6-D: Portt 2015 Road Baseline Report

It should be noted that this historical baseline report (Appendix 6-D) was reviewed and received conformity approval as part of the Approved Project FEIS submission (Agnico Eagle 2016c), and then final approval under Project Certificate No. 008. This baseline report remain unchanged.

AMARUQ EXPLORATION ACCESS ROAD AQUATICS BASELINE REPORT
2015 AGNICO EAGLE MINES LTD. - MEADOWBANK DIVISION

Submitted to:

Agnico Eagle Mines Ltd: Meadowbank Division
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November 25, 2015.

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EXECUTIVE SUMMARY

The Meadowbank Mine is one of Canada's most northerly operating mines, located approximately 75 km north of the Hamlet of Baker Lake, Kivalliq District, Nunavut. It has been in operation since 2009, with open pit mining activities underway since March 2010. The Amaruq project is a 408-square-kilometre exploration property located approximately 50 kilometres northwest of the Meadowbank Mine, where a drilling program started in July 2013 has revealed promising gold mineralization.

An all-weather access road is deemed necessary to facilitate year-round exploration activities. In 2014, an evaluation was initiated to look at possible locations of an all-weather exploration access road between the Meadowbank mine and the Amaruq exploration site. A desktop exercise to identify potential fish habitat and initial field investigations along an approximate road corridor were conducted in late August and early September, 2014. Field investigations included reconnaissance and photographing all locations where the approximate corridor intersected water bodies or watercourses from a helicopter, and on-the-ground investigations that included electrofishing at 8 watercourses that were considered to be the most likely to support fish. An assessment of fish habitat potential was based on the field investigations and aerial photography. Factors considered included the presence or absence of late summer flow, the presence or absence of reaches where only interstitial flow was occurring in late summer, and the potential that the watercourse provides a migration corridor to upstream habitats. Those investigations were documented, in a report entitled *Amaruq Exploration Access Road Aquatics Baseline Report 2014 Agnico Eagle Mines Ltd. – Meadowbank Division* (C. Portt and Associates, 2015).

A revised road alignment that avoided aquatic habitat at many of the locations identified during the 2014 field investigations was examined in the field in June and early July of 2015. Also, in late June, 2015, several locations were examined on the ground by with road engineers and crossing locations were 'field fit' to minimize impacts to fish habitat, taking into account engineering constraints. More refinements to the road alignment were made, based in part on the field-fit exercise. The current road alignment was provided to C. Portt and Associates by Agnico Eagle in October of 2015. The habitat characteristics and recommended crossing methods where fish habitat or potential fish habitat is intersected by the revised alignment reflect the changes to the road alignment and the findings of the 2015 field investigations.

Electrofishing was conducted at eleven locations deemed to be the most likely to support fish based on their habitat characteristics. Fish were captured at eight of those locations. In total, five fish species were captured at one or more locations. Slimy sculpin was the most commonly captured species; individuals were captured at seven of the eleven sites sampled. Juvenile Arctic Char were captured at three locations, two of which were large rivers. Ninespine Stickleback, Burbot and Arctic Grayling were each captured at one location. Based on their size, all of the Slimy Sculpin and Ninespine Stickleback were adults and the Burbot, Arctic Char and Arctic Grayling were all juveniles.

The total number of locations where fish habitat exists or may exist, based on the observed habitat conditions, along the road alignment is 28. The watercourses at three of the locations (km 16.0, km 23.9

and km 32.3) were characterized as rivers. These provide habitat for small-bodied fish, and potentially also for large-bodied fish, throughout the open-water period. Due to their depth and flow, these watercourses are also potential migration routes for large-bodied fish throughout the open water period. Clear-span bridges are recommended for these locations. One juvenile Arctic Grayling was captured in one watercourse in both 2014 and 2015 and there is gravel substrate suitable for Arctic Grayling spawning at numerous locations within this watercourse, although no Arctic Grayling or disturbed gravel that might be indicative of Arctic Grayling spawning were observed here in the spring of 2015. Due to the potential habitat significance, a clear-span bridge has also been recommended at this location. At another five locations, the presence of potential fish-bearing lakes upstream suggest that the watercourses could be important migration routes for large-bodied fish during the open water season. Open-bottom structures spawning at least a portion of the channel are recommended at those locations to ensure that such migrations, if they occur, are not impeded.

The remaining 19 locations are smaller watercourses that do not have fish-bearing lakes upstream and/or have sections where only interstitial flow occurs, preventing the movement of large fish. The dominant habitat type is boulder at 12 locations and graminoid at 7 locations. At 11 of the boulder watercourses most or all of the flow is interstitial. For those watercourses, it is recommended that the interstitial flow be maintained and if additional conveyance is required it may be provided by corrugated steel pipes on top of the boulders. For graminoid streams and the one boulder stream where surface flow predominates, at least one corrugated steel pipe embedded 0.3 m below the stream invert is recommended, with other unembedded corrugated steel pipes used for additional conveyance if required.

The approach taken with respect to crossing recommendations protects the most significant fish habitats and maintains the existing potential for fish movement at all watercourse crossings. A Pathways of Effects analysis will be undertaken to determine the nature and scale of any residual effects on fish and fish habitat.

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1.0 INTRODUCTION

The Amaruq project is an exploration property located approximately 50 kilometres northwest of the Meadowbank mine in Nunavut as shown in Figure 1-1. The 408-square-kilometre exploration property is located on Inuit Owned Land, and was acquired by Agnico Eagle in April 2013 subject to a mineral exploration agreement with Nunavut Tunngavik Incorporated.

A drilling program started in July 2013 has revealed promising gold mineralization. Given the size and scope of the discovery, studies are currently underway to evaluate how Amaruq could be incorporated into the Meadowbank mine operational plan.

An all-weather access road is deemed necessary to facilitate year-round exploration activities. A desktop exercise and initial field investigations to identify potential fish habitat along an approximate road corridor were conducted in late August and early September, 2014. Those investigations were documented in a report entitled *Amaruq Exploration Access Road Aquatics Baseline Report 2014 Agnico Eagle Mines Ltd. – Meadowbank Division* (C. Portt and Associates, 2015). The desktop evaluation of the approximate road corridor in 2014 identified 52 locations where fish habitat might be intersected by the road. Field investigations revealed that there was no fish habitat present at 11 of those locations. At another 13 locations the road intersected a lake or pond and the report recommended that these be avoided by realigning the road. For the remaining 28 locations, the report made preliminary recommendations with respect to crossing structures to avoid or mitigate effects on fish habitat.

A revised road alignment, established just prior to the 2015 field season, avoided lakes and ponds at the 13 locations identified along the approximate alignment in 2014. At three locations where the road alignment was adjusted to avoid a lake or pond, this necessitated crossing a new watercourse. However, at another three locations the proposed road was adjusted to eliminate a watercourse crossing. The new alignment was examined in the field in late June and early July, 2015. At that time a number of the water crossing locations were examined jointly with road engineers and crossings were 'field fit' to minimize fish habitat impacts, given other constraints. As a result of the 'field fitting' and an engineering field survey of the proposed road route during the summer of 2015, a refined road alignment was provided in October 2015. While most adjustments were minor, at one location this resulted in the shifting of one crossing to a different watercourse. The total number of locations where fish habitat exists based on the observed habitat conditions, and is intersected by the revised road alignment, is 28.

This report consolidates the results of the 2014 and 2015 investigations as they apply to the October 2015 road alignment (hereafter referred to as the road alignment). It presents information for the 28 locations where fish habitat exists, or may exist based on the observed habitat conditions, and is intersected by the road alignment. It does not make reference to locations that were identified during the initial desktop study of the earlier alignment where it was subsequently determined in the field that there was no fish habitat present nor does it discuss locations where fish habitat is now avoided by the

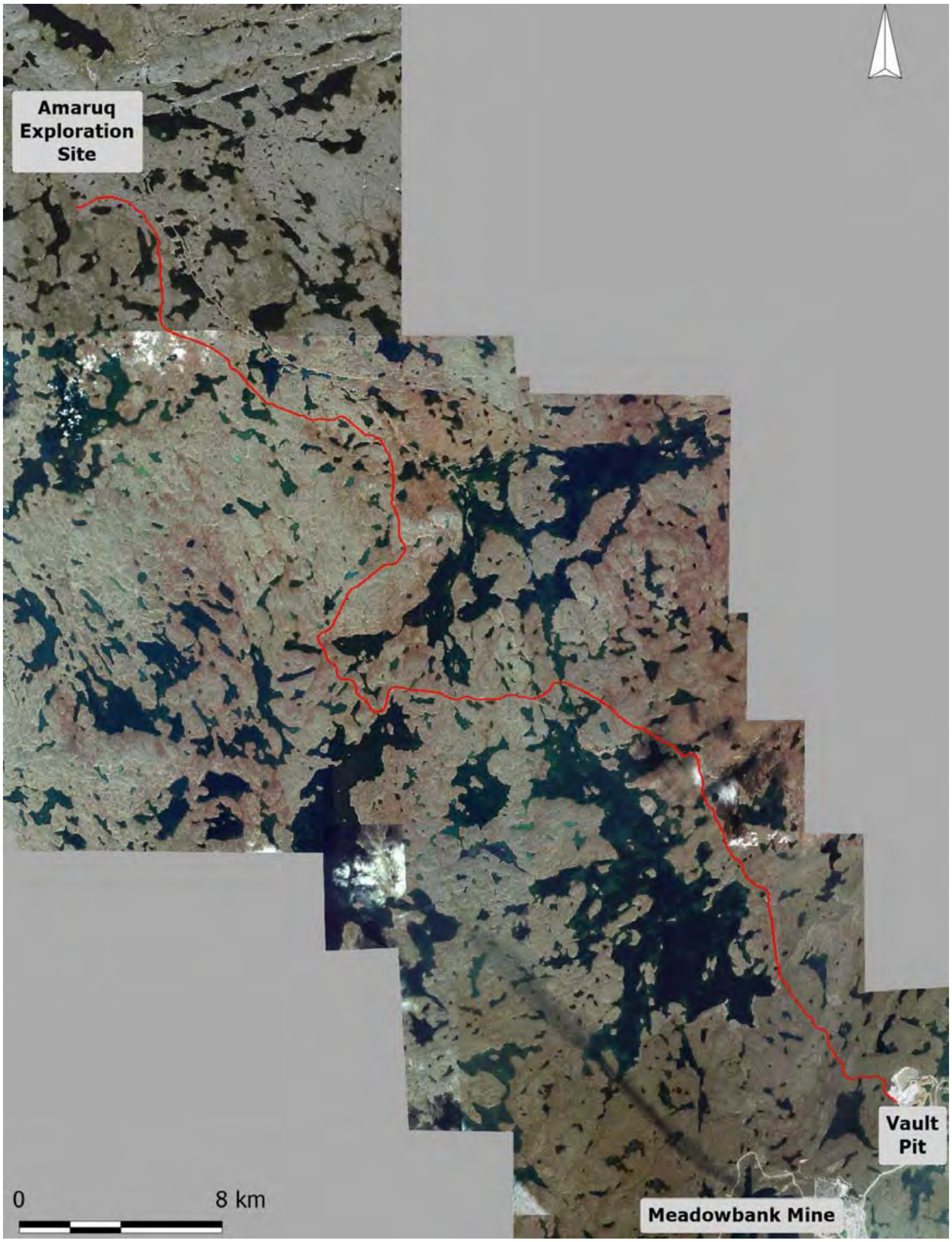

Figure 1-1. Location of the proposed Amaruq Exploration Access Road corridor.

road alignment. Crossing structure recommendations were re-evaluated based on the final, for construction alignment and the conditions observed in 2015.

1.1 Background

The Meadowbank Mine (65°N, 96°W) is one of Canada's most northerly operating mines, located approximately 75-km north of the Hamlet of Baker Lake, Kivalliq District, Nunavut (Figure 1-2). Mine construction began in 2008 under Nunavut Water Board Type A License 2AM-MEA0815 and Fisheries and Oceans Canada Authorization for Works or Undertaking Affecting Fish Habitat NU-03-0191.3 and NU-03-0191.4. Meadowbank has been in operation since 2009, with mining activities formally underway since March 2010, and projected to occur until February 2018. Meadowbank is an open pit operation, with most of the pit development located in close proximity to the mill, office and lodging infrastructure, with the exception of the Vault Pit which is approximately 10 km northeast of the main mine site. The southern terminus of the proposed Amaruq Exploration Access road is at the Vault Pit and the northern terminus is at the Amaruq exploration site.

1.2 Scope

This report presents an assessment of the watercourses along the proposed Amaruq Exploration Access Road corridor, based on field work conducted from August 29 to September 2, 2014 and from June 23 to July 11, 2015.

1.3 Objectives

- Characterize the existing fish and fish habitat conditions
- Identify potential impacts of the proposed access road on fish and fish habitat
- Recommend crossing structures to avoid or mitigate serious harm to fish and fish habitat

1.4 Physical Setting

The Meadowbank Mine is located on the Canadian Shield within a Low Arctic ecoclimate of continuous permafrost, which is one of the coldest and driest regions of Canada (Azimuth, 2010). The lakes within the Meadowbank project area are ultra-oligotrophic/oligotrophic (nutrient poor, unproductive) headwater lakes that are typical of the Arctic. The ice-free season on the lakes is very short. Ice break-up usually occurs during mid- to late-June, and ice begins to form again on the lakes in late September or early October. Complete ice cover is attained by late October, with maximum ice thickness of about 2 m occurring in March/April (Azimuth, 2013). Many small watercourses become dry once the land begins to freeze in the fall and, where water is present, most freeze to the bottom during the winter (BAER, 2005; Jones *et al*, 2010). Flows during the spring melt and the summer vary with drainage area.

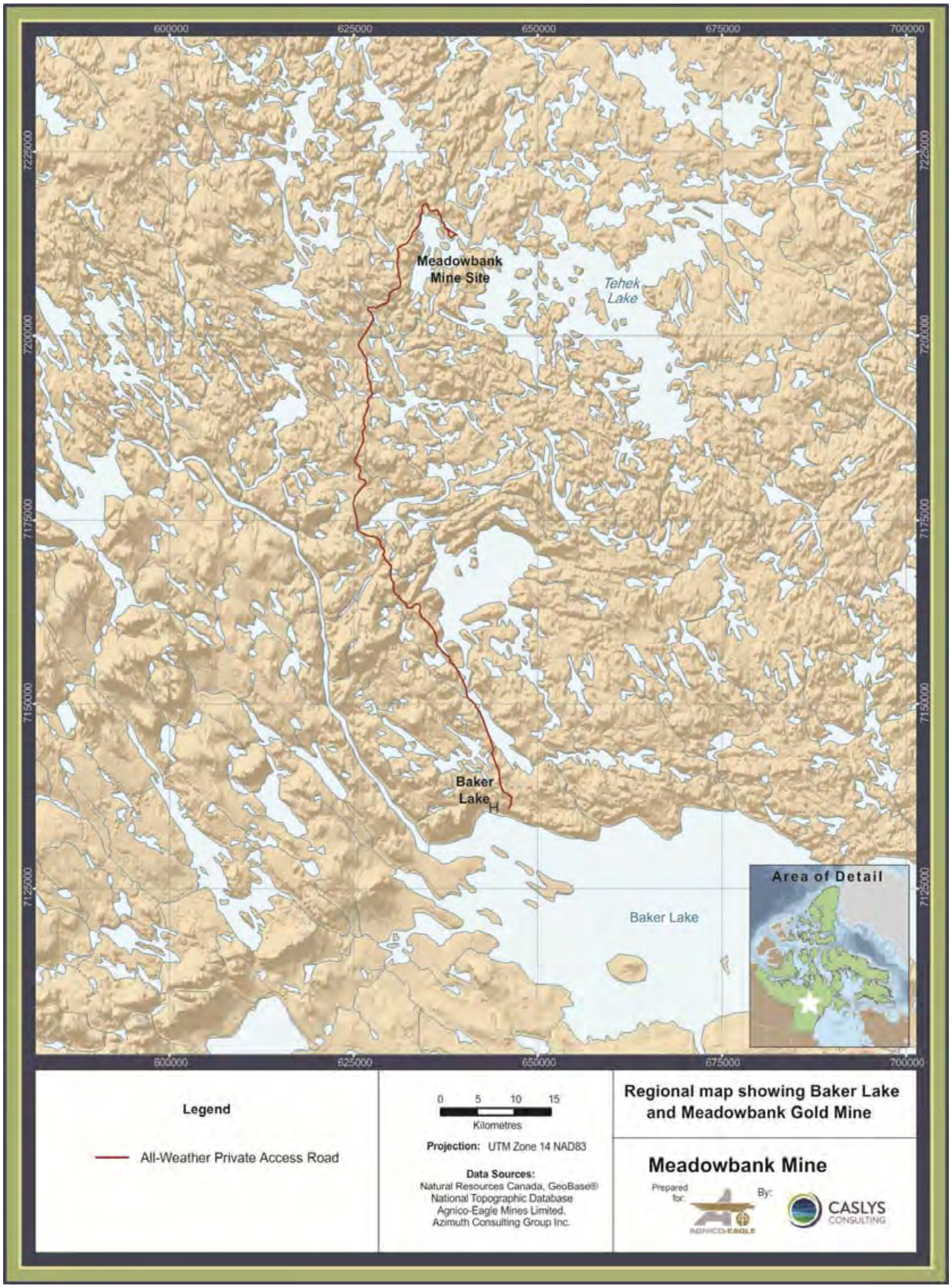

Figure 1-2. Location of the permitted and licensed Meadowbank Mine that includes an operational all-weather access road to Baker Lake.

The southern terminus of the proposed Amaruq Exploration Access road is at the Vault Pit and the northern terminus is at the Amaruq exploration site. The most southern watercourse crossing along the proposed road (km 2.1) is within the headwater area of the Chesterfield Inlet watershed that flows to Hudson Bay. All of the other locations examined along the proposed road alignment are within the Meadowbank River watershed which flows to the Back River and then to the Arctic Ocean.

There are no known anthropogenic influences between the Vault Pit and the Amaruq exploration site. The nearest community is Baker Lake, 75 km south of the Meadowbank Mine. At the present time, the only practical way of accessing most of the proposed road alignment is by helicopter, ATV or snowmobile.

2.0 METHODS

2.1 Preparation for Field Work

In 2014 the approximate road alignment, provided by Agnico Eagle Mines, was overlain on digital topographic mapping of the area (Garmin Topo Canada) and uploaded to a Garmin GPSmap76CSx hand-held GPS receiver. Potential watercourse crossings and waterbodies in close proximity to the road were identified on the topographic maps supplemented with examination of satellite images. These were located on printed copies of the same topographic mapping, which were also taken into the field. The same process was followed with the revised road alignment prior to the 2015 field investigations. Watercourse crossings and waterbodies in close proximity to the revised road alignment were identified based on the topographic maps supplemented with examination of satellite images, a photo mosaic, and the 2014 field investigations and photographs. The route was uploaded to a Garmin Oregon 650 hand-held GPS receiver that was used for orientation and to determine coordinates in the field.

The road route shown in Figure 2-1 and in the figures in Appendix A is the alignment provided by Agnico Eagle Mines Ltd. in November 2015, which reflects subsequent minor route refinements at some crossings.

2.2 Aerial Reconnaissance

The proposed access road alignment was examined from the air by helicopter on August 29 and 30, 2014. Each of the previously identified watercourse crossings and waterbodies was located and oblique aerial photographs were taken of each as well as upstream and downstream of watercourse crossings, to include the entire length of watercourse between lakes or to the watercourse's upstream limit. At some locations additional potential crossings were identified and documented in the same manner. The photographs taken during this reconnaissance and during the on-the-ground investigations (see below)

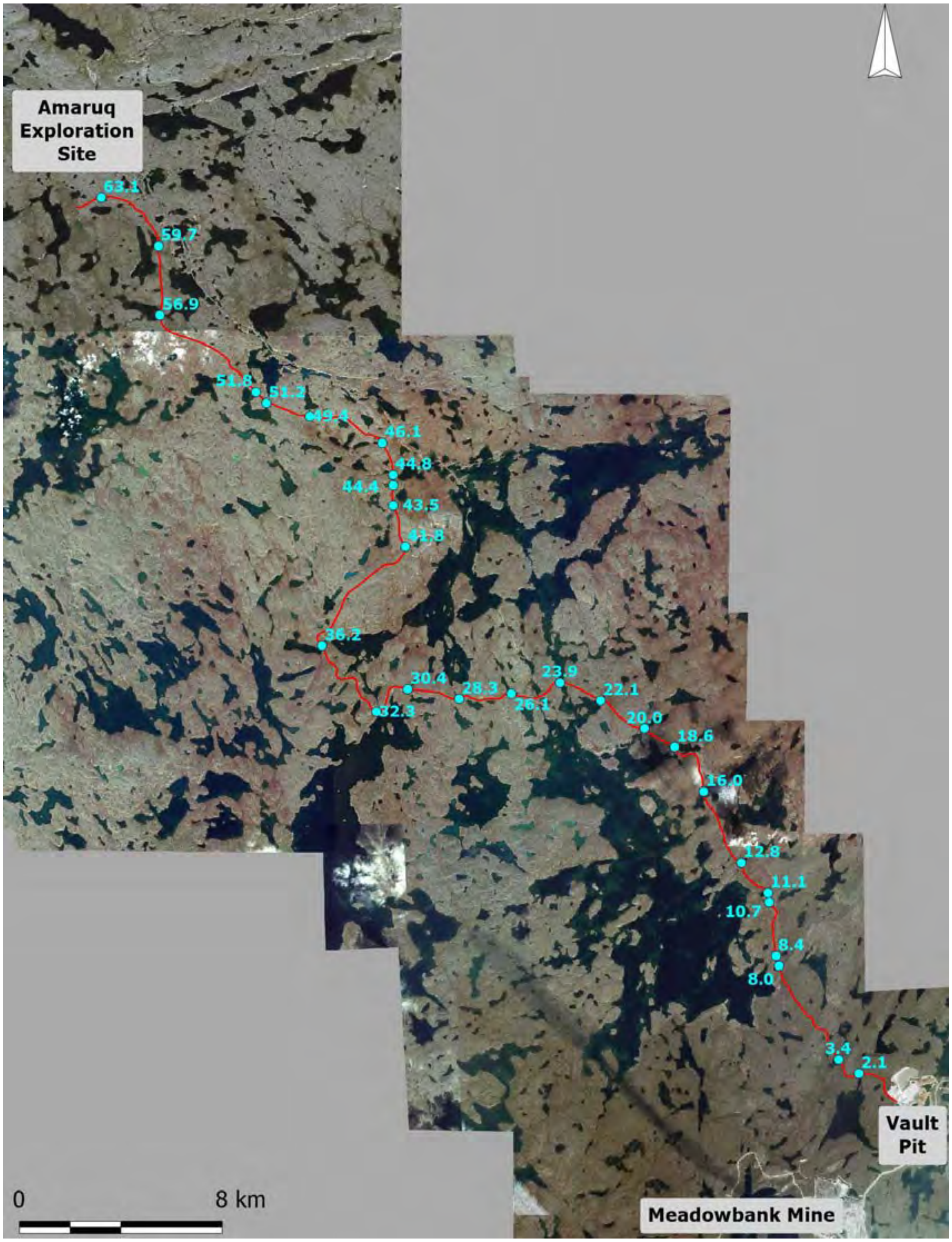

Figure 2-1. Route of the Amaruq Exploration Access Road and the 28 locations where the road intersects actual or potential fish habitat.

were reviewed and supplemental aerial photographs were taken on September 2, 2014, when the entire corridor was flown once more to ensure no important features were overlooked.

Observations were made by helicopter along the road alignment from km 3.4 to km 44.8 on June 23, 2015. On June 29, 2015, the entire alignment was flown again by helicopter and oblique aerial photographs were taken of the locations where fish habitat was considered to be present, or potentially present, based on the 2014 field investigations, the current conditions and the updated road alignment. At one location (km 41.8) the road alignment was shifted across a drainage divide subsequent to the 2015 field investigations. As a result, it crosses a watercourse that was not examined during the aerial reconnaissance. The assessment at that location is based on the aerial photomosaic.

2.3 Field Fitting of Crossings

On June 23, 2015 the road alignment was flown from crossing km 3.4 to km 44.8 with members of the road design team. The locations where bridges were recommended based on the 2014 field investigations were examined on the ground, and preferred crossing locations were identified based on the potential change to fish habitat, as well as engineering and construction considerations.

2.4 Fish Community Assessment

Each of the locations examined on the ground in 2014 was electrofished using a Halltech Model HT 2000 backpack electrofisher with a 47 cm diameter anode ring and a dipnet. Settings of 950 volts and 250 hertz, resulting in approximately 3-4 amperes of current, were used at all locations. Electrofishing was conducted with the two-person crew, one person using the electofisher and the second person netting the fish that were shocked, moving in an upstream direction, sampling as many habitat types as possible. In the smaller watercourses all of the habitat within the reach was eletrofished but in the large rivers only the shoreline could be safely sampled. The number of electroseconds (amount of time power was applied to the water) and the length of watercourse electrofished were recorded for each location that was sampled. Most fish were identified to species in-situ and released, but some were photographed and the photographs were used to confirm identity at a later time using keys in Scott and Crossman (1973) and McPhail and Lindsey (1970). The number of adults and juveniles captured, distinguished on the basis of size, was recorded for each species.

On June 23, 2015, site visits were conducted at km 3.4, 10.7, 16.0, 18.6, 20.0, 23.9, 26.1, 28.3, 32.3, 43.5, and 44.8. At the two largest crossings, km 23.9and 32.3, the entire length of watercourse between the lakes was examined for spawning Arctic Grayling, though dangerous shoreline conditions and the width of the river precluded close physical inspection at many places. At km 3.4, 16.0 and 44.8, more than half of the watercourse length between lakes was examined for spawning fish. Watercourses at the remaining crossings were examined in the vicinity of the proposed road.

