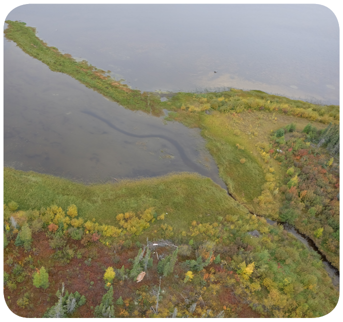
Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Wetland Loss and Disturbance Monitoring Report

TEMP-2020-03



Manitoba Conservation and Climate Client File 5550.00
Manitoba Environment Act Licence No. 3107

2019 - 2020

KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2020-03

WETLAND LOSS AND DISTURBANCE MONITORING

Prepared for

Manitoba Hydro

By

ECOSTEM Ltd.

June 2020

This report should be cited as follows:

ECOSTEM Ltd. 2020. Keeyask Generation Project Terrestrial Effects Monitoring Plan Report #TEMP-2020-03: Wetland Loss and Disturbance Monitoring. A report prepared for Manitoba Hydro by ECOSTEM Ltd., June 2020.

SUMMARY

Background

Construction of the Keeyask Generation Project (the Project) at Gull Rapids began in July 2014. The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the generating station on the terrestrial environment. Monitoring results will help the KHLP, government regulators, members of local First Nation communities, and the general public understand how construction and operation of the generating station are affecting the environment, and whether or not more needs to be done to reduce harmful effects.

Wetlands are land areas where the ground is usually either wet or under shallow water. Wetlands are important for the ecosystem and people for many reasons, such as protecting shorelines, adding to the variety of habitat types and providing good areas to find wildlife. Several medicinal or country food plants used by Members of the partner First Nations (e.g., sweet flag [*wekes*, *wekas* or *wihkis* in Cree], and tamarack) are either only or mostly found in wetlands. In the Keeyask region, marsh in areas off the Nelson River (i.e., off-system marsh) is a very important wetland type, mostly because it is rare, and it provides the only very good habitat for some kinds of plants and animals. Off-system marshes are usually good areas to hunt moose and waterfowl.

This report describes the results of wetland loss and disturbance monitoring conducted during the sixth summer of Project construction.

Off-system marsh wetland in the Keeyask region in 2019

Why is the study being done?

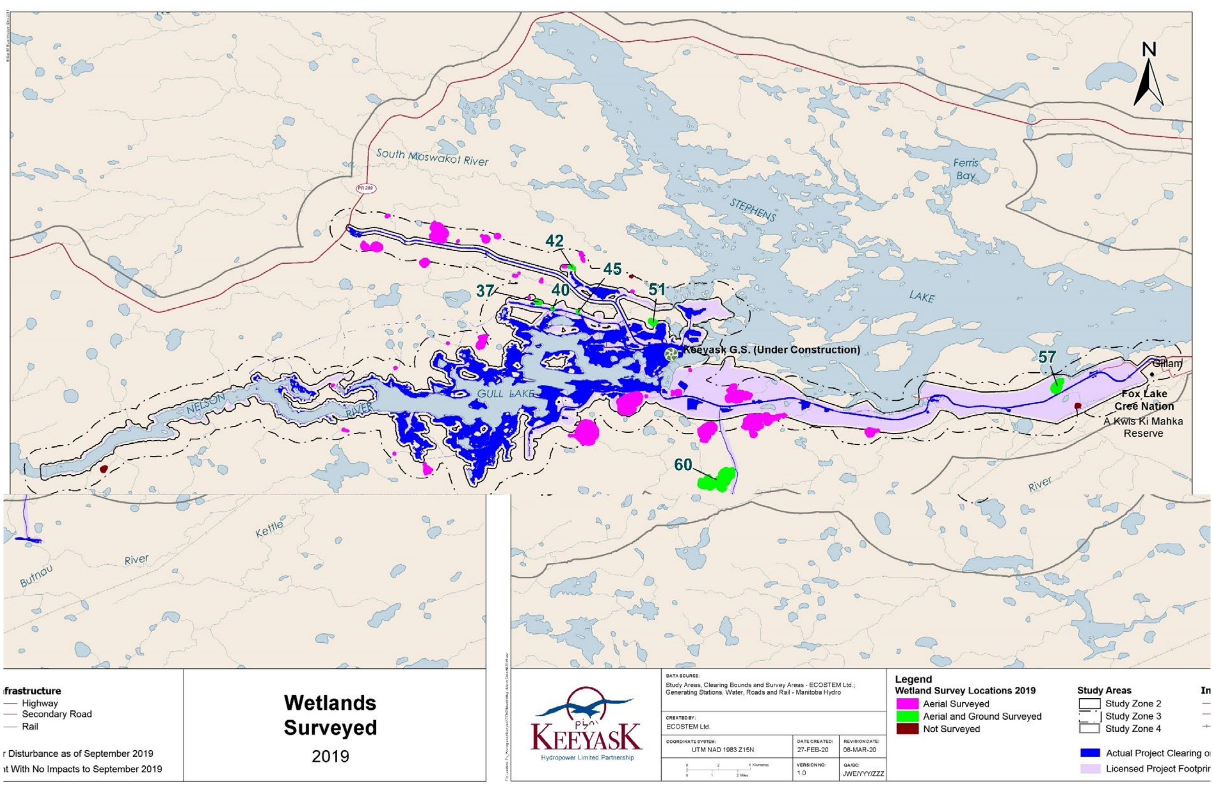
Wetland mapping for the environmental assessment showed that the Project would affect some wetland areas. Since it is impossible to avoid all wetlands in the area given the size of the Project footprint and the widespread nature of wetland habitat (i.e., peatlands are common throughout the Keeyask region), mitigation (replacement of 12 ha of off-system marsh wetland) is planned to help reduce Project effects.

As construction proceeds, this monitoring study documents Project impacts on, and mitigation related to, the very important marsh wetland type. This is to make sure the Project effects predictions are accurate and that no additional unanticipated impacts are occurring. Following the end of construction, Project effects on all wetland types will be evaluated.

What was done?

Off-system marsh was the only very important wetland type identified by the environmental assessment. Off-system marsh and its habitat occur within a waterbody. The area surrounding these waterbodies is important for the off-system marsh and its habitat because these areas affect each other, and in most cases the surrounding area is peatland, another type of wetland common in the Keeyask region. For these reasons, each monitored wetland includes the entire waterbody, plus a 100 m buffer of the waterbody.

In each year of construction, aerial and ground surveys are done at wetlands that are close to the Project construction areas. In September 2019, 42 wetlands were surveyed from a helicopter (see map below), and seven of these wetlands were also surveyed on the ground.



What was found?

As of 2019, Project clearing or disturbance in the monitored wetlands totalled 4.19 ha, and all of this was within seven of the 44 wetlands. Clearing accounted for the vast majority (99.9%) of this total. No new clearing in these areas had occurred since the 2018 surveys.

The vast majority (4.09 ha; 98%) of the clearing and disturbance was within the planned Project footprint. This was expected, and outlined in the environmental assessment, since a portion of these wetlands overlapped a permanent Project feature such as a dyke, a road or the future reservoir area.

In six of the seven impacted wetlands, Project clearing only occurred in the marsh habitat buffer. In the seventh wetland, clearing extended into a very small amount (0.11 ha) of marsh habitat where taller vegetation had been cleared for the future reservoir area.

A very small area (<0.1 ha) in one wetland had been disturbed by sediment deposition from a nearby construction area. All of this sediment deposition was in the marsh habitat buffer. In another wetland, altered water levels increased the extent of wetland vegetation.

Potential future Project impacts were noted for two of the wetlands located within 100 m of actual Project clearing or disturbance. At these locations, altered water flows could potentially affect the amounts of marsh and its habitat.

What does it mean?

To date, there have been no unanticipated impacts on the wetlands being monitored by this study. While some Project clearing or disturbance occurred in a small portion of seven wetland areas, it was expected that there would be some impacts at wetlands overlapping the planned Project footprint or to those close to active construction areas. Erosion control or other mitigation measures (e.g. no additional clearing within a wetland buffer) have been recommended where there are potential future risks to an off-system marsh or its habitat.

What will be done next?

Off-system marsh wetland monitoring, including the effectiveness of mitigation measures, will continue in 2020. Where needed, additional mitigation measures will be recommended after the 2020 surveys.

ACKNOWLEDGEMENTS

ECOSTEM Ltd. would like to thank Rachel Boone, Sherrie Mason and the on-site Manitoba Hydro staff, including Megan Anger, Rachelle Budge, Gord Macdonald and Linda Campbell for their support and assistance in planning field activities and providing access to the sites. Rachel Boone and Sherrie Mason are also gratefully acknowledged for coordinating the terrestrial monitoring studies.

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

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

Custom Helicopters is gratefully acknowledged for providing transportation during fieldwork and Nicole Pokornowska for coordinating the logistics.

STUDY TEAM

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

Fieldwork in 2019 was conducted by Nathan Ricard and Brock Epp.

Data analysis and report writing in 2020 were completed by Alex Snitowski, Brock Epp and James Ehnes. GIS analysis and cartography were completed by Alex Snitowski and Brock Epp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

LIST OF PHOTOS

LIST OF APPENDICES

1.0 INTRODUCTION

Construction of the Keeyask Generation Project (the Project), a 695-megawatt hydroelectric generating station (GS) and associated facilities, began in July 2014. The Project is located at Gull Rapids on the lower Nelson River in northern Manitoba where Gull Lake flows into Stephens Lake, 35 km upstream of the existing Kettle GS.

The *Keeyask Generation Project Response to EIS Guidelines* (the EIS), completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project (KHLP 2012a). Technical supporting information for the terrestrial environment, including a description of the environmental setting, effects and mitigation, and a summary of proposed monitoring and follow-up programs is provided in the *Keeyask Generation Project Environmental Impact Statement Terrestrial Supporting Volume* (TE SV; KHLP 2012b). The *Keeyask Generation Project Terrestrial Effects Monitoring Plan* (TEMP) was developed as part of the licensing process for the Project (KHLP 2015). Monitoring activities for various components of the terrestrial environment were described, including the focus of this report, which is wetland 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. 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 ecosystem function. 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 Project's TEMP, two studies are monitoring Project effects on wetland function. During construction, the Wetland Loss and Disturbance study is monitoring direct Project effects on wetlands due to habitat loss and disturbance (see KHLP 2015, Section 2.5.2). During operation, the Long-Term Effects on Wetlands study will monitor long-term direct and indirect Project effects on wetland function (see KHLP 2015, Section 2.5.3). The Created Wetlands study will monitor the efficacy of mitigation measures implemented to create 12 ha of off-system marsh (see KHLP 2015, Section 8.1).

This report presents results for the Wetland Loss and Disturbance monitoring conducted in 2019.

The goal of the Wetland Loss and Disturbance study is to determine direct Project effects on wetland function during construction. Based on this goal, the objectives of this study are to:

- Verify the implementation and effectiveness of off-system marsh protection measures; and,
- Locate and quantify direct Project effects on wetland function during construction based on wetland quality scores.

This report addresses the first of these objectives based on monitoring conducted from 2015 to 2019. A synthesis report completed following the end of construction will provide a detailed evaluation of effects on off-system marshes as well as addressing the second study objective.

ECOSTEM (2016, 2017, 2018 and 2019) provides results for the wetland loss and disturbance monitoring conducted from 2015 to 2018.

2.0 METHODS

2.1 INTRODUCTION

Section 2.5.2 of the TEMP details the methods for the Wetland Loss and Disturbance study, which began in 2015. The following summarizes the activities conducted in 2019. The same monitoring methods were implemented from 2015 to 2019.

Prior to describing the activities, some terminology is introduced to assist the reader. The following definitions are used in all of the terrestrial habitat, ecosystems and plant monitoring studies.

"Impact" refers to what the Project does in terms of the question of interest (e.g., lowering water levels in a lake, vegetation clearing), while "effect" refers to the consequence relative to the question of interest (e.g., marsh habitat loss, reduced wetland function).

Clearing refers to complete vegetation removal of trees and tall shrubs (e.g., the herbaceous and moss cover can be intact) in an area that is at least 400 m^2 in size. In the results, "clearing" also includes areas where excavated material was piled on uncleared vegetation since the vegetation was no longer visible. Many of the cleared areas also included excavation of topsoil and overburden (e.g., in a borrow area).

Disturbance refers to either physical disturbance in an area of intact vegetation (e.g., machinery trail, test pits), use of a pre-existing trail or an area of clearing smaller than 400 m^2.

It is noted that, while the definition of clearing means that every cleared patch being referred to in this report is at least 400 m^2, the portion of a clearing that overlaps a wetland or its buffer can be much smaller than 400 m^2. In other words, all uses of "clearing" in this report are referring to the entire area cleared (including areas outside the wetland and its buffer).

As noted above, this study is focusing on how the Project is affecting off-system marsh wetlands. Even under natural conditions, the amounts and locations of off-system marsh change from year to year in response to a number of factors. Such changes are possible because only a portion of the wetland areas that can support marsh (i.e., marsh habitat) actually have marsh in them at a given time. For this reason, the monitoring extends beyond the originally mapped patches of off-system marsh to also include all marsh habitat. This approach is analogous to monitoring both the number of beavers and the amount of beaver habitat to understand Project effects on beaver.

The locations where marsh habitat occurs are predominantly determined by a combination of water depths and water level variations (TE SV; KHLP 2012b). In the study area where detailed marsh mapping was completed (i.e., Study Zone 4; Map 2-1), off-system marsh was not found in water known or thought to be deeper than 2 m (ECOSTEM 2012). While EIS studies indicated that the waterbodies containing off-system marshes generally had a maximum depth of less than 2 m (ECOSTEM 2012 unpublished raw data), bathymetry was not available to confirm this for all waterbodies. To err on the side of caution, for the selected waterbodies, the entire waterbody was included as off-system marsh habitat.

Total precipitation over the preceding months and years has an important natural influence on the distribution and abundance of marsh through its influence on water depths and water level variations. The pathways and nature of precipitation effects can be quite complex as they are also controlled by subsurface topography, surficial material stratigraphy and ground ice in broad areas dominated by peatlands, such as Study Zone 4. ECOSTEM (2013) provides an overview of key pathways and processes for the Project region.

