ALASKA GEOBOTANY CENTER DATA REPORT

INFRASTRUCTURE-THERMOKARST-SOIL-VEGETATION INTERACTIONS AT LAKE COLLEEN SITE A, PRUDHOE BAY, ALASKA

DONALD A. WALKER, MARCEL BUCHHORN, MIKHAIL KANEVSKIY, GEORGE V. MATYSHAK, MARTHA K. RAYNOLDS, YURI L. SHUR, LISA M. WIRTH

AGC 15-01

EDITED BY DONALD A. WALKER, MARTHA K. RAYNOLDS, MARCEL BUCHHORN AND JANA L. PEIRCE

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UAF UNIVERSITY OF ALASKA FAIRBANKS

The research team. From left to right: Martha Raynolds, Skip Walker, Marcel Buchhorn, Lisa Wirth, Gosha Matyshak, Yuri Shur and Misha Kanevskiy. Photo: IMG_0842.

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On the cover:

Thermokarst and eroded high-centered polygons that have developed in a flooded area between the road and the margin of a drained lake basin. Photo: IMG_0783.

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UAF UNIVERSITY OF ALASKA FAIRBANKS

CONTRIBUTORS

DONALD A. WALKER
Alaska Geobotany Center, Institute of Arctic Biology and Department of Biology and Wildlife, University of Alaska Fairbanks, Fairbanks, Alaska

MARCEL BUCHHORN
Alaska Geobotany Center, Institute of Arctic Biology, and Hyperspectral Imaging Laboratory, Geophysical Institute, University of Alaska Fairbanks, Fairbanks, Alaska

MIKHAIL KANEVSKIY
Institute of Northern Engineering, University of Alaska Fairbanks, Fairbanks, Alaska

GEORGE V. MATYSHAK
Department of Soil Science, Lomonosov Moscow State University, Moscow, Russia

MARTHA K. RAYNOLDS
Alaska Geobotany Center, Institute of Arctic Biology, University of Alaska Fairbanks, Fairbanks, Alaska

YURI L. SHUR
Department of Civil and Environmental Engineering, University of Alaska Fairbanks, Fairbanks, Alaska

LISA M. WIRTH
Geographic Information Network of Alaska, Geophysical Institute, University of Alaska Fairbanks, Fairbanks, Alaska

1 Effects of development on permafrost and tundra along the Spine Road at Prudhoe Bay, Alaska

Introduction

Following the discovery of oil at Prudhoe Bay in 1968, a series of environmental studies documented the landscape changes resulting from the rapidly expanding network of roads and oilfield facilities (Walker *et al.*, 1987; National Research Council (NRC), 2003; Raynolds *et al.*, 2014). The latest study in 2014 noted a steep increase in the abundance of thermokarst features within the oilfield since 1990 (Raynolds *et al.*, 2014). Thermokarst is the process by which characteristic landforms result from the thawing of ice-rich permafrost or the melting of massive ice (van Everdingen, 1998). An earlier study, near Fish Creek, about 40 km west of the oilfield also noted abrupt changes in thermokarst features that are likely related to a series of recent exceptionally warm summers (Jorgenson *et al.*, 2006). These findings triggered more in-depth field studies of thermokarst within the Prudhoe Bay Oilfield. Torre Jorgenson and colleagues are examining thermokarst in a relatively natural area within the Prudhoe Bay oilfield (Fig. 1.1).

Data presented in this report were collected for a study that focuses on thermokarst in relationship to both climate change and oilfield infrastructure. A fuller description of the landscape and permafrost