The two largest watercourses (km 23.9 and km 32.3) could not be safely waded or electrofished in the spring of 2014 due to high flows and/or large slippery boulders dominating the shoreline habitats. They are assumed to be significant fish habitat.

On June 24 (km 16.0) and 25 (km 3.4, 20.0, 26.1, 43.5 and 44.8) visual surveys for Arctic Grayling and electrofishing were conducted at six locations where, based on the habitat conditions observed in 2014 or the June 23, 2015, inspection, it was thought there was potential for Arctic Grayling spawning. The watercourses were approached and examined carefully at and adjacent to the proposed crossing locations to try to observe adult Arctic Grayling or areas of disturbed gravel that could indicate Arctic Grayling spawning had occurred. At km 3.4, 16.0, and 44.8, where the habitat appeared most suitable, the entire length of the watercourse was examined. Following the visual search for Arctic Grayling each watercourse was electrofished using a Halltech Model HT 2000 backpack electrofisher (950 volts, 250 hertz). The number of electroseconds (amount of time power was applied to the water) and the length of watercourse electrofished were recorded for each location. The watercourse at km 16.0 was examined and electrofished again on July 5, 2015, after an Inuit field assistant to archaeologists reported seeing an Arctic Grayling in the stream a few metres upstream from the lake to which it drains on July 4. Electrofishing was also conducted, on July 11, 2015, at two additional locations (km 10.7 and km 11.1) where flows in 2015 suggested fish use might be greater than anticipated based on the 2014 observations. Most captured fish were identified to species in the field and released. Representative individuals were photographed.

2.5 Habitat Characterization

Watercourses which were considered to have the most potential to support fish were examined on the ground from August 30 to September 2, 2014, and/or from June 23 – July 11, 2015. These locations were selected based upon apparent flow and channel morphology and proximity to lakes that are deep enough to not freeze completely during the winter, as observed during the aerial reconnaissance. Each of these watercourses was examined visually in the immediate location of the proposed road crossing and, typically, for several hundred metres upstream and downstream. In most cases where watercourses joined lakes, the entire watercourse between the upstream and downstream lakes was examined. Observations of habitat characteristics including channel dimensions, channel form, and substrate, were recorded and photographs were taken.

A Garmin GPSmap76CSx (2014) or a Garmin Oregon 650 (2015) hand-held GPS was used to record the location of all observations and photographs, and aid in the stream width and distance measurements. The final habitat characterization for all watercourses was a desktop process that combined field observations with GIS analysis utilizing an orthorectified aerial photograph mosaic. If the 2015 crossing location changed from the earlier (2014) alignment, habitat was examined and characterized at the new location. The watercourses were characterized in terms of their flow condition, channel configuration, dominant habitat type in the vicinity of the proposed crossing location (which was approximate), active channel width and connection to potentially fish-bearing lakes upstream. Potential fish utilization was subsequently inferred based on the habitat characteristics.

Flow condition was characterized in 2014 as either surface flow or interstitial flow. Surface flow was considered to be present where surface water was visible in the watercourse either from the ground, from the helicopter, or in aerial photographs. "Interstitial flow" refers to flow through the interstitial spaces of the boulders and cobble that make up many of the streambeds along the proposed route, which was often not visible. Interstitial flow through boulder or cobble sections was assumed if surface water was visible elsewhere along the watercourse. Interstitial flow was deemed to be ”possible” if no surface water was detected anywhere along a boulder watercourse. Those watercourses may be dry, but this was not confirmed on the ground. Occasionally, if there did not appear to be a defined channel but at least seasonal flow was suspected, the flow was characterized as "potential diffuse". Flow condition was characterized again for boulder watercourses where flow was not observed in 2014 during the June 23 and 29, 2015, field investigations.

Channel configuration was characterized as single channel (one flow path), multiple channels (more than one flow path, or what is often termed a "braided" channel), or a diffuse channel (insufficient flow to form an obvious, defined flow path). For a few watercourses the additional descriptor "poorly defined" is used, which indicates that the edge or path of the active channel is unclear, suggesting that surface flow rarely occurs.

The watercourse habitats were divided into three categories, river, boulder, and graminoid. Examples of each are shown in Figure 2-2. River habitats were large, flowing, open channels, which occurred at only three locations. Boulder habitats typically appear in the aerial photographs as well-defined, linear, boulder fields associated with depressions on the landscape. Graminoid habitats are reaches of small watercourses whose banks are vegetated primarily by graminoids growing on peat. Often there are multiple smaller channels that branch and coalesce. Some of these habitats have a significant sand/gravel fraction in the substrate while others flow almost entirely over an organic peaty layer.

Approximate active channel width was measured using GIS with the orthorectified aerial photograph mosaic. Channels that were reasonably uniform in width were assigned a single number, while those channels of widely varying width have been assigned a range. The width of boulder channels was discerned in the aerial photography by the colouration of the boulders or the absence of vegetation. Rivers and graminoid single channels were measured directly in GIS. Multiple channel watercourses were measured from the outer edge of the first channel on one side, to the outer edge of the last channel on the opposite side. Width could not be accurately determined from the aerial photographs for diffuse channels.

Figure 2-2. Examples of habitat types encountered. The top row are rivers. The middle row are boulder watercourses. The bottom row are graminoid watercourses, with the right photograph showing graminoid with coarse substrate, and the left photograph showing graminoid with organic substrate.

2.6 Assessment of Fish Habitat Significance and Crossing Recommendation

The significance of fish habitat in each watercourse was evaluated based upon the habitat in the vicinity of the proposed road crossing, the potential for the watercourse being a migratory route for large-bodied or small-bodied fish between habitats upstream and downstream of the crossing, the life histories and habitat requirements of the fish species present in the study area, and the ecology of Arctic streams. The type of crossing structure recommended was selected to protect the habitat attributes and functions for the maintenance of existing fish populations. The recommended crossing structures are discussed in Section 4.0 (Mitigation and Impact Assessment) and listed for each watercourse crossing in Table 3-2.

3.0 RESULTS

3.1 Overview of Watercourses Intersected by the Proposed Access Road Corridor

The road alignment intersects watercourses at 28 locations where fish habitat exists, or may exist based on the observed habitat conditions (Figure 2-1). The watercourses at three of the locations were characterized as rivers. These provide habitat for small-bodied fish, and potentially also for large-bodied fish, throughout the open-water period. Due to their depth and flow, these watercourses are also potential migration routes for large-bodied fish throughout the open water period. The remaining 25 locations are smaller watercourses where the dominant habitat type is either boulder (16 locations) or graminoid (9 locations).

3.2 Fish Communities

The relatively recent glaciation and the harsh winters of northern Canada have resulted in a fairly short list of fishes that occur in the vicinity of the Meadowbank mine (McPhail and Lindsey, 1970; Scott and Crossman, 1973). The effect of long cold winters upon fish communities is further amplified in small streams and shallow lakes which freeze completely each winter (Haynes *et al*, 2014; Jones *et al*, 2010). In total, five fish species were captured in one or more of the eleven watercourses sampled during the field investigations.

3.2.1 Species Present

The number of individuals of each fish species collected in each watercourse sampled are provided in Table 3-1**Error! Reference source not found.**. The sampling effort, expressed as electroseconds, and the length of channel sampled are also provided. Five fish species were captured at one or more locations. Based on their size, all of the Slimy Sculpin and Ninespine Stickleback were adults and the Burbot, Arctic Char and Arctic Grayling were all juveniles. Fish were not captured at one location that was electrofished in 2014 (km 22.1) and at three locations that were electrofished in 2015 (km 3.4, km 26.1 and km 43.5).

Slimy sculpin was the most commonly captured species; individuals were captured at seven of the eleven sites sampled. Ninespine Stickleback, Burbot and Arctic Grayling were each captured at one location. The most species captured at a site on one occasion was three, at km 16.0 in 2014; this is a short river connecting two lakes.

Table 3-1. Electrofishing catch and effort. Locations are shown in Figure 2-1 and in more detail in Appendix A.

Location	Date dd/mm/yyyy	Electro-seconds (s)	Channel length sampled (m)	Slimy Sculpin (*Cottus cognatus*)	Ninespine Stickleback (*Pungitius pungitius*)	Burbot (*Lota lota*)	Arctic Char (*Salvelinus alpinus*)	Arctic Grayling (*Thymallus arcticus*)
km 3.4	30/08/2014	416	66	2	0	0	0	0
	25/06/2015	430	95	0	0	0	0	0
km 10.7	11/07/2015	621	76	1	0	0	0	0
km 11.1	11/07/2015	1436	204	0	0	0	4	0
km 16.0	01/09/2014	438	88	4	0	1	1	0
	24/06/2015	2156	248	1	0	0	1	0
	06/07/2015	1213	58	2	0	0	1	0
km 20.0	02/09/2014	353	20	13	0	0	1	0
	25/06/2015	465	47	2	0	0	0	0
km 22.1	31/08/2014	368	70	0	0	0	0	0
km 23.9	31/08/2014	590	95	5	1	0	0	0
km 26.1	25/06/2015	466	49	0	0	0	0	0
km 32.3	01/09/2014	626	135	2	0	0	0	0
km 43.5	25/06/2015	403	80	0	0	0	0	0
km 44.8	01/09/2014	249	47	7	0	0	0	1
	25/06/2015	946	207	1	0	0	0	1

3.2.2 Biological Characteristics

The following presents an overview of the fish species that were captured in this study. The natural history of these fishes was considered during the habitat assessment and in determining mitigation recommendations. In addition to these 5 species, lakes in the vicinity of the Meadowbank Mine that have been sampled also contain Lake Trout (*Salvelinus namaycush*) and Round Whitefish (*Prosopium cylindraceum*).

Slimy Sculpin

This species is widespread in rivers and streams of the north, and prefers running water with rocky, gravelly or sandy substrate (McPhail and Lindsey, 1970; Scott and Crossman, 1973). It spawns in the early spring under rocks in shallow shore areas of lakes or in streams (McPhail and Lindsey, 1970; Scott and Crossman, 1973). Slimy Sculpin may be less tolerant of winter conditions than Ninespine Stickleback (Haynes *et al*. 2014), and may be restricted to areas with large amounts of overwintering habitat (Haynes *et al*. 2014; Hershey *et al*. 2006). Based upon the ecology of Slimy Sculpin in the Arctic, as presented in Haynes *et al*. (2014) and Hershey *et al*. (2006), it is speculated that they were captured at almost all electrofished locations because of those locations' close proximity to winter refugia in upstream and/or downstream lakes. The greater abundance of this species in the late summer, relative to the early summer, is consistent with it recolonizing stream habitats each year.

Ninespine Stickleback

The Ninespine Stickleback is found in the shallow bays of lakes, slow flowing streams, and tundra ponds. It apparently is most associated with aquatic vegetation, but is also found in lower numbers over sand and gravel. It spawns during the spring and summer, usually in dense vegetation (McPhail and Lindsey, 1970). Haynes *et al*. (2014) suggest that Ninespine Stickleback is widely distributed in the Arctic because it can tolerate low oxygen concentrations and high salinity which allows the species to overwinter in lakes where other fish species cannot, as well as its ability to rapidly recolonize de-populated waterbodies via shallow and ephemeral connections during the spring, and then build populations rapidly due to short generation time and rapid growth.

Burbot

Adult Burbot tend to inhabit lakes and large rivers (McPhail and Lindsey, 1970; Scott and Crossman, 1973), but are also known to occur in small streams in the north (McPhail and Lindsey, 1970). Burbot spawn under the ice in late winter, in streams or lake shallows (McPhail and Lindsey, 1970). In the study area spawning is probably limited to deeper lake habitats that do not freeze. The single Burbot captured in this study was in a short river joining two lakes.

Arctic Char

Freshwater Arctic Char are most commonly lake-dwellers, but they will also live in rivers (Stewart and Watkinson, 2004). They must overwinter in water deep enough to not freeze to the bottom (Stewart and Watkinson, 2004). Spawning occurs in the fall, over gravel beds or rocky shoals in lakes and in quiet pools below rapids in rivers, where water depth is sufficient to prevent the embryos from freezing over the winter (McPhail and Lindsey, 1970; Scott and Crossman, 1973).

Arctic Grayling

Arctic Grayling are typically found in schools in clear-water lakes, large rivers and streams (McPhail and Lindsey, 1970; Scott and Crossman, 1973). They spawn during the spring at about the time that the lake ice is breaking-up, usually in small streams over a gravel or rocky bottom (McPhail and Lindsey, 1970), but will spawn in larger rivers if smaller streams are not available (Scott and Crossman, 1973). Arctic Grayling is the only species captured in this study that spawns exclusively in streams.

3.2.3 Abundance

Fish abundance was low at all of the locations sampled. Slimy Sculpin was the most abundant of the fish species captured, and adults were collected in all but one of the watercourses where fish were captured (**Error! Reference source not found.**). Adult Ninespine Stickleback were collected at one location. Juvenile Arctic Char were captured at three locations, and juvenile Arctic Grayling and juvenile Burbot were each captured at one location. At the four locations that were electrofished in both the late summer of 2014 and the spring/early summer of 2015, catch per unit effort of Slimy Sculpin was always higher in the late summer which is consistent with the streams being recolonized each year.

3.3 Arctic Grayling Spawning Surveys

No Arctic Grayling were observed at any of the watercourses examined by visual survey, nor were there any areas of disturbed gravel substrate that might be indicative of Arctic Grayling spawning observed. There was little or no gravel substrate suitable for grayling spawning present in most of the watercourses. The exceptions were the watercourses at km 16.0 and km 44.8, both of which had substantial areas of gravel substrate. No Arctic Grayling or evidence of potential spawning was observed during intensive searching at either of those locations, however one Arctic Grayling was observed by an Inuit assistant working with the archaeology crew while crossing the watercourse at km 16.0 on July 5, 2015 (Michael Haqpi, personal communication with C. Portt). This fish was observed within a few metres of the downstream lake and no Arctic Grayling were observed during a visual examination or captured by electrofishing at that location on June 24 or July 6, 2015. As indicated above, a single juvenile Arctic Grayling was captured at km 44.8 both times that the watercourse was electrofished (Table 3-1).

3.4 Flow Characterization and Potential for Fish Movement

No attempt was made to investigate fish movement directly but, because most small arctic streams freeze down to the permafrost every winter (Jones *et al*, 2010), the fish in those streams are thought to be present as a consequence of either directed seasonal movement (i.e. spawning or feeding migrations) or non-directed seasonal dispersal which, in the case of Ninespine Stickleback, may include dispersal to sink habitats where individuals perish during the winter (Haynes *et al*, 2014). The movement of large-bodied fish may be precluded in the smaller streams by the shallow depth. Also, in many of the smaller streams examined in this study there are reaches where there is no surface flow, only interstitial flow among boulders and cobbles. The extent of movement by small-bodied fish through the interstitial spaces is not known but it is unlikely that there is movement through those spaces by large-bodied fish. Large fish passage might occur if there is flow on top of the boulders or around the boulders during the spring freshet.

It was estimated visually that flow in most of the watercourses during the spring melt of 2015 was approximately twice that observed in the fall of 2014. This increased flow was generally accommodated by wider wetted widths and modest increases in depth. In some locations flow was over ice or frozen ground in June. The greater spring flows appeared to make little difference to the potential for fish passage through the boulder watercourses that have only interstitial flow, because the depth of the boulder/interstitial space layer accommodated the spring flow along at least part of the watercourses. In the watercourses where surface flow dominated, the somewhat greater water depths during higher flows may facilitate upstream migration by larger fish, if it occurs.

3.5 Habitat Characterization and Crossing Recommendations

The habitat characterizations for each of the locations where the road alignment impinges upon known or potential fish habitat are provided in Table 3-2. A close-up of the orthophoto at each location showing the road alignment, as well as oblique aerial photographs taken from a helicopter and on-the-ground photographs, where available, are presented in Appendix A. The orthophotos covering the route from approximately km 56.3 north were taken on July 21, 2011, while south of that location were taken at approximately the time of the field investigations in 2014.

The total number of locations where fish habitat exists or may exist, based on the observed habitat conditions along the road alignment, is 28. The watercourses at three of the locations (km 16.0, km 23.9 and km 32.3) were characterized as rivers. These provide habitat for small-bodied fish, and potentially also for large-bodied fish, throughout the open-water period. Due to their depth and flow, these watercourses are also potential migration routes for large-bodied fish throughout the open water period. Clear-span bridges are recommended for these locations.

A juvenile Arctic Grayling was captured in the watercourse at km 44.8 in both 2014 and 2015 and there is gravel substrate suitable for Arctic Grayling spawning at numerous places within this watercourse, although no Arctic Grayling or disturbed gravel that might be indicative of Arctic Grayling spawning were observed here in the spring of 2015. This watercourse also provides a connection to a series of upstream lakes and therefore could be an important migration corridor. Due to the potential habitat significance, a clear-span bridge is also recommended at this location.

The remaining 24 locations are smaller watercourses where the dominant habitat type is either boulder (16 locations) or graminoid (8 locations). The crossing recommendations at these locations were based primarily on the presence of potential fish-bearing lakes, that is lakes of sufficient depth to support fish year-round, upstream and, the probability that the watercourses could serve as migration corridors for large-bodied fish during the open-water period. At five locations (km 3.4, km 10.7, km 20.0, km 26.1 and km 43.5) the potential for the watercourses to serve as migration corridors for large-bodied fish to or from upstream habitats was deemed to warrant an open-bottom structure, either an open-bottom arch culvert or a bridge, across a portion of the watercourse to ensure that large fish passage is not impeded. For boulder watercourses, it is recommended that the interstitial flow be maintained on either side of the open-bottomed structure; if additional conveyance is required it may be provided by corrugated steel pipes on top of the boulders. For graminoid streams, corrugated steel pipes may be installed on either side of the open-bottomed structure if additional conveyance is required.

The watercourses at the remaining 19 locations are considered unlikely to be important migration corridors for large fish due to various factors which included shallow depths, the absence of suitable habitat upstream and, in a number of boulder streams, sections of the watercourse where there is only interstitial flow. Some of these watercourses are used seasonally by small fish which include Slimy Sculpin, Ninespine Stickleback and juvenile Arctic Char. The electrofishing catches in the smaller watercourses were low, ranging from no catch to approximately 3 fish per 100 m of stream. The likelihood of small fish being present is likely related to the proximity to downstream lake habitat that is sufficiently deep to support fish over the winter. As it is not possible to determine with certainty which of these watercourses do and do not support small fish during the open water season, the crossing recommendations for all of them are intended to ensure that small fish movement can continue to occur. For graminoid watercourses (n=7) and for the one boulder watercourse where surface flow was present along its entire length, it is recommended that at least one culvert be embedded 0.3 m below the existing stream invert; additional culverts, if required, may be embedded or installed at the existing stream invert. For the boulder watercourses with interstitial flow in at least some sections (n=11), it is recommended that interstitial flow be maintained across the watercourse and at least one culvert be installed level with the top of the boulders at the lowest point in the channel. If additional culverts are required for conveyance, they may be installed at higher elevations.

Table 3-2. Habitat characterization and assessment and crossing recommendations where the road intersects known or potential fish habitat. Locations are shown in Figure 2-1. The road alignment at each location, super-imposed on the aerial photography, and photographs are presented in Appendix A. Location is the distance of each crossing from the southern terminus of the road.

Location (km)	Latitude	Longitude	Flow characteristics	Channel configuration	Dominant habitat	Approximate flood plain width (m)	Potential fish-bearing lake upstream	Examined on ground	Fish captured	Comment	Habitat assessment.	Minimum crossing type recommended to mitigate potential impacts to fish.
2.1	65.0838	-96.0420	No surface flow. May be interstitial flow	Single	Boulder	25	Yes	No		Surface flow is infrequent	May not provide fish habitat most of the time due to lack of flow. Fish passage also unlikely.	Corrugated steel pipe installed level with the top of the boulders at the lowest point in the crossing. Maintain interstitial flow across remainder of channel.
3.4	65.0891	-96.0587	Mainly surface flow, but short sections of interstitial flow near proposed crossing in both 2014 and 2015.	Single	Boulder	20-50	Yes	Yes (2014 and 2015)	2 Slimy Sculpin; no fish captured	Upstream of crossing is open with boulder and cobble, with some patches of graminoid. In boulder section, lichen suggest flow rarely covers boulders. Higher gradient.	Provides seasonal small-bodied fish habitat and a potential migration route for fish, but upstream lakes not extensive or deep and so may have limited fish habitat. No Arctic Grayling were observed.	Use an open-bottom structure to span open channel. Maintain interstitial flow across remainder of channel. If additional capacity required, can use corrugated steel pipe(s) on top of channel boulders.
8.0	65.1232	-96.1048	Surface flow, but diffuse in places.	Multiple/Diffuse	Graminoid	25	No	No		Was not crossed by earlier alignment	May provide seasonal small fish habitat.	Corrugated steel pipe inset 0.3 m below channel invert.
8.4	65.1267	-96.1071	Surface flow at crossing. Only interstitial flow in boulder section downstream in 2014 and 2015.	Multiple	Graminoid	Not determinable	Yes	No		Watercourse poorly defined, and upstream lake is small	May provide seasonal small-bodied fish habitat only. Upstream migration by large-bodied fish unlikely. Only small lake upstream.	Corrugated steel pipe inset 0.3 m below channel invert.
10.7	65.1458	-96.1108	Interstitial flow at crossing and surface flow in upstream bedrock sections during fall of 2014. Surface flow more widespread during spring 2015 but still sections with only interstitial flow.	Single	Boulder	25-90	Yes	Yes (2015)	1 Slimy Sculpin	Flow may rarely if ever cover boulders. Bedrock sections upstream of crossing. Channel features suggest that higher flows than observed may occur occasionally. No gravel observed.	May provide seasonal small fish habitat. Possible upstream migration route for fish during spring freshet or during other periods of high flow. No Arctic Grayling were observed.	Use an open-bottom structure to span open channel. Maintain interstitial flow across remainder of channel. If additional capacity required, can use corrugated steel pipe(s) on top of channel boulders.
11.1	65.1492	-96.1112	Surface flow	Single	Graminoid	01-Aug	No	Yes (2015)	4 Arctic Char (juveniles)	Substrate nearly all organic mat with about 5% gravel.	No Arctic Grayling were observed, but provides seasonal habitat for juvenile Arctic Char and likely also provides seasonal habitat for small-bodied fishes.	Corrugated steel pipe inset 0.3 m below channel invert.
12.8	65.1602	-96.1327	Surface flow, but diffuse in places.	Multiple/	Graminoid	30	No	No		Poorly defined channel resembles wetland. Upstream pond shallow	May provide seasonal small-bodied fish habitat only. No upstream migration of large fish likely, due to wetland character of connection and lack of upstream lake habitat.	Corrugated steel pipe inset 0.3 m below channel invert.

Location (km)	Latitude	Longitude	Flow characteristics	Channel configuration	Dominant habitat	Approximate flood plain width (m)	Potential fish-bearing lake upstream	Examined on ground	Fish captured	Comment	Habitat assessment.	Minimum crossing type recommended to mitigate potential impacts to fish.
16.0	65.1860	-96.1614	Surface flow	Single	River	71	Yes	Yes (2014) and 2015)	4 Slimy Sculpin, 1 Burbot, 1 Arctic Char; 1 Slimy Sculpin, 1 Arctic Char; 2 Slimy Sculpin, I Arctic Char	Wide, shallow, flowing watercourse with cobble/gravel/boulder substrate and graminoid patches	Watercourse provides seasonal small fish habitat and contains gravel substrate that may be suitable for Arctic Grayling spawning. Potential migration route between lakes. No Arctic Grayling were observed.	Span bankfull channel with bridge.
18.6	65.2022	-96.1844	Mainly interstitial flow in the fall of 2014. Substantial flow, but still only interstitial in places in the spring of 2015.	Single	Boulder	40	Yes	Yes (2015)	Not electro-fished	Boulder/cobble substrate. Tundra vegetation in parts of wide channel suggest surface flow is infrequent. Some sections may have high gradient.	Small wetted channel within the larger feature may provide seasonal habitat for small-bodied fishes only. High flows may be infrequent. Not an upstream migration route for large-bodied fish during spring freshet due to sections with only interstitial flowNo Arctic Grayling were observed.	Corrugated steel pipe installed level with the top of the boulders at the lowest point in the crossing. Maintain interstitial flow across remainder of channel.
20.0	65.2092	-96.2089	Surface flow at crossing location, but only interstitial flow in both 2014 and 2015 where boulders dominate downstream of proposed crossing.	Multiple	Graminoid	18-50	Yes	Yes (2014 and 2015)	13 Slimy Sculpin, 1 juvenile Arctic Char; 2 Slimy Sculpin	Steeper sections have shrubs and other tundra vegetation perched on top of boulders, with water flowing beneath. At crossing it is graminoid controlled, but with ample boulder and cobble. Crossing was shifted to location with lower gradient.	Provides seasonal small fish habitat, as well as potential spawning habitat with cobble/gravel substrate in places for Arctic Grayling. Migration between lakes by large-bodied fishes unlikely due to sections with only interstitial flow, but could occur during high flows. Joins two relatively large lakes. No Arctic Grayling were observed.	Use an open-bottom structure to span open channel. Maintain interstitial flow across remainder of channel. If additional capacity required, can use corrugated steel pipe(s) on top of channel boulders.
22.1	65.2198	-96.2451	Surface flow, but diffuse in some locations in 2014 and 2015.	Multiple/Diffuse	Graminoid	Not determinable	No	Yes (2014)	no fish captured	No invertebrates observed.	May provide seasonal small-bodied fish habitat only. Upstream migration likely not possible or important due to channel configuration and flow volume. Upstream pond is shallow.	Corrugated steel pipe inset 0.3 m below channel invert.
23.9	65.2268	-96.2785	Surface flow	Single	River	100-120	Yes	Yes (2014 and 2015)	5 Slimy Sculpin, 1 Ninespine Stickle-back (in 2014). Not electrofished in 2015.	Short watercourse between lakes. Flow from south to north. Some algae on rocks. Boulder/cobble substrate.	Fish habitat. Broad, short section of river between two large lake systems. Therefore fish passage may be an important function. No Arctic Grayling were observed.	Span bankfull channel with bridge.
26.1	65.2235	-96.3198	Surface flow in some sections and only interstitial flow in others in June 2015.	Single	Boulder	17-72	Yes	Yes (2015)	No fish captured		May not provide fish habitat most of the time, however, it appears as if flows may occasionally be substantial and fish passage may occur at that time, as this is a connection between two potentially fish-bearing lakes. No Arctic Grayling were observed.	Use an open-bottom structure to span open channel. Maintain interstitial flow across remainder of channel. If additional capacity required, can use corrugated steel pipe(s) on top of channel boulders.
28.3	65.2225	-96.3641	No surface flow in 2014 or 2015. Interstitial flow only in 2015.	Single	Boulder	21-135	Yes	Yes (2015)	Not possible to sample for fish		May not provide fish habitat due to lack of surface flow. Fish passage is unlikely.	Corrugated steel pipe installed level with the top of the boulders at the lowest point in the crossing. Maintain interstitial flow across remainder of channel.

