
		2			5	1			

	LTESKNO1B	1			6				
		2			5			1	
	LTESKSE1A	1			5				1
		2			5				1
	LTESKSE1B	1			5	1			
		2			5	1			
2	LTESKSW1A	1	1	1	4				
		2	1	2	3				
	LTESKNO2A	1					6		
		2					6		
	LTESKNO2B	1			1		5		
		2					6		
	LTESKSE2A	1						1	5
		2			6				
	LTESKSO2B	1			6				
		2					6		
	LTESKSW2A	1			2			4	
		2					6		
3	LTESKNO3A	1						6	
		2						6	
	LTESKNO3B	1						6	
		2						6	
	LTESKSE3A	1					6		
		2					6		
	LTESKSE3B	1							6
		2						6	
	LTESKSO3A	1					6		
		2					6		
	LTESKSW3B	1					6		
		2					6		
4	LTESKNO4A	1					6		
		2					6		
	LTESKSE4A	1					6		
		2					6		
	LTESKSO4A	1					6		
		2					6		
	LTESKSW4A	1					6		
		2					6		
	LTESKSW4B	1					6		
		2					6		
5	LTESKNO5C	1					6		

		2		6	
	LTESKNO5A	1		6	
		2		6	
	LTESKNO5B	1		6	
		2		6	
	LTESKSO5A	1			6
		2	1		5
	LTESKSO5B	1			6
		2	1		5