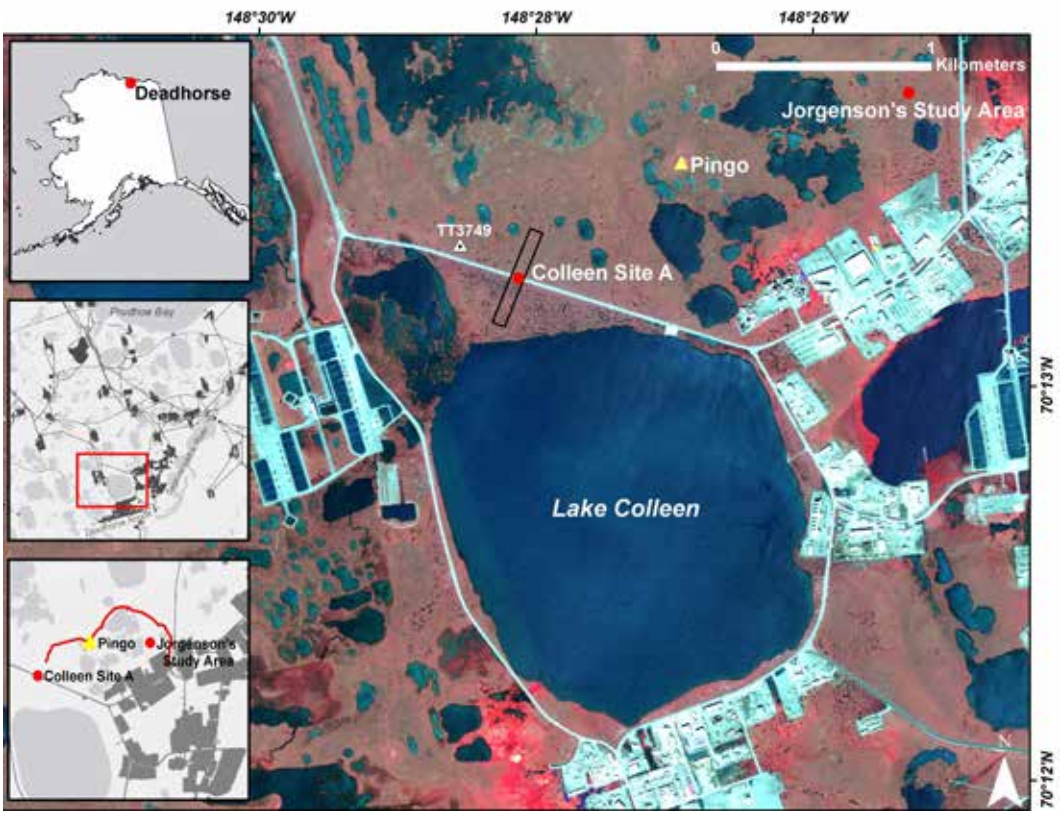

Figure 1.1. *The Lake Colleen region. The Colleen Site A study area is located along a straight section of the road on the north side of Lake Colleen, 2.9 km north of the main Deadhorse airport. Several partially drained thaw lakes are on the east, north, and west sides of the lake. Colleen Site A and Jorgenson's study area are both on a residual surface that shows no apparent history of thaw lake processes. Note that the lake is surrounded by roads and other infrastructure. TT3749 is a benchmark that provided reference for the topographic survey. The main study area, Colleen Site A, is shown enlarged in Fig. 1.2. The base image is derived from a false-color-infrared World View image (July 9, 2010). The bright red tones show areas of highly productive vegetation, mainly in drained lake basins and in areas of altered drainage near roads and gravel pads.*

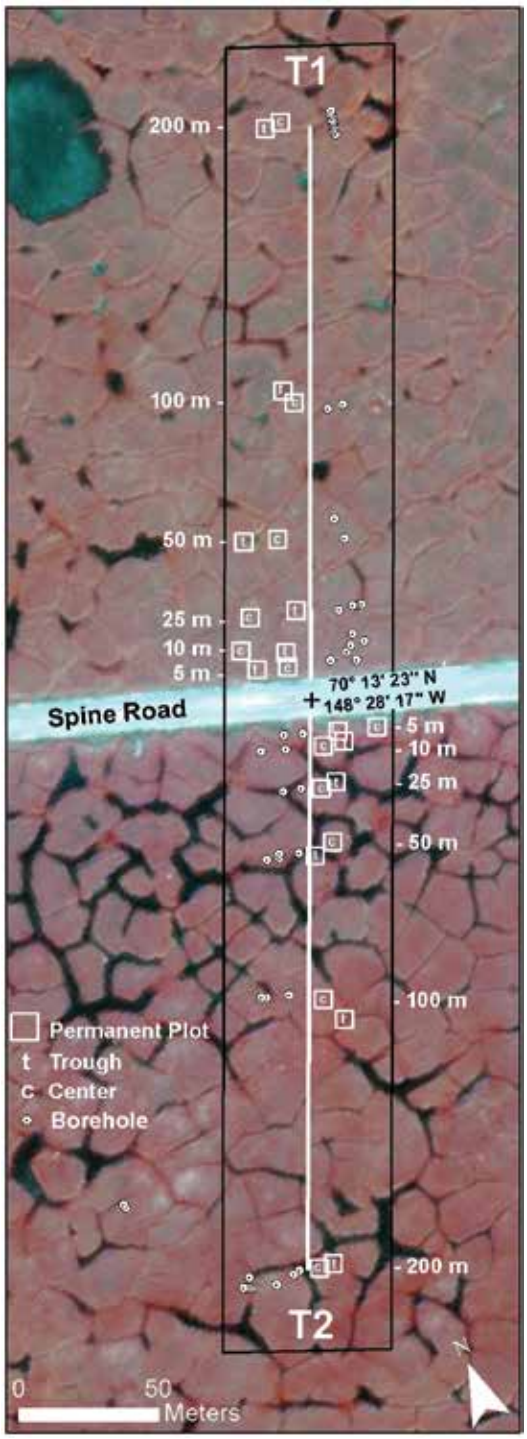

Figure 1.2. *The Colleen Site A study area. Two transects (white lines) are each 200 m long. Permanent plots (white squares) are located in centers* **(c)** *and troughs* **(t)** *of ice-wedge polygons at 5, 10, 25, 50, 100, and 200 m from the road. Boreholes (white circles) are located at the same distances from the road in centers and troughs. Base image is the same as in Fig. 1.1. Transect 1 (T1) traverses mainly low-centered ice-wedge polygons. Transect 2 (T2) is periodically flooded. In late summer at the time of the image, flooding has subsided exposing the mainly high-centered ice-wedge polygons with interconnected flooding in the polygon troughs.*

changes in the Prudhoe Bay Oilfield appears in Walker *et al.* (2014).