Location (km)	Latitude	Longitude	Flow characteristics	Channel configuration	Dominant habitat	Approximate flood plain width (m)	Potential fish-bearing lake upstream	Examined on ground	Fish captured	Comment	Habitat assessment.	Minimum crossing type recommended to mitigate potential impacts to fish.
30.4	65.2267	-96.4070	No surface connection in 2014. Surface connection in 2015.	Single	Boulder	50	No	No			Provides seasonal fish habitat and seasonal fish passage between ponds. Migration of large-bodied fish unlikely due to shallow nature of small pond south of alignment.	Corrugated steel pipe installed level with the top of the boulders at the lowest point in the crossing. Maintain interstitial flow across remainder of channel.
32.3	65.2193	-96.4342	Surface flow	Single	River	13-25	Yes	Yes (2014 and 2015)	2 Slimy Sculpins (in 2014); not electrofished in 2015	Meadowbank River. Flowing south to north. Boulder/cobble/bedrock substrate	Large flowing river, with large lakes upstream and downstream. Important fish habitat. May provide spawning habitat for large-bodied fishes and likely is an important migration route for fishes. No Arctic Grayling were observed.	Span bankfull channel with bridge.
36.2	65.2433	-96.4778	No surface flow at crossing in 2014. May be interstitial flow.	Single	Boulder	22	Yes	No		Drainage feature appears to feed a downslope seepage area.	Likely does not provide fish habitat. Surface flow is unlikely except possibly during an extreme flow-generating event. Fish passage is likely not an issue due the lack of surface flow in the watercourse.	Corrugated steel pipe installed level with the top of the boulders at the lowest point in the crossing. Maintain interstitial flow across remainder of channel.
41.8	65.2772	-96.4042	Likely seasonal interstitial flow	Single	Boulder	41	No	No		Crossing relocated and therefore not examined during field investigations. Assessment is based on aerial photography. Small catchment. Upstream pond is approximately 170 m at widest point.	Likely does not provide fish habitat. Surface flow is unlikely except possibly during an extreme flow-generating event. Fish passage is likely not an issue due the lack of flow in the watercourse. Recommendation is precautionary.	Corrugated steel pipe installed level with the top of the boulders at the lowest point in the crossing. Maintain interstitial flow across remainder of channel.
43.5	65.2919	-96.4131	Surface flow at crossing and other discrete locations, but interstitial flow through much of watercourse in 2014. More surface flow in 2015.	Single	Boulder	50-90	Yes	Yes (2015)	No fish captured	Substrate primarily cobble and boulder.	May provide seasonal fish habitat. Fish passage may be possible during the spring freshet during some years, and may be important for the chain of upstream lakes. No Arctic Grayling were observed.	Use an open-bottom structure to span open channel. Maintain interstitial flow across remainder of channel. If additional capacity required, can use corrugated steel pipe(s) on top of channel boulders.
44.4	65.2991	-96.4123	Surface flow at crossing in 2014 and 2015, but diffuse at some downstream locations	Multiple/Diffuse	Graminoid	14-50	No	Yes (2014)	Not electro-fished	One channel examined had cobble/boulder substrate, but others had organic (peat) substrate.	May provide seasonal small-bodied fish habitat only. Upstream migration probably not important due shallowness of small upstream lake. No spawning habitat for large-bodied fish downstream of crossing due to lack of suitable substrate.	Corrugated steel pipe inset 0.3 m below channel invert.
44.8	65.3028	-96.4122	Surface flow	Multiple	Graminoid	30	Yes	Yes (2014 and 2015)	7 Slimy Sculpin, 1 juvenile Arctic Grayling; 1 Slimy Sculpin, 1 Arctic Grayling	Variety of substrate sizes (gravel/cobble). Caddisflies on rocks.	Seasonal small-bodied fish habitat and potential spawning habitat for Arctic Grayling. Likely provides fish passage upstream to a number of small lakes. No spawning Arctic Grayling were observed, but one juvenile was captured in 2014 and in 2015.	Span bankfull channel with bridge.

Location (km)	Latitude	Longitude	Flow characteristics	Channel configuration	Dominant habitat	Approximate flood plain width (m)	Potential fish-bearing lake upstream	Examined on ground	Fish captured	Comment	Habitat assessment.	Minimum crossing type recommended to mitigate potential impacts to fish.
46.1	65.3143	-96.4200	Surface flow at crossing but diffuse in some locations and interstitial section downstream in 2014 and 2015.	Single	Graminoid	Not determinable	No	No		Poorly defined channel.	May provide seasonal small-bodied fish habitat only, Upstream migration for large-bodied fishes unlikely due to section of interstitial flow downstream. Only shallow pond upstream.	Corrugated steel pipe inset 0.3 m below channel invert.
49.4	65.3246	-96.4805	Surface flow, but diffuse or interstitial in many locations in 2014 and 2015.	Single	Boulder	Not determinable	Yes	No		Poorly defined channel	May provide seasonal habitat for small-bodied fish. Migration of large-bodied fish unlikely due to nature of channel, and lack of surface flow in many places.	Corrugated steel pipe inset 0.3 m below channel invert.
51.2	65.3300	-96.5168	No surface flow in 2014 or 2015. May be interstitial flow.	Single	Boulder	65-100	Yes	No		May occasionally be a surface connection when lake levels are high	May not provide fish habitat most of the time. May never be sufficient water to allow large-bodied fish passage.	Corrugated steel pipe installed level with the top of the boulders at the lowest point in the crossing. Maintain interstitial flow across remainder of channel.
51.8	65.3342	-96.5255	No surface water in 2014. Surface water, but appears to be standing water, in 2015.	Single	Boulder	98	Yes	No		Does not appear to be a connection to lakes to north. Possible there is an interstitial connection.	Probably no connection to lakes to north. May provide seasonal habitat for small fishes when flooded in spring.	Corrugated steel pipe installed level with the top of the boulders at the lowest point in the crossing. Maintain interstitial flow across remainder of channel.
56.9	65.3626	-96.6040	Surface water at crossing in 2015, but appears to be due to high levels in adjacent lakes. Probably dry most of the year.	Single	Boulder	60-85	Yes	No		Connection between lakes when lake levels high	Provides small-bodied fish habitat and passage between lakes when flooded in spring.	Corrugated steel pipe installed level with the top of the boulders at the lowest point in the crossing. Maintain interstitial flow across remainder of channel.
59.7	65.3871	-96.6031	Some surface flow at crossing and other discrete location in 2015, but does not appear to be a surface connection to upstream ponds.	Single	Boulder	25	No	No		May occasionally connect two small shallow ponds to lake to west, but only during high lake water levels.	May provide seasonal habitat for small-bodied fishes.	Corrugated steel pipe installed level with the top of the boulders at the lowest point in the crossing. Maintain interstitial flow across remainder of channel.
63.1	65.4050	-96.6503	Some surface flow or standing water at crossing and other discrete locations in 2015. Probably seasonal flow only.	Single. Poorly defined	Boulder	27	No	No		New location in 2015 due to shift in alignment. Poorly defined boulder feature with some tundra vegetation. Very small drainage area	May provide seasonal habitat for small-bodied fishes. No upstream lake.	Corrugated steel pipe installed level with the top of the boulders at the lowest point in the crossing. Maintain interstitial flow across remainder of channel.

3.6 Summary and Conclusions

The Amaruq Exploration Access Road route is 64.1 km long, and runs from the Vault Pit of the Meadowbank Mine to the Amaruq project exploration property, which is located approximately 50 kilometres northwest of the Meadowbank mine. The Amaruq Exploration Access Road alignment intersects aquatic habitat that is or has the potential to be fish habitat at 28 locations. Some of the watercourses, based on their flow characteristics and habitats and/or connections to upstream waterbodies, are potential spawning habitat and/or potential migration routes for larger fish species. Many of the smaller watercourses provide seasonal habitat for Slimy Sculpin and Ninespine Stickleback. Some of these also provide seasonal habitat for juvenile Arctic Char. Based on the electrofishing results and their habitat characteristics, it is likely that some of the smaller watercourses do not support fish.

Clear-span bridges are recommended at four locations which are considered to be the most significant in terms of in-stream fish habitat. Open-bottom structures spanning a portion of the channel are recommended at five locations where there is the potential for the migration of large fish between suitable habitats during the open-water season. At 19 locations, where seasonal movement of small fish may occur, corrugated steel pipes are recommended. At each of those locations, at least one corrugated steel pipe is to be embedded 0.3 m below the stream invert where surface flow occurs or at the boulder surface where only interstitial flow occurs along part of the watercourse, to ensure that small fish passage can occur. A Pathways of Effect analysis will be undertaken to identify mitigation measures to avoid harm to fish and fish habitat and determine if residual effects will remain.

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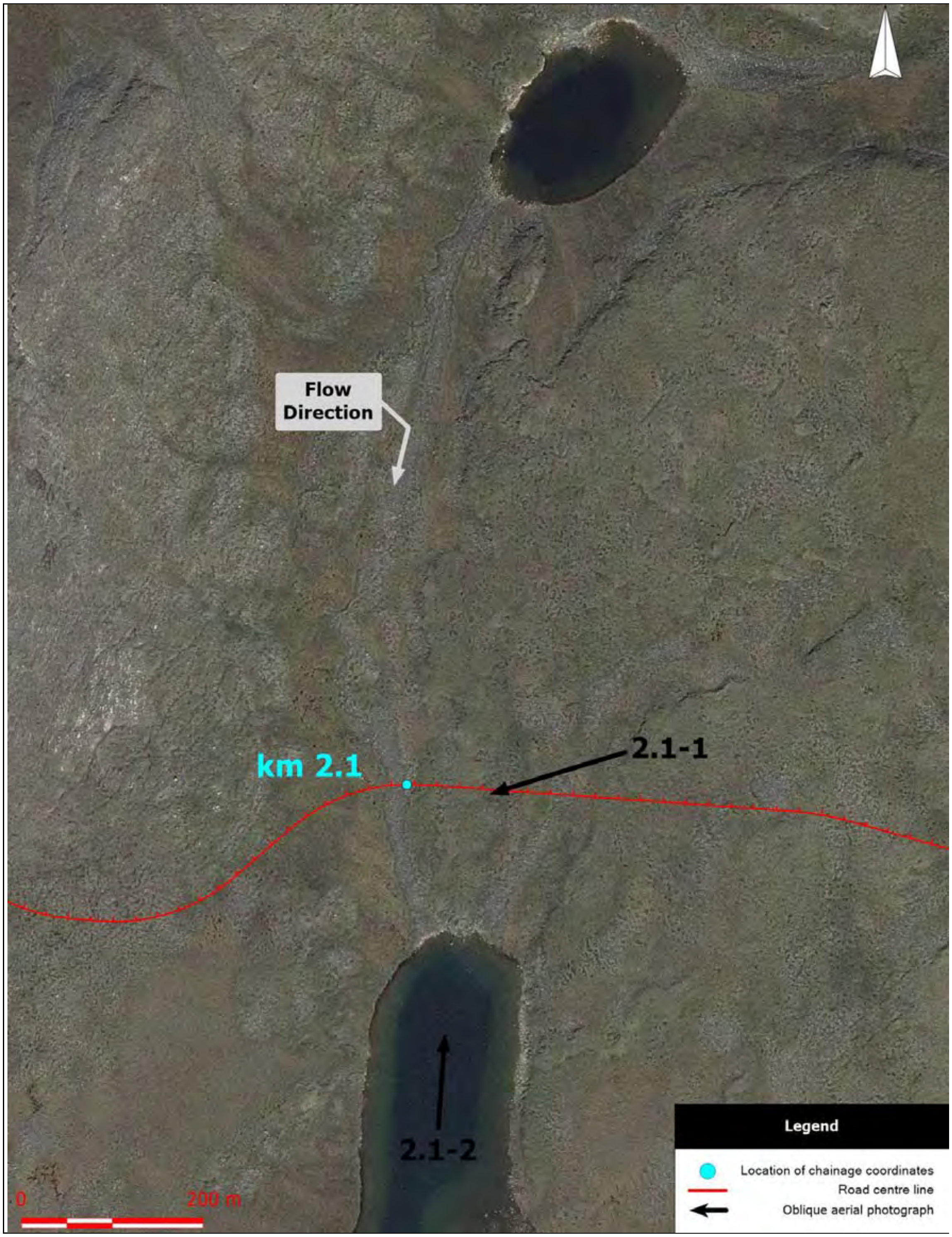
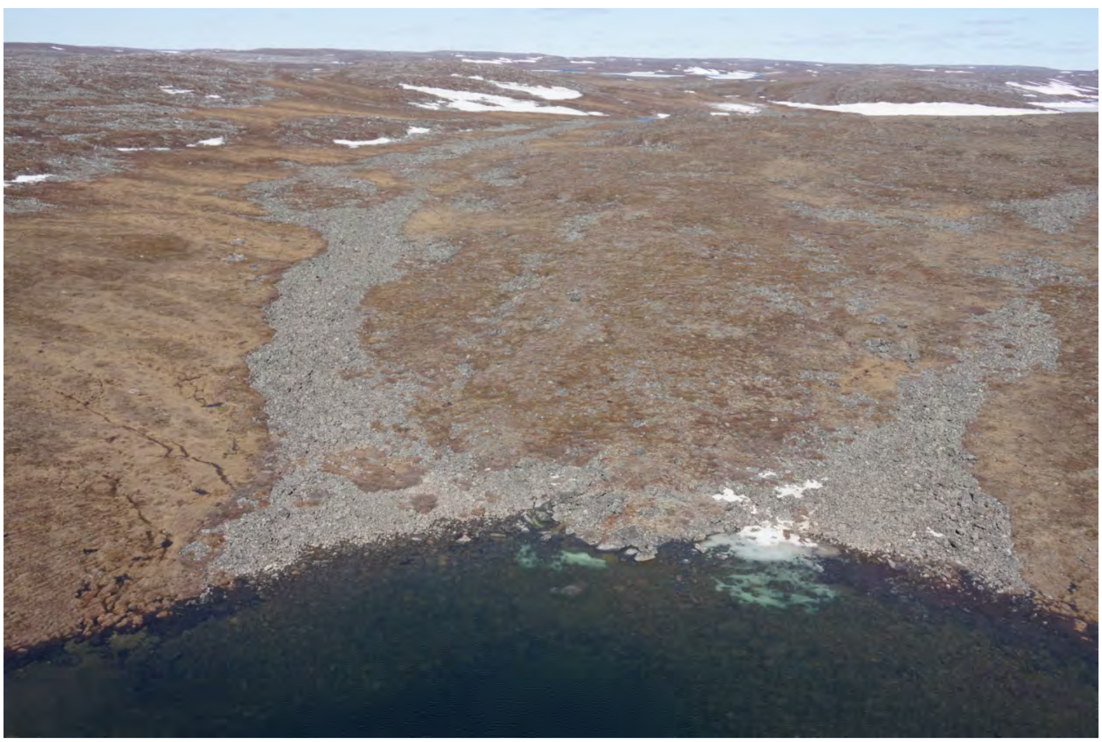
APPENDIX A - PHOTOGRAPHS



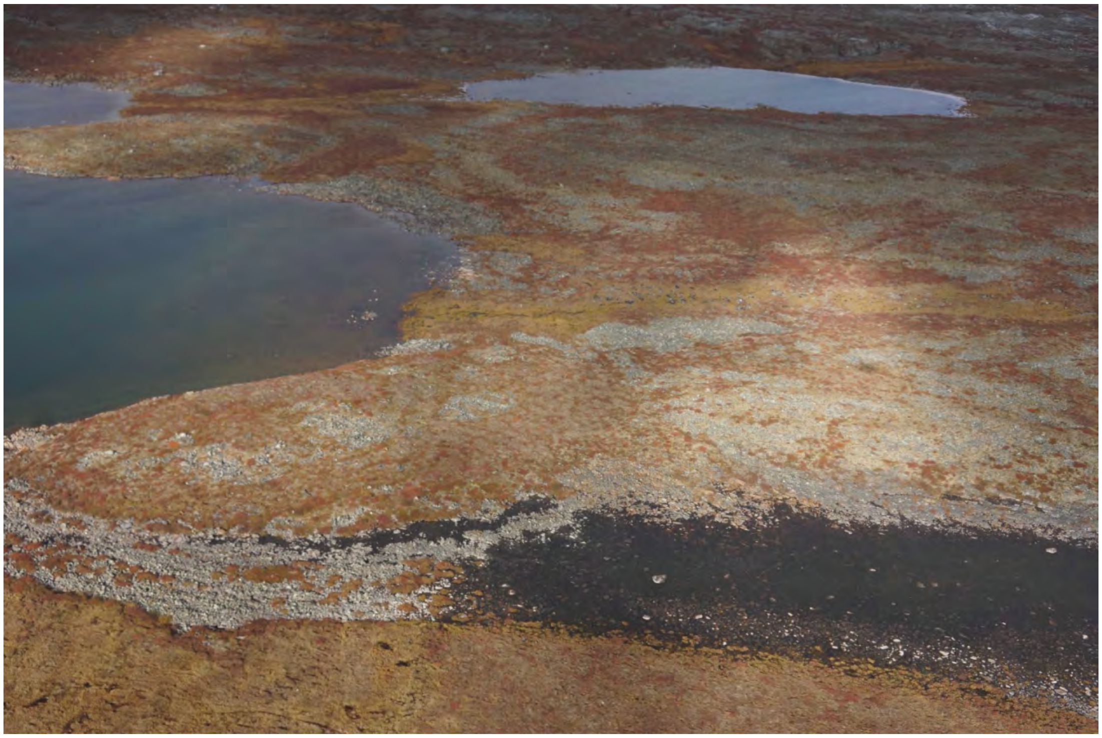
Kilometre 2.1. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

Kilometre 2.1. Oblique aerial photograph 2.1-1. August 30, 2014.

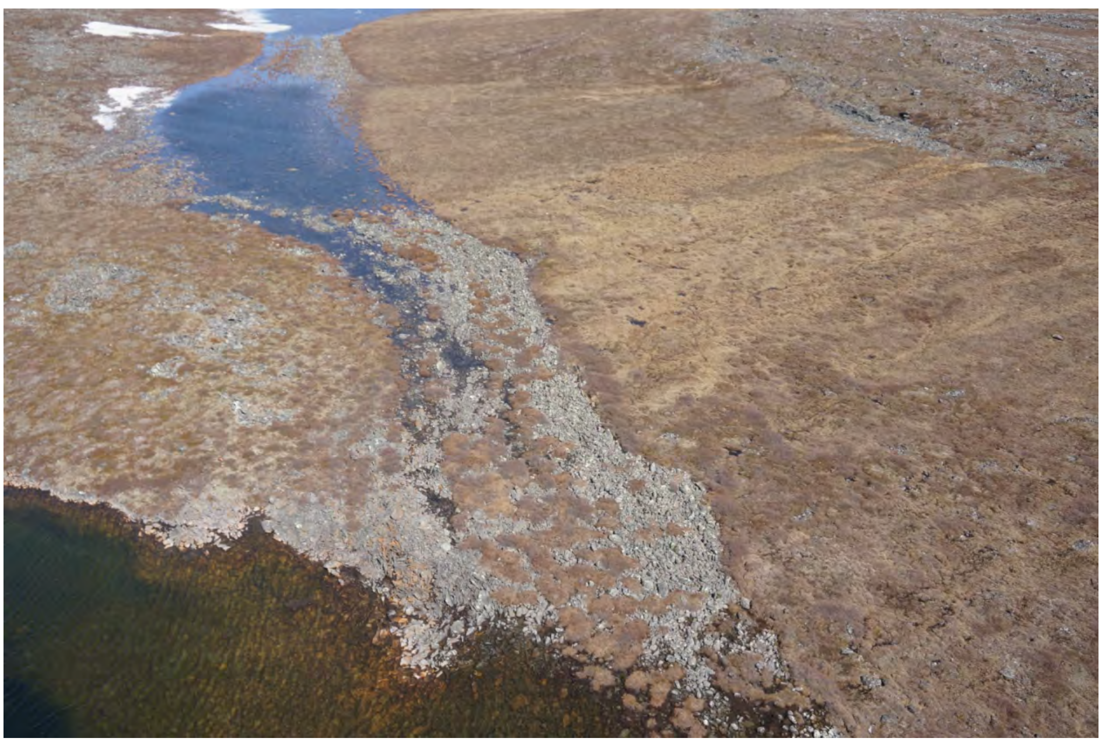


Kilometre 2.1. Oblique aerial photograph 2.1-2. June 29, 2015.

Kilometre 3.4. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.



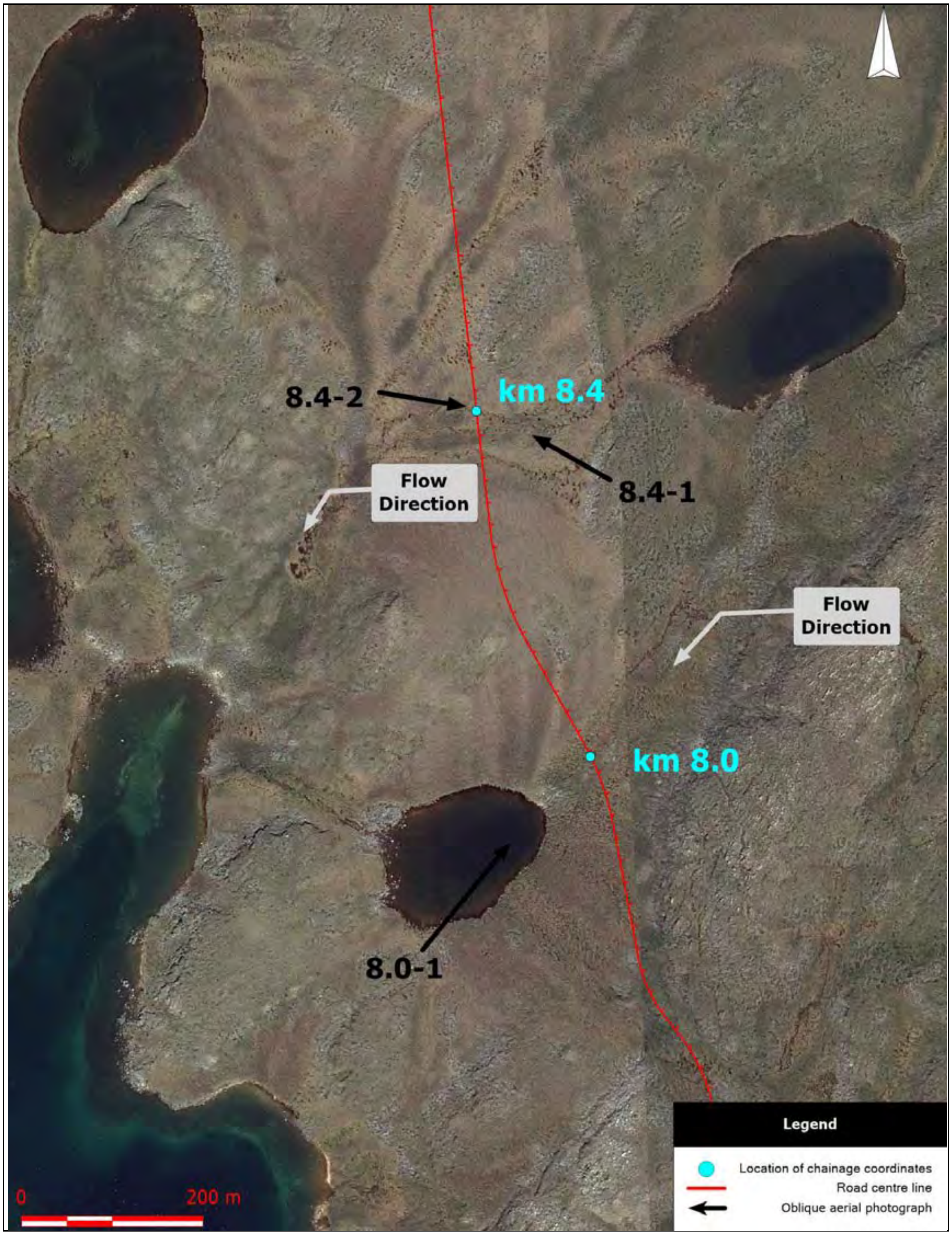
Kilometre 3.4. Oblique aerial photograph 3.4-1. August 30, 2014.