Marsh and its habitat can be strongly influenced and altered by human impacts such as physical disturbance or hydrological alterations, both within its habitat and in surrounding areas. For this reason, in addition to monitoring waterbodies (i.e., the marshes and their habitat), this study also monitors changes within a 100 m buffer of the waterbody. For this same reason, the Project's environmental protection plans (EnvPPs) had already designated the portions of the marsh habitat buffers outside of the planned Project footprint as environmentally sensitive sites, which are to be avoided whenever possible.

In this report, a waterbody and its buffer are referred to as a monitored wetland. In other words, references to a specific wetland in the Wetland Loss and Disturbance study include a waterbody and its 100 m buffer zone.

2.2 PROJECT AREAS

In this study, four distinct Project areas are used when reporting on where Project clearing or disturbance occurred. This is being done to facilitate future comparisons with EIS predictions.

The first two areas are a subdivision of the footprint licensed for Project use under the Project's *Environment Act* Licence (i.e., licensed Project footprint): the planned Project footprint and the possibly disturbed Project footprint (Map 2-1). The planned Project footprint is largely comprised of permanent Project features. There is little to no opportunity to reduce Project impacts in these areas.

The possibly disturbed Project footprint provided for some of the unknown components of the Project design at the time the Project was being licensed (e.g., the actual volume of suitable material available in each borrow area, or the actual area needed for each of the Excavated Material Placement Areas (EMPAs)). There is some flexibility in locating clearing, disturbance or material placement within the possibly disturbed Project footprint. Project EnvPPs include provisions to minimize clearing or disturbance within the possibly disturbed Project footprint, and the avoidance of environmentally sensitive sites to the extent feasible within this area.

After the Project was licensed, several additional areas (called "subsequently approved Project areas" in this report) were approved for Project use by the Government of Manitoba (initially Conservation and Water Stewardship, then Sustainable Development, now Conservation and Climate). This is the third type of Project area. These subsequently approved areas primarily included the former KIP start-up camp (which was originally planned as only a temporary camp for the KIP) and trails that were used to access reservoir clearing areas.

The subsequently approved areas were evaluated for potential effects by terrestrial specialists prior to their submission to the Government of Manitoba, and their locations modified to alleviate any ecological concerns that were identified at that time. Given the modifications recommended by terrestrial specialists, the subsequently approved areas were not a concern from the terrestrial ecosystem health perspective.

An important consideration for the evaluation of areas that were subsequently submitted for approval was how these potential additions would alter predicted cumulative effects. This evaluation primarily focused on the characteristics of the potentially affected areas and the amount of the licensed Project footprint that was expected to remain undisturbed at the end of construction. For the latter factor, it was expected that a large proportion of the licensed Project footprint would remain undisturbed because the EIS intentionally erred on the side of overestimating the amount of habitat loss and disturbance. As of September 2019, the majority (56%) of the originally licensed Project footprint had not been impacted by the Project (ECOSTEM 2020).

This report refers to the licensed Project footprint and the subsequently approved areas as the “approved Project footprint”.

The fourth, and final, type of Project area used in this report includes any areas cleared or disturbed outside the approved Project footprint. This includes all areas that are not part of the approved Project footprint.

It was expected that portions of a particular wetland (Section 2.1) that overlapped the planned Project footprint would be lost or disturbed. Project impacts on the off-system marshes and/or their buffers were assessed during the EIS and were expected to be minimal outside of the planned Project footprint. This study monitors the area actually impacted by the Project in comparison to the amount assessed for the Project in the EIS. The Long-Term Effects on Wetlands study will monitor long-term direct and indirect Project effects on wetland function.

2.3 DATA COLLECTION

To verify the implementation and effectiveness of off-system marsh protection measures (i.e., the first study objective; Section 1.0), the Wetland Loss and Disturbance study includes annual surveys during Project construction. Mapping and analysis to locate and quantify direct Project effects on wetland function during construction (i.e., the second study objective) will be completed after construction completion.

For the first study objective, the wetlands selected for monitoring were all off-system marsh wetlands located in Study Zone 3 and not entirely within the planned Project Footprint (Map 2-2). Wetlands entirely in the planned Project Footprint was excluded because we expect these areas to be lost to Project construction, and this is reflected in the Project’s Environmental Protection

Plans (EnvPPs). Study Zone 2 captures the areas that could potentially experience direct and indirect Project effects on terrestrial habitat, which includes off-system marsh wetlands. Wetlands in Study Zone 3 were also included because, while unlikely, it is possible for some hydrological effects to extend for a considerable distance beyond the licensed Project footprint. Although not a focus for the first objective of this study (Section 1.0), it is important to document when potential hydrological effects occur as they will be evaluated when addressing the second objective.

Studies completed for the environmental impact statement (EIS) had mapped the off-system marshes that were present in Study Zone 4 (Map 2-2) in 2012. This mapping was used to select the waterbodies in Study Zone 3 to be included in this monitoring.

Map 2-2 shows the 44 wetlands in Study Zone 3 that are being monitored to verify the implementation and effectiveness of off-system marsh protection measures, and to quantify direct Project effects on wetland function. Each of the 44 monitored wetlands was assigned a unique wetland identification number for the monitoring (e.g., Wetland 17).

Once each year during construction, surveys are conducted in the monitored wetlands that are sufficiently close to actual Project impacts to be potentially affected. Potentially affected wetlands are identified in two stages. The first stage selects all of the wetlands that are within approximately 1 km of the Project clearing or disturbance as seen in the most recent digital orthorectified imagery (DOI; a DOI is a digital dataset produced from satellite images or digital stereo photos that have been stitched together and processed so that all pixels are positioned in an accurate ground position). A 1 km distance was used because it is possible for hydrological effects to extend well beyond the immediate vicinity of a Project impact in continuous peatlands (Section 2.1).

In the second stage of wetland selection, an aerial survey is conducted to identify and add any other of the monitored wetlands within 1 km of Project clearing or disturbance that occurred after the DOI was acquired.

Aerial surveys are conducted for every wetland that has been selected for that year. Ground surveys are also conducted at a subset of these wetlands that are within 100 m of the actual Project footprint if impacts have changed with the past three years. Ground surveys search for effects not visible from the air, document implemented mitigation measures, and document possible Project effects.

Conditions in the surveyed wetlands are recorded with geo-referenced photographs, marked-up maps and/or notes. Any erosion, siltation, or surface hydrological alteration observed is recorded, as well as any mitigation implemented to address these issues.

The spatial extent of impacts on the surveyed wetlands are mapped in a GIS using remote sensing. Remote sensing refers to data obtained from above the ground from sources such as satellite imagery, digital stereo photos or photos taken from a helicopter). In this case, remote sensing includes a combination of photos acquired from a helicopter and DOIs. The most recent growing season DOI is also generally used as the base map. Exceptions occur where the spatial extents of the most recent DOI do not overlap a wetland, in which case the next most recent DOI is used.

Areas burned in the 2013 wildfire (which was unrelated to the Project) are of interest for the wetland monitoring because runoff from Project areas could be carried over burned bare mineral areas rather than being trapped by mosses and other ground plants. A GIS is used to map the percentage of the wetland's buffer that was burned in the 2013 wildfire.

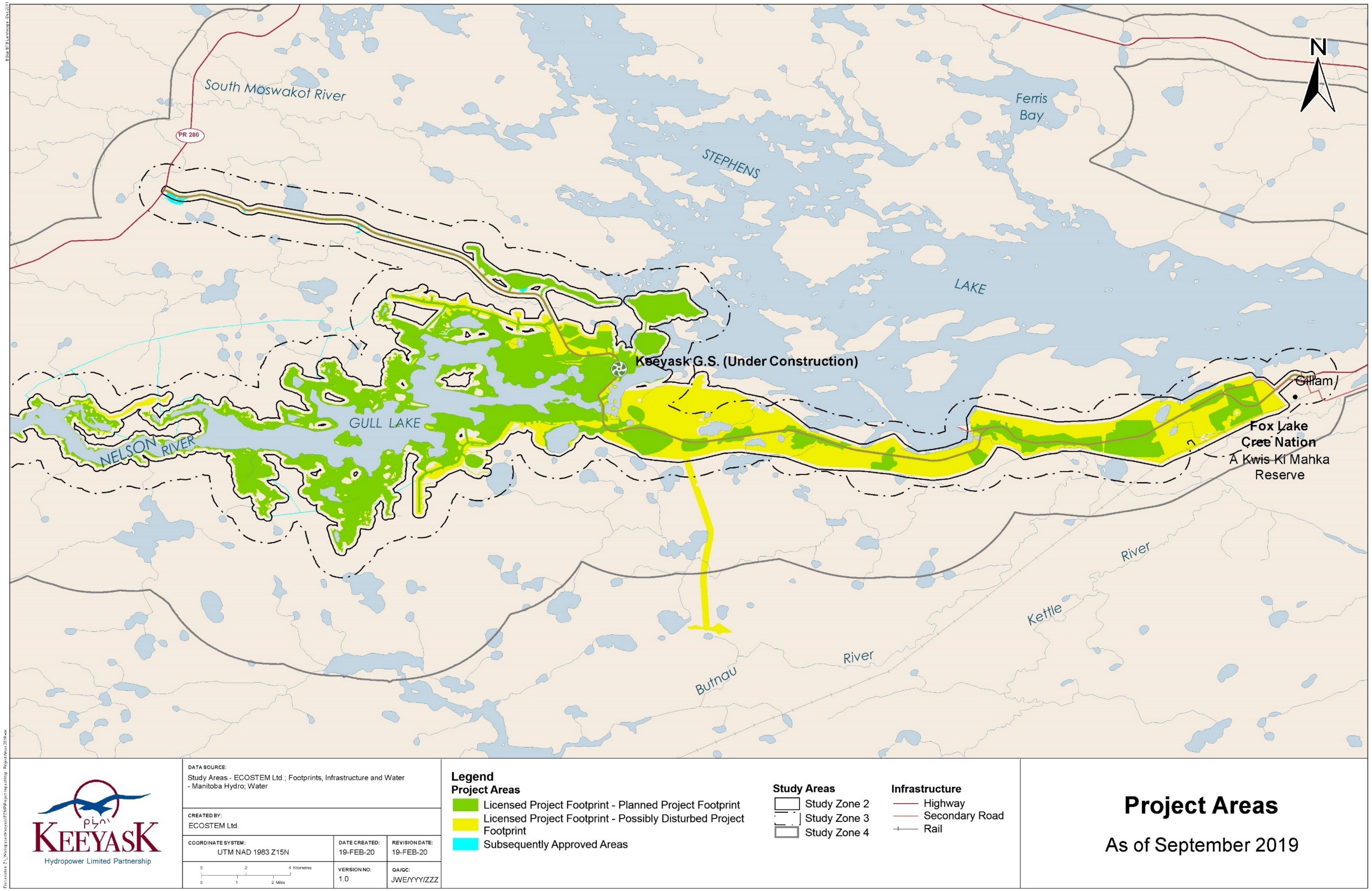
In 2019, the first stage of wetland selection used a DOI created from 30 cm resolution Worldview 2 imagery (acquired July 2018) because a DOI from summer 2019 was not available prior to the aerial surveys, which were conducted on September 9, 2019. A total of 42 wetlands were identified for inclusion in the aerial surveys. This was the same number of wetlands as surveyed in 2018. Aerial surveys conducted on September 9, 2019 did not identify any additional wetlands for inclusion in the 2019 monitoring.

Of the 42 wetlands surveyed in 2019, 13 were within 100 m of existing clearing or disturbance. Ground surveys were conducted at seven of the 13 wetlands within 100 m of existing clearing or disturbance (Map 2-2) on September 9, 2019. Five of the remaining six wetlands (wetlands 3, 17, 53 and 54) were not ground-surveyed because there had been no new clearing or other impacts near them for several years, and there were no documented Project effects at these wetlands in the previously surveyed years. Wetland 47 was not ground surveyed due to heavy construction activity being conducted near it. Aerial survey data were used to monitor this wetland in 2019.

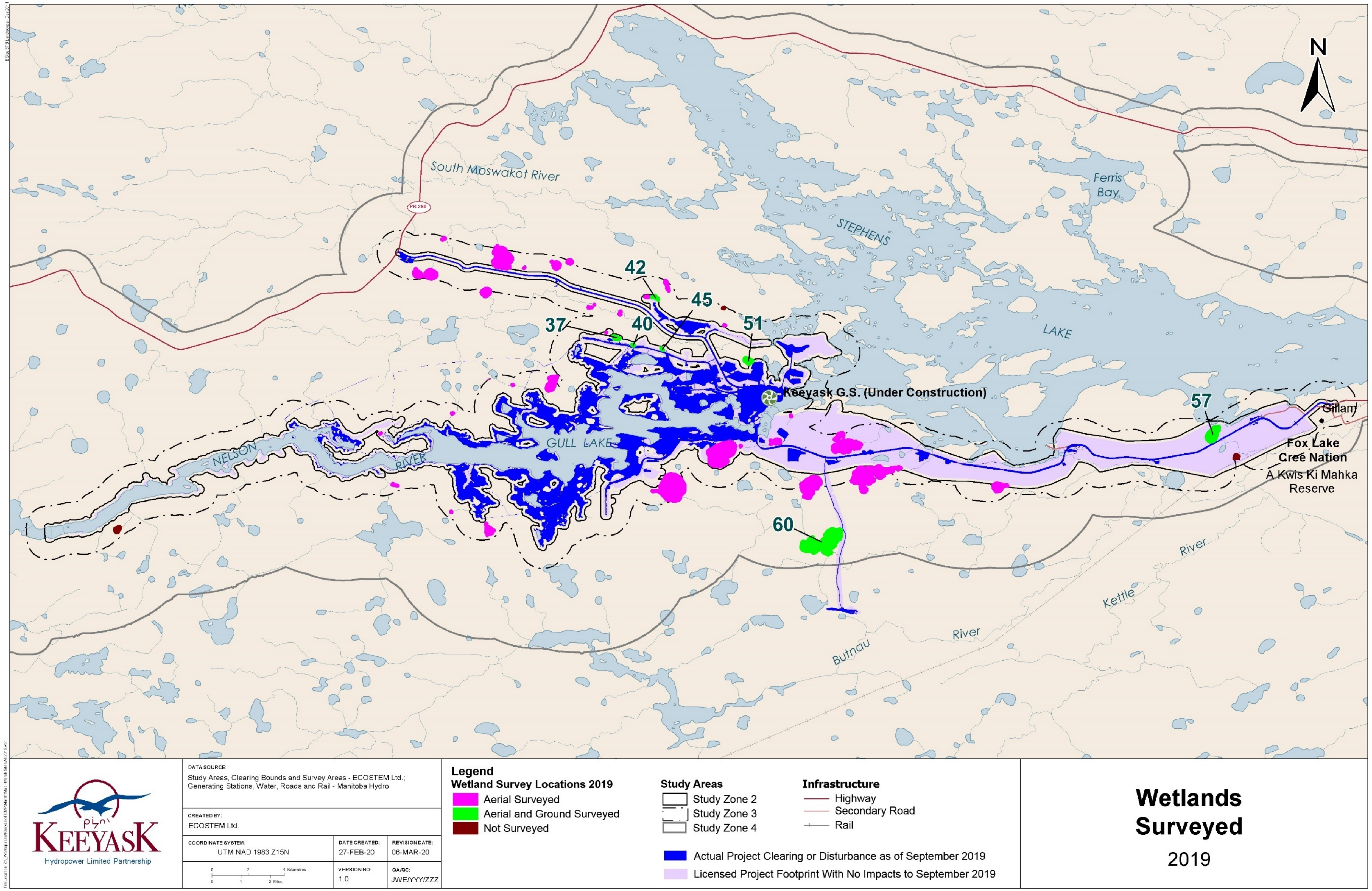
2.4 WATER LEVELS AND WEATHER DATA

Project related effects on both water levels and water level variability are of interest for the wetland monitoring because these factors are primary determinants of the amounts of marsh wetland and marsh habitat. As water levels in off-system waterbodies are not monitored with equipment, the apparent deviation of water levels relative to the median were recorded at the time of the wetland surveys. The degrees of exposed aquatic vegetation and lake-bottoms were the indicators for relatively low water levels while degrees of flooding in upper beach and inland edge vegetation were the indicators for relatively high-water levels.