The main objectives of our 2014 field program were to document the extent and effects of road dust and road-related flooding to the topography, landforms, permafrost, soils, and vegetation. We were particularly interested in changes to the permafrost and ice-wedges. During 2-13 August 2014, we examined thermokarst features that were easily accessible within the Lake Colleen region (Fig. 1.1).

We chose an intensive study site along the Spine Road, the oldest most heavily traveled road in the region. The area of the study site is defined as a 60-m swath centered on two transects, T1 on the northeast side of the road and T2 on the southwest side (Fig. 1.2).

Colleen Site A before and after construction of the Spine Road

The Colleen study area has changed dramatically since the development of the Prudhoe Bay Oilfield. The landforms, soils and vegetation at the Colleen Site A and the Jorgenson site were mapped as of 1973 in the *Geobotanical Atlas of the Prudhoe Bay Region, Alaska* (Walker *et al.*, 1980) (Fig. 1.3). The terrain and vegetation of the Colleen region prior to construction of the Spine Road were interpreted from 1:20,000-scale black and white aerial photographs taken by the U.S. Navy in 1949. Photos taken by the oil industry shortly after road construction in 1972 and then periodically up to the present show the transformation of the area to its present condition (Fig. 1.4).

Although the study area is partially obscured by clouds on the 1949 imagery, both sides of the road at the Colleen Site A were on a level residual surface with no obvious signs of previous thaw-lake processes. Scattered thermokarst pits are visible in the vicinity of Colleen Site A and Jorgenson's study site. The presence of the thermokarst pits indicates high ice content of the permafrost. The 1972 aerial photos indicate that little change in the distribution of thermokarst pits occurred between 1949 and 1972.

Through reference to the geobotanical map of the region (Fig. 1.3), descriptions of the vegetation and terrain of the region as of the 1970s (Walker *et al.*, 1980; Everett *et al.*, 1980) and periodic aerial photos (Fig. 1.4), we can deduce that in 1972 the Colleen Site A was a rather homogeneous network of low-centered polygons with less than 50 cm of trough-rim elevation contrast.