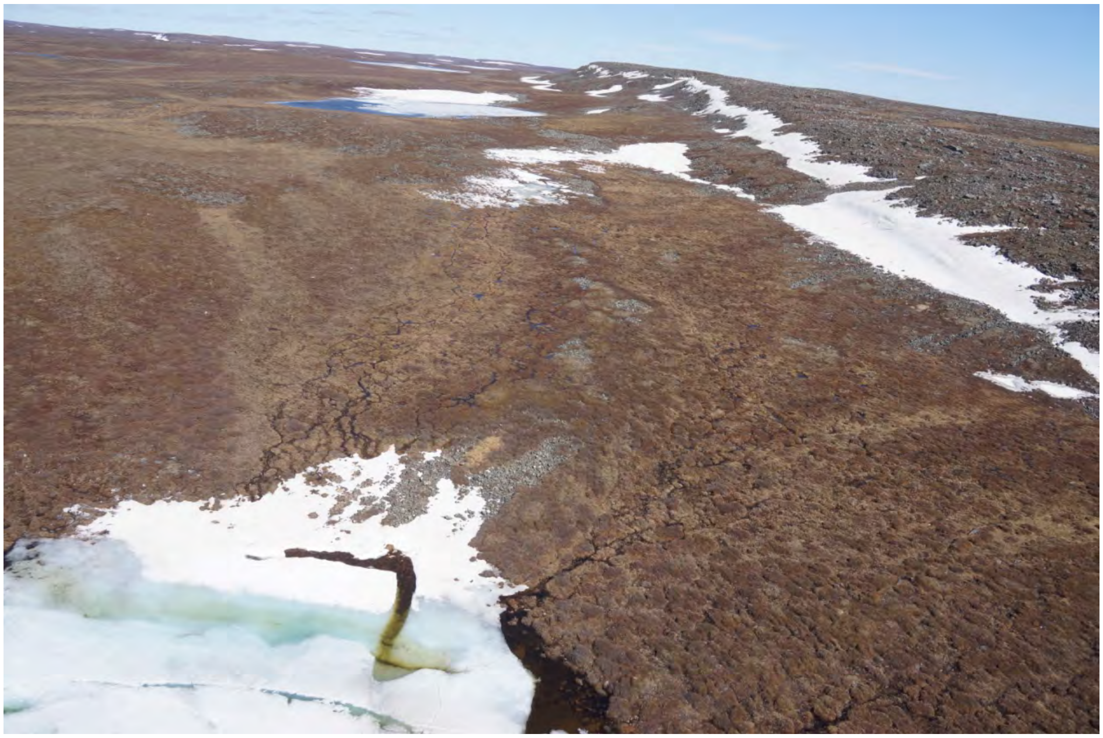
Kilometre 3.4. Oblique aerial photograph 3.4-2. June 29, 2015.

Kilometre 3.4. Photograph from the ground. Upstream view from the proposed road crossing. August 30, 2014.

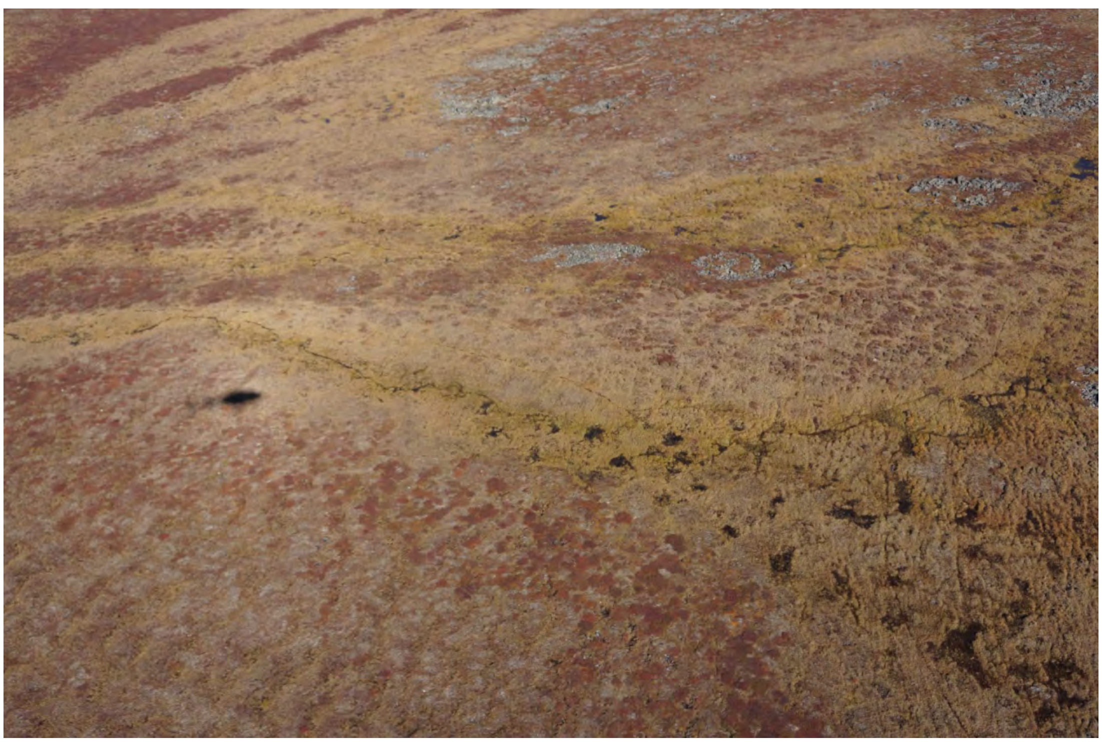
Kilometre 3.4. Photograph from the ground. Downstream view from approximately 30 m downstream from the proposed road crossing. June 23, 2015.



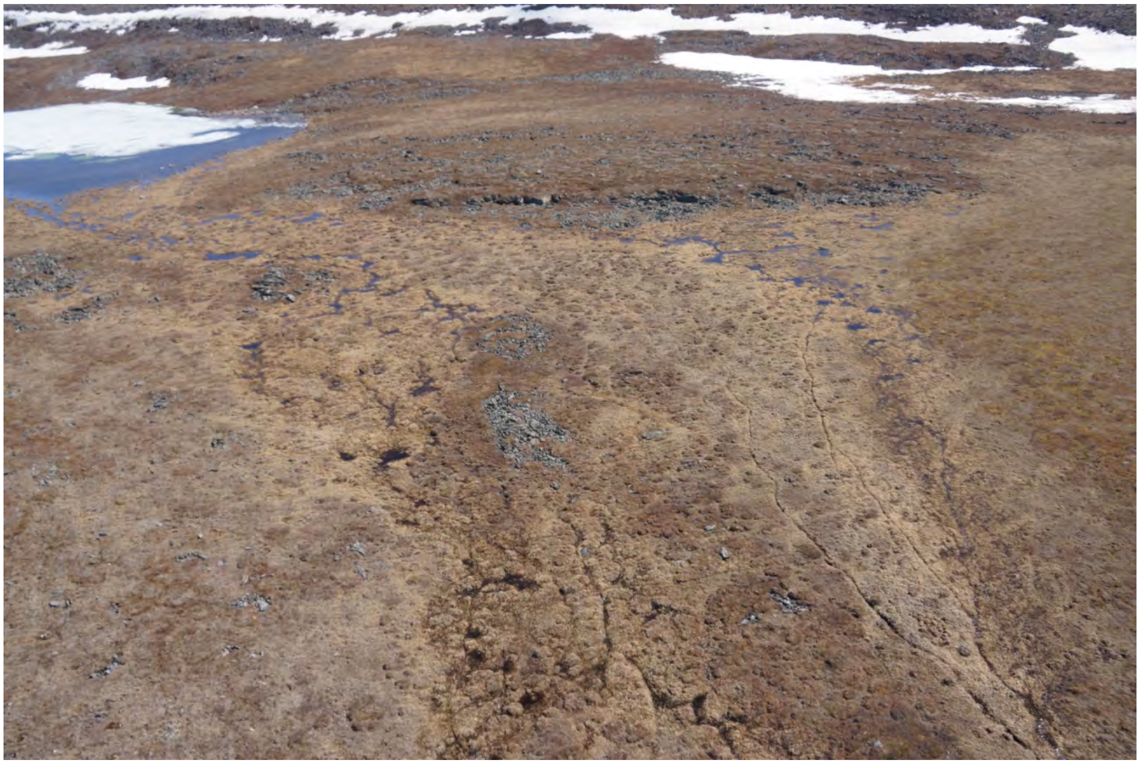
Kilometres 8.0 and 8.4. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.



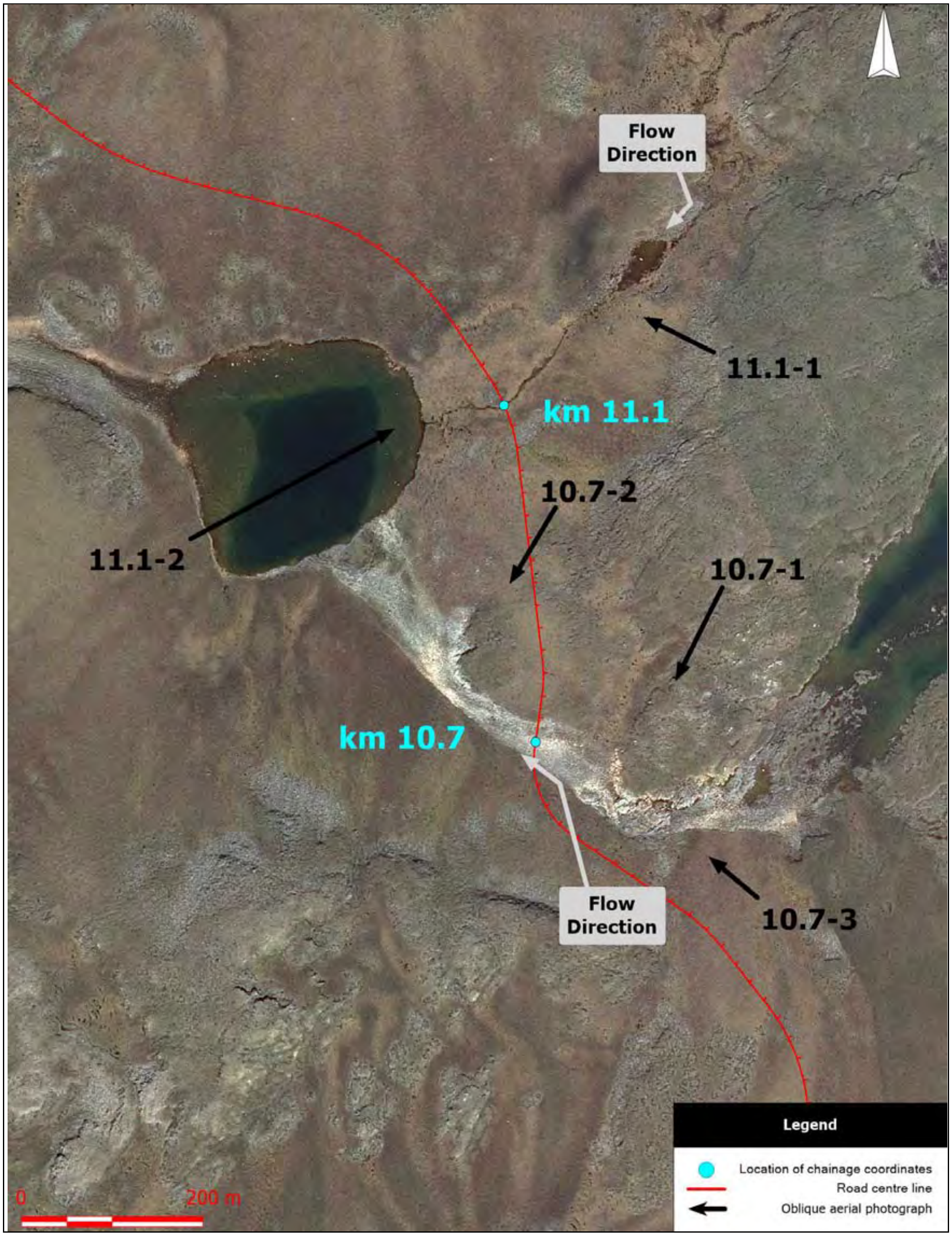
Kilometre 8.0. Oblique aerial photograph 8.0-1. June 29, 2015. There is no 2014 photograph.



Kilometre 8.4. Oblique aerial photograph 8.4-1. September 2, 2014.



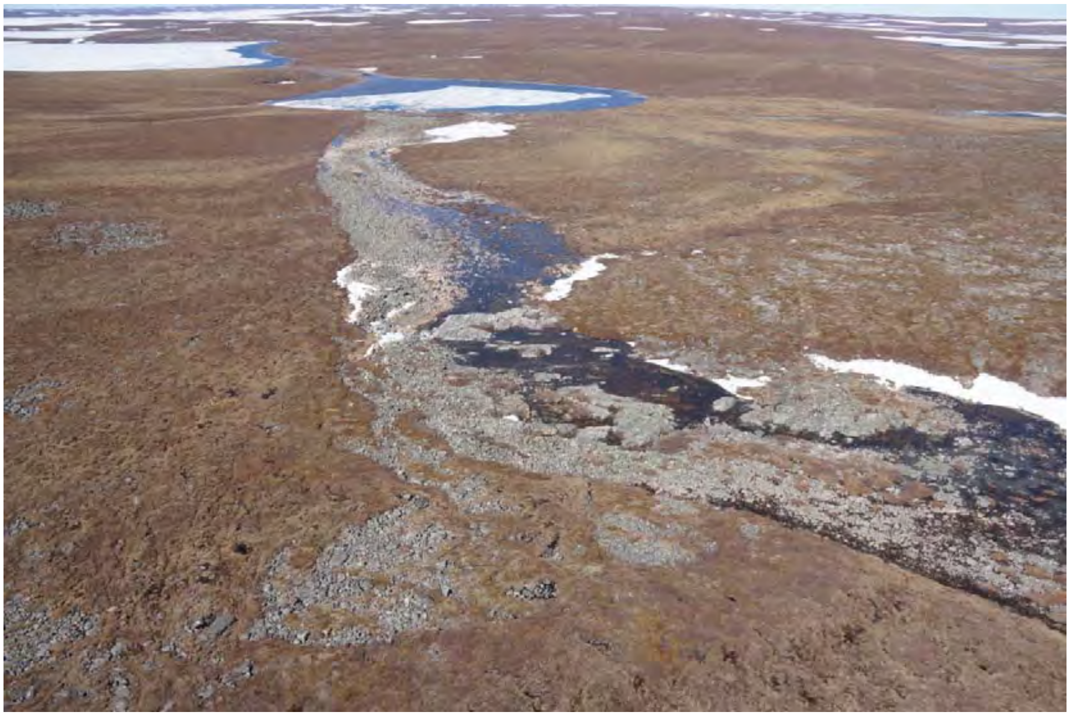
Kilometre 8.4. Oblique aerial photograph 8.4-2. June 29, 2015.



Kilometres 10.7 and 11.1. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.


Kilometre 10.7. Oblique aerial photograph 10.7-1. August 30, 2014.

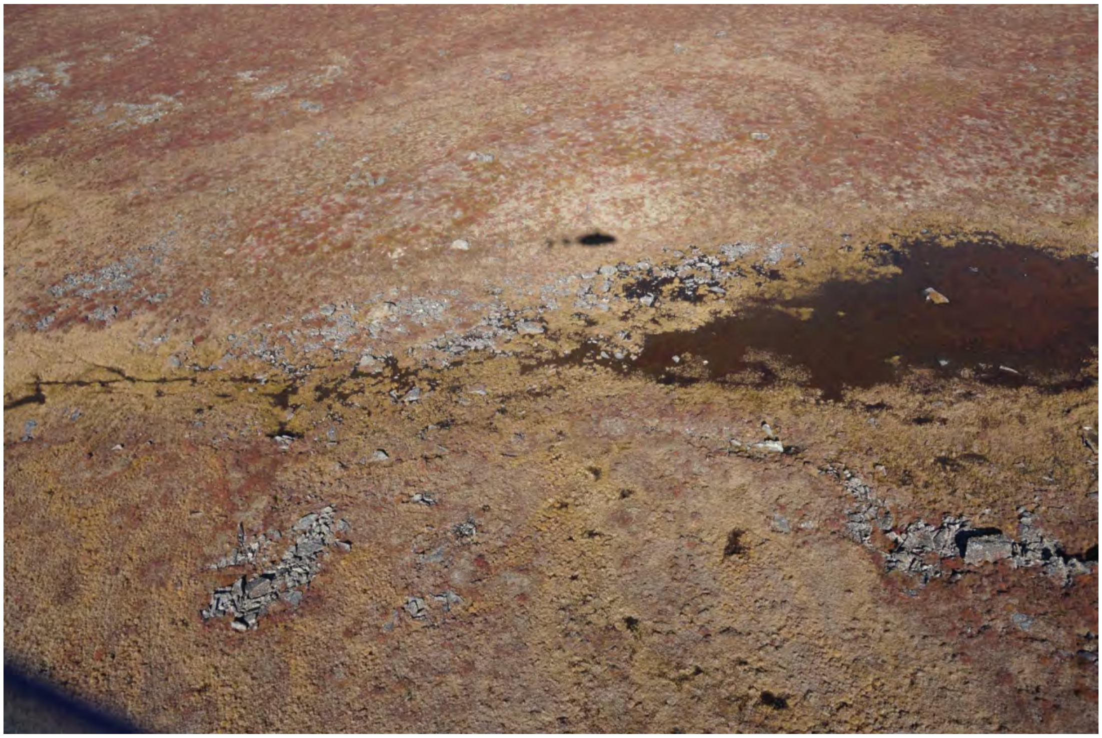

Kilometre 10.7. Oblique aerial photograph 10.7-2. August 30, 2014.



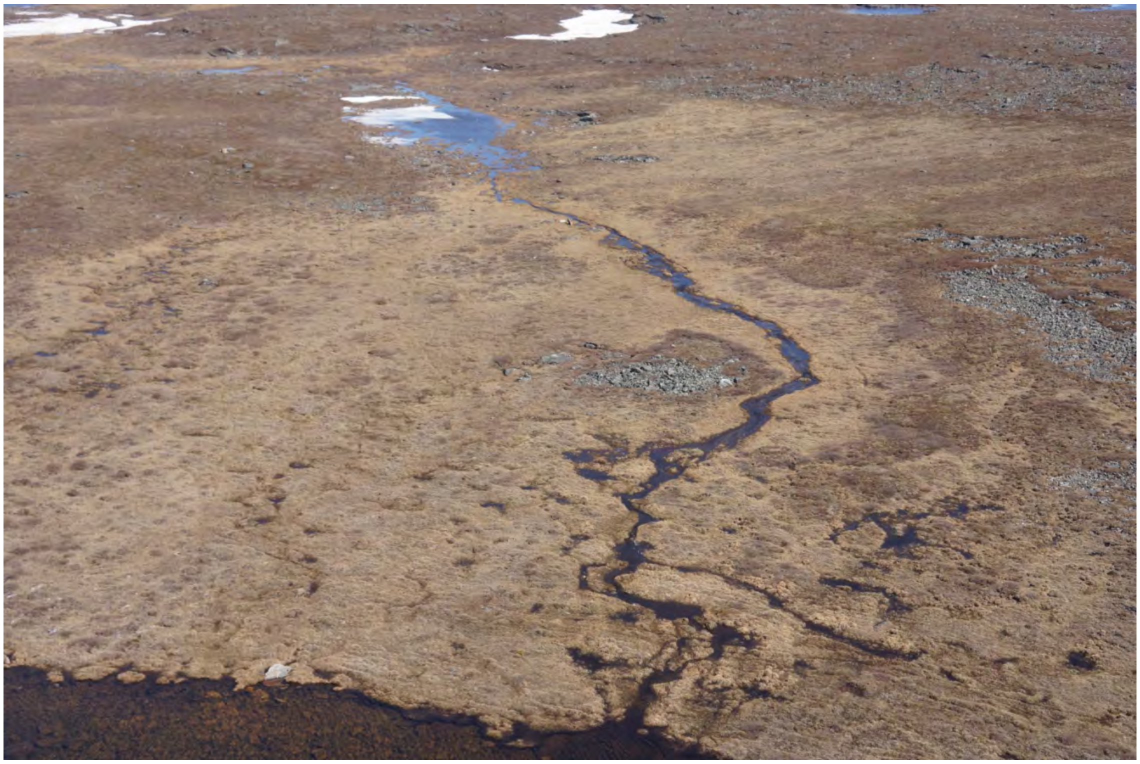
Kilometre 10.7. Oblique aerial photograph 10.7-3. June 29, 2015.

Kilometre 10.7. Photograph from the ground. View of the proposed road crossing. June 23, 2015.

Kilometre 10.7. Photograph from the ground. View downstream from the proposed road crossing. June 23, 2015.



Kilometre 11.1. Oblique aerial photograph 11.1-1. August 30, 2014.

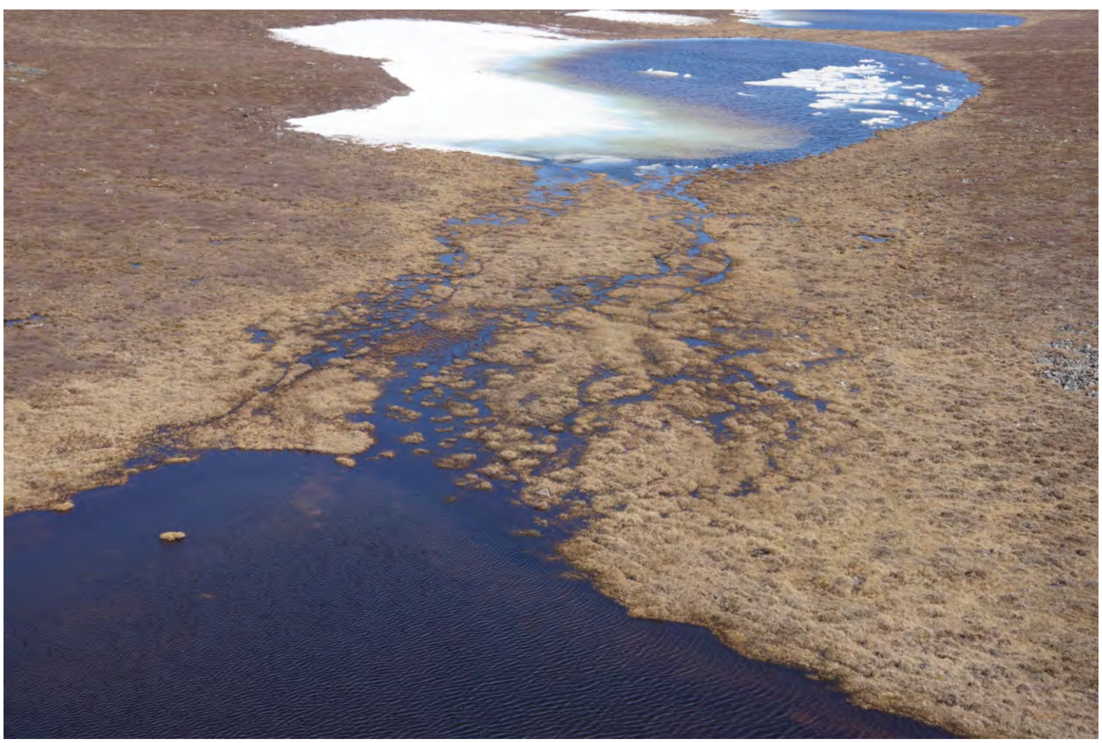


Kilometre 11.1. Oblique aerial photograph 11.1-2. June 29, 2015.

Kilometre 11.1. Photograph from the ground. View upstream from near the downstream lake. July 11, 2015.

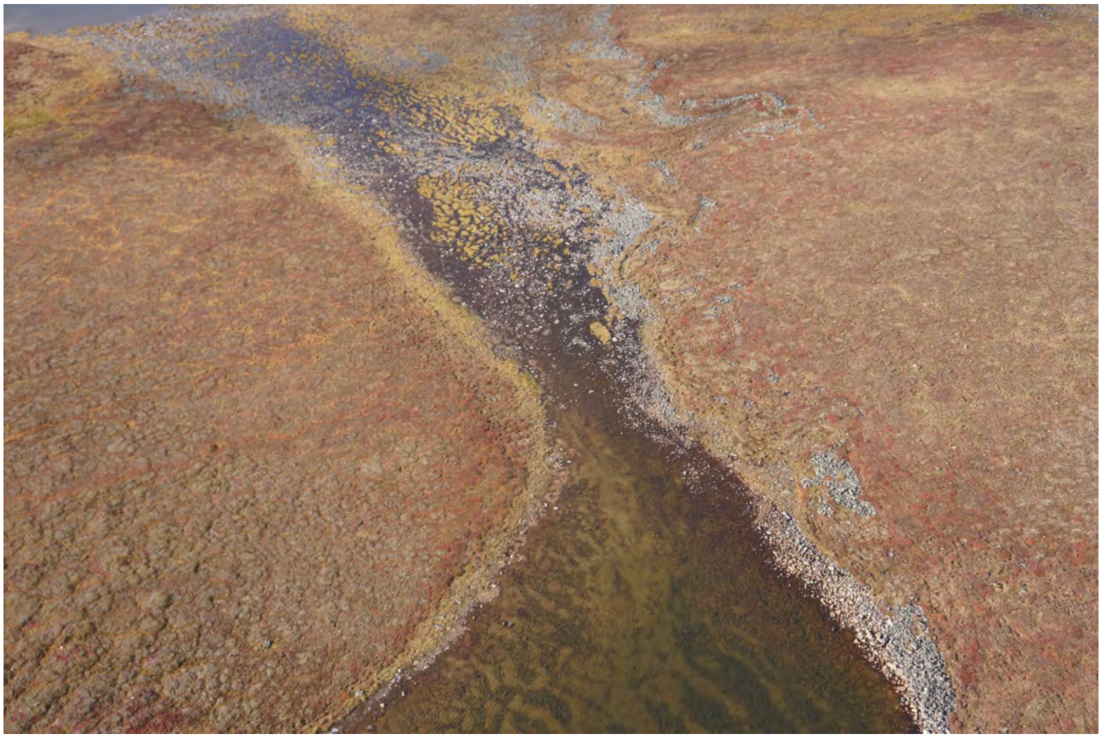
Kilometre 12.8. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

Kilometre 12.8. Oblique aerial photograph 12.8-1. August 30, 2014.