As noted in Section 2.1, total precipitation over the preceding months and years has an important natural influence on the distribution and abundance of marsh. Initial attempts to relate observed water levels to precipitation data were unsuccessful due to serious limitations to the available weather data. For example, the closest weather station, which is at Gillam, is missing total precipitation data for 48% of the days in 2015 (including entire consecutive summer months) and 18% of the days in 2016. A similar, but less pronounced, situation exists for the next closest weather station, which is at the Kelsey dam site. The construction synthesis report will explore possible approaches to developing precipitation data for the Project area (e.g., estimating missing data or using a more distant weather station) as this report is produced when all of the relevant data will be available.



Map 2-1: Project areas as of September 2019



Map 2-2: **Monitored off-system marsh wetlands, and those that were surveyed in 2019**

3.0 RESULTS

3.1 OVERVIEW

The 2019 surveys did not detect any new clearing since 2018 in the marsh habitat or marsh habitat buffers for any of the 42 surveyed wetlands (Map 2-2). At two wetlands, a disturbance (e.g., sediment deposition) or substantive change was recorded.

One marsh habitat buffer (at Wetland 51) that had been disturbed by sediment runoff in 2018 was still receiving sediment in 2019. At Wetland 57, water levels continued to show more year-to-year variability than the other monitored wetlands.

Table 3-1 summarizes the main findings for the 13 wetlands within 100 m of Project impacts. Of the 4.19 ha of Project clearing or disturbance within wetlands, 0.10 ha was in marsh habitat while 4.09 ha was in the marsh habitat buffer. These areas have remained unchanged since 2017.

To date, all recorded impacts in wetlands have been within the licensed Project footprint, with the vast majority being in the planned Project footprint. Of the 4.19 ha of impacted area, 3.91 ha was within the planned Project footprint while 0.28 ha was within the possibly disturbed Project footprint (Table 3-2).

Table 3-1: Impacts and potential future effects in the off-system marsh wetlands within 100 m of Project clearing or disturbance, as of September, 2019

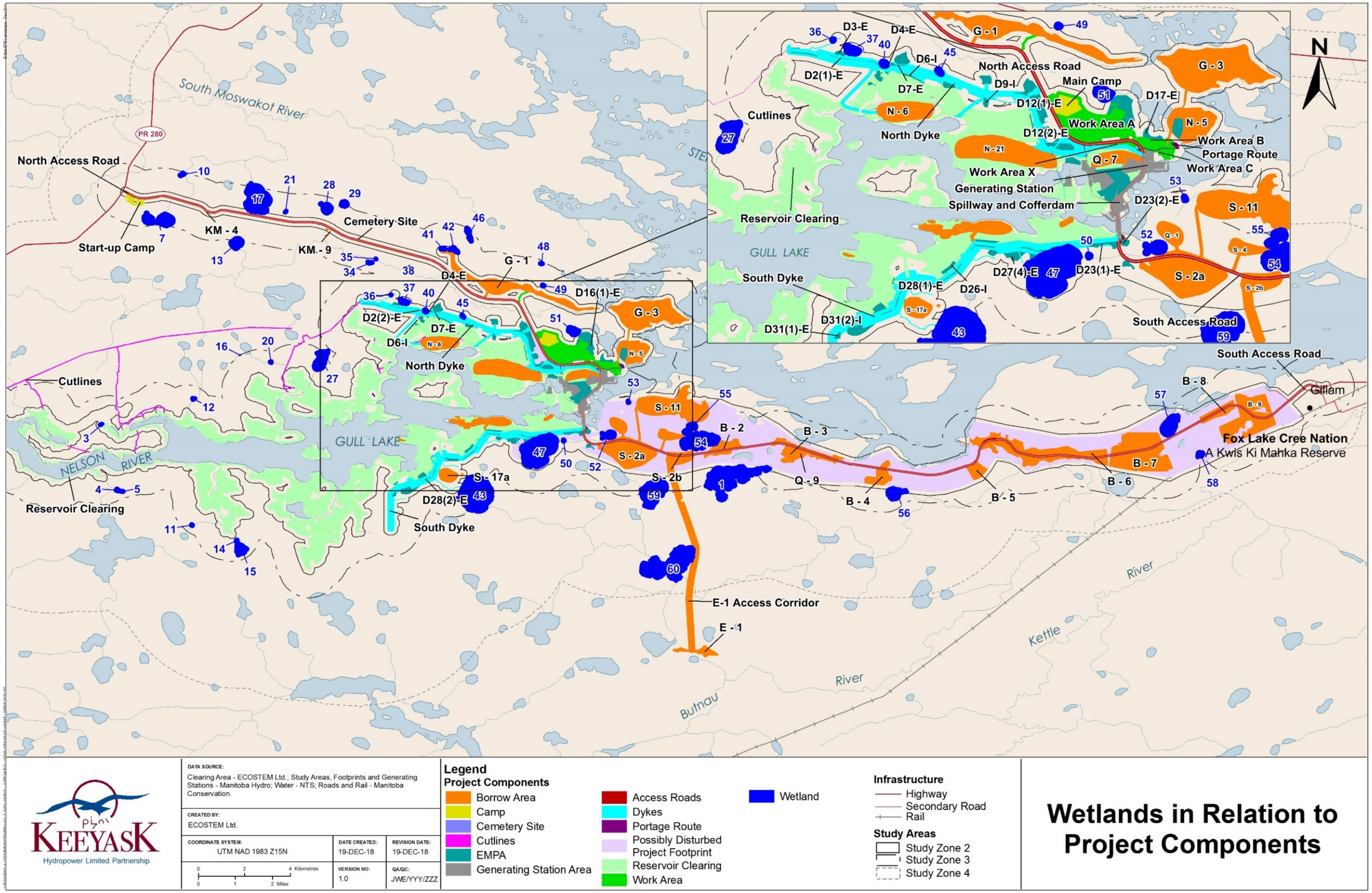
Wet-land ID[1]	Wetland Area (ha)			Area (ha) Impacted[2] by Project Clearing and Disturbance			Other Project Impacts up to 2019	2013 Burn in Buffer (%)[3]	Potential Additional Future Effects or Effects Outside of the Monitored Wetlands
	Total	Marsh Habitat	Buffer	Total	Marsh Habitat	Buffer			
3	5.0	1.0	4.0	0.364	0.105	0.260	None	90	None
17	135.1	97.4	37.7	-	-	-	None	85	Water flow from a road culvert
37	17.0	4.1	12.9	0.006	-	0.006	None	5	Likely none[5]
40	7.9	1.2	6.7	1.754	-	1.754	None	10	Likely none[5]
42	15.7	2.9	12.8	-	-	-	None	50	Likely none[5]
45	7.3	0.8	6.5	0.236	-	0.236	None	50	Likely none[5]
47	189.7	140.7	49.0	1.033	-	1.033	None	0	Runoff from dyke through drainage channels into marsh
51	25.7	10.5	15.2	0.005	-	0.005[4]	None	20	Deposition of sediment or other materials into the marsh habitat buffer or other wetlands from EMPA
52	28.4	9.1	19.4	-	-	-	None	0	Hydrological effects from a road culvert
53	5.5	0.3	5.2	-	-	-	None	0	None
54	113.1	70.1	43.0	-	-	-	None	0	None
57	64.6	37.6	27.0	0.793	-	0.793	None	0	Hydrological effects from a road culvert
60	232.4	150.0	82.5	-	-	-	None	0	None
All	847.6	525.7	322.0	4.190	0.105	4.086			

Notes:
[1] Bold font identifies wetlands that were ground sampled in 2019.
[2] All mapped Project clearing or physical disturbance in monitored wetlands. See ECOSTEM (2020) for the mapping.
[3] Percentage of total buffer area that burned in the 2013 wildfire (which was unrelated to the Project).
[4] Area is an arbitrary value to capture sediment deposited in patches of standing water intermingled in surface peat.
[5] The potential runoff from EMPA or dyke slope is declining. Evidence of runoff has not been recorded for past few years and colonizing vegetation may eventually prevent it.

Table 3-2: Project clearing or disturbance in the off-system marsh wetlands within 100 m of Project clearing or disturbance as of September, 2019, by Project area

Wetland ID	Total Wetland Area (ha)	Area (ha) Impacted by Project Clearing and Disturbance[1]			Percent of Total Wetland Area Impacted
		Total	Planned Project Footprint	Possibly Disturbed Project Footprint	
3	5.0	0.364	0.117	0.247	7.2
17	135.1	-	-	-	-
37	17.0	0.006	-	0.006	0.0
40	7.9	1.754	1.754	-	22.2
42	15.7	-	-	-	-
45	7.3	0.236	0.236	-	3.2
47	189.7	1.033	1.015	0.018	0.5
51	25.7	0.005	-	0.005[2]	0.0
52	28.4	-	-	-	-
53	5.5	-	-	-	-
54	113.1	-	-	-	-
57	64.6	0.793	0.793	0.00	1.2
60	232.4	-	-	-	-
All	847.6	4.190	3.914	0.276	0.5

Notes:
[1] All mapped Project clearing or physical disturbance in monitored wetlands. See ECOSTEM (2020) for the mapping.
[2] Area shown is an arbitrary value to capture sediment deposited in patches of standing water intermingled in surface peat.



Map 3-1: **Monitored off-system marsh wetlands in relation to the Project components**

3.2 INDIVIDUAL WETLANDS

3.2.1 WETLAND 3

Wetland 3 (Photo 3-1) is 5.0 ha in size (Table 3-1), and located about 1 km from the Nelson River, approximately 21 km west of the generating station site (Map 2-2). This wetland has a direct surface water connection to the Nelson River through a lake and then a short stream. Marsh habitat comprised 1.1 ha of the wetland's total area. The 2013 wildfire (see Section 2.0) burned approximately 90% of the marsh habitat buffer (*i.e.*, a 100 m buffer of the marsh habitat) included in Wetland 3.

No Project clearing or disturbance was observed in Wetland 3 during the 2015 survey.

By 2016, a band of trees ranging from approximately 1 to 10 m wide in the marsh habitat and buffer had been removed by reservoir clearing (Map 3-1; Figure 3-1). This clearing, which was located along the shoreline, impacted 0.36 ha of the total 5.0 ha Wetland 3 area (Table 3-2). Approximately 0.25 ha of this clearing was within the possibly disturbed Project footprint.

Approximately 0.26 ha of the cleared area was in the marsh habitat buffer and 0.10 ha was in the marsh habitat (Table 3-1). Cleared trees were visible where collapsed or collapsing peatlands outside of the planned Project footprint had become part of the marsh habitat (Photo 3-2).

No further clearing or disturbance was observed in this wetland during the 2017, 2018 or 2019 surveys. It was noted in 2017 that water levels were lower than in previous years, but water levels appeared to be near the median in 2018 and relatively unchanged in 2019.

Figure 3-1: Satellite imagery showing reservoir clearing (all within the approved Project footprint) at Wetland 3 in 2019

Photo 3-1: Aerial view of Wetland 3 on September 9, 2019

Photo 3-2: Cleared trees in Wetland 3 on August 31, 2017

3.2.2 WETLAND 17

Wetland 17 (Photo 3-3) is 135.1 ha in size and located on the southwest shore of a small lake located near the kilometer 6 point of the north access road (NAR) (Map 3.1). Marsh habitat comprised 97.5 ha of the wetland's total area. Approximately 85% of the marsh habitat buffer burned in the 2013 wildfire.

Project disturbance or clearing had not been observed within Wetland 17 up to the time of the 2019 surveys (Figure 3-2). Ground surveys conducted from 2015 to 2017 found no incremental changes in the condition of the wetland (Photo 3-4). Ground surveys were not conducted in 2018 and 2019 as the aerial surveys found no new clearing or activity nearby. Details about conditions observed in Wetland 17 in previous survey years are provided in ECOSTEM (2018).

Future surveys will continue to monitor Wetland 17 for signs of change.

Figure 3-2: Satellite imagery showing Wetland 17 in relation to the North Access Road in 2019

Photo 3-3: Aerial view of Wetland 17 on September 9, 2019

Photo 3-4: Ground photo of Wetland 17 on August 23, 2017

3.2.3 WETLAND 37

Wetland 37 (Photo 3-5, Photo 3-6) is 17.0 ha in size, and located near the north dyke, adjacent to EMPA D3-E (Map 3-1). Marsh habitat comprised 4.1 ha of the wetland's total area. Approximately 5% of the marsh habitat buffer burned in the 2013 wildfire.