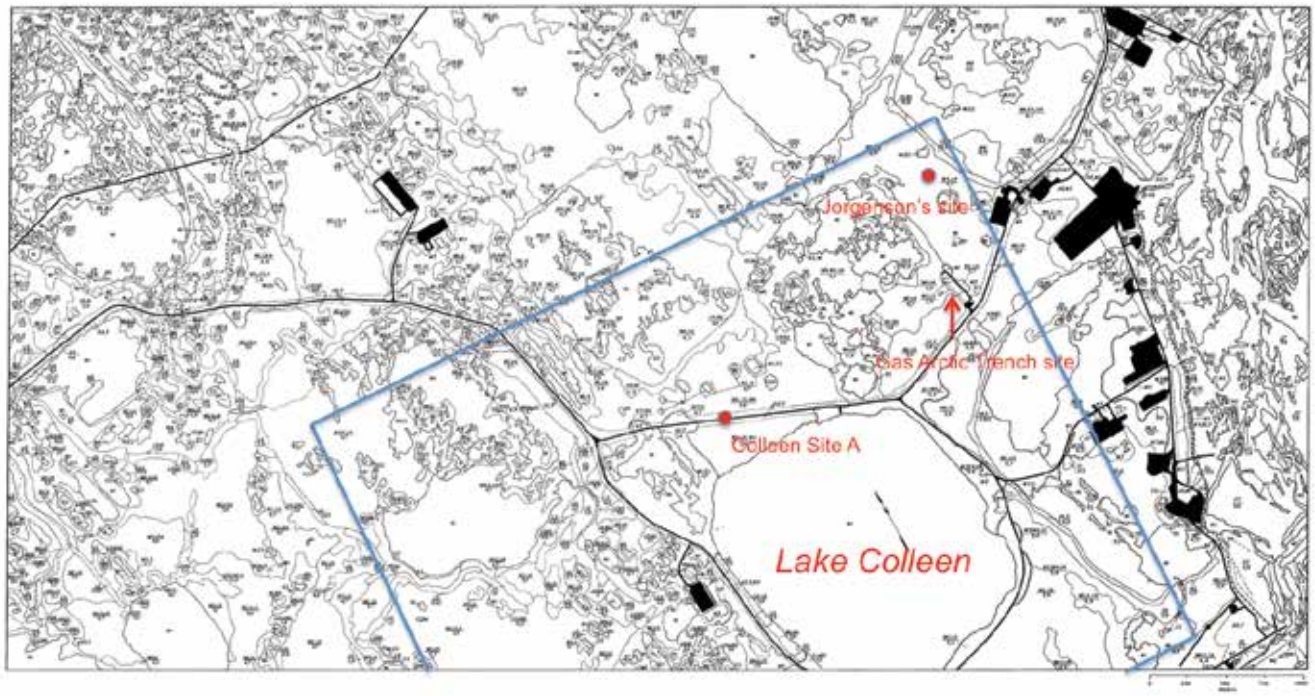

Figure 1.3. *Geobotanical map containing the Lake Colleen region (blue rectangle and Fig. 1.1) at Prudhoe Bay, Alaska. The map is coded with vegetation, soils and landforms as of 1973 (Everett* et al.*, 1980). Also shown are the Colleen Site A study area (see also Fig. 1.2), Jorgenson's study area, and the Gas Arctic Trench Site, where Kaye Everett conducted dust studies and described permafrost characteristics in a 117 x 2.5 m trench.*

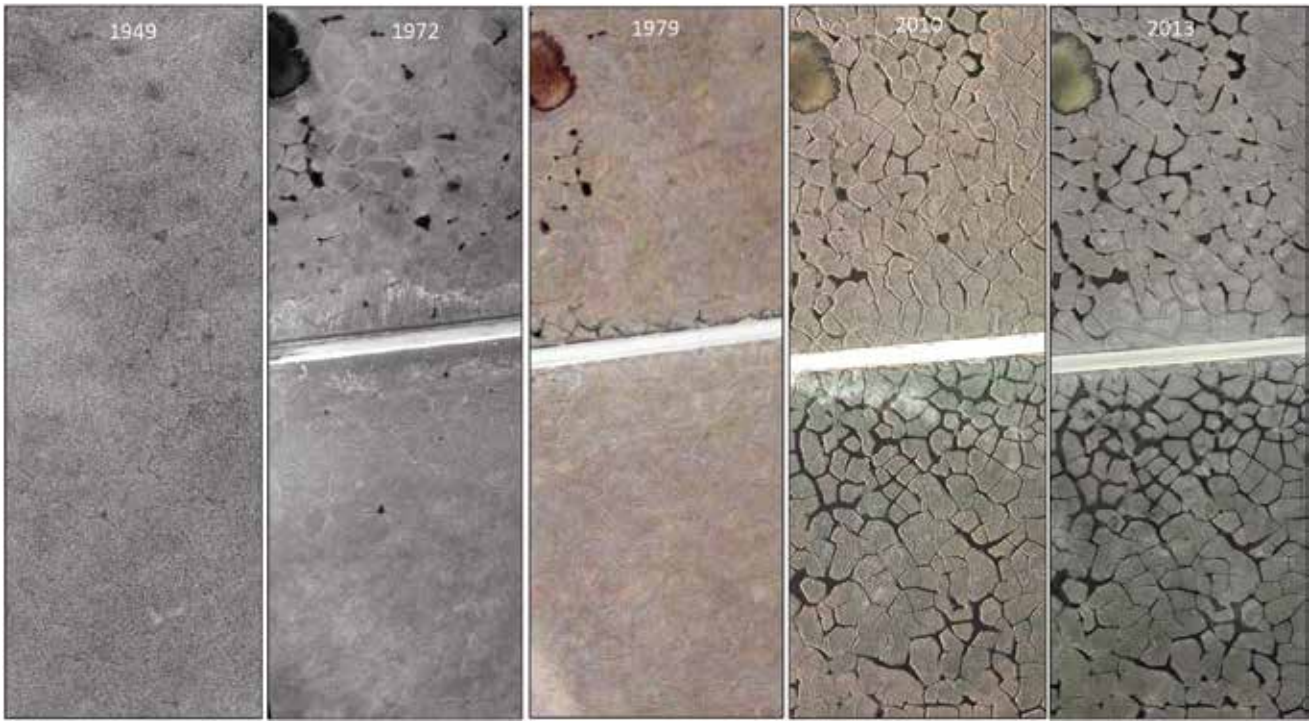

Figure 1.4. *Colleen Site A study area (as in Figure 1.2) time series 1949-2013, showing progression of change. Imagery and original scales: Jul 1, 1949, U.S. Navy, BAR, black & white, 1:20,000; July 15, 1972, U.S Army Cold Regions Research and Engineering Laboratory (CRREL), black & white, 1:6,000; July 13, 1979, Prudhoe Bay Unit, color,1:18,000; 2010 BP Alaska, digital, color, 1-foot resolutions; 2013 BP Alaska, digital, color, 0.75-foot resolution. Notes: The Spine Road was constructed in 1969 so it does not appear on the 1949 image. Thin cloud cover obscures the 1949 image, but most of the thermokarst pits that are present in 1972 are visible through the clouds.*