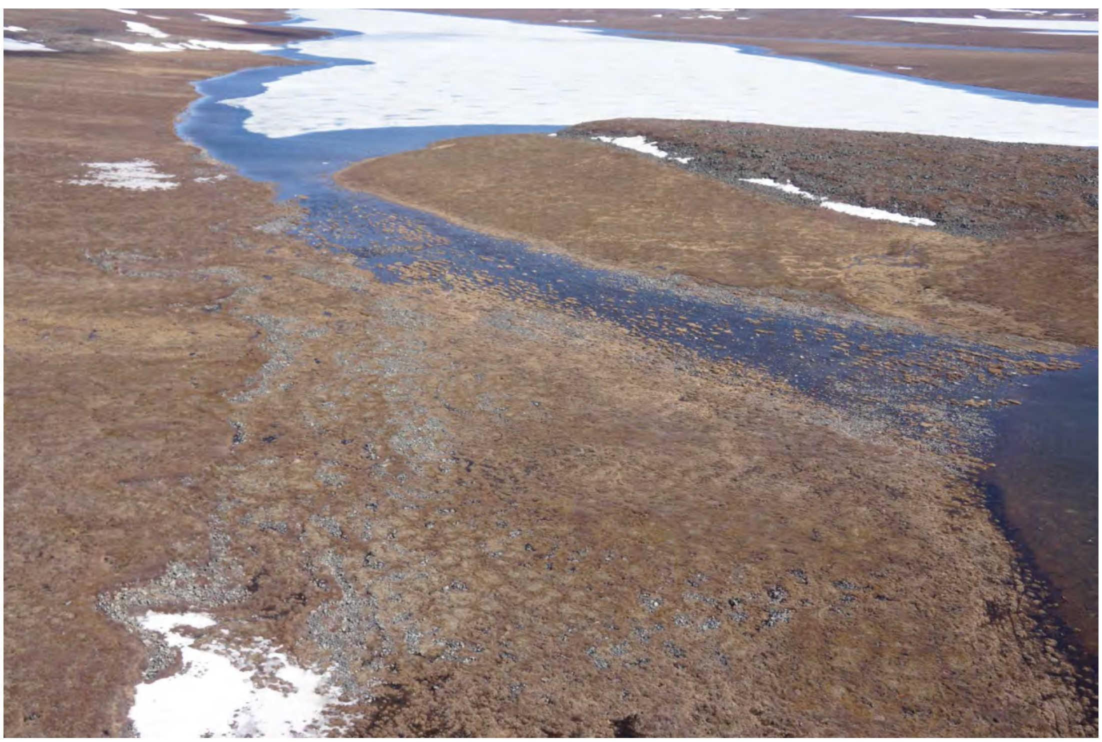


Kilometre 12.8. Oblique aerial photograph 12.8-2. June 29, 2015.

Kilometre 16.0. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.



Kilometre 16.0. Oblique aerial photograph 16.0-1. August 30, 2014.



Kilometre 16.0. Oblique aerial photograph 16.0-2. June 29, 2015.

Kilometre 16.0. Photograph from the ground. Approximately 100 m upstream from lake.

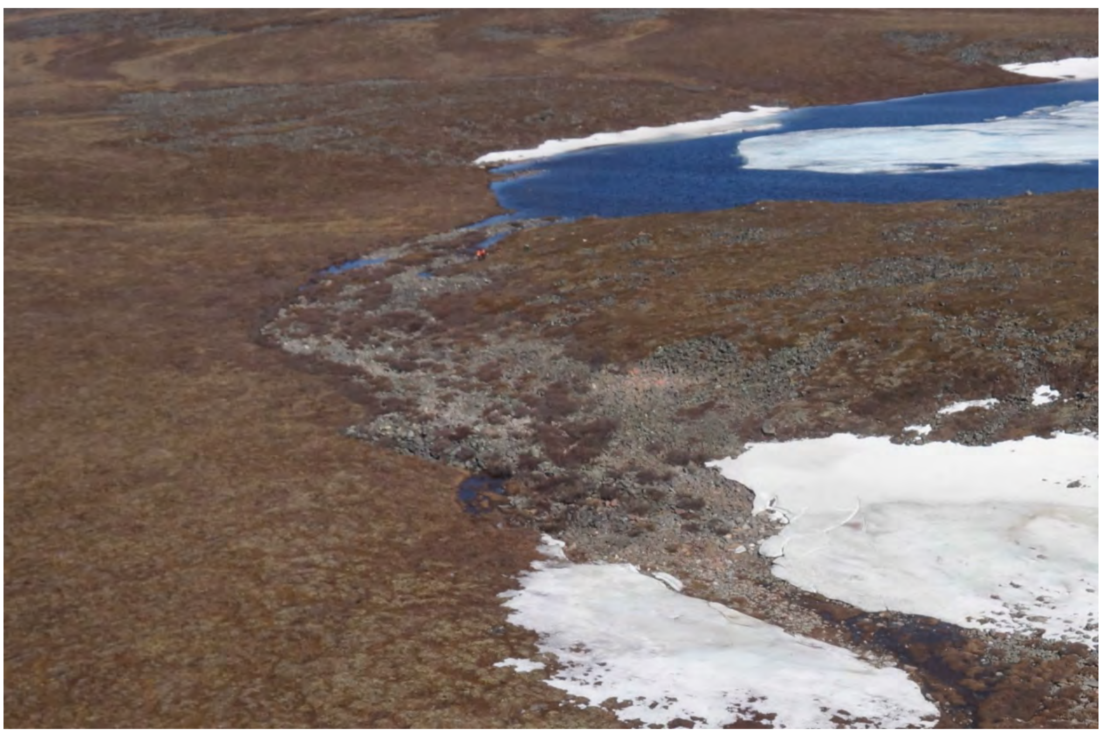
Kilometre 16.0. Photograph from the ground. Upstream view from 37 m downstream of the proposed road crossing location. September 1, 2014.

Kilometre 16.0. Photograph from the ground. Downstream view from 56 m upstream of the proposed road crossing location. September 1, 2014.

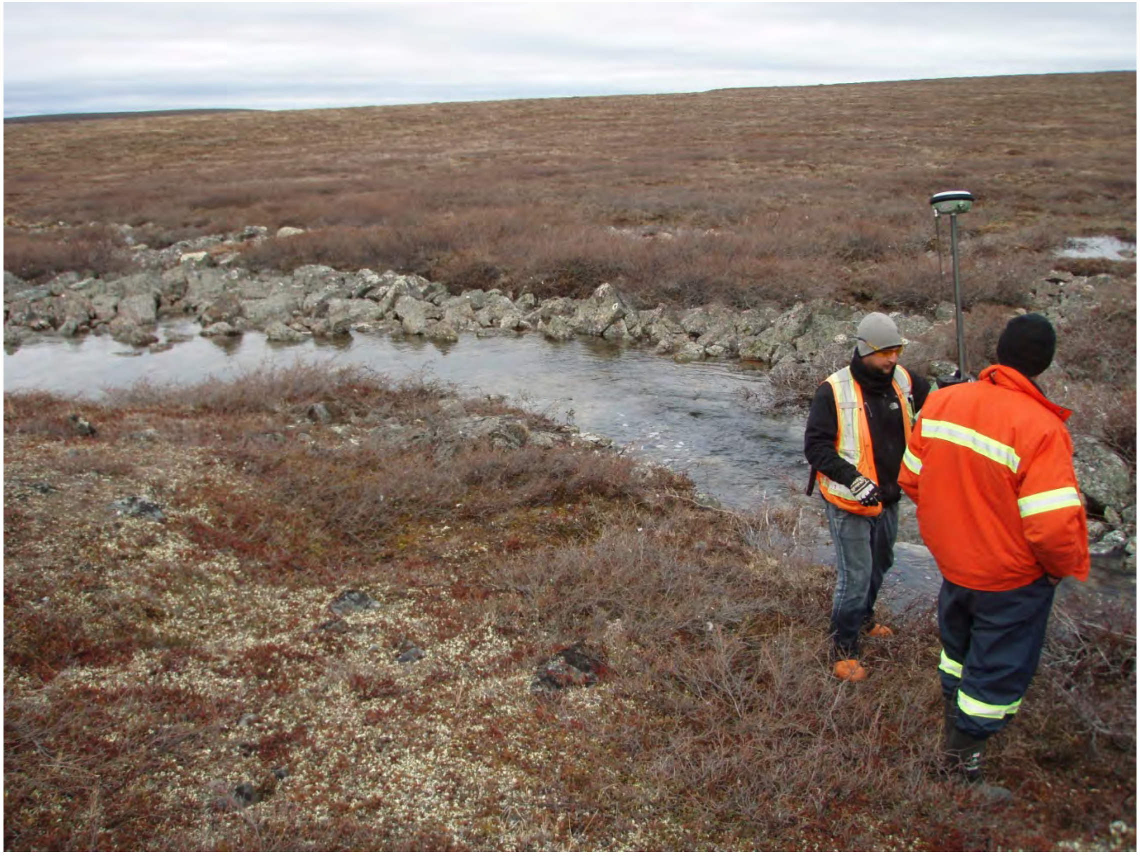
Kilometre 16.0. Photograph from the ground. Approximately 250 m upstream from lake at the proposed bridge location. June 23, 2015.

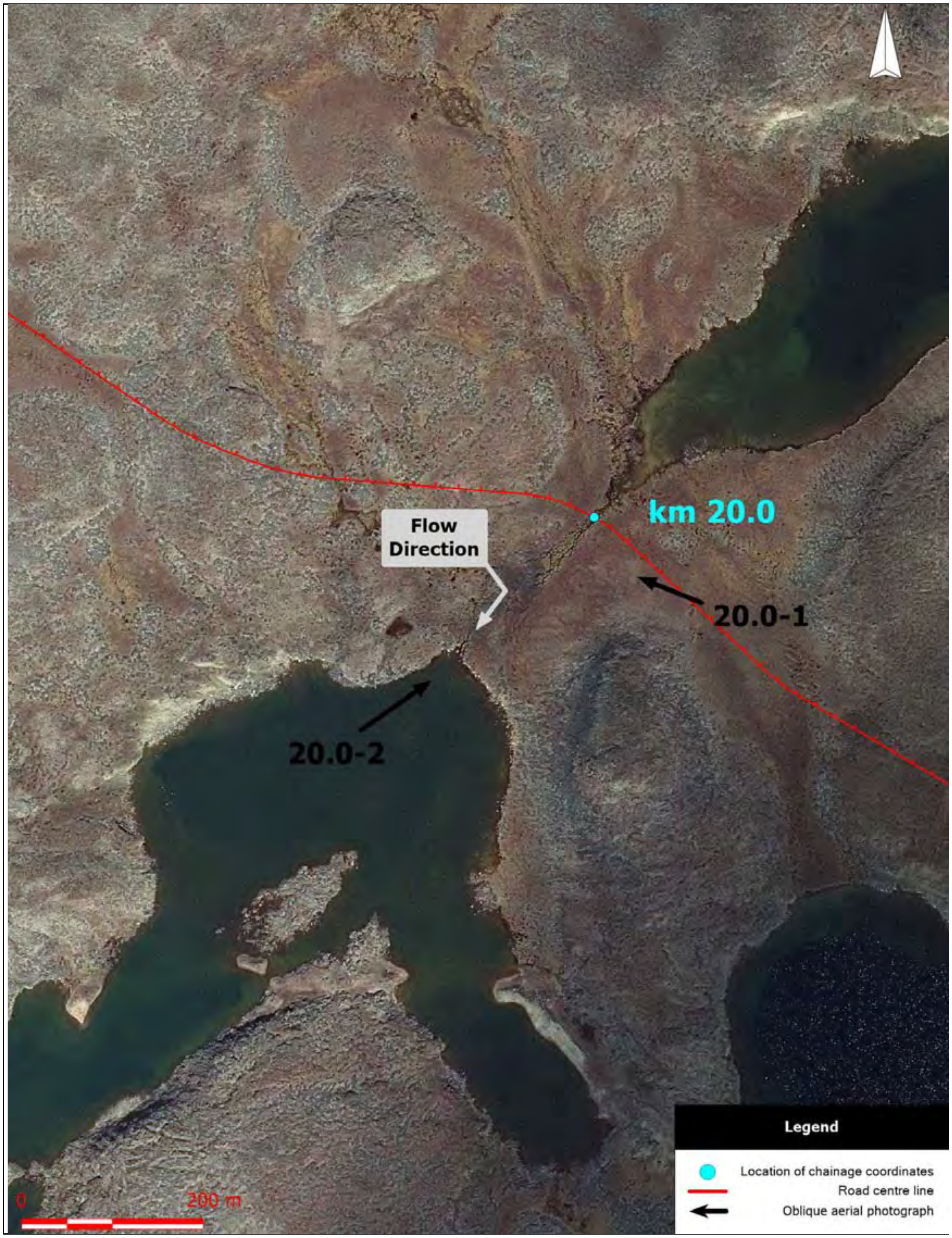
Kilometre 18.6. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

Kilometre 18.6. Oblique aerial photograph 18.6-1. August 30, 2014.

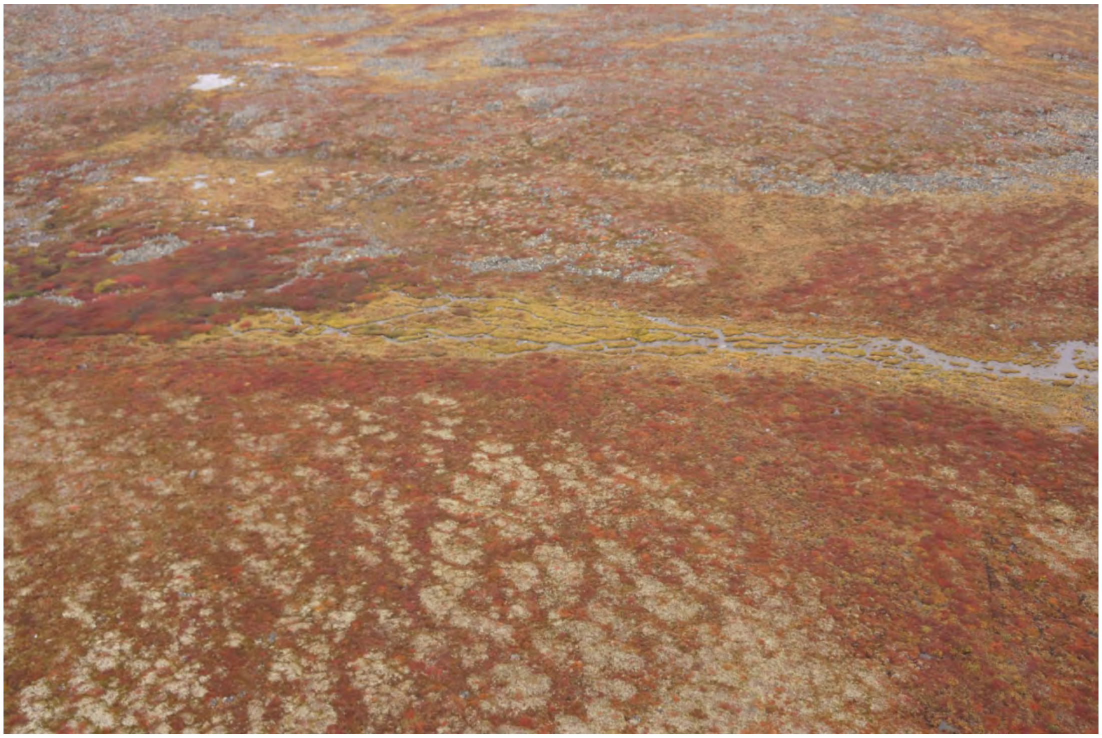


Kilometre 18.6. Oblique aerial photograph 18.6-2. June 29, 2015.

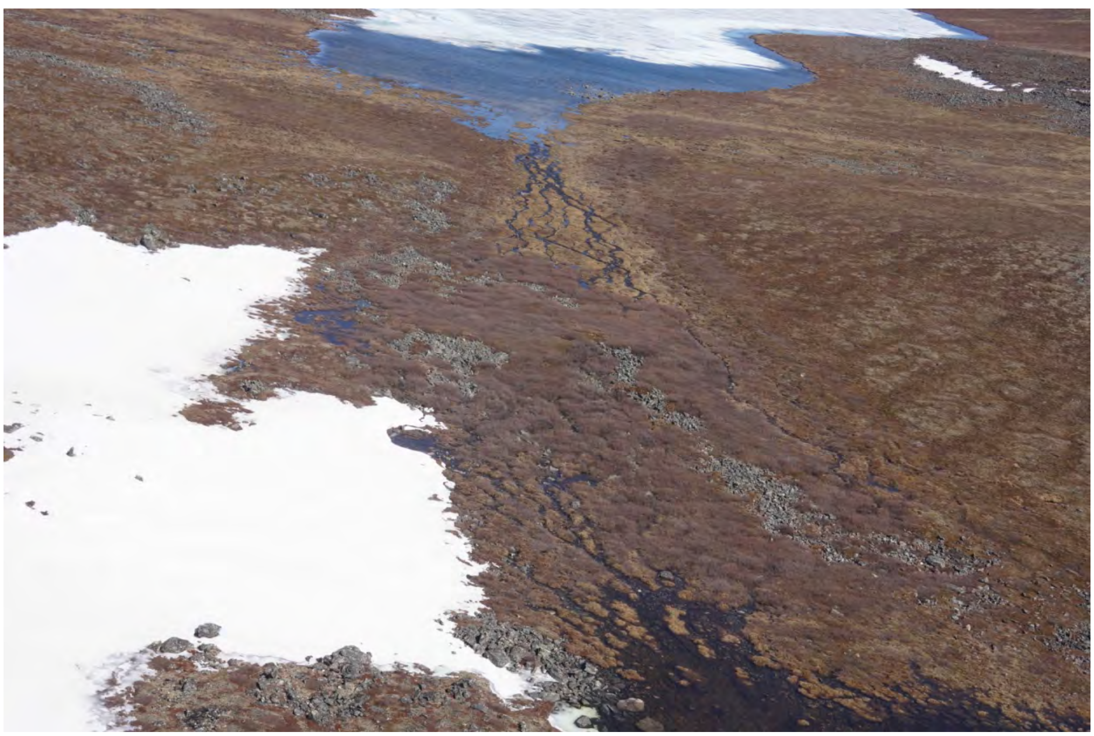

Kilometre 18.6. Photograph from the ground. Road crossing location. June 23, 2015.



Kilometre 20.0. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.



Kilometre 20.0. Oblique aerial photograph 20.0-1. August 29, 2014.

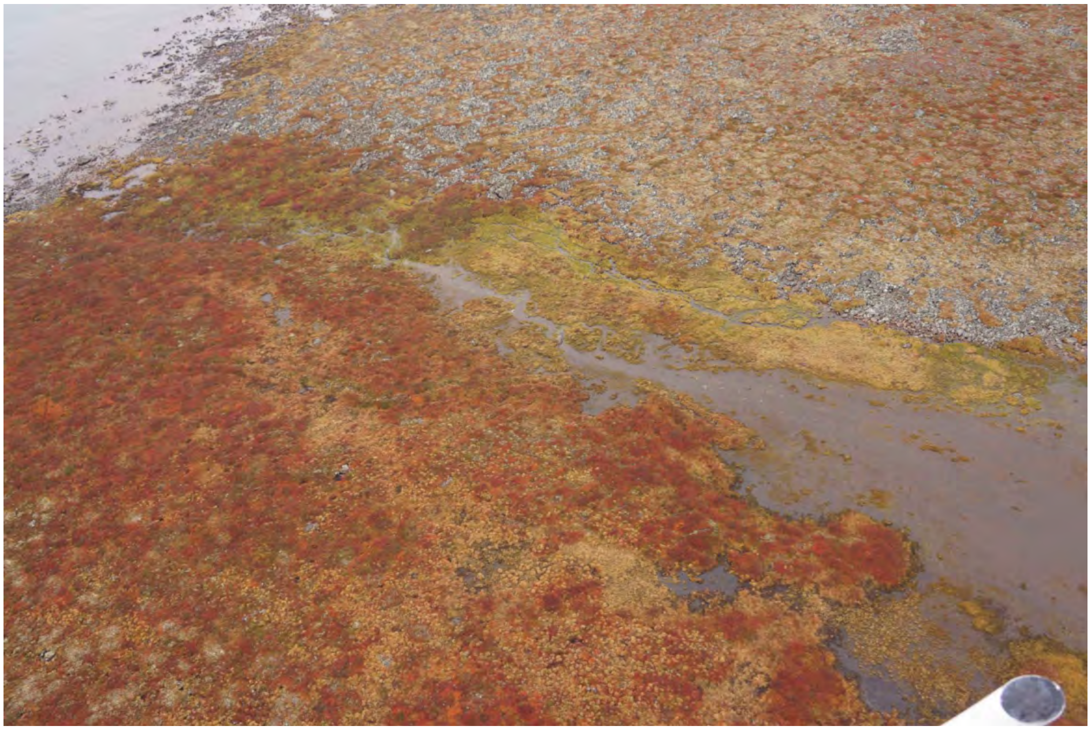


Kilometre 20.0. Oblique aerial photograph 20.0-2. June 29, 2015.

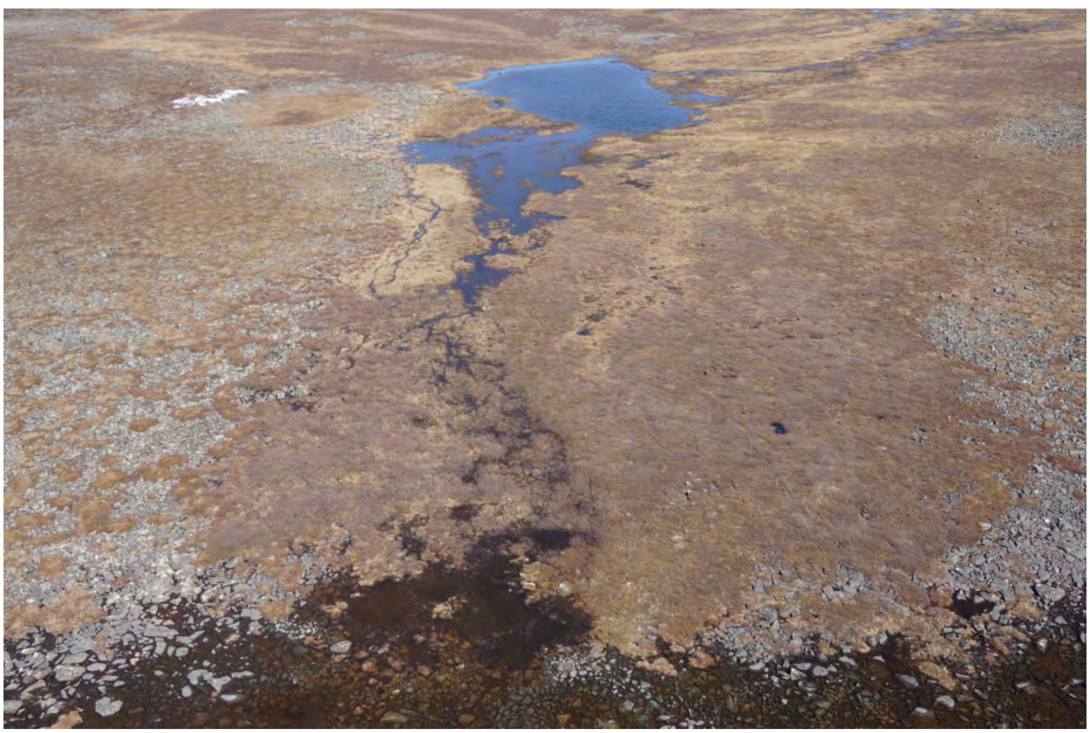
Kilometre 20.0. Photograph from the ground. Near watercourse mouth. September 2, 2014.

Kilometre 20.0. Photograph from the ground. Upstream view approximately 200 m upstream of watercourse mouth. September 2, 2014.