No Project clearing or disturbance was observed in Wetland 37 in 2015.

The 2016 ground survey found that a very small amount of EMPA clearing in the possibly disturbed Project footprint (< 0.01 ha; Table 3-1; Figure 3-3) extended into the buffer portion of the wetland. Ground surveys from 2017 to 2019 found no further changes to the EMPA and no new impacts on the wetland were observed.

The potential for sediment runoff from the EMPA into the wetland buffer is likely decreasing because the EMPA is becoming increasingly vegetated, which will help stabilize the soil (Photo 3-6). Evidence of runoff has not been recorded for past few years.

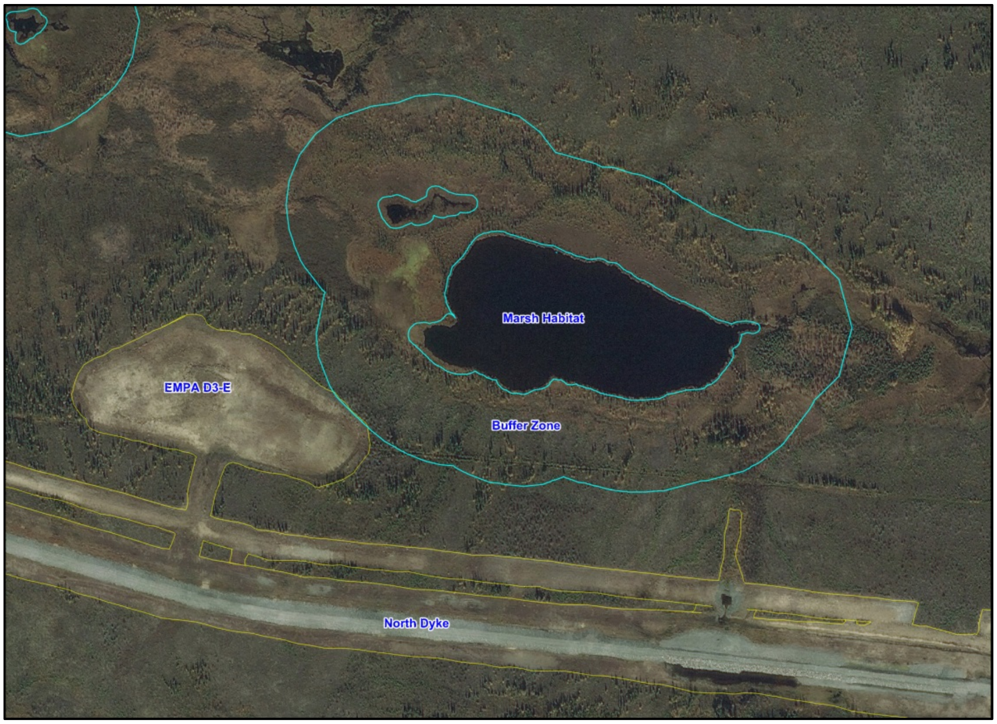


Figure 3-3: Satellite image showing EMPA D3-E adjacent to the Wetland 37 buffer

Photo 3-5: Ground photo of Wetland 37 in 2019

Photo 3-6: Aerial photo of Wetland 37 in 2019 looking south with EMPA D3-E (yellow arrow) in background

3.2.4 WETLAND 40

Wetland 40 (Photo 3-7) is 7.9 ha in size, and located along the north dyke, approximately 750 m east of Wetland 37 (Map 2-2). Marsh habitat comprised 1.2 ha of the wetland's total area. Approximately 10% of the marsh habitat buffer burned in the 2013 wildfire.

There was no Project clearing or disturbance observed within Wetland 40 during the 2015 ground survey.

By the time of the 2016 survey, planned Project clearing for the dyke (Map 3-1) had extended through the buffer to approximately 3 m away from the southern portion of the marsh habitat (Figure 3-4). All of this 1.75 ha of clearing was within the planned Project footprint (Table 3-2). It was noted in 2017 that water levels in the marsh habitat at the time of the survey appeared to be lower than the median level based on exposed underwater portions of marsh vegetation. Surveys in 2018 and 2019 found that water levels appeared to be approximately at the median level in Wetland 40 (Figure 3-5).

It was also noted in 2016 that a shallow slope leading from the dyke clearing to the water's edge should be monitored for the potential to transport sediment from the exposed mineral of the dyke into the marsh. In 2017, it was recommended that a silt fence be installed between the dyke clearing and the wetland at the base of the slope. As of September 2019, no sedimentation or runoff from the dyke was observed, and there had been no recent construction activity in the vicinity. The mineral slope facing the marsh remained shallow, and it appeared that risk of sedimentation due to runoff was low under current conditions. A peatland with black spruce seedlings and saplings was continuing to regenerate between the dyke clearing and the marsh (Figure 3-5). As regeneration progresses, this peatland is expected to become an increasing barrier to potential runoff. Given the stable condition of the area, no mitigation is recommended at this location. These areas will be monitored for any future runoff effects.

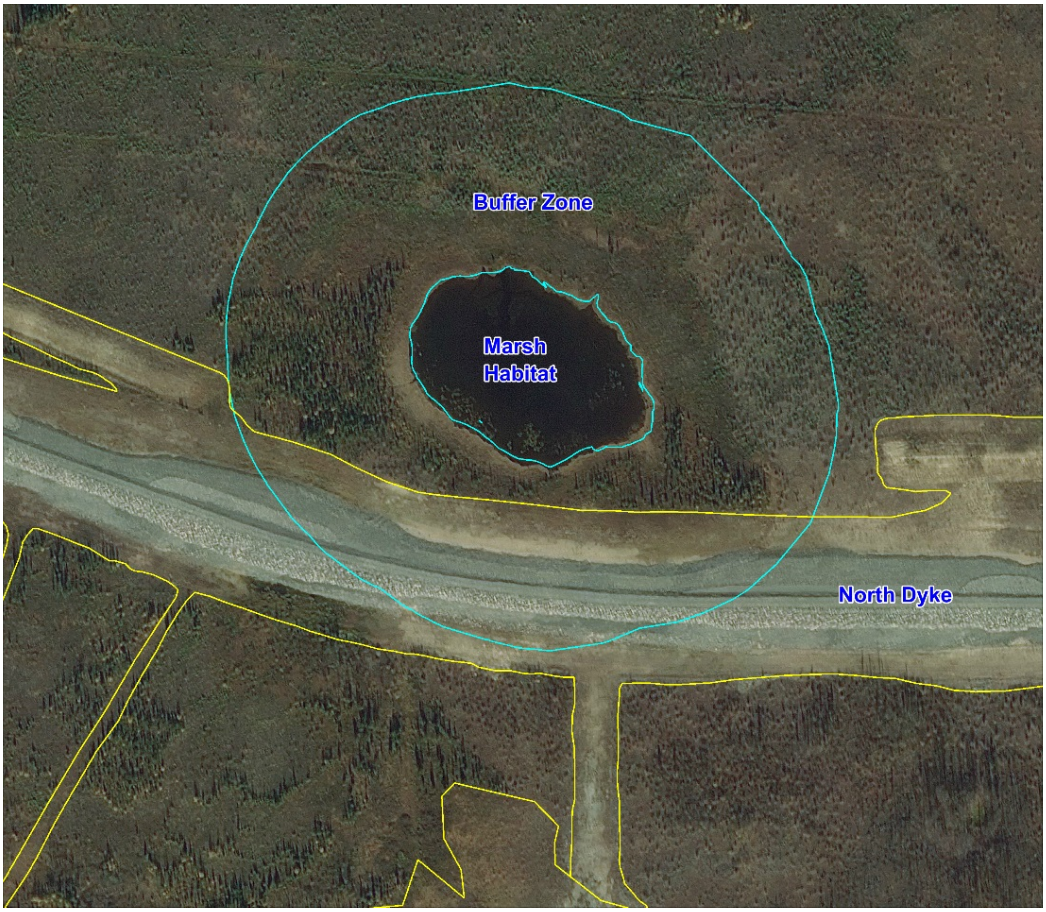


Figure 3-4: Satellite imagery showing dyke clearing (all within the planned Project footprint) at Wetland 40 in 2019

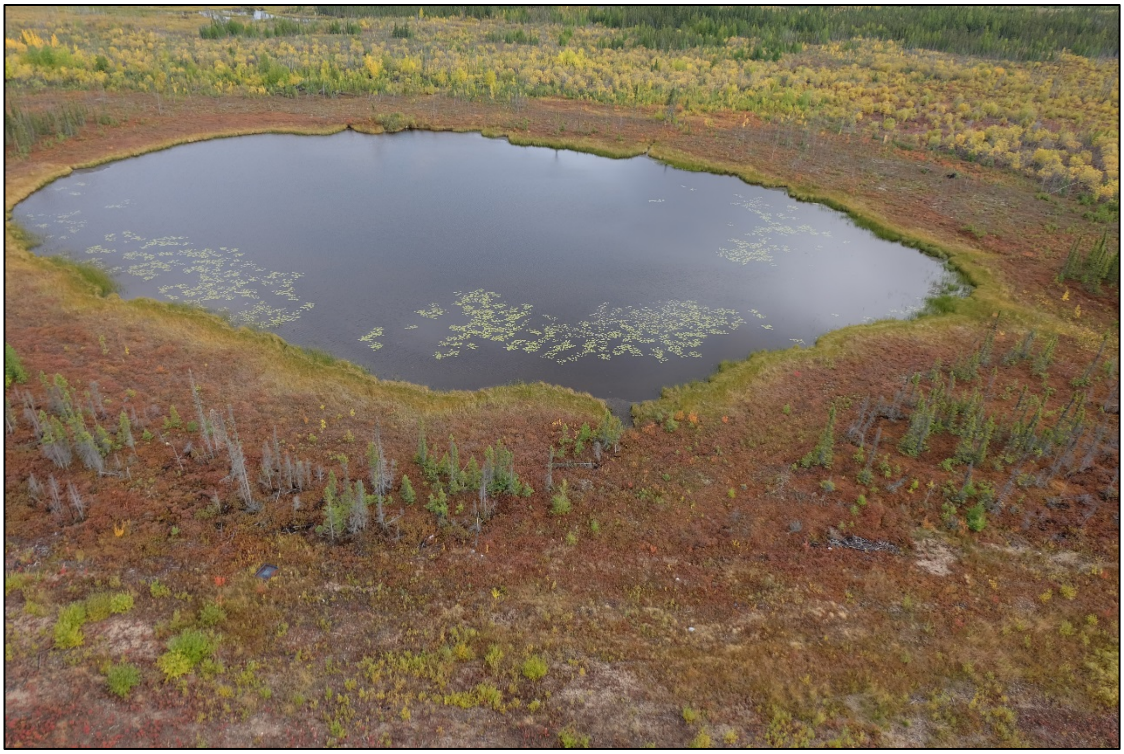


Photo 3-7: Aerial view of Wetland 40 on September 9, 2019

View along the shores of Wetland 40

Regenerating peatland between marsh and dyke clearing

Figure 3-5: Ground photos of Wetland 40 on September 9, 2019

3.2.5 WETLAND 42

Wetland 42 (Photo 3-8) is 15.5 ha in size, and located approximately 750 m north of the NAR at kilometer 14, at the northwestern end of Borrow Area G-1 (Map 2-2). Marsh habitat comprised 2.9 ha of the wetland's total area. Approximately 50% of the marsh habitat buffer burned in the 2013 wildfire.

There was no Project clearing or disturbance observed near Wetland 42 during the 2015 aerial survey.

Ground surveys were not conducted at Wetland 42 in 2016 due to safety-related access restrictions. Aerial surveys in 2016 found that clearing for Borrow Area G-1 had expanded northwest towards Wetland 42 since 2015 (Map 3-1). At the time of the 2016 surveys, clearing was still approximately 90 m away from the marsh habitat buffer (Figure 3-6). Project disturbance within the wetland was not visible in the DOIs or aerial photos.

During the 2016 aerial survey, it was noted that there was a significant slope extending downwards from Borrow Area G-1 clearing to the southern edge of the wetland. A sediment control recommendation was not made given that the band of undisturbed vegetation between the exposed mineral area and the marsh buffer was approximately 90 m wide.

Up to the time of the 2019 surveys, there were no signs of erosion along the slope to the wetland. Also, there were no apparent changes in the undisturbed vegetation between the wetland and the cleared area in Borrow Area G-1 (Photo 3-9), and no new clearing or excavation in the nearby portion of Borrow Area G-1. Ground surveys in 2018 found that the peat bank at the base of the slope adjacent to the wetland was beginning to slump and break apart (Photo 3-10). This was likely due to melting permafrost in the recently burned peat plateau bog. The band of intact vegetation will continue to be monitored in order to determine if there is any erosion or surface runoff from the slope into the marsh, but the risk for this is declining due to the advanced state of regeneration in Borrow Area G-1.