The vegetation in the polygon basins was dominated by wet nonacidic tundra (Map Unit M2, Walker *et al.*, 1980) with the following common species: *Carex aquatilis, Eriophorum angustifolium, Pedicularis sudetica, Drepanocladus brevifolius, Catascopium nigritum, Cinclidium arcticum,* and *Meesia triquetrum*. Better drained polygons and polygon rims were dominated by moist nonacidic tundra (Map Unit U3) with the following common species: *Eriophorum angustifolium, Carex bigelowii, C. membranacea, Dryas integrifolia, Salix reticulata, S. arctica, S. lanata, Polygonum viviparum, Tomentypnum nitens, Ditrichum flexicaule, Thamnolia spp., Cetraria spp.,* and *Dactylina arctica*. Over 20% of the area mapped as very wet nonacidic tundra (Map Unit M4) with the following common species: *Carex aquatilis, C. saxatilis*, *Eriophorum angustifolium*, *Pedicularis sudetica*, and *Scorpidium scorpioides*. The 1973 aerial photos show scattered thermokarst pits that probably contained either unvegetated water or aquatic sedge tundra (vegetation map unit M4 or E1), dominated by *Carex aquatilis.*

The soils of the Colleen region were mapped by Everett (1980a) using the U.S. Soil Taxonomy classification (Soil Survey Staff, 1975). All of Colleen Site A is mapped as Soil Unit 3, which is a complex of three primary soil types: 1) Histic Pergelic Cryaquepts (= Histic Aquorthels, Soil Survey Staff 1999) (cold wet, gray mineral soils, commonly mottled, having a surface horizon >25 cm thick, composed predominantly of organic (peaty) material); 2) Pergelic Cryohemists (= Typic Hemistels) (cold wet, dark-colored soils consisting of moderately decomposed organic material to depths > 40 cm); and 3) Pergelic Cryosaprists (Typic Sapristels) (cold, wet dark soils consisting of well-decomposed organic material to depths >40 cm) (Everett, 1980a). The classification of the soils is often difficult because key information regarding the total thickness of the organic layer is often hidden below the upper surface of the permafrost table. The soils in the region are strongly affected by windblown calcareous silt from the Sagavanirktok River. Typical pH (1:1 water) of the mineral horizons is 8.0 (Everett, 1980a).

Effects of flooding

Lake Colleen is completely surrounded by roads with few culverts (Fig. 1.1). Several areas between the lake and the roads periodically experience flooding during spring and early summer. The Spine Road was constructed in 1969, and is presently elevated about 1 m above the general tundra level to protect the underlying permafrost. No culverts were placed along the 1.9 km straight section of road that runs along the north side of the lake where Colleen Site A is located. Thermokarst is more prevalent now than in 1949 or 1972 on both sides of the road, as indicated in the aerial photos (Fig. 1.2). Thermokarst is now most extensive on the southwest side, where the previous network of low-centered ice-wedge polygons has been converted into a network of high-centered polygons with greater than 50 cm of elevation contrast between the polygon troughs and centers (Fig. 1.5 and 1.6).

The water level in the flooded area fluctuates considerably during the summer. At the time of our visit (Aug 4-14), the water level was 75 cm below a wave cut line strand line that contains dead sedge leaves and stems uprooted by waterfowl. The plant material

Figure 1.5. *Degraded ice-wedge polygon troughs along Transect 2 on the southwest side of the road. Note the lack of rims on the ice-wedge polygon centers, greater than 0.5 m of trough-center relief, and lush sedge vegetation in the troughs and on the polygon centers. The brighter green sedge in the troughs is* Carex aquatilis*, and the duller sedge on the polygon centers is* Eriophorum angustifolium. *Photo: IMG_ 0910.*

Figure 1.6. *Thermokarst pit at the junction of two ice wedges on the southwest side of the road. Photo XAR_6304.*

was relatively fresh, so it was likely deposited during a high water level in 2014. At this level, water would have covered the polygon centers within Colleen A on the southwest side of the road with approximately 45 cm of water. In early August 2014, water up to about 70 cm deep was still present in thermokarst pits at the junction of ice-wedge polygon troughs and in most troughs on the southwest side of the road, which required hip waders to work in these areas (Fig. 1.6).

Lush aquatic sedge (*Carex aquatilis*) plant communities occupy most ice-wedge polygon troughs (Figs. 1.5 and 1.6). Other common species in the troughs include common mare's tail (*Hippuris vulgaris*), small yellow water buttercup (*Ranunculus gmelinii*), and abundant aquatic mosses such as *Scorpidium scorpioides* and *Calliergon giganteum*. The relatively well-drained polygon centers have plant communities dominated by common cottongrass (*Eriophorum angustifolium*), some prostrate dwarf willows (*Salix arctica*, *S. lanata*), and mosses (mostly *Distichium capillaceum*) that have their origins in the original plant Type M2 and U3 communities described above.