Kilometre 22.1. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

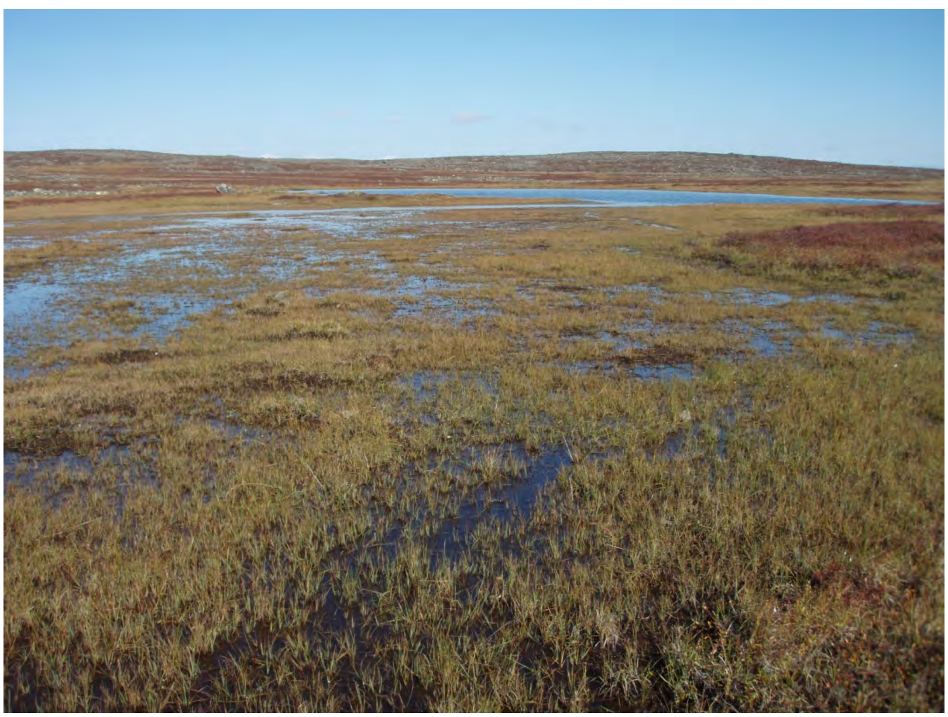


Kilometre 22.1. Oblique aerial photograph 22.1-1. August 29, 2014.

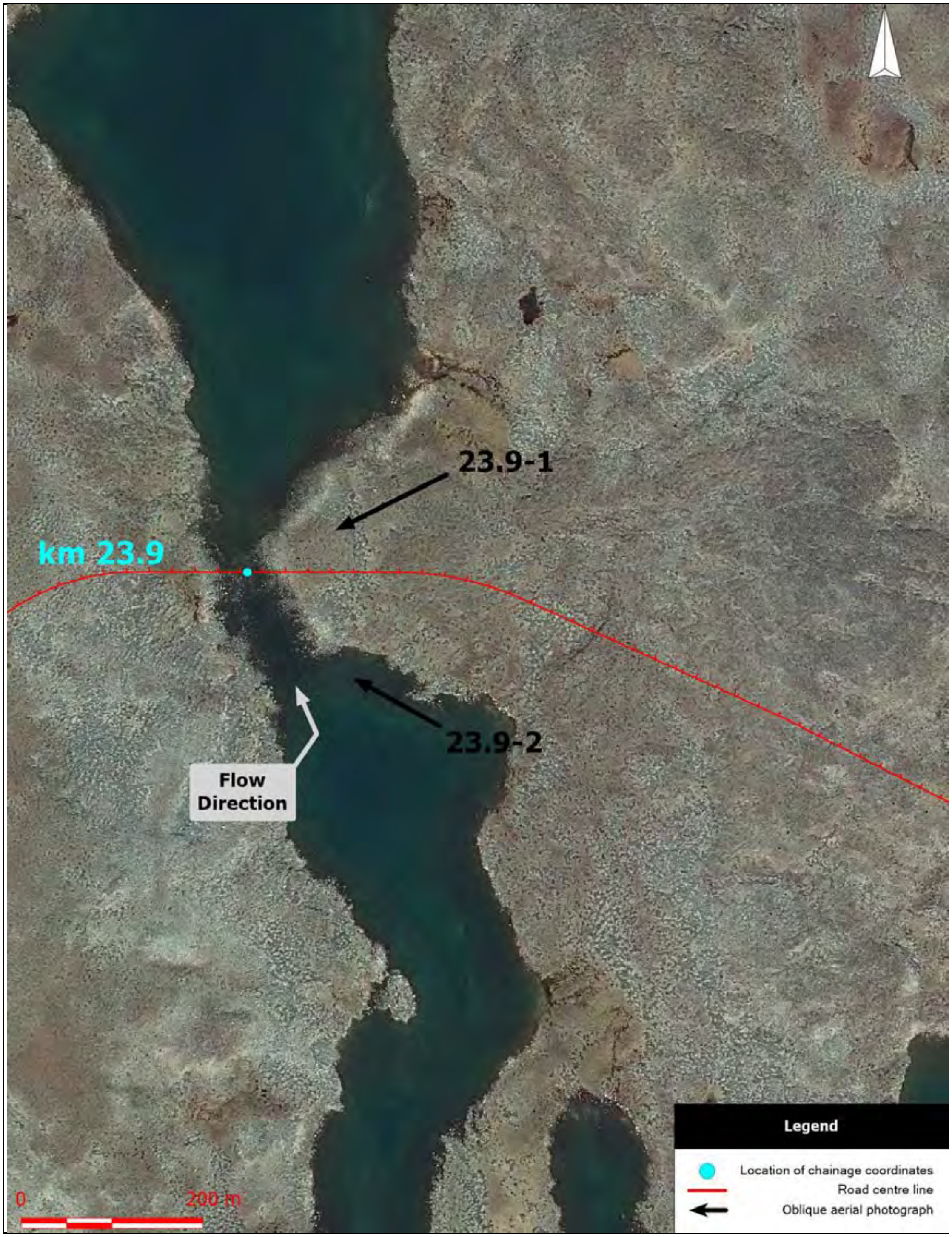


Kilometre 22.1. Oblique aerial photograph 22.1-2. June 29, 2015.

Kilometre 22.1. Photograph from the ground. Upstream view approximately 100 m upstream of watercourse mouth. August 31, 2014.

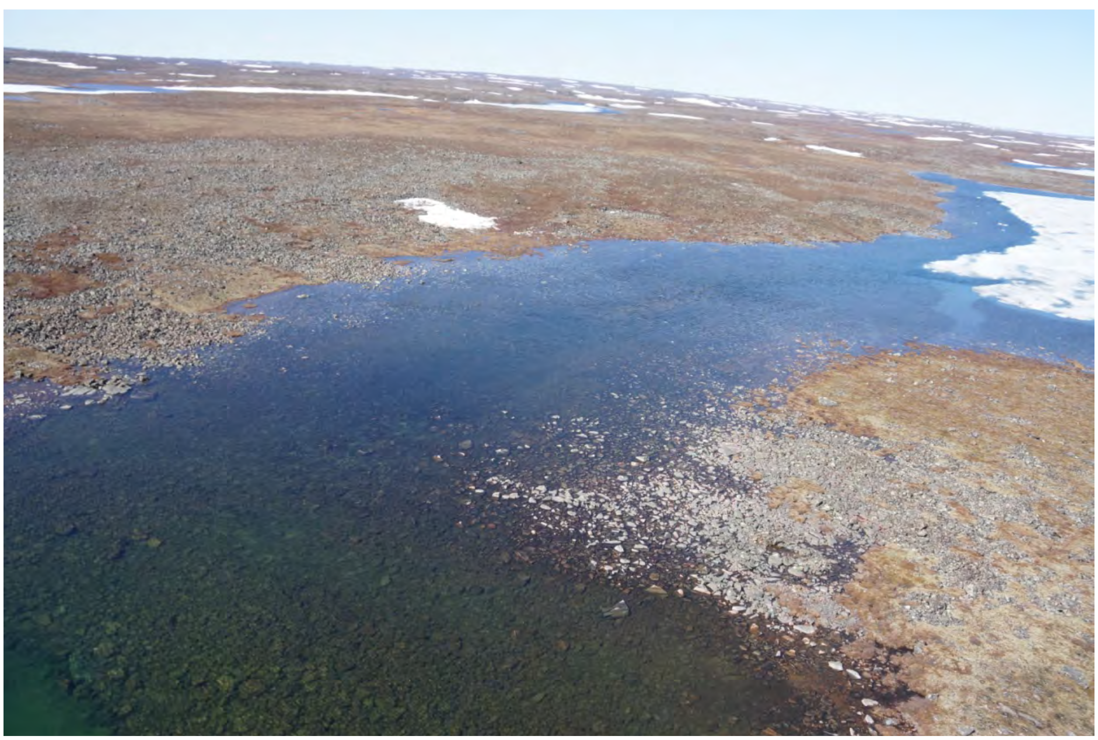


Kilometre 22.1. Photograph from the ground. Upstream view approximately 180 m upstream of watercourse mouth. August 31, 2014.



Kilometre 23.9. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

Kilometre 23.9. Oblique aerial photograph 23.9-1. August 29, 2014.



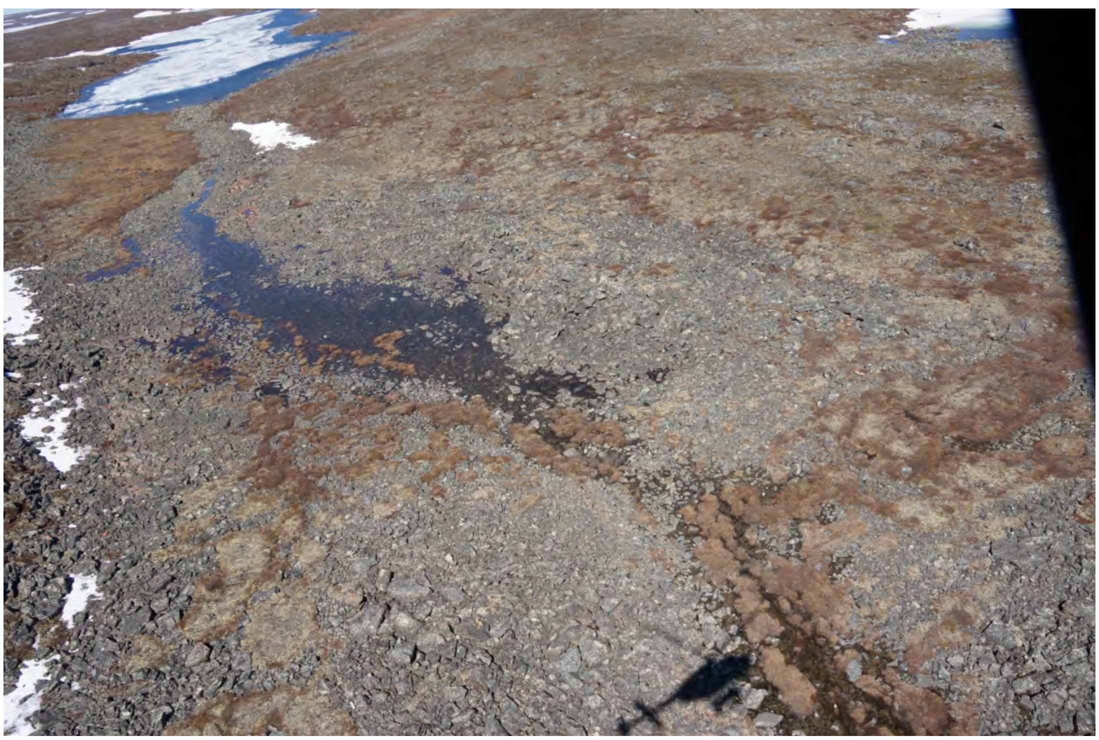
Kilometre 23.9. Oblique aerial photograph 23.9-2. June 29, 2015.

Kilometre 23.9. Photograph from the ground. Note flow through narrows. August 31, 2014.

Kilometre 23.9. Photograph from the ground. June 23, 2015.

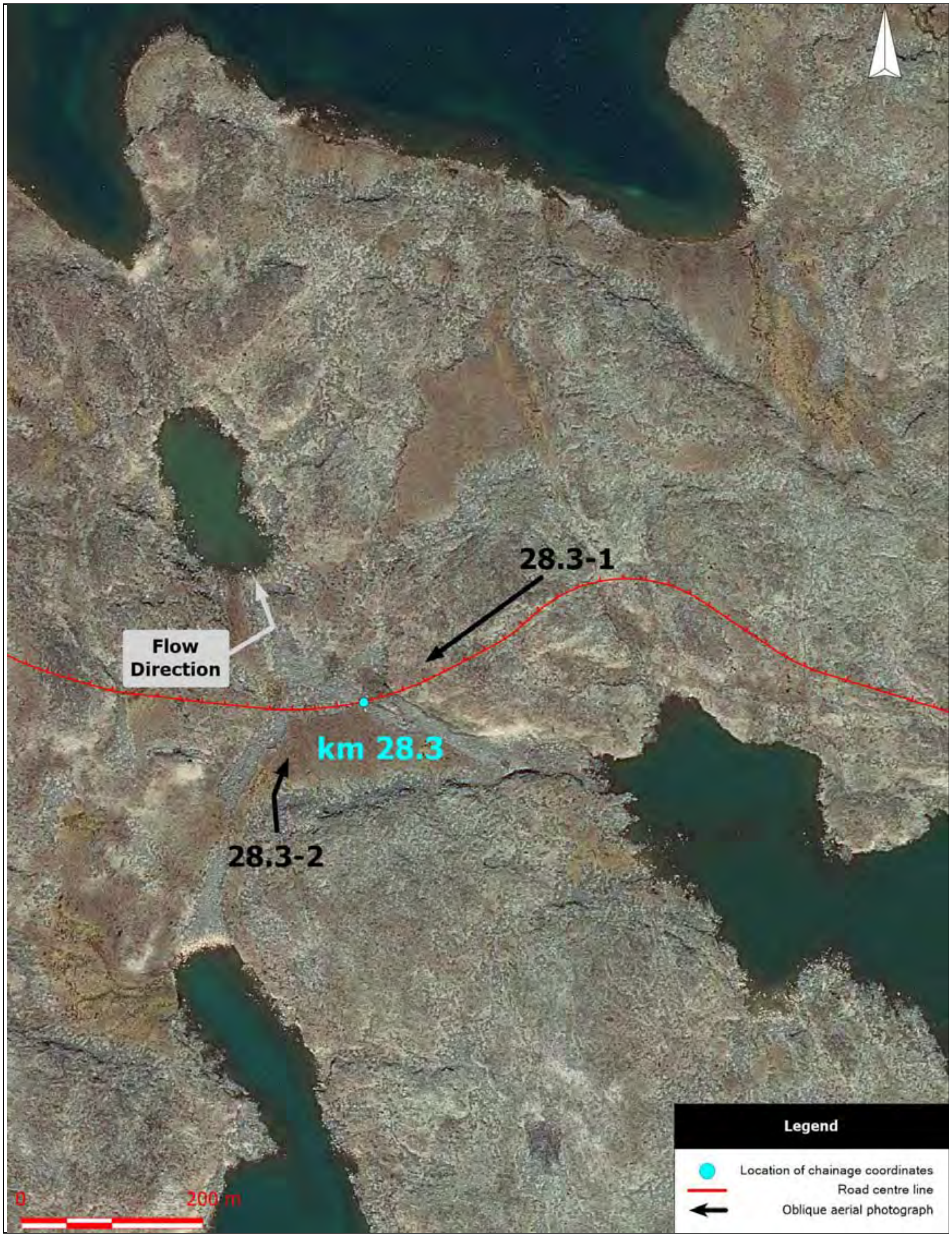
Kilometre 26.1. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

Kilometre 26.1. Oblique aerial photograph 26.1-1. August 29, 2014. Crossing at centre.

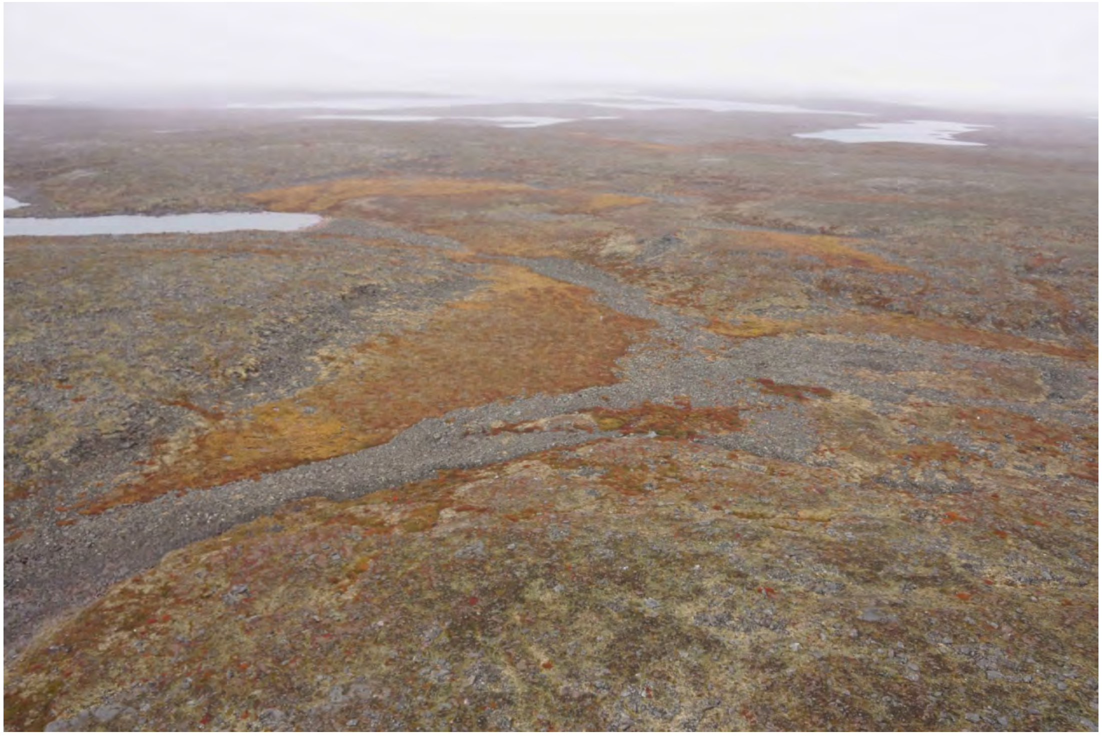


Kilometre 26.1. Oblique aerial photograph 26.1-2. June 29, 2015.

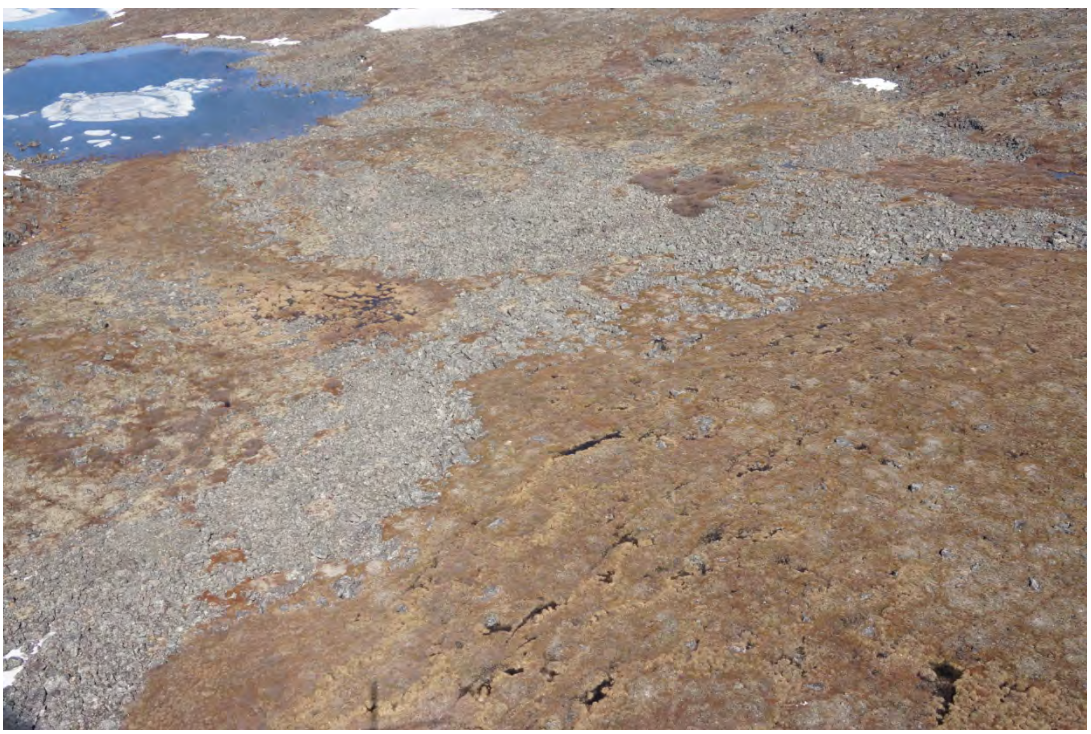
Kilometre 26.1. Photograph from the ground. Upstream view approximately 130 m downstream from road crossing location. June 23, 2015.



Kilometre 28.3. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.



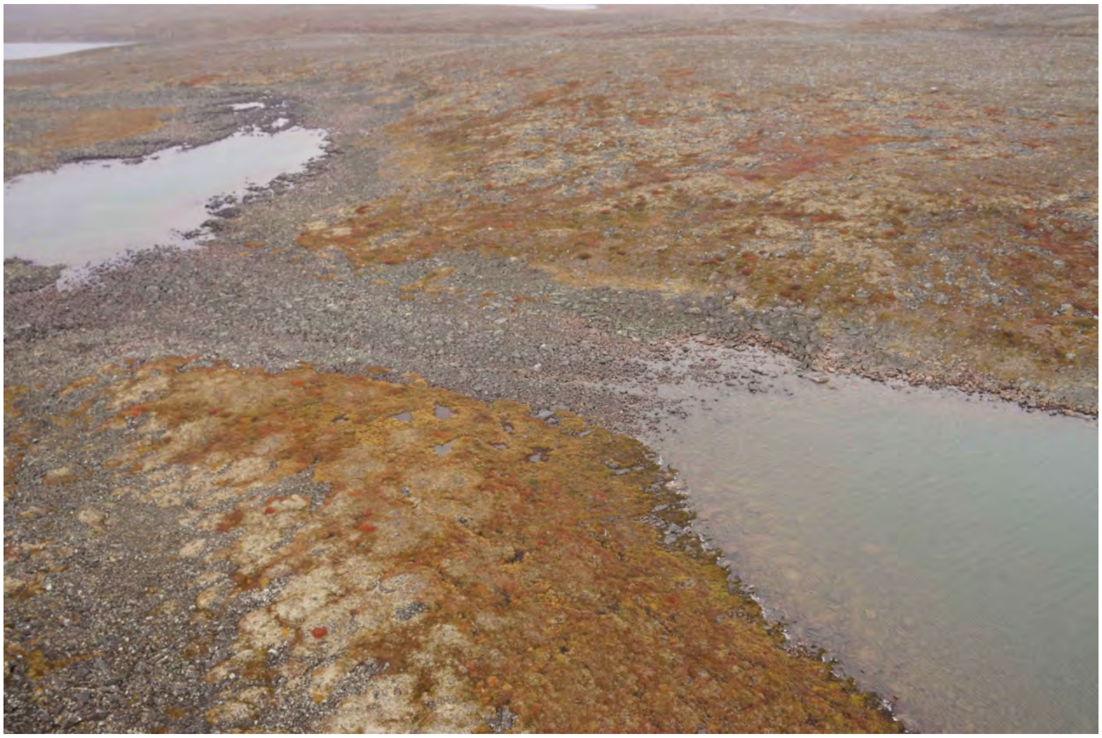
Kilometre 28.3. Oblique aerial photograph 28.3-1. August 29, 2014.



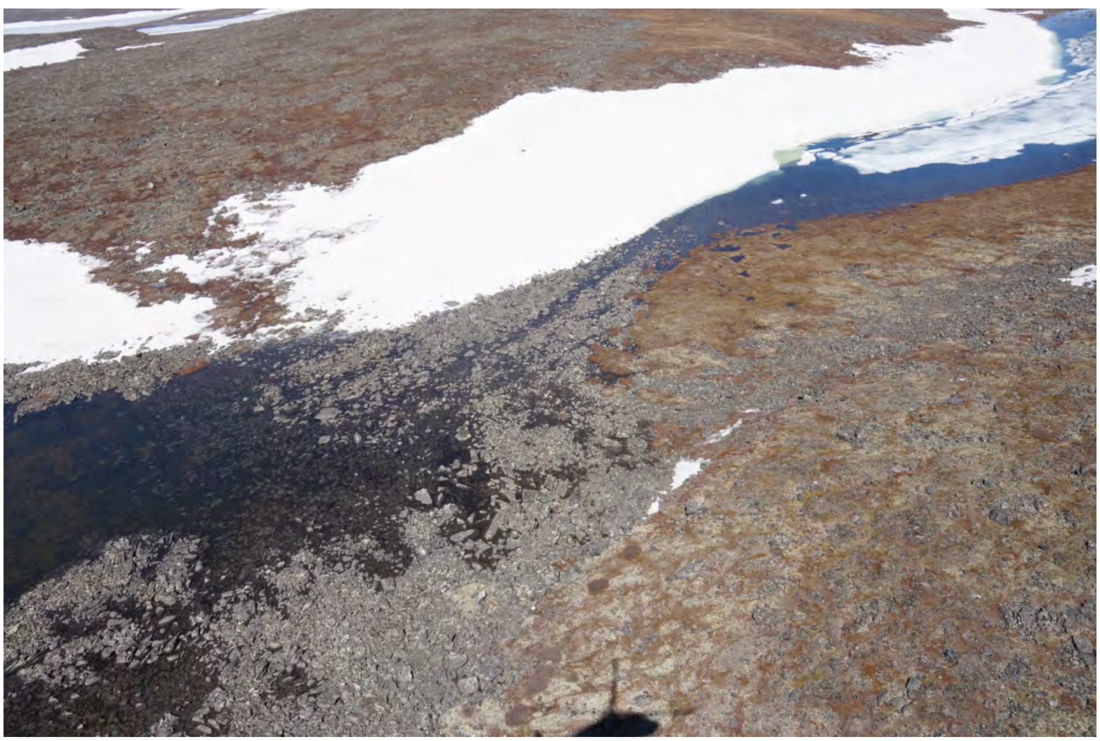
Kilometre 28.3. Oblique aerial photograph 28.3-2. June 29, 2015.