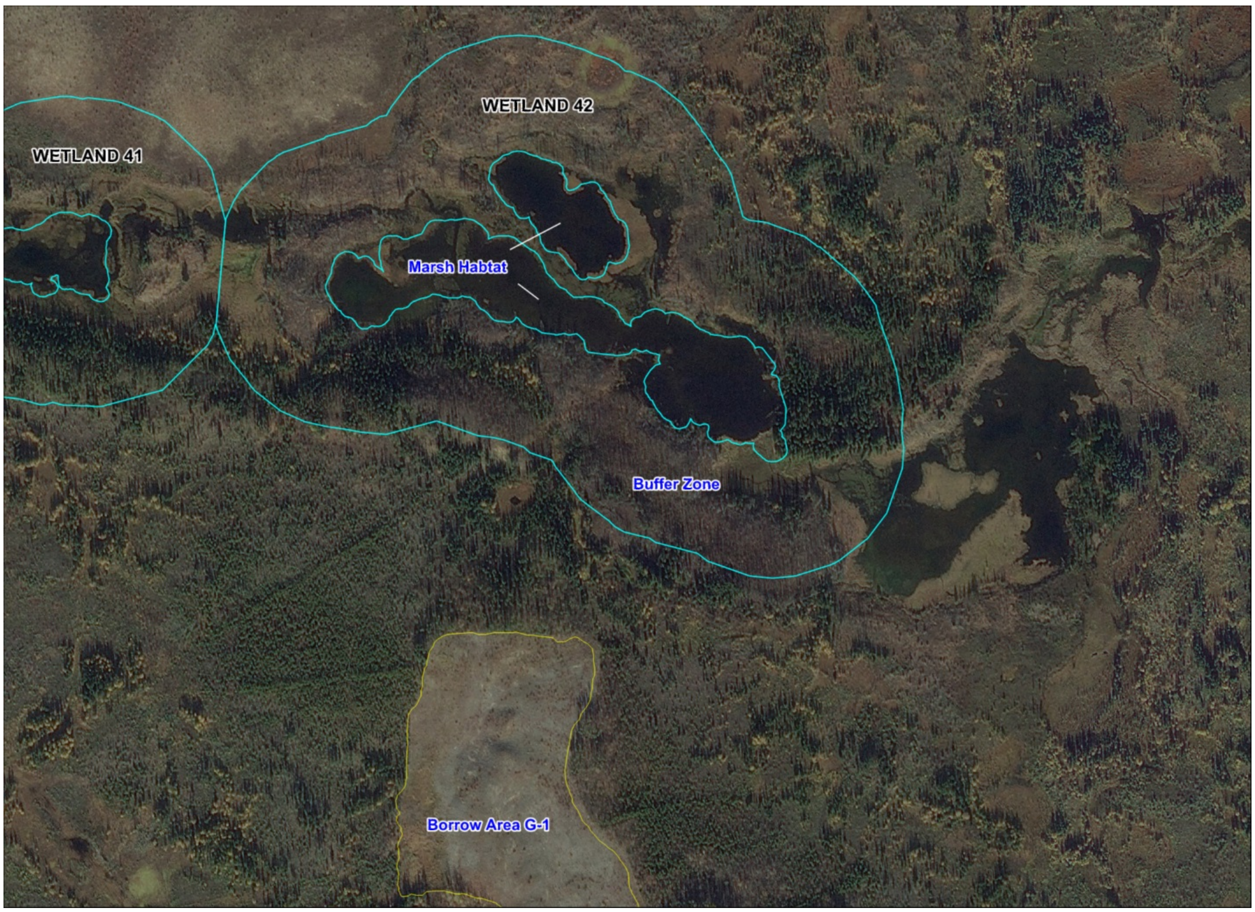


Figure 3-6: Satellite imagery showing proximity of Borrow Area G-1 clearing to Wetland 42

Photo 3-8: Aerial view of Wetland 42 on September 9, 2019

Photo 3-9: Marsh habitat in Wetland 42 on September 9, 2019

Photo 3-10: Slumping peat bank adjacent to Wetland 42 on September 16, 2018

3.2.6 WETLAND 45

Wetland 45 (Photo 3-11) is 7.3 ha in size, and located along the north dyke, approximately 1.5 km east of Wetland 40 (Map 2-2). Marsh habitat comprised 0.8 ha of the wetland's total area. Approximately 50% of the marsh habitat buffer burned in the 2013 wildfire. Some of the burned area was between the planned north dyke and the marsh habitat, and some sites within this area had either a thin layer of organic matter or exposed mineral substrate.

At the time of the 2015 ground survey, north dyke clearing extended approximately 3 m into the buffer on the south side of Wetland 45 for about 60 m. All of this clearing was within the planned Project footprint. No other Project clearing or disturbance was observed next to this wetland in 2015.

By the time of the 2016 ground survey, north dyke clearing had extended approximately 25 m into the marsh habitat buffer (Figure 3-7; Map 3-1). All of this 0.24 ha of clearing was within the planned Project footprint (Table 3-2) and no other Project impacts were noted at that time. All of the dyke clearing within Wetland 45 was also within the above noted burned area.

No further clearing was recorded within the marsh habitat buffer between 2016 and 2019.

A slope of approximately 15% through the dyke clearing area to the marsh habitat creates the potential for future surface runoff to carry material into the marsh habitat. In addition to the slope containing exposed mineral material in the cleared area (Figure 3-8), the entire slope had been burned with some areas having virtually all vegetation removed. At the time of the 2019 surveys, no runoff or sedimentation was seen entering the marsh habitat. It was noted that there was a small hill between the wetland and the dyke, which may serve as a natural barrier to potential future runoff. In 2017, it was recommended that staff evaluate and implement sediment control measures such as silt fence where needed as a preventative measure (e.g., a silt fence at the base of the dyke). A short silt fence was installed at one location (Figure 3-8). Given the subsequent stability, additional silt fences no longer appear to be necessary at this location. These areas will be monitored for any future runoff effects.

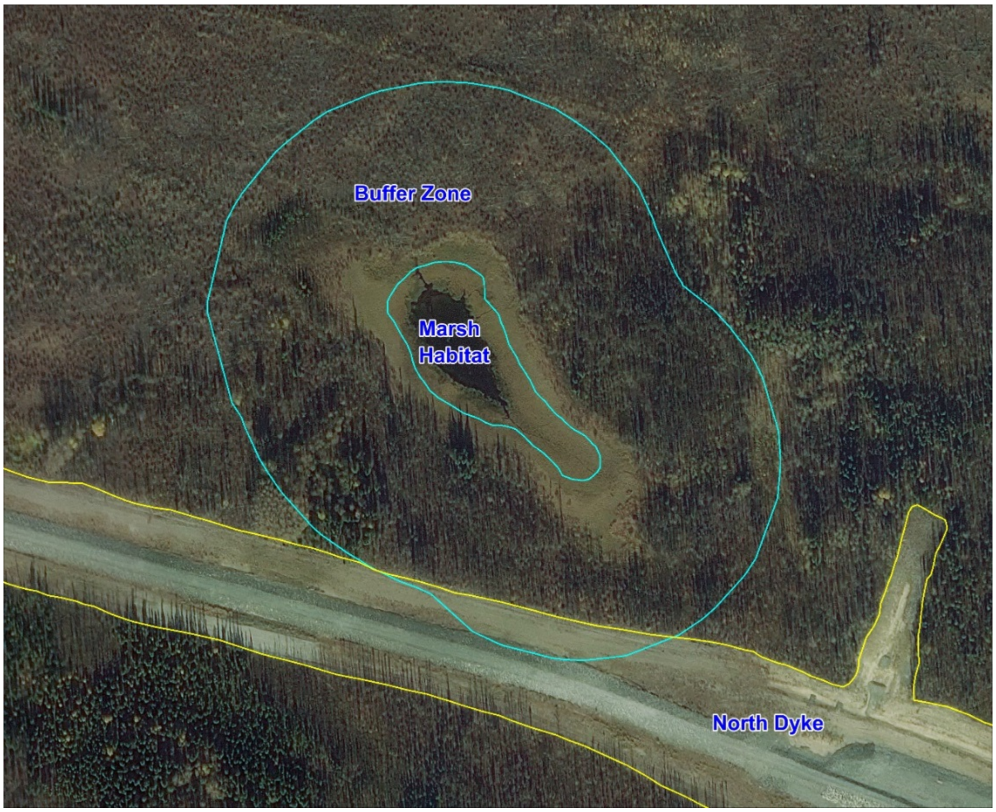


Figure 3-7: Satellite imagery showing North Dyke clearing (all within the planned Project footprint) at Wetland 45 in 2019

Photo 3-11: Aerial view of Wetland 45 on September 9, 2019

View along the shore of Wetland 45

Silt fence installed at bottom of North Dyke slope near Wetland 45

Figure 3-8: Ground and aerial photos of Wetland 45 on September 9, 2019

3.2.7 WETLAND 47

Wetland 47 (Figure 3-9; Photo 3-12) is 189.1 ha in size, and located approximately 100 m southeast of EMPA D27(4)-E (Map 2-2). Marsh habitat comprised 140.1 ha of the wetland's total area. None of the marsh habitat buffer burned in the 2013 wildfire.

Project clearing or disturbance in this wetland was not observed during the 2015 aerial survey.

In 2016, a small amount of clearing within the possibly disturbed Project footprint (0.02 ha in total) extended into the northwestern and northeastern edges of Wetland 47 (Map 3-1), all of which was in the marsh habitat buffer. Approximately half of this clearing was for an EMPA, and the other half was for a cutline, both of which were within the possibly disturbed Project footprint.

As of August 2017, a total of 1.03 ha of Wetland 47 was cleared, 1.01 ha of which was in the planned Project footprint (Table 3-2). No further clearing had occurred within the possibly disturbed Project footprint. At the northwestern edge, South Dyke clearing occurred within 50 m of the shoreline (Figure 3-9). A runnel, draining water through the wetland north of the dyke into the lake, was cleared and blocked by the dyke where it was within the planned Project footprint. Water had started to accumulate in the reservoir area north of the dyke by the time of the 2019 aerial surveys. This buildup of water is not expected to cause any further disturbance once the reservoir has been impounded.

While no further clearing had occurred between the 2017 and 2019 surveys, the South Dyke construction was occurring near the wetland. Aerial surveys found no apparent effects in the marsh habitat due to runoff from the dyke clearing and infrastructure (Figure 3-9). Ground surveys were not conducted in 2019 due to heavy construction activity nearby.

In 2017, it was noted that water levels in the wetland were lower than the median based on the degrees of exposed aquatic vegetation and lake-bottom. In 2018, water levels appeared to be approximately at the median. Aerial surveys in 2019 found that water levels appeared to be lower than in 2018, but not as low as in 2017. Construction of the South Dyke may have altered water inputs into the lake in Wetland 47. The wetland will continue to be monitored for changes in 2020.

Figure 3-9: Satellite imagery showing water accumulation north of Wetland 47 in the future reservoir area in 2019

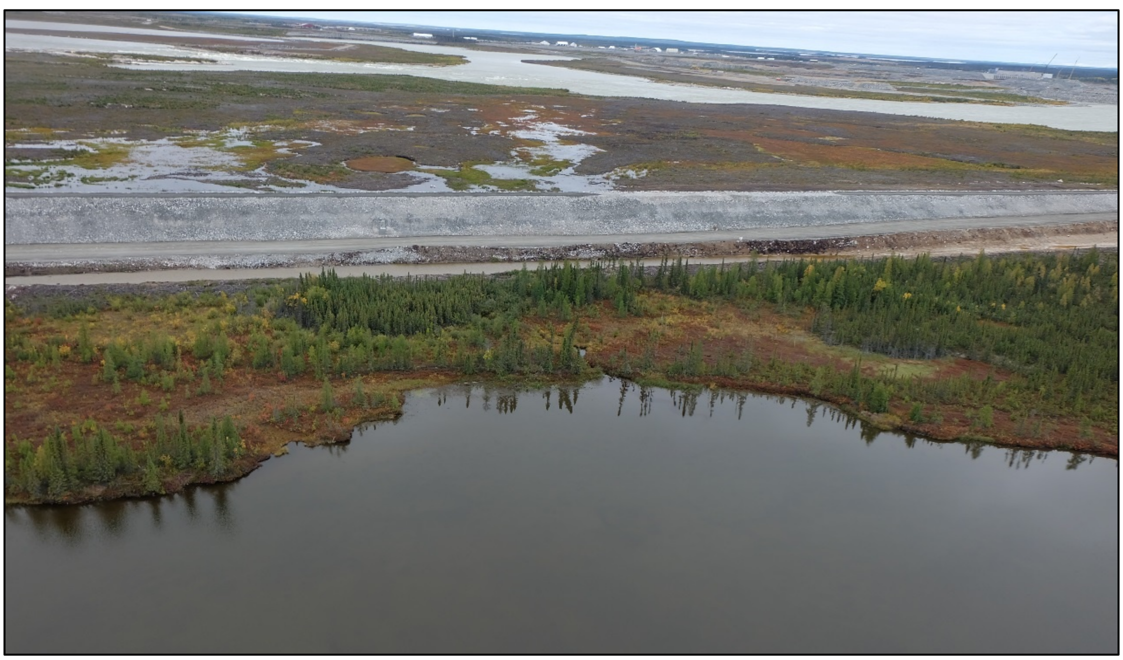


Photo 3-12: Aerial view of Wetland 47 on September 9, 2019

3.2.8 WETLAND 51

Wetland 51 is 25.7 ha in size and located immediately northwest of EMPA D16 (Map 2-2, Figure 3-10). Marsh habitat comprised 10.5 ha of the wetland's total area. Approximately 20% of the marsh habitat buffer burned in the 2013 wildfire.

Ground surveys in August 2015 identified clearing for an EMPA within 25 m of the edge of Wetland 51 (Map 3-1), all of which was within the planned Project footprint.

Project disturbances recorded in 2015 included heavy machinery rutting along the western edge of the EMPA. Other Project impacts included erosion and sedimentation at the base of the EMPA slope on the northern and northwestern edges. Mitigation measures in place at the time of the survey included a soil berm and a silt fence to prevent runoff into the adjacent marsh habitat. Portions of the silt fence, which was installed along the western edge of the EMPA, had fallen over. Erosion and sedimentation into a creek that flows into Wetland 51 were observed.

Some dead and dying vegetation was observed adjacent to the creek near the base of the EMPA slope during the 2015 survey. It was unclear if construction activity or sedimentation had caused this. Mineral soil had begun to cover the creek bed in areas where marsh plants were growing (this was outside of Wetland 51 boundaries).

No Project clearing, disturbance or other impacts were observed within Wetland 51 in 2016. By the time of the 2016 ground survey, some EMPA D16 banks had been graded, creating gentler slopes on the northwestern edges. The slope grading had removed the heavy machinery rutting and soil berm that was present in 2015, and the silt fence that was previously present had also been removed. These slopes were within the licensed Project footprint and came within approximately 2 m of the Wetland 51 boundaries. There was no sedimentation into the wetland at the time if the 2016 survey. In that year's annual report (ECOSTEM 2017), it was recommended that sediment control measures be placed at strategic locations along the northwestern, northern and eastern EMPA banks to prevent further spread towards Wetland 51 or towards the Stephens Lake/Nelson river channel.

As of late summer 2017, the only additional Project impact within Wetland 51 was sediment deposition into the buffer portion of the wetland. There was no apparent vegetation mortality within Wetland 51 between the EMPA slope and waterbody shoreline.