At the time of our visit, thaw depths were greater along Transect 2 (T2) on the flooded side of the road compared to thaw along Transect 1 (T1). (T1 thaw = 49 ± 0.01 cm, n = 200; T2 thaw = 58 ± 0.3 (s.e.) cm, n = 200). The sedges on the southwest side of the road were much taller and greener, resulting in 36% higher LAI compared to the northeast side (T2 LAI = 0.61 ± 0.027, T1 LAI = 0.45 ± 0.014). The enhanced productivity on the flooded southwest side of the road was likely caused by a combination of wetter soils, deeper thaw, higher rates of organic-matter decomposition, more nutrients from the dust, and high inputs of feces and decayed organic matter from the waterfowl. There were tracks, feathers, feces, and signs of grazing by waterfowl throughout the study area on the southwest side of the road. Several flocks of Greater White-fronted Geese, and Canada Geese and two pair of Tundra Swans persistently grazed the southwest side of the road near our study area during the field visit.

Road-related flooding and thermokarst were much less prevalent on the northeast side of the road in 2013. Most of the present-day thermokarst at distances greater than 100 m from the road on the northeast side does not appear to be directly related to the road and is similar in appearance to the thermokarst at Jorgenson's study site and an area outside the oilfield where natural thermokarst has abruptly expanded in recent years (Jorgenson *et al.*, 2006).

Effects of dust and altered snow regimes

Traffic along the Spine Road has generated high volumes of dust over the 45-year history of the road (Fig. 1.7). The material used in the roadbed came from the Sagavanirktok River, so the dust generated by road traffic is similar in composition the local loess. The naturally calcareous soils at Prudhoe Bay are relatively well adapted to high road-dust concentrations compared to acidic tundra areas along the Dalton Highway in the Arctic Foothills (Walker & Everett, 1987). The distribution and properties of Prudhoe Bay road dust were monitored in 1977 and 1978 approximately 2 km east of Colleen Site A (Everett, 1980b) (Gas Arctic Trench Site in Fig. 1.3).

Road dust and snowdrifts associated with elevated roads affect the soil temperatures and plant communities in roadside areas. An earlier study by Benson *et al.* (1975) explains the contrast between the distribution of summer dust and the winter snow:

> *The movement of dust and coarser sediments by the wind is related to snow drifting but there is an interesting difference. The most effective winds in moving… sediments are clearly from the east. The east winds move several times more dust than do the west winds: (a) There is a noticeable change in the direction of the strongest winds with the seasons. The strongest most frequent winds of winter are from the west. They yield progressively from April through July to winds that are predominantly from the northeast. (b) During the time when*

Figure 1.7. *Elevated road and dust during vegetation surveys on the southwest side of the road. Photo: XAR_6169.*

the strong west winds are most active there is little exposed sediment, so they move snow. When the northeast winds become more active the spring thaw exposes sediments in the dune area and along the river channels. Also, the roads become sources of dust when they become snow free during spring in direct proportion to the amount of traffic on them (Benson et al., *1975).*

On roads oriented perpendicular to the main storm winds from the WSW, the largest snowdrifts form on the northeast side of the roads. Sequential aerial photographs taken by Benson during the melt period, May 24-June 30, 1972, showed that the drifts extend approximately 10 m downwind from the roads. The tundra adjacent to the southwest sides of roads with heavy traffic and abundant dust were snow free by 24 May, whereas most tundra areas in areas distant from the roads were not snow free until 13 Jun. Snowdrifts persisted on the northeast side of the roads until 5 Jun and on both sides of infrequently travelled roads until at least 15 Jun (Benson *et al.*, 1975).

These findings are consistent with those of Everett (1980), who monitored traffic volumes, wind velocities, dust volumes, particle sizes and dust chemistry at several sites along the Dalton Highway and at the Gas Arctic site at Prudhoe Bay. He found that 40% of the June-August winds are from the NE and E, but in late August a strong SW component is also common. Winds at Prudhoe Bay were the highest of any of the sites with 25% of the July and August winds exceeding 6 m s^{-1}. Compared to sites further south, the Prudhoe Bay site was unusual for its generally windier conditions, greater percentage of high velocity winds, and for exceptionally high volumes of dust recorded at over 100 m from the road. Of four sites studied by Everett (Prudhoe, Franklin Bluffs, Sagwon, Toolik), Prudhoe Bay had the highest dust volume of any site at 500 m and 1,000 m. The volume of dust at 1,000 m was 2 to 9 times greater than at the other sites, probably reflecting both the transport of dust to greater distances from the road caused by higher wind velocities

a **b**

Figure 1.8. (a) *Soil plug from center of an ice-wedge polygon at 5 m from the road along Transect 2. Note the 13-cm thick mineral surface horizon, which is the dust layer above the original organic surface horizon. Photo: DSC_0122.* **(b)** *Soil plug from trough of an ice-wedge polygon at 200 m from the road along Transect 2. Note the gray color at the top of the organic soil horizon underlying the surface layer of moss, indicating leaching of dust into the organic layer. Photo: DSC_0162. The blade of the Sharpshooter shovel used to extract the soil plugs is shown in both photos.*