Kilometre 28.3. Photograph from the ground. Road crossing location. June 23, 2015.

Kilometre 30.4. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.



Kilometre 30.4. Oblique aerial photograph 30.4-1. August 29, 2014.



Kilometre 30.4. Oblique aerial photograph 30.4-2. June 29, 2015.

Kilometre 32.3. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

Kilometre 32.3. Oblique aerial photograph 32.3-1. August 30, 2014. Crossing a photograph centre.

Kilometre 32.3. Oblique aerial photograph 32.3-2. June 29, 2015.

Kilometre 32.3. Photograph from the ground. Upstream view through approximate crossing located approximately 80 m from camera. September 1, 2014.

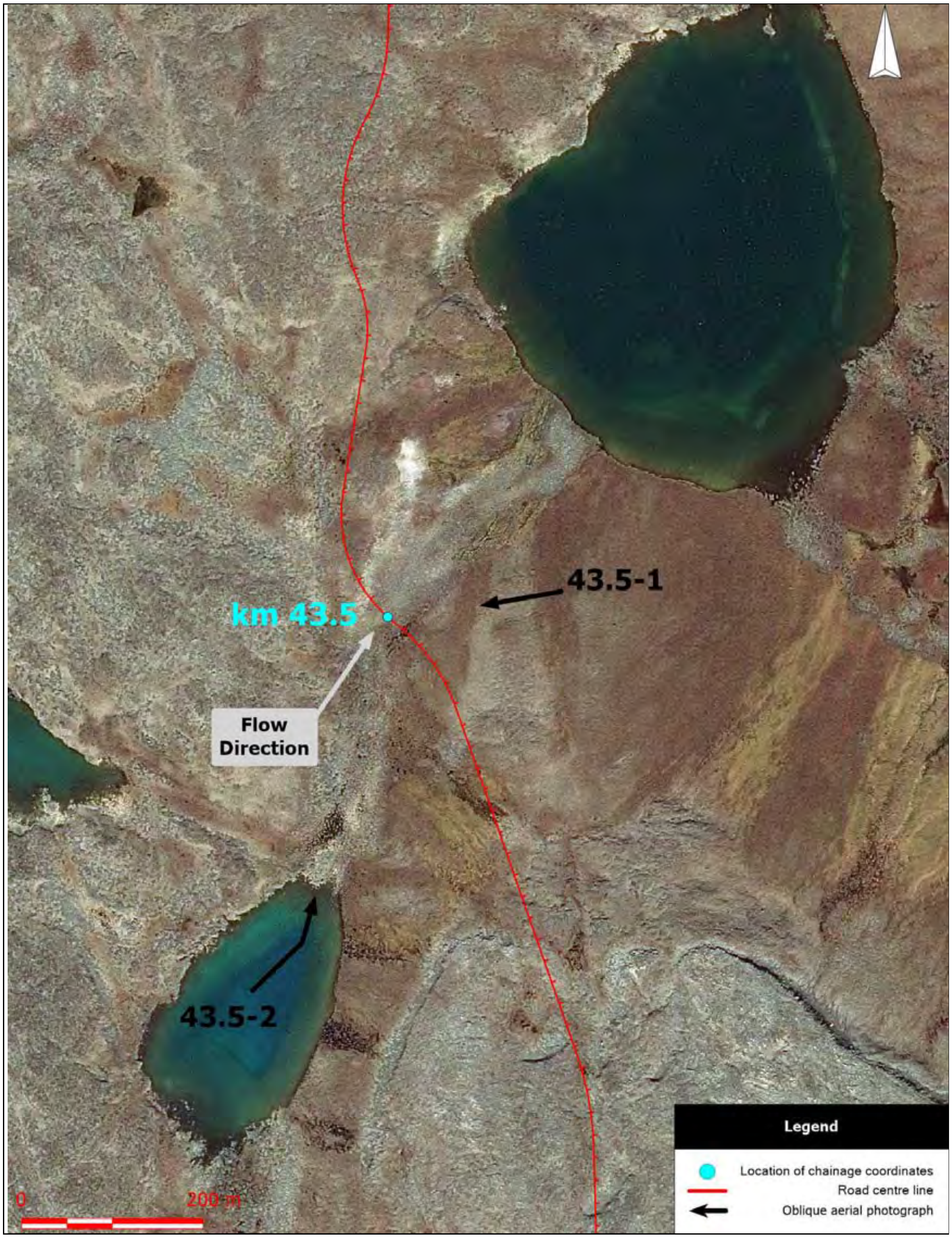
Kilometre 32.3. Photograph from the ground. Upstream view through approximate crossing located approximately 60 m from camera. June 23, 2015.

Kilometre 36.2. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

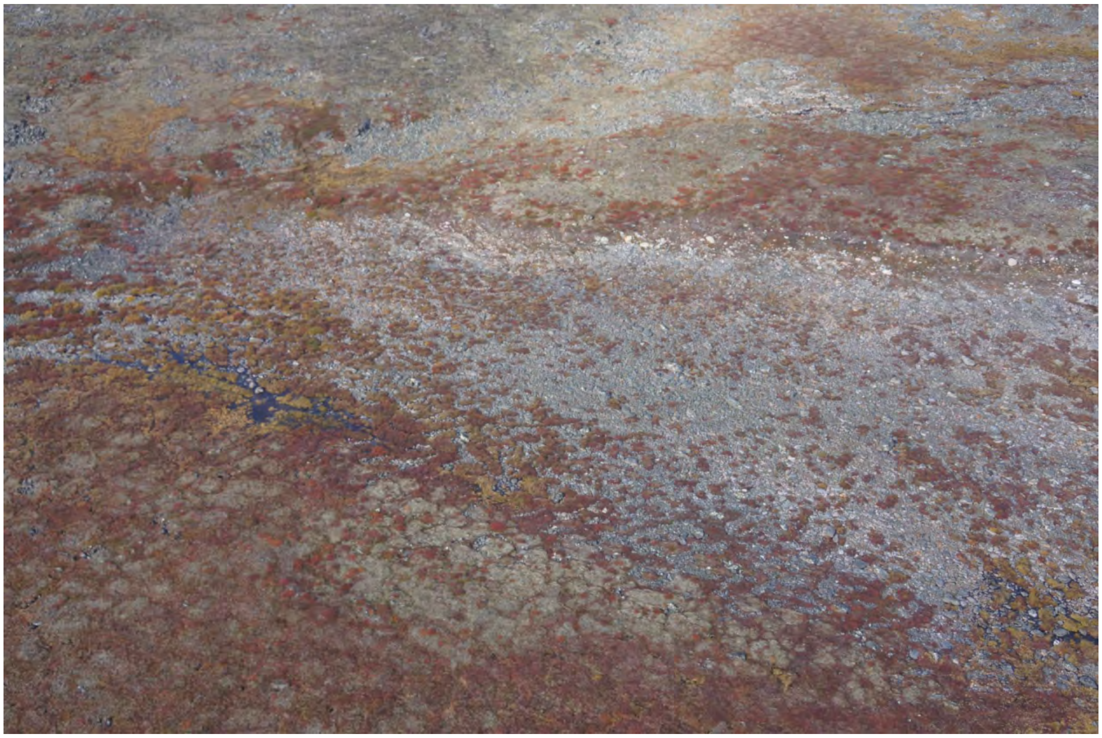
Kilometre 36.2. Oblique aerial photograph 36.2-1. August 30, 2014.

Kilometre 36.2. Oblique aerial photograph 36.2-2. August 30, 2014.

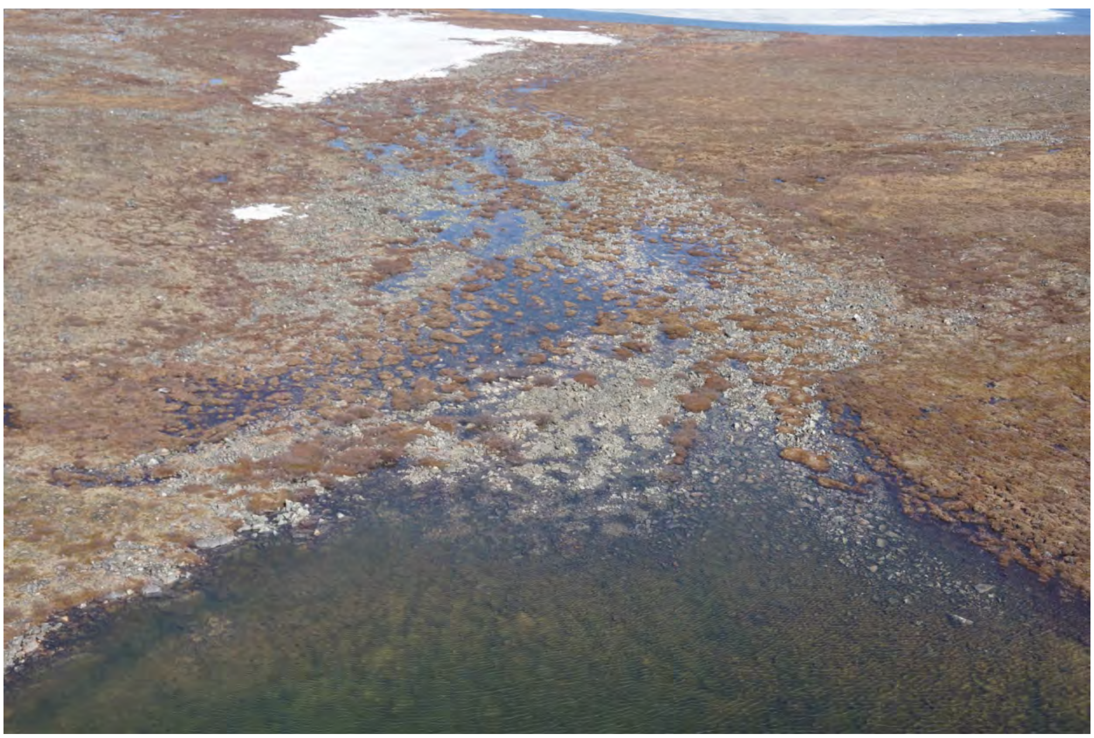
Kilometre 41.8. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, and the flow direction.



Kilometre 43.5. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

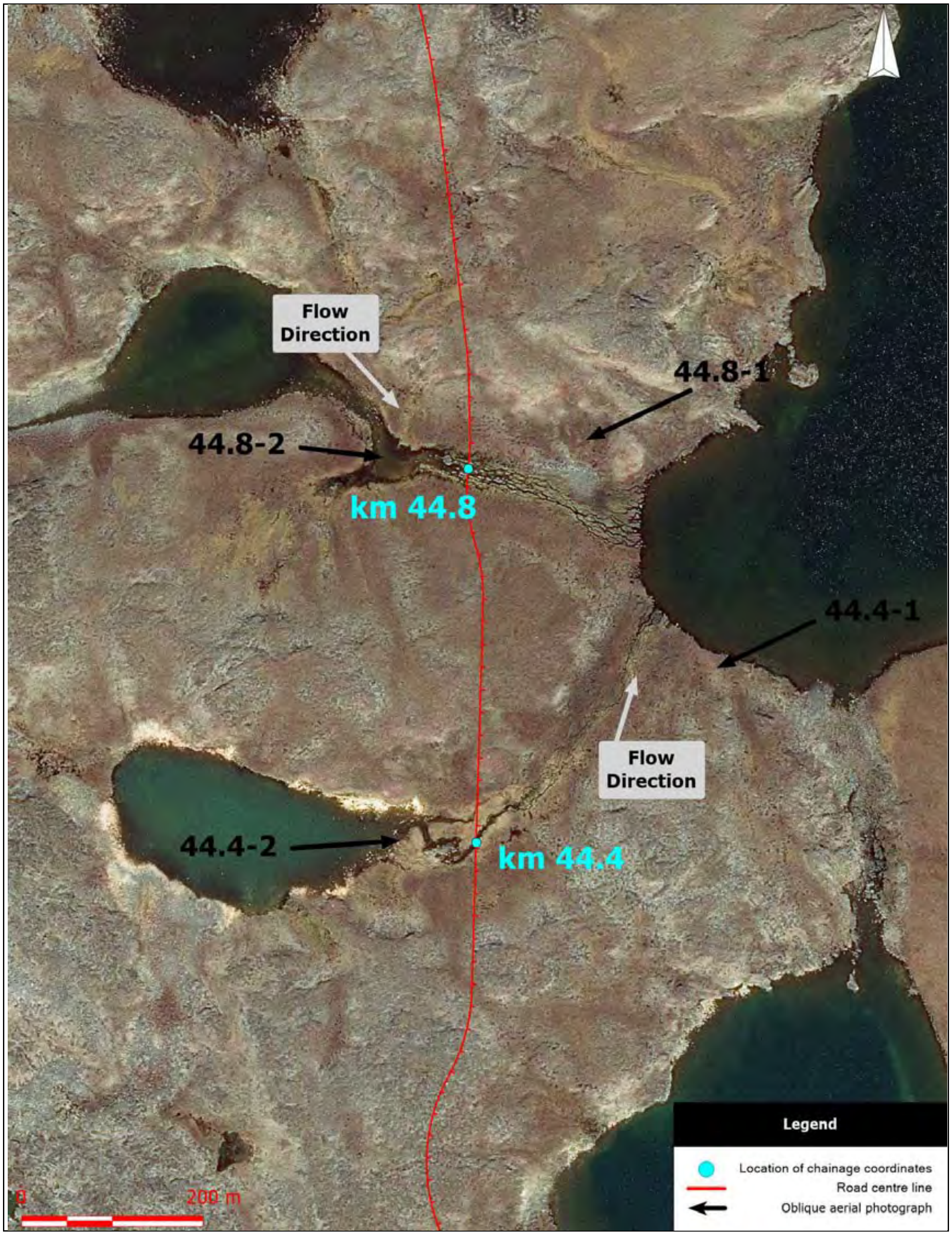


Kilometre 43.5. Oblique aerial photograph 43.5-1. August 30, 2014.



Kilometre 43.5. Oblique aerial photograph 43.5-2. June 29, 2015.


Kilometre 43.5. Photograph from the ground. Road crossing location. June 23, 2015.



Kilometres 44.4 and 44.8. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

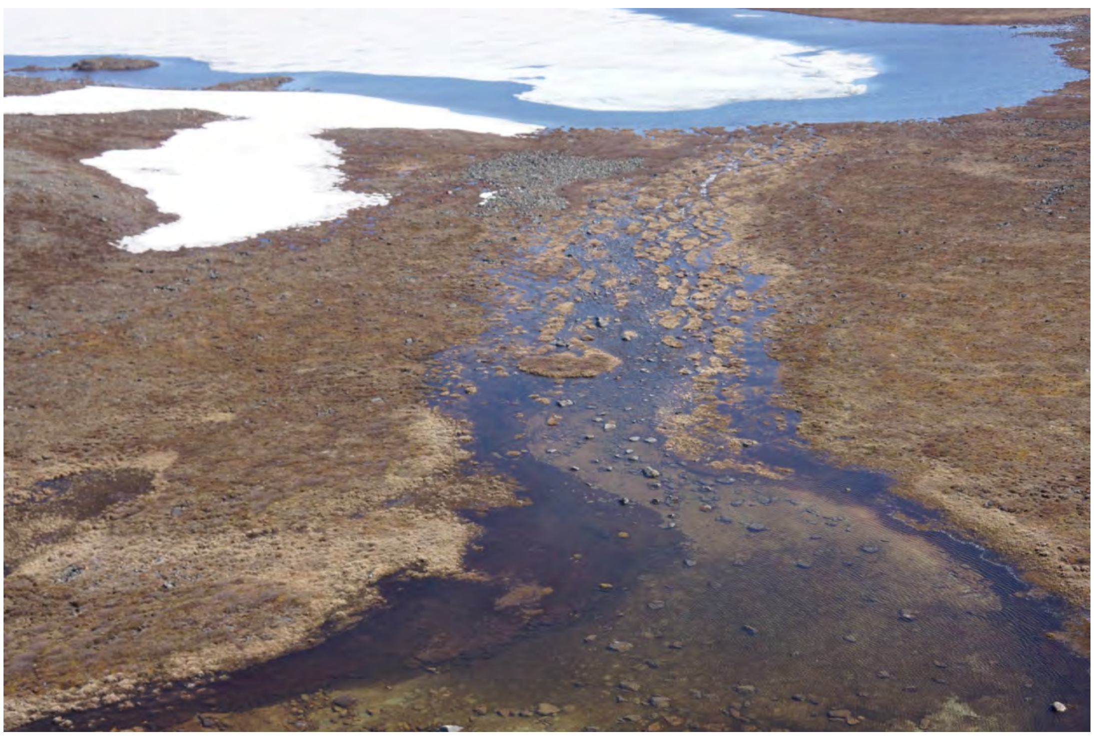
Kilometre 44.4. Oblique aerial photograph 44.4-1. September 1, 2014.

Kilometre 44.4. Oblique aerial photograph 44.4-2. June 29, 2015.

Kilometre 44.4. Photograph from the ground. Downstream view of one channel from 270 m downstream from the approximate crossing location. Rocky section of watercourse. September 1, 2014.

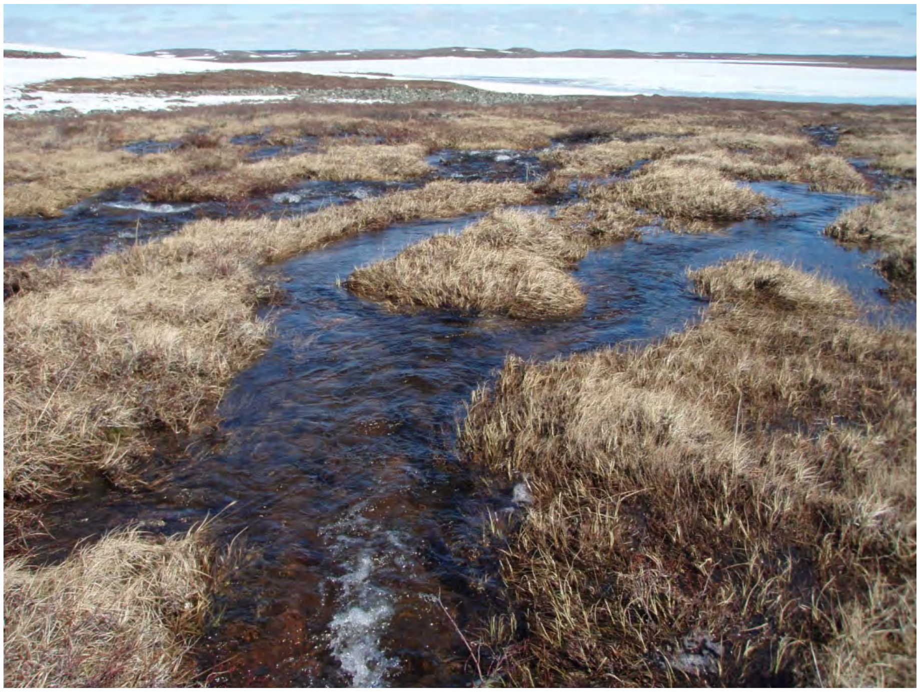
Kilometre 44.4. Photograph from the ground. Downstream view of one channel from 270 m downstream from the approximate crossing location. Diffuse flow through vegetation. September 1, 2014.

Kilometre 44.8. Oblique aerial photograph 44.8-1. August 30, 2014.



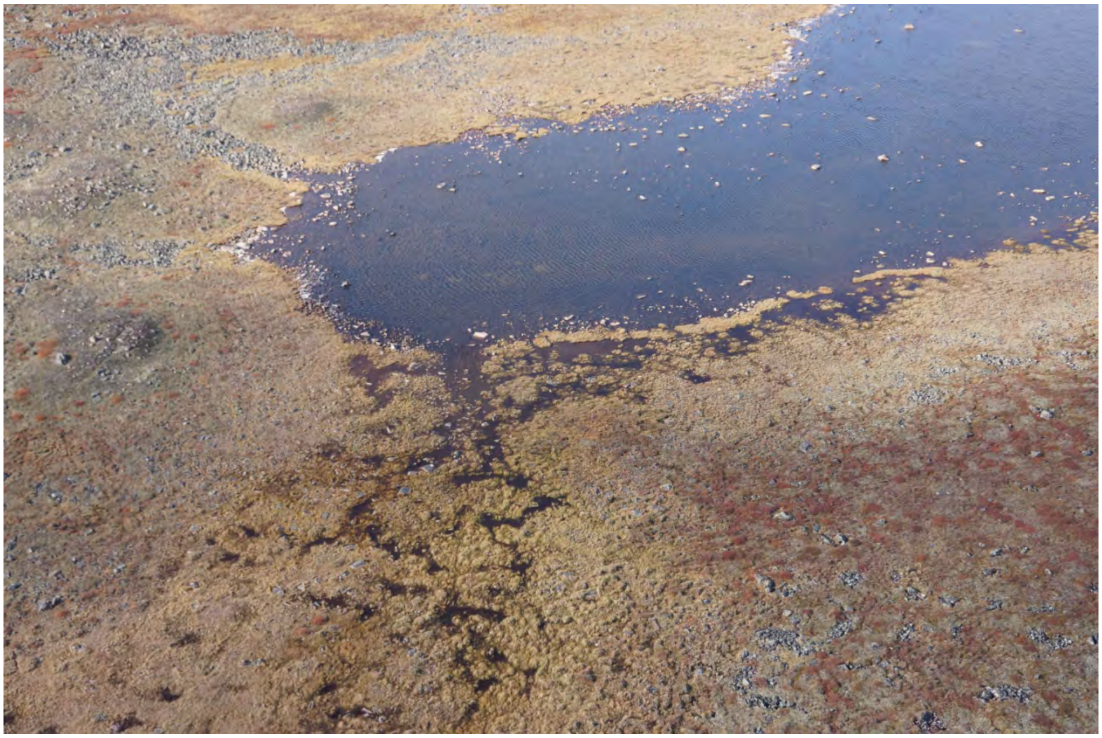
Kilometre 44.8. Oblique aerial photograph 44.8-2. June 29, 2015.

Kilometre 44.8. Photograph from the ground. Downstream view from downstream of the road crossing location. September 1, 2014.

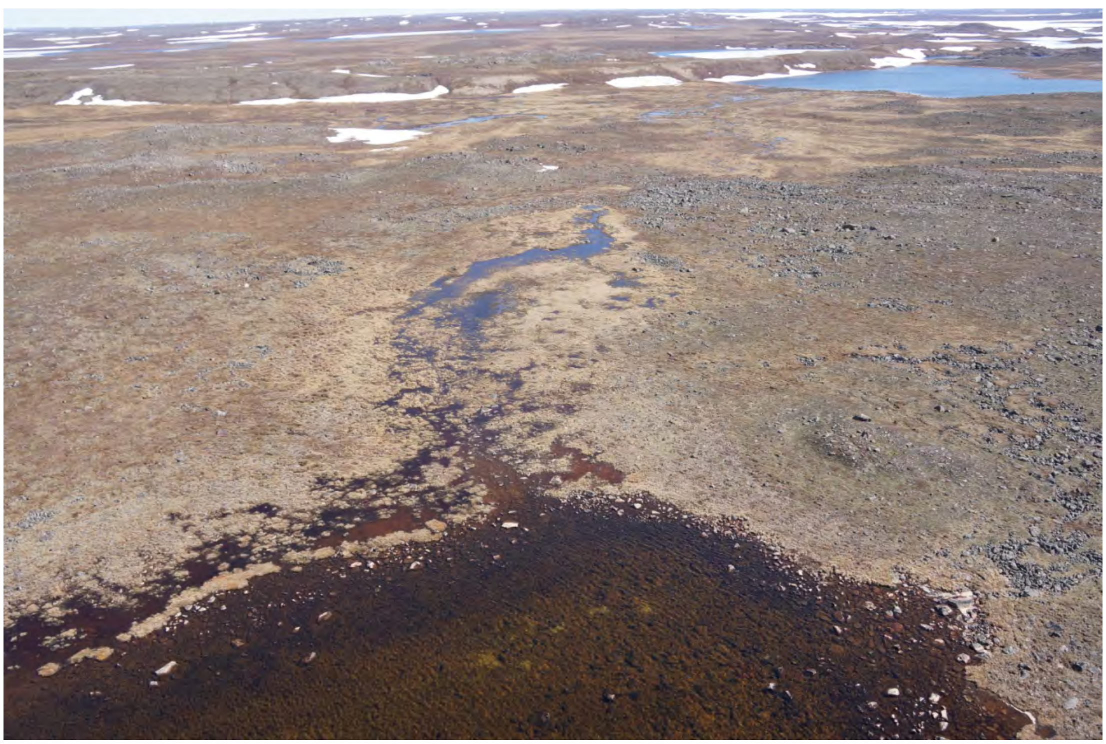


Kilometre 44.8. Photograph from the ground. Downstream view from downstream of the road crossing location. June 23, 2015.