Sediment deposition from EMPA D16 into the marsh habitat buffer was still ongoing as of September 2019, despite the previous installation, and subsequent removal, of silt fences at the base of the EMPA slope. The apparent affected area had not increased since 2017. While the EMPA D16 slopes adjacent to the buffer in Wetland 51 had been graded, erosion channels had developed in the slope. Flow from the larger channels undermined or overtopped the silt fences at a couple locations in 2018. Installation of straw wattles within the channels slowed but did not stop sediment deposition into the water adjacent to the wetland (Figure 3-12). While sediment had not covered any of the wetland vegetation within the marsh buffer, sediment may have been deposited into the waterbody. There was no noticeable change in emergent vegetation cover in the sediment deposition area between 2018 and 2019. As no attempt was made to map the spatial extent of sediment deposition in the waterbody, the impact was represented by an area of 0.005 ha.

Peat bank slumping was observed around a small peat plateau bog between the wetland and EMPA slope in 2017. There did not appear to be any incremental change to the bog between 2017 and 2019. It was unclear if potential water regime changes due to the EMPA caused or accelerated this slumping, or if the slumping was due to massive ground ice melting that is occurring throughout the Keeyask region as a delayed response to past climate warming (ECOSTEM 2011).

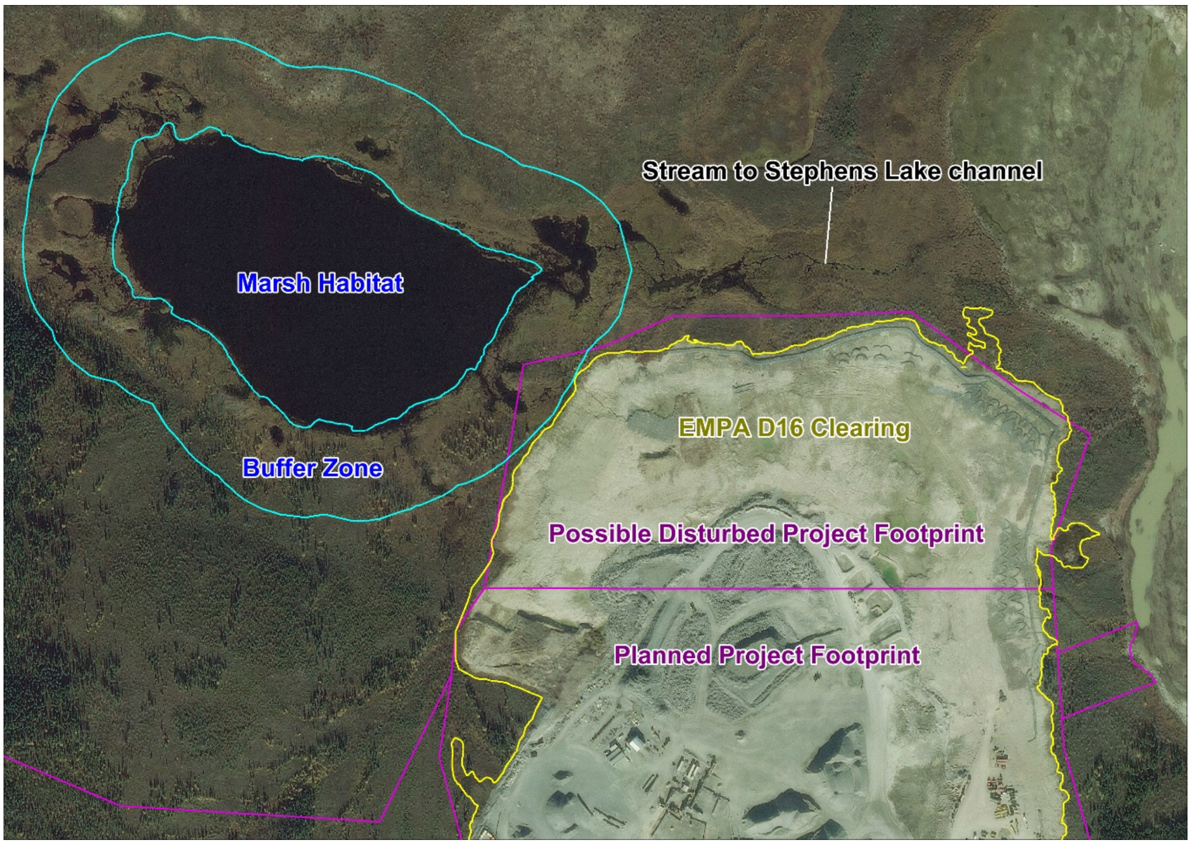


Figure 3-11: Wetland 51 in 2019 satellite imagery showing adjacent EMPA, stream to Stephens Lake channel, 2019 Project clearing (yellow line), and the boundaries of licensed Project footprint (purple line)

Aerial view of EMPA D16 slope near the east shore of Wetland 51, showing erosion channels and sediment entering marsh habitat buffer

Sediment overtopping straw wattles placed within channels along western edge of Wetland 51

Figure 3-12: Aerial and ground photos of Wetland 51 in September 2019

3.2.9 WETLAND 52

Wetland 52 (Figure 3-13) is 28.4 ha in size and located south of Gull Rapids (Map 2-2). Marsh habitat comprised 9.1 ha of the wetland's total area. None of this wetland's buffer was burned in the 2013 wildfire.

There was no observed clearing or disturbance in or near Wetland 52 at the time of the 2015 aerial survey. The south access road (SAR) right-of-way (ROW) had been cleared, but road construction had not entered the marsh habitat buffer.

Project clearing or disturbance was not observed within Wetland 52 during the surveys from 2016 to 2019 (Map 3-1). Potential hydrological impacts from the SAR were being monitored, but to date none have been observed. Consequently, ground surveys were not conducted at Wetland 52 in 2019. See ECOSTEM (2018) for specific observations made in previous survey years.

Monitoring for potential Project effects will continue.

Figure 3-13: Satellite imagery showing proximity of Project clearing to Wetland 52

3.2.10 WETLAND 53

Wetland 53 is 5.5 ha in size. It is located on the south side of the Nelson River, just downstream of the future generating station (Map 2-2). Marsh habitat comprised 0.3 ha of the wetland's total area. None of the marsh habitat buffer burned in the 2013 wildfire.

Clearing in the marsh habitat buffer was observed during the 2015 aerial surveys. This clearing was for the Keeyask Transmission Project right-of-way (RoW), which is a separate project (Figure 3-14; Photo 3-13). See ECOSTEM (2018) for details.

Surveys from 2016 to 2019 found no new impacts or expansion of the impacts that were present in 2015.

Figure 3-14: Satellite imagery showing Keeyask Transmission Project clearing in the Wetland 53 buffer zone

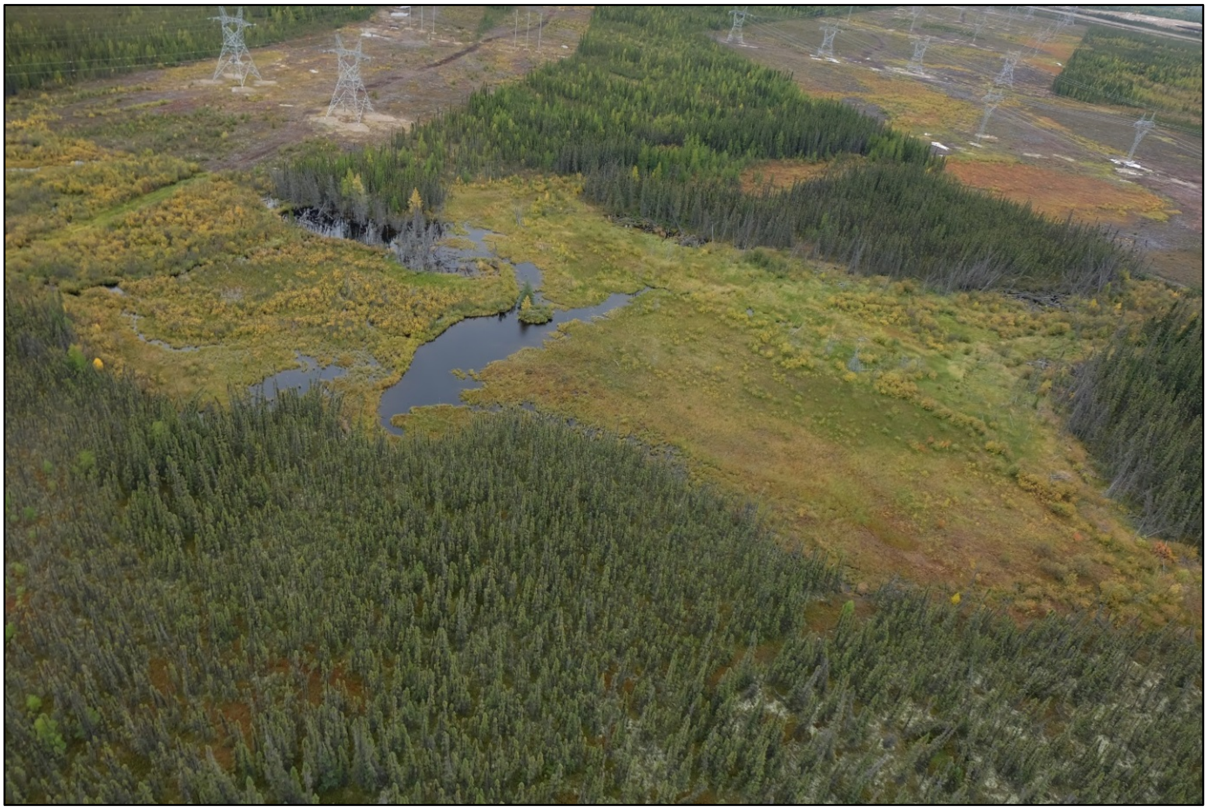


Photo 3-13: Aerial photo of Wetland 53 on September 9, 2019

3.2.11 WETLAND 54

Wetland 54 (Photo 3-14) is 113.1 ha in size, and located along the north side of the SAR, north of Borrow Area S-2b (Map 2-2). Marsh habitat comprised 70.1 ha of the wetland's total area. None of the marsh habitat buffer burned in the 2013 wildfire.

Surveys in 2015 and 2016 found clearing and disturbance in the marsh habitat buffer, but this was for the Keeyask Transmission Project RoW (Figure 3-15). Ground surveys in 2016 and 2017, and aerial surveys in 2018 and 2019 found no expansion of the impacts recorded in 2015 and 2016. The relatively dense existing low vegetation in the cleared areas within 100 m of the marsh should be adequate to stabilize soils and facilitate revegetation. Specific observations regarding the impacts observed in 2015 and 2016 are provided in ECOSTEM (2018).

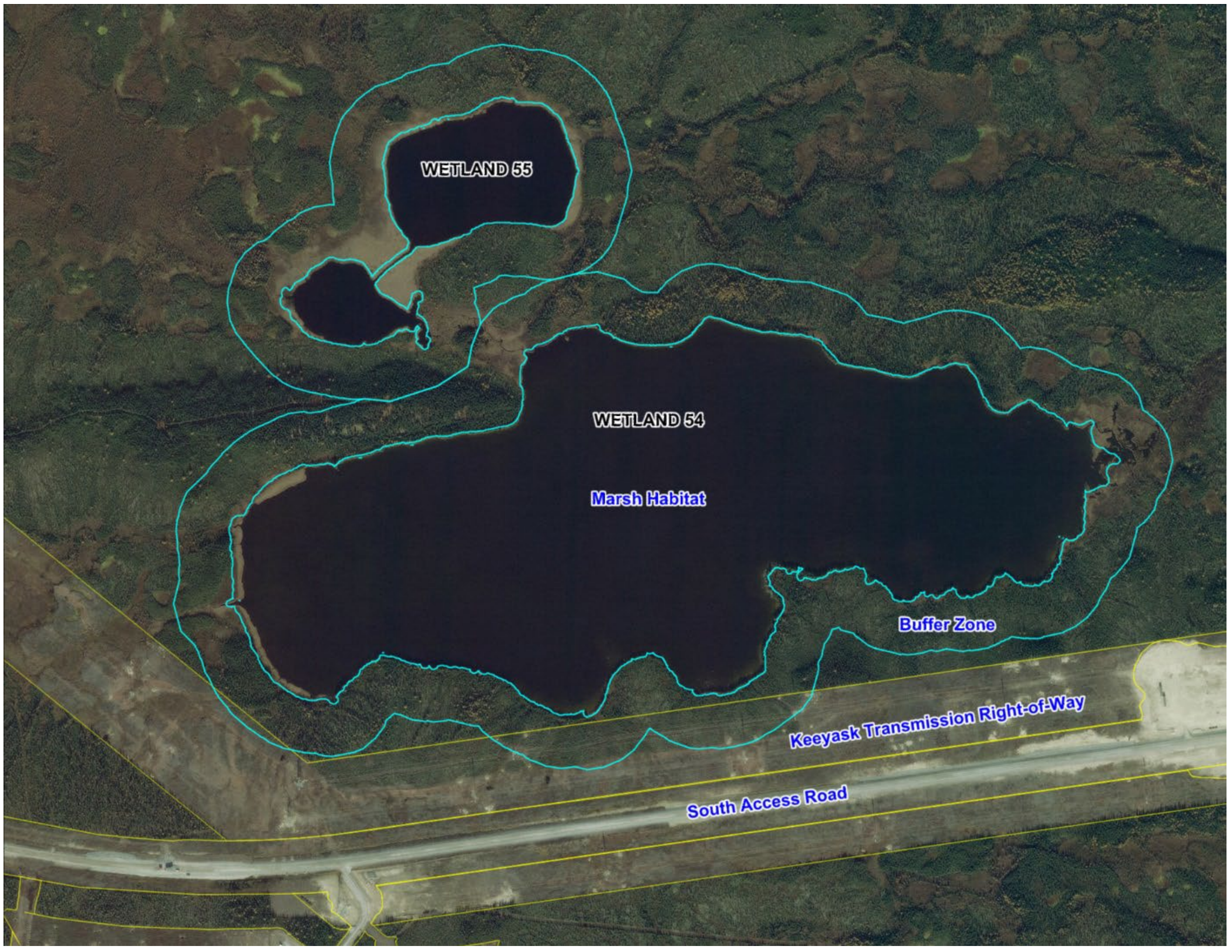


Figure 3-15: Satellite imagery showing Keeyask Transmission Project clearing in the Wetland 54 buffer zone

Photo 3-14: Aerial view of Wetland 54 (west end) on September 9, 2019

3.2.12 WETLAND 57

Wetland 57 is 64.6 ha in size, and nestled between the Butnau Road and Stephens Lake, with its buffer overlapping the road to the south and a dyke to the north (Map 2-2). Marsh habitat comprised 37.6 ha of the wetland's total area. None of the marsh habitat buffer burned in the 2013 wildfire.