Figure 1.9. *Roadside areas along the Spine Road.* **(a)** *Heavy dust area adjacent to the southwest side of the road. Up to 18 cm of dust and gravel were measured in areas 5 m from the road. This photo shows deeper accumulations within 5 m have elevated the surface creating a relatively well drained gentle slope from the foot of the road that is colonized mainly by a few coastal and dune species, such as* Alopecurus alpinus, Dupontia fisheri, Elymus arenarius, Puccinellia phryganodes, P. andersonii, *and* Salix ovalifolia. **(b)** *Strip of erect dwarf willow (*Salix lanata*) growing on northeast side of the road.*

and the contributions from numerous road sources in the Prudhoe Bay Oilfield. This is an important finding because it shows that dust is pervasive throughout the Prudhoe Bay region even at great distances from the roads. However, it is also unknown how much of the dust at any of the sites was natural background loess from the Sagavanirktok River.

Soils within about 50 m of the road on both sides of the road now have mineral surface horizons composed largely of road dust and gravel that overlie the original organic soil horizons (Fig.1.8a). The organic horizons below the mineral horizon also have a distinctive gray color that indicates dust has leached into the organic soil horizons from the overlying dust horizon. Clear surface mineral horizons up to 18 cm thick occur near the southwest side of the road and up to 10 cm thick on the northeast side. The mineral surface horizons decrease in thickness away from the road, but even at 200 m from the road the underlying organic material have a gray color indicating leached dust (Fig. 1.8b).

Vegetation in areas within approximately 25-50 m of the road have much diminished diversity of plants and reduced moss and lichen layers compared to species composition in similar nearby areas surveyed in 1975 (Walker, 1981). The original thick moss carpets, composed of such large-branched mosses as *Aulacomnium turgidum, Drepanocladus uncinatus, Hypnum bambergeri, Orthothecium chryseum,* and *Tomentypnum nitens*, have been replaced by bare soils or sparse moss carpets composed of a small dust-tolerant species such *Bryum* sp., *Catascopium nigritum, Distichium capillaceum, Ditrichum flexicaule, Encalypta* spp., and *Pohlia* spp.

Previously common lichens such as *Cetraria islandica, Flavocetraria cucullata, F. nivalis,* and *Dactylina arctica*, are now relatively uncommon along both transects. In some especially heavily dusted areas immediately adjacent to the road, the original tundra has been replaced by sparse plant communities composed of plant species more commonly found in salt marshes, beaches, and sand dunes near the Arctic coast (*e.g., Alopecurus alpinus, Dupontia fisheri, Elymus arenarius, Puccinellia phryganodes, P. andersonii,* and *Salix ovalifolia*) (Fig. 1.9a).

The changes caused by road-related dust, flooding, snowdrifts, and thermokarst have major implications for the whole ecosystem (Walker & Everett, 1987). Earlier snow melt, warmer soil temperatures, and extensive new wetlands near the roads affect the phenology of vegetation and use of the roadside areas by wildlife. Large flocks of waterfowl forage in the roadside areas during the melt period until other areas become snow free. Other animals including ground squirrels and caribou, also concentrate near the roads during this period. A zone of noticeably high cover of taller erect dwarf willows (*Salix lanata*) occurs on the northeast side of the road in response to the protective winter snowdrift and the warmer soils in a gravelly berm that apparently covers a buried cable or pipeline (Fig. 1.9b).

2 Methods and data

This portion of the document contains copies of the data tables available from the study and serves as a metadata record of the methods used in data collection. The data are also archived in digital format on the ArcSEES website (geobotany.uaf.edu) and at the NSF ACADIS Arctic data repository (nsidc.org/acadis).

Transects

We established two 200-m transects at the Colleen Site A study area to quantify differences in microtopography, soil temperatures, thaw depth, soils, vegetation, permafrost and snow in relationship to distance from the road. Transect 1 (T1) is on the northeast side of the road and Transect 2 (T2) is on the southwest side (Figs. 1.1, 2.1 and 2.2). Pin flags were placed at one-meter intervals to 100 m from the road and then at 5-m intervals to 200 m. Vertical 150-cm PVC posts were placed at 50, 100, and 200 m. The poles have red stripes at 100 and 150 cm height to help locate the transects in winter.