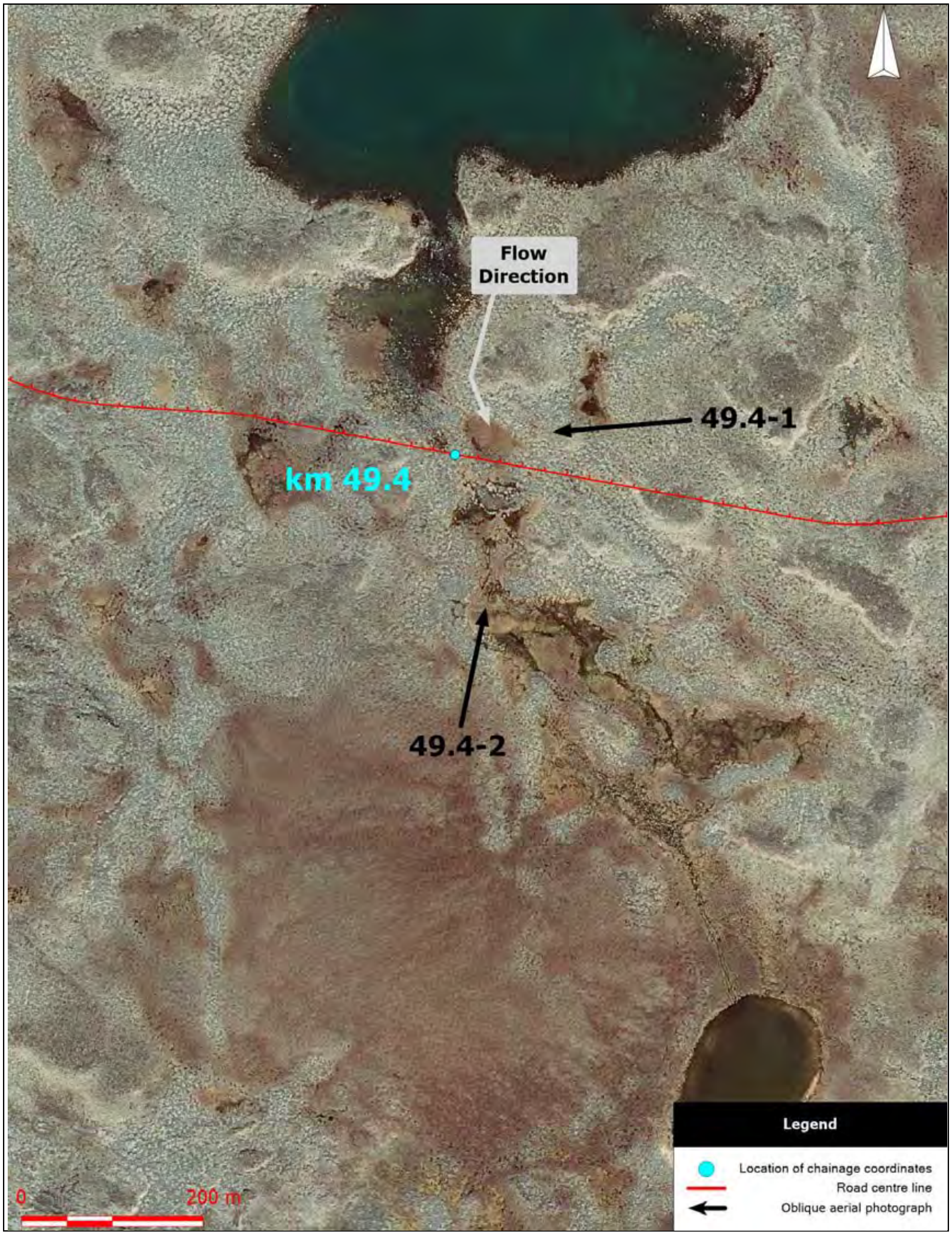
Kilometre 46.1. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.



Kilometre 46.1. Oblique aerial photograph 46.1-1. August 30, 2014.

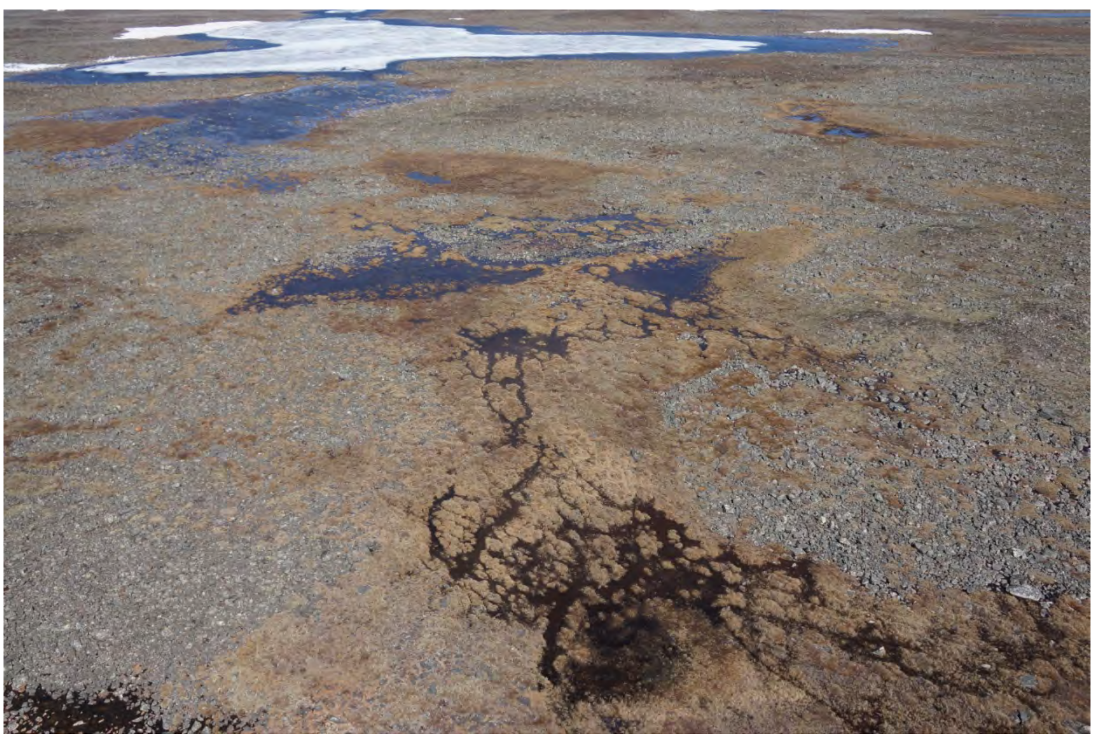


Kilometre 46.1. Oblique aerial photograph 46.1-2. June 29, 2015.



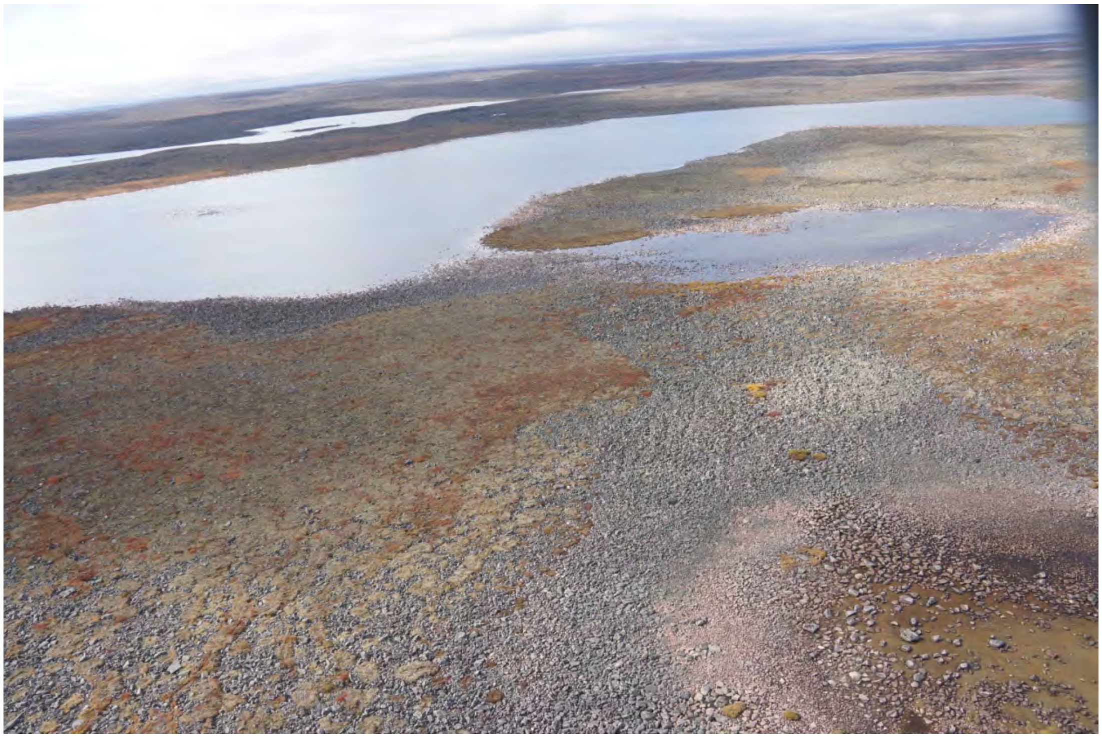
Kilometre 49.4. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

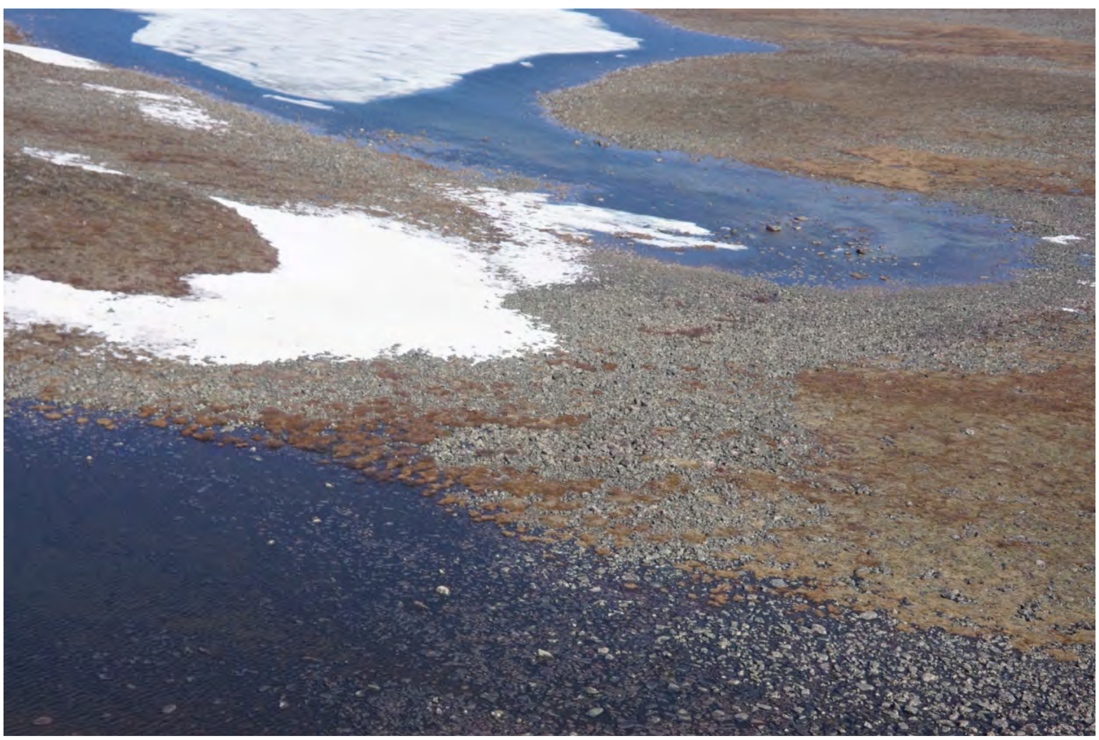
Kilometre 49.4. Oblique aerial photograph 49.4-1. August 30, 2014.

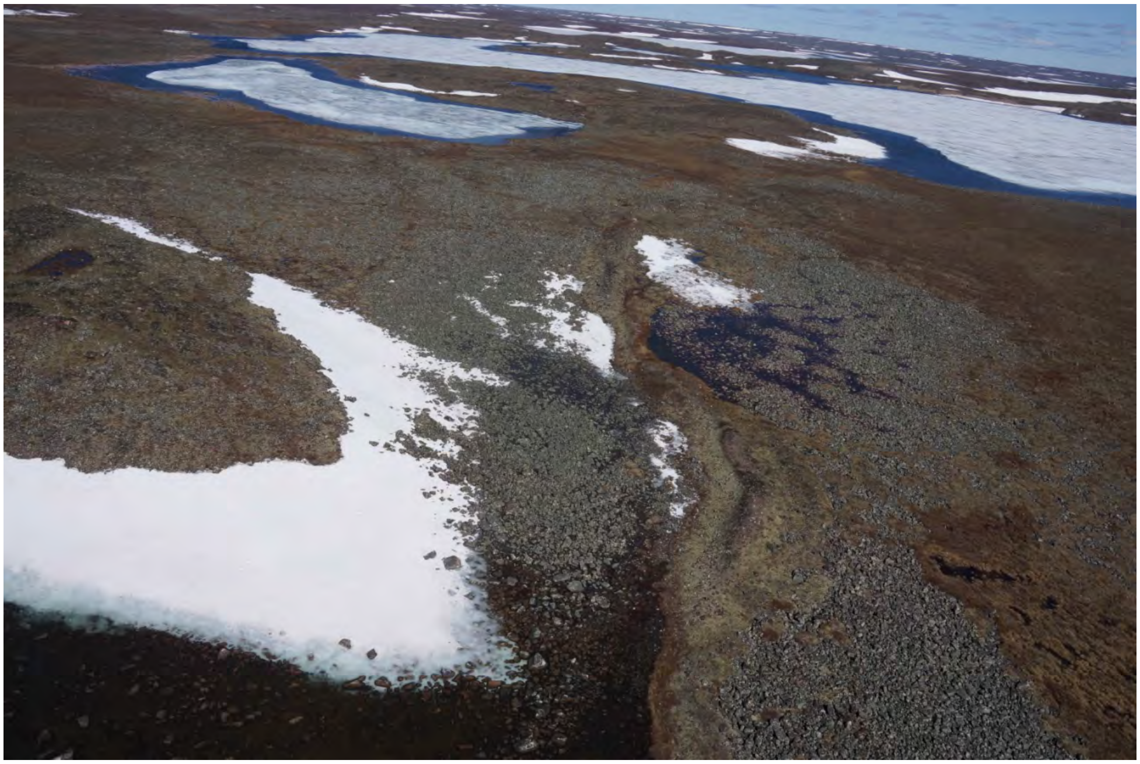


Kilometre 49.4. Oblique aerial photograph 49.4-2. June 29, 2015.

Kilometres 51.2 and 51.8. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

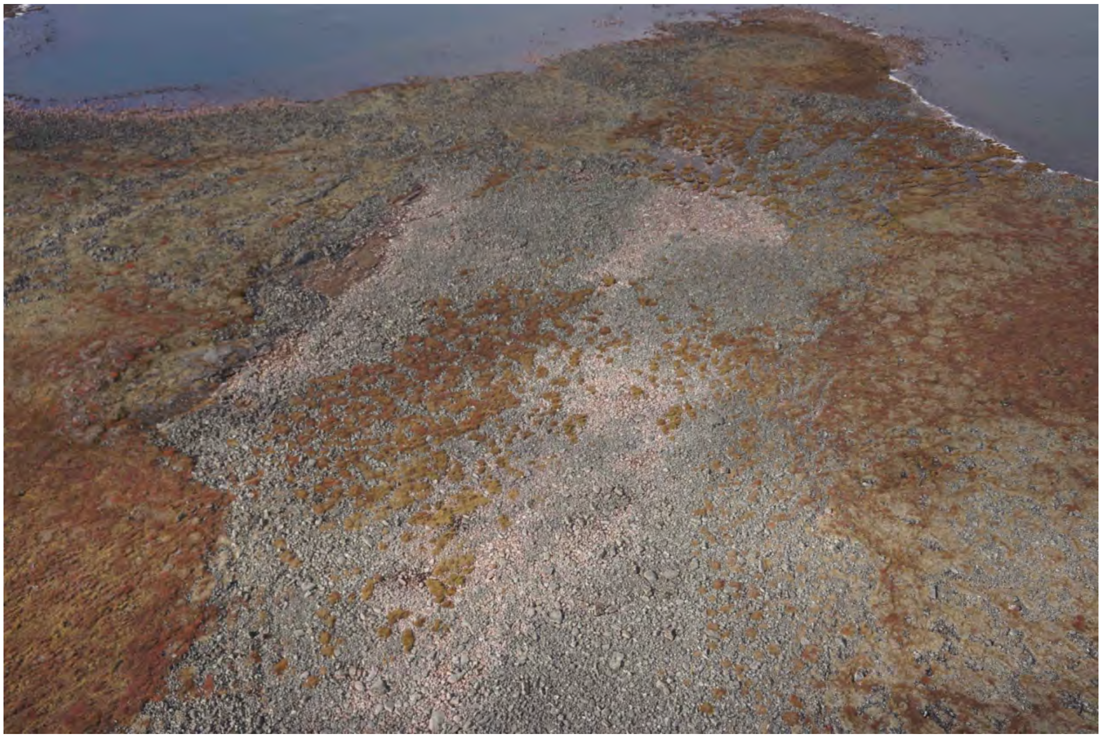

Kilometre 51.2. Oblique aerial photograph 51.2-1. August 30, 2014.


Kilometre 51.2. Oblique aerial photograph 51.2-2. June 29, 2015.

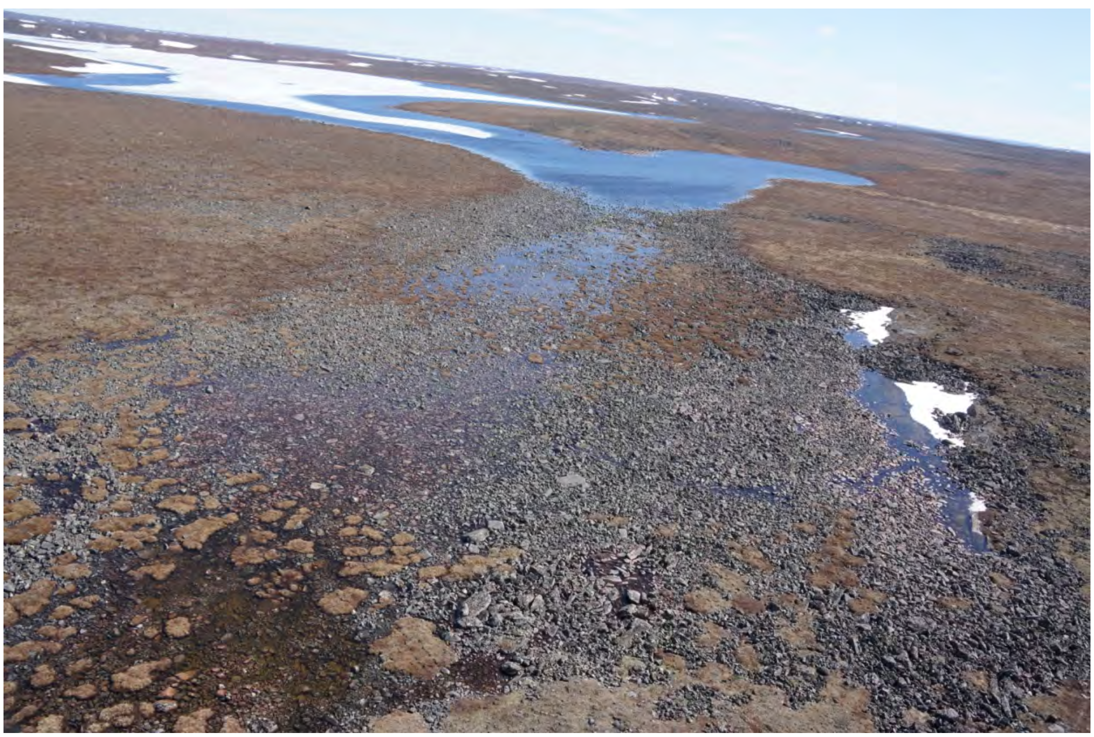


Kilometre 51.8. Oblique aerial photograph 51.8-1. June 29, 2015. There is no 2014 photograph.

Kilometre 56.9. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.



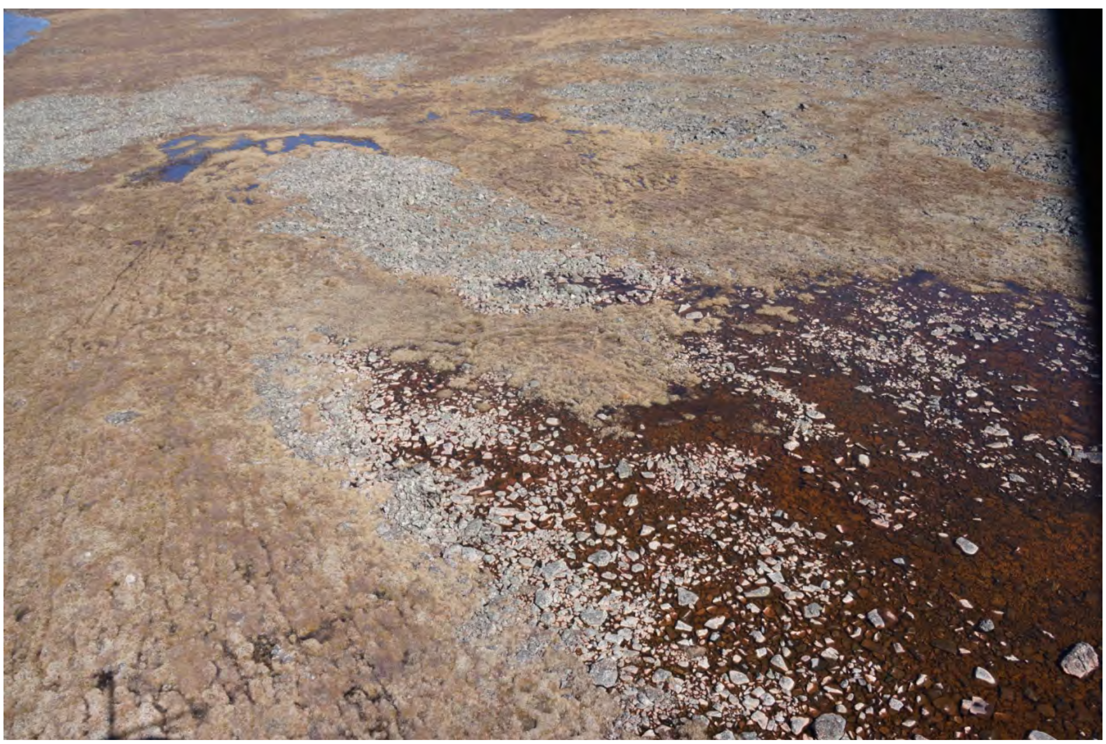
Kilometre 56.9. Oblique aerial photograph 56.9-1. August 30, 2014.



Kilometre 56.9. Oblique aerial photograph 56.9-2. June 29, 2015.

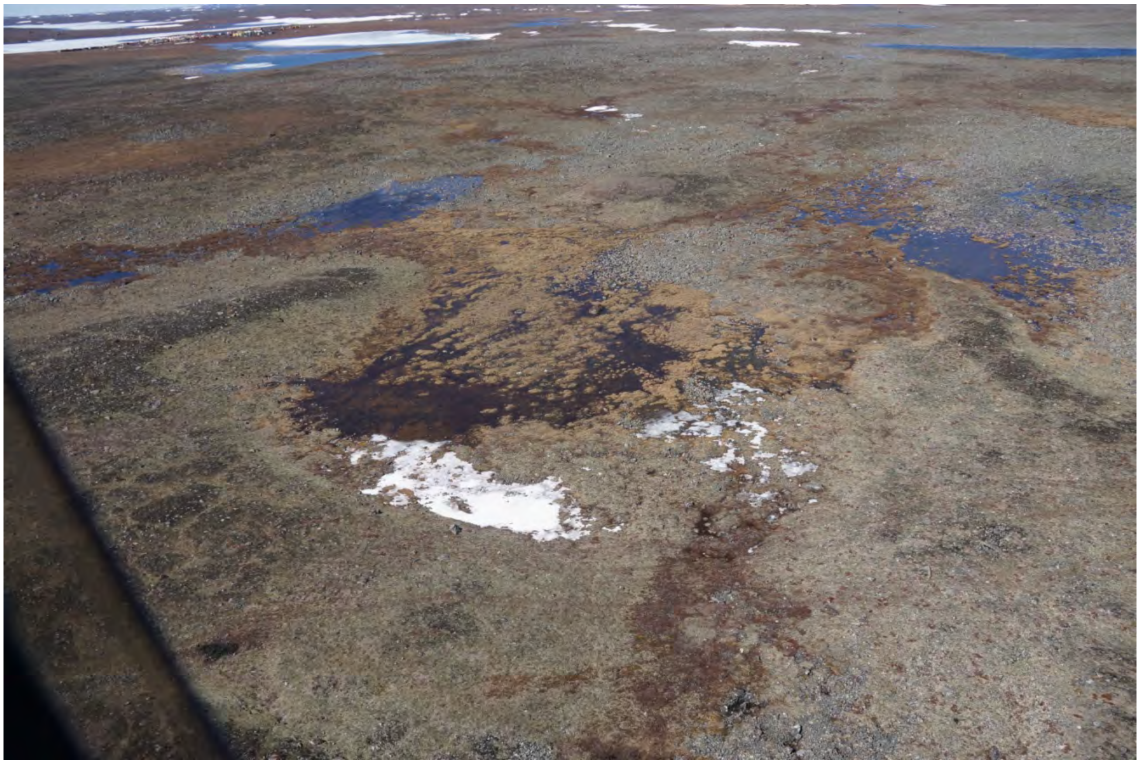
Kilometre 59.7. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

Kilometre 59.7. Oblique aerial photograph 59.7-1. August 30, 2014.



Kilometre 59.7. Oblique aerial photograph 59.7-2. June 29, 2015.

Kilometre 63.1. Aerial photograph showing the road centre line, the location of chainage coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.



Kilometre 63.1. Oblique aerial photograph 63.1-1. June 29, 2015. Crossing near left side of photograph. There is no 2014 photograph.