Ground surveys in 2015 found that construction of the SAR had cleared 0.21 ha in the southern edge of the buffer, and all of this was within the planned Project footprint (Figure 3-16). No clearing or disturbance was found in the marsh habitat. Ground surveys in 2016 found that clearing in the marsh habitat buffer had increased to 0.79 ha (Table 3-2), which was 0.58 ha higher than in 2015. All of the clearing was still within the planned Project footprint and no clearing or disturbance was found in the marsh habitat.

Surveys from 2017 to 2019 found no additional clearing or disturbance in the marsh habitat buffer or marsh habitat.

In terms of other potential Project impacts, the wetland drains through a natural channel into a ditch along the SAR (Figure 3-17). In 2016 and 2017, the observed water levels in the wetland's waterbody were very low compared to those observed in 2015 (Figure 3-17). One possible cause for the low water levels observed in 2016 and 2017 was the construction of the SAR, itself. Improved drainage through the new culvert under the road may have increased the rate of outflow from the wetland, thereby lowering water levels. The lower water levels exposed some of the lake bottom, and by 2017, new wetland vegetation was establishing on the exposed lake bottom and in the shallow water, resulting in expansion of the wetland vegetation.

By the time of the 2018 surveys, water levels increased to levels similar to those observed in 2015. The most likely reason for the change between 2017 and 2018 was that a beaver dam was constructed in the drainage channel to the SAR ditch, which raised water levels in the wetland. Shore zone vegetation that had appeared in 2017 was still present in 2018.

In 2019, water levels were slightly lower than observed in 2018. Surveys in 2019 showed that the beaver dam had been breached (Photo 3-15) and water was flowing freely from the wetland (Photo 3-16) towards the SAR. The extent of shore zone vegetation remained approximately the same or greater compared to 2018.

This wetland will continue to be monitored in 2020.

Figure 3-16: Satellite imagery showing South Access Road clearing in the Wetland 57 buffer zone (all within the planned Project footprint)

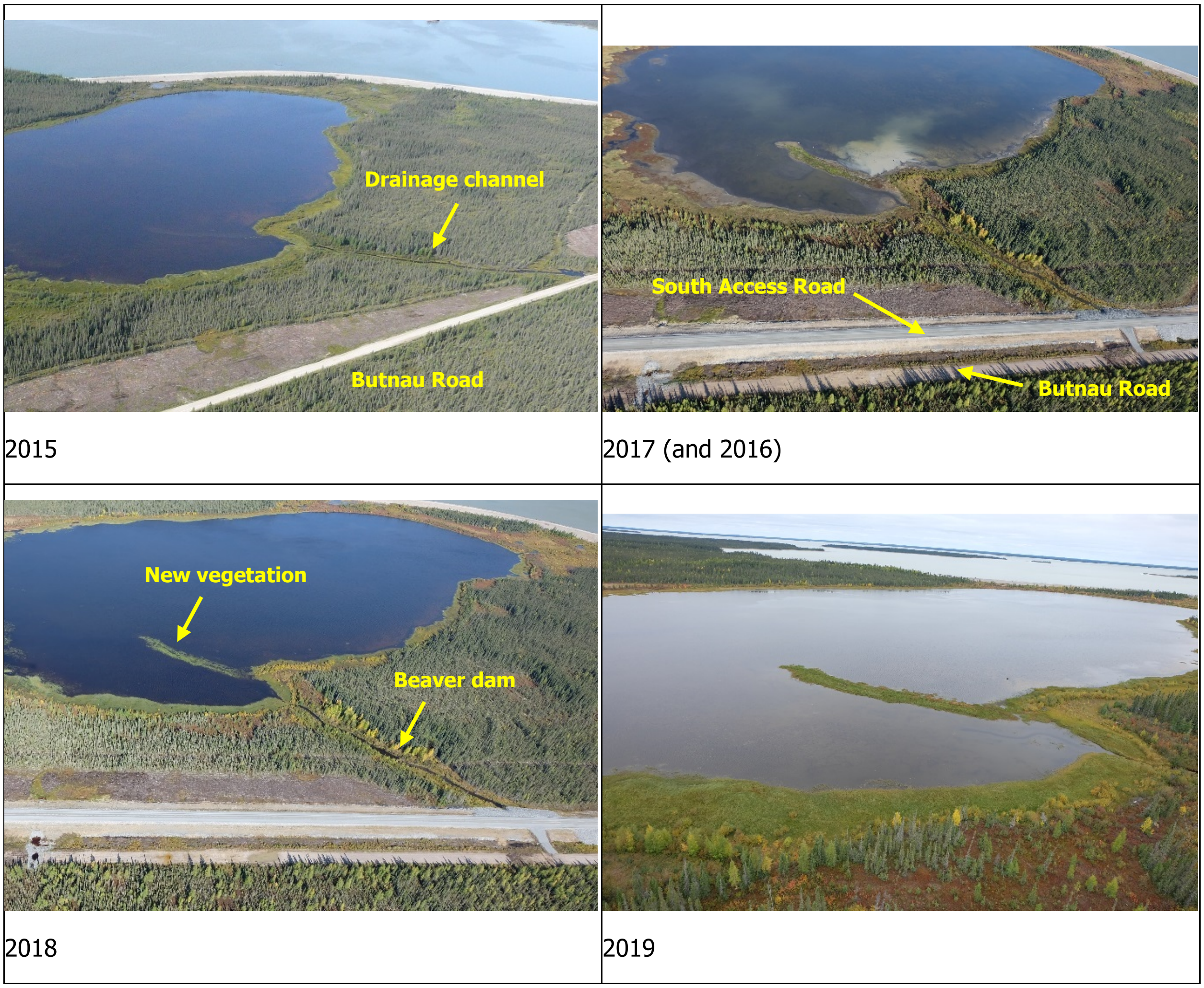


Figure 3-17: Aerial view of Wetland 57 showing varying water levels from 2015 to 2019

Photo 3-15: Breached beaver dam in drainage channel of Wetland 57 on September 9, 2019

Photo 3-16: Marsh habitat upstream of beaver dam in Wetland 57 on September 9, 2019

3.2.13 WETLAND 60

Wetland 60 is 232.4 ha in size. It is located approximately 6.6 km south of Stephens Lake, just west of the access road corridor for the Ellis Esker borrow area (E-1) (Figure 3-18; Map 2-2). Marsh habitat comprised 150 ha of the wetland's total area. None of the marsh habitat buffer burned in the 2013 wildfire.

Wetland 60 was monitored for the first time in 2018. The wetland is situated well outside of Study Zone 3 because this study zone was a buffer of the planned and possibly disturbed areas at the time the EIS was completed. At that time, it was thought the use of the Ellis Esker borrow area was highly unlikely (even so, its potential effects were assessed in the EIS).

Wetland 60 was added to the wetlands being monitored once the Ellis Esker area was cleared. Mapped Project clearing using the DOI recorded clearing within one meter of the buffer zone, which was likely within less than the positional error range of the DOI (Figure 3-18).

Surveys in 2018 and 2019 did not find any apparent effects of Project clearing on the marsh vegetation or hydrology. Impacts from the clearing were minimal, presumably because the road clearing and construction activity took place in the winter when the ground was frozen.

In terms of other potential Project impacts, a natural drainage channel into the wetland ran through the clearing (Figure 3-19). There is a possibility that the vegetation clearing, past construction activity or future revegetation activity could alter water flow into the wetland through localized changes to the moisture regime or soil compaction.

Figure 3-18: Satellite imagery showing proximity of Project clearing to Wetland 60

Ellis Esker access road adjacent to wetland buffer

Looking southwest at western end

Figure 3-19: Aerial views of Wetland 60 on September 9, 2019

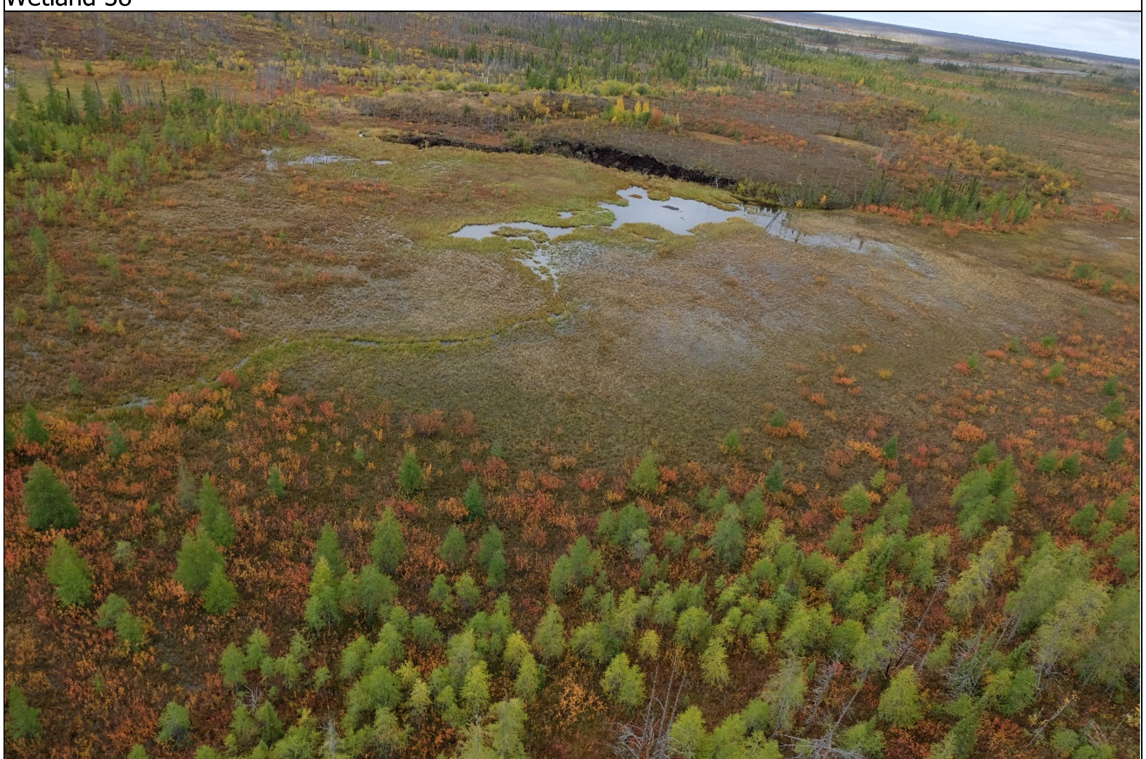
Photo 3-17: Ground view of marsh habitat (background) and marsh buffer (foreground) at Wetland 60 on September 9, 2019

3.2.14 REMAINING WETLANDS

As an example, Figure 3-20 shows the state of two of the remaining 31 wetlands visited during the aerial surveys. These wetlands were not closely surveyed because they were more than 100 m from existing Project clearing or disturbance, and there were no visible Project effects in them.

Monitoring in 2020 will determine if any of these 31 wetlands have been impacted by the Project since the 2019 surveys.

Wetland 38



Wetland 36

Figure 3-20: Aerial photos of Wetlands 38 and 36 on September 9, 2019

4.0 DISCUSSION

4.1 WATER LEVELS IN OFF-SYSTEM WATERBODIES

Project related effects on water levels and water level variability were of interest for the wetland monitoring because these factors are primary determinants of the amounts of off-system marsh and its habitat. As water levels in off-system waterbodies are not being monitored with equipment, the monitoring surveys recorded the water levels relative to the apparent median level in the waterbody. For this evaluation, indicators that water levels were relatively low were the degrees of exposed aquatic vegetation and lake-bottoms while indicators that water levels were relatively high were the degrees of flooding in upper beach and inland edge vegetation.

During the aerial surveys conducted in 2016 and 2017, it was noted that water levels most, if not all off-system waterbodies throughout Study Zone 3 (Map 2-2) appeared to be relatively low. The 2018 monitoring found that the water levels in these same waterbodies appeared to have risen to around median levels. Surveys in 2019 did not find any major changes from 2018.

The lower water levels observed in off-system waterbodies in 2016 and 2017 were likely due to natural factors rather than being related to Project development. The widespread extent of lower water levels suggested they were due to weather. As described in Section 2.4, this suggestion could not be supported with precipitation data because both of the weather stations within 125 km of the Project have large amounts of missing data for this period. The construction synthesis report, which is produced when all of the relevant data are available, will examine possible approaches to developing precipitation data for the Project area.

4.2 WETLAND IMPACTS AND MITIGATION

This section focuses on wetlands with new or ongoing Project impacts in 2019, and on wetlands with potential future impacts that merit mitigation or a particular focus during ongoing monitoring. Appendix 1 summarizes all mitigation recommendations provided to date for all wetlands.

At Wetland 57, water levels exhibited a pattern that was different from the overall pattern across all of the monitored wetlands, indicating possible hydrological effects from the Project. At the time of the surveys, water levels were very low in 2016 and 2017 in comparison with 2015, increased to 2015 levels in 2018, and then decreased slightly in 2019.

The available information suggested that a combination of Project and natural factors produced variable water levels in Wetland 57. One possible sequence of events is the following. Lower water levels in 2016 and 2017 could have been due to increased drainage following South Access Road (SAR) construction. The higher water levels seen in 2018 was at least partly due to a beaver dam that had been constructed in the channel draining the wetland. The subsequent drop in 2019 was at least partly due to the beaver dam having been breached. Variation in precipitation may have contributed to the degree of the year-to-year water level changes. In any event, the annual changes appear to have been minor relative to natural water variability. However, there still could be additional future Project influences since this wetland drains through a channel into a SAR ditch (e.g., if the nearby culvert becomes blocked or the beaver dam is repaired).

At Wetland 51, sediment was continuing to run off the west slopes of the nearby EMPA (D16) into the water adjacent to the buffer. As the situation between this EMPA and the marsh area is somewhat complex, several mitigation measures had been recommended and implemented for strategic locations from 2016 to 2018 (see Appendix 1 for details). Despite the mitigation efforts, the impacts continued into 2019.

In light of this, and due to its proximity to waterbodies connected to the Nelson River, two mitigation measures are recommended for Wetland 51. First, additional sediment control measures should be considered for the northwestern banks of EMPA D16 to prevent further deposition into the wetland buffer (sediment deposition and mitigation options for the eastern banks of the EMPA are addressed in another report (ECOSTEM 2020)). It is also recommended that, if this EMPA receives further excavated material, then it should be placed to the southwest of the existing material or on existing areas well back from the top of the bank.

New project disturbance or clearing was not observed at the remaining 11 wetlands that were within 100 m of actual Project clearing or disturbance at the time of the 2019 surveys. However, potential future impacts that merit a particular focus during future monitoring were noted for two of these wetlands.

At Wetland 47, there is a possibility that construction of the South Dyke has altered water flows into the lake, possibly affecting water levels. South Access Road construction may be altering water levels in Wetland 57. Over time, altered water flows and levels may change the amounts of marsh and its habitat in these wetlands.

For Wetlands 37, 40, 42 and 45, it is recommended that ground surveys be discontinued unless future aerial surveys detect evidence of recent disturbance or new construction activity near these wetlands.

5.0 SUMMARY AND CONCLUSIONS

The 2019 monitoring found that there had been no new Project clearing in any of the monitored wetlands since the 2016 surveys. Ongoing disturbance was recorded in one wetland (Wetland 51). In Wetland 51, previously recorded sediment deposition into standing water adjacent to the marsh habitat buffer was continuing.

As of 2019, Project clearing or disturbance within wetlands totalled 4.19 ha, and all of this was within seven of the 44 wetlands being monitored. Clearing accounted for the vast majority (99.9%) of this total.

Of the 4.19 ha of total Project clearing or disturbance within wetlands, only 0.11 ha (2.6% of the impacted area) was in marsh habitat (in one wetland within the future reservoir area) while 4.09 ha was in the marsh habitat buffers (in seven of the monitored wetlands). All of these impacts were within the licensed Project footprint (with 3.91 ha (93%) in the planned Project footprint and 0.28 ha in the possibly disturbed Project footprint).

Potential future Project impacts were noted for two of the monitored wetlands. At Wetland 47, South Dyke construction may have altered water flows into the lake where the wetland is located, affecting water levels. At Wetland 57, median water levels may have been decreased by South Access Road construction, but natural factors likely contributed as well (e.g., nearby beaver activity, precipitation variability).

To date, there have been no unanticipated effects on the off-system marsh wetlands being monitored by this study. While there has been some clearing or disturbance within four of the wetlands monitored under this study, this was expected as they overlapped the licensed Project footprint.

A number of mitigation recommendations were made to avoid or minimize potential future Project effects on the monitored wetlands. Monitoring fieldwork for the off-system marsh wetlands will continue in 2020. No major changes to field methods are anticipated.

6.0 LITERATURE CITED

ECOSTEM. 2011. Composition and distribution of shoreline and inland peatlands in the Keeyask reservoir area and historical trends in peatland disintegration. Report GN 9.2.1 prepared for Manitoba Hydro.

ECOSTEM. 2012. Terrestrial habitats and ecosystems in the lower Nelson River region: Keeyask regional study area. Keeyask Project Environmental Studies Program, Prepared for Manitoba Hydro. Report # 12-02.

ECOSTEM. 2013. Responses of Terrestrial Habitats to Reservoir Flooding and Water Regulation in Northern Manitoba. Keeyask Project Environmental Studies Program, Prepared for Manitoba Hydro. Report # 11-06.

ECOSTEM. 2016. Terrestrial Plant, Habitat, and Ecosystem Monitoring Report. Keeyask Generation Project Terrestrial Effects Monitoring Plan Annual Report #TEMP2016-01. A report prepared for Manitoba Hydro by ECOSTEM Ltd., June 2016.

ECOSTEM. 2017. Keeyask Generation Project Terrestrial Effects Monitoring Plan Report #TEMP-2017-03: Wetland Loss and Disturbance Monitoring Report. A report prepared for Manitoba Hydro by ECOSTEM Ltd., June 2017.

ECOSTEM. 2018. Keeyask Generation Project Terrestrial Effects Monitoring Plan Report #TEMP-2018-03: Wetland Loss and Disturbance Monitoring. A report prepared for Manitoba Hydro by ECOSTEM Ltd., June 2018.

ECOSTEM Ltd. 2019. Keeyask Generation Project Terrestrial Effects Monitoring Plan Report #TEMP-2019-03: Wetland Loss and Disturbance Monitoring. A report prepared for Manitoba Hydro by ECOSTEM Ltd., June 2019.

ECOSTEM. 2020. Keeyask Generation Project Terrestrial Effects Monitoring Plan Report #TEMP-2020-01: Habitat Loss and Disturbance Monitoring. A report prepared for Manitoba Hydro by ECOSTEM Ltd., June 2020.

Keeyask Hydropower Limited Partnership (KHLP). 2012a. Keeyask Generation Project Environmental Impact Statement: Response to EIS Guidelines, Winnipeg, Manitoba. June 2012.

Keeyask Hydropower Limited Partnership (KHLP). 2012b. Keeyask Generation Project Environmental Impact Statement: Terrestrial Environment Supporting Volume, Winnipeg, Manitoba. June 2012.

Keeyask Hydropower Limited Partnership (KHLP). 2015. Keeyask Generation Project Terrestrial Effects Monitoring Plan. Winnipeg, Manitoba. December 2015.

APPENDIX 1:
MITIGATION RECOMMENDATIONS

This appendix collates and summarizes the off-system marsh wetland mitigation recommendations made during the TEMP construction monitoring.

Table 6-1: Summary of Mitigation Recommendations

Wetland	Recommendation[1]	Mitigation or Follow-up Implemented
Wetland 37	2015: Evaluate and implement sediment control measures where needed to prevent sediment from entering the site along the north dyke. 2016, 2017 and 2018: Limit further clearing along northeastern edge of EMPA (D3-E) that overlaps buffer. Monitor for potential effects from slope runoff. 2019: The potential for runoff from EMPA is declining. Monitor only if new construction activity or disturbance occurs nearby.	No additional clearing has occurred along the northeastern edge of the EMPA. No mitigation recommended. In 2020, ground survey only if air surveys detect new construction activity or disturbance.
Wetland 40	2015: Add silt fence between the north dyke clearing and marsh at the base of the dyke. Evaluate and implement sediment control measures where needed. 2016, 2017 and 2018: Evaluate and implement sediment control measures such as silt fence where needed. Avoid northward extension of the existing dyke clearing, if possible. 2019: The potential for runoff from the dyke is declining. Monitor only if new construction activity or disturbance occurs nearby.	No additional northward clearing has occurred near the wetland buffer. No mitigation recommended. In 2020, ground survey only if air surveys detect new construction activity or disturbance.
Wetland 42	2017 and 2018: Monitor intact vegetation between Borrow Area G-1 and wetland for any erosion or surface runoff from the slope into the marsh. 2019: The potential for runoff from the borrow area is declining. Monitor only if new construction activity or disturbance occurs nearby.	No mitigation recommended. In 2020, ground survey only if air surveys detect new construction activity or disturbance.
Wetland 45	2015: Silt fence be added between the north dyke clearing and marsh at the base of the slope. Evaluate and implement sediment control measures where needed. 2016, 2017 and 2018: Evaluate and implement sediment control measures such as silt fence where needed. Avoid northward extension of the existing clearing, if possible. 2019: The potential for runoff from the dyke is declining. Monitor only if new construction activity or disturbance occurs nearby.	No additional northward clearing has occurred near the wetland buffer. Between 2017 and 2018, sediment fencing was installed at the base of the dyke bank adjacent to the wetland. Mitigation no longer recommended. In 2020, ground survey only if air surveys detect new construction activity or disturbance.
Wetland 47	2016 and 2017: Avoid a southeastern extension of the existing south dyke clearing, if possible.	No additional southward clearing has occurred near the wetland buffer.

Wetland	Recommendation[1]	Mitigation or Follow-up Implemented
	2017 and 2018: Monitor the drainage channels passing through the clearing into the wetland during south dyke construction. 2019: Monitor water levels in wetland and for potential effects from altered water flows. See Figure 6-1.	No mitigation recommended at this time
Wetland 51	2015: Inspect and enhance sediment control measures along the northern edges of the EMPA (D16). Erect a silt fence around the north and northwest side of the EMPA. 2016 and 2017: Silt fence be placed between the EMPA and marsh and water channel along the northwest, north and northeast edges of the EMPA at strategic locations. Place any additional excavated materials to the southwest of the placement area, or well back from the top of the bank. See Figure 6-2. 2018 and 2019: Consider additional sediment control measures along the northwestern banks of the EMPA to prevent continued sediment deposition into wetland.	In fall 2017, material in EMPA D16 was re-sloped and additional sediment fencing was installed. Between 2017 and 2018, additional sediment fencing was installed at the base of the slope adjacent to the wetland. Rock berms and woody debris armouring placed around northern and eastern edges of EMPA D16 in spring, 2018. Silt fences on western edge of EMPA D16 removed and straw wattles placed into erosion channels in April, 2019.
Wetland 52	2016, 2017, 2018 and 2019: Monitor water levels and condition of marsh outlet for runoff effects from SAR.	No mitigation recommended at this time.
Wetland 57	2016: Investigate possible causes for low water levels during 2017 surveys. 2019: Continue to monitor for water level changes and wetland development.	Field surveys in 2018 suggested that the low water levels may have been one of, or a combination of, natural water level variability, altered drainage due to construction of the SAR. A beaver dam increased water levels in the wetland in 2018. Breaching of the beaver dam in 2019 lowered water levels slightly since 2018.
Wetland 60	2018 and 2019: Monitor wetland for runoff effects from the Ellis Esker access corridor. Avoid additional clearing or disturbance near this wetland. See Figure 6-3.	No mitigation recommended at this time.

Notes: [1] Recommendations in addition to continued monitoring. The number at the beginning of a line indicates the year that the recommendation was made. See ECOSTEM (2016; 2017; 2018; 2019) for the 2015, 2016, 2017 and 2018 recommendations, respectively.

Figure 6-1: Mitigation areas and recommendations for Wetland 47

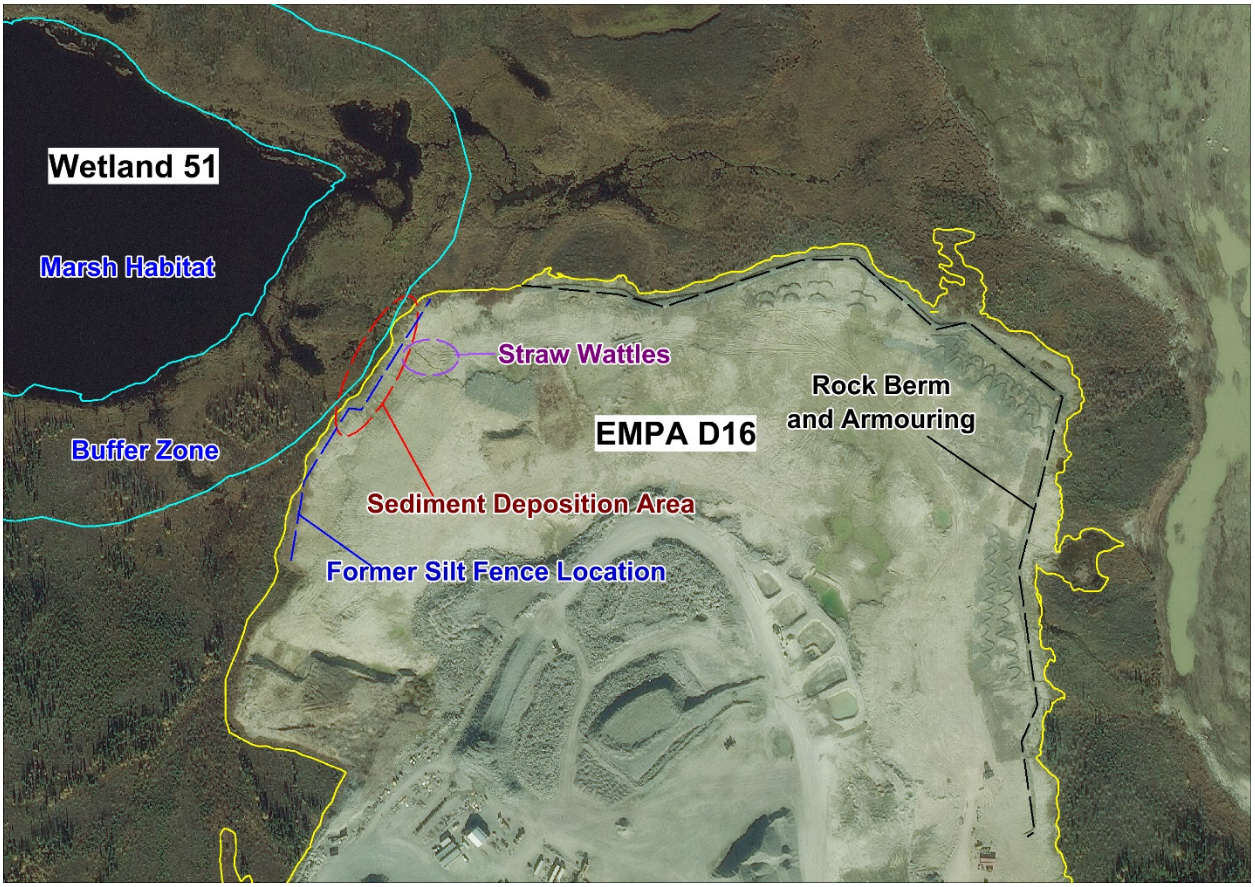


Figure 6-2: Mitigation areas and recommendations for Wetland 51

Figure 6-3: Mitigation areas and recommendations for Wetland 60