At each pin flag, we measured thaw depth with a 1-m steel thaw probe, and we measured water depth and plant canopy height with a meter stick. Leaf-area index (LAI) was measured with an AccuPAR LP-80 PAR/LAI Ceptometer (Fig. 2.3) The vegetation type and microrelief feature were recorded at each meter according to the vegetation classification system of the *Geobotanical Atlas of the Prudhoe Bay Region, Alaska* (Walker & Webber, 1980). Elevations along the transect were measured using a Topcon RTK (real time kinematic) GPS HiPer Lite+ and robotic Topcon IS3 surveying instrument (see p. 36 for topographic survey methods). Thickness of the surface dust layer was measured at 5 m intervals by removing a core of soil using a Sharpshooter shovel. Data from the transect surveys are in Table 2.1, and a visualiation of the data is shown in Appendix C.

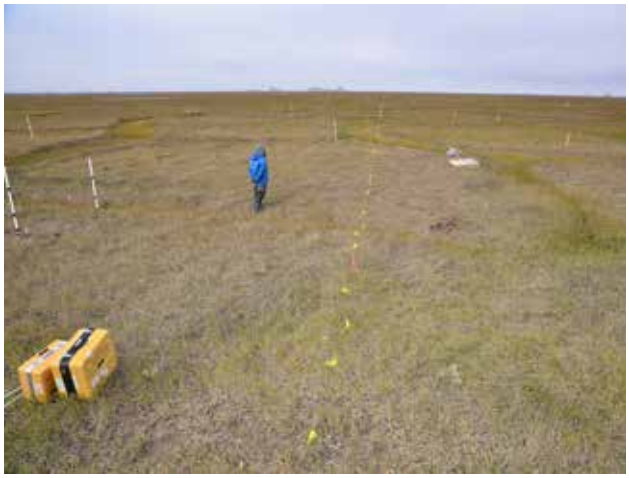

Figure 2.1. *Transect 1 looking northeast from the Spine Road. Pin flags mark sample points spaced at 1-m intervals. White poles mark permanent vegetation plots for winter snow sampling. Black stripes on the poles are the locations of Maxim iButton® temperature loggers. Wooden stakes on the right side of the transect mark permafrost borehole locations. Note network of low-centered polygons. Sampling was conducted on both sides of the transect in centers and troughs of the polygons at distances from the road of 5, 10, 25, 50, 100, and 200 m from the road. Photo: XAR_6046.*

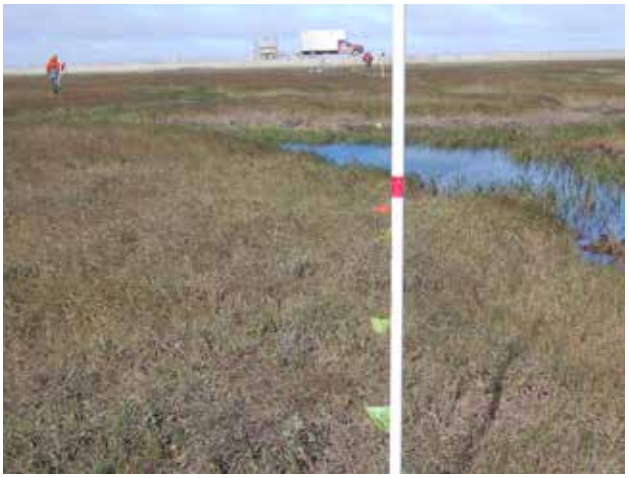

Figure 2.2. *Transect 2 looking northeast toward the Spine Road from the 100 m point. Vertical PVC posts are placed at 50, 100 and 200 m along the transect for locating the transect in winter. The red tape at 1 m is intended to increase visibility of the pole in winter. Note the difference in terrain and vegetation compared to T1, with extensive thermokarst ponds, the lack of rims on the ice-wedge polygon centers, greater than 0.5 m of trough-center relief, and lush sedge vegetation in the troughs and on the polygon centers. Photo: DSC_0115.*

Table 2.1A. *Summary of data from **Transect 1 (T1)**. Measurements (except for dust depth) were taken every 1 m for 100 m from the road, then every 5 m to 200 m. **Vegetation type:** Based on Walker (1980, Table 6); a suffix of 'd' indicates disturbed vegetation types. **Microrelief type:** Frost boil (F), flat-centered polygon (FC), low-centered polygon (LC), high-centered polygon (HC), thermokarst pit (P), low-centered polygon rim (R), roadside berm (RB), and trough (T). **LAI:** Leaf Area Index measured using an AcuPAR Model 80 instrument (1 measurement/point). **Vegetation height:** Average height in cm of dominant layer above the ground or water. **Dust depth:** measured from a soil plug. **Thaw depth:** Measured using a 1-m steel probe. (A visualization of these data appear in Appendix C.)*

m	Vegetation type	Micro-relief type	LAI	Vegetation height (cm)	Water depth (cm)	Dust depth (cm)	Thaw depth (cm)	Latitude	Longitude	Elevation (m)
Transect 1										
0	B	RB	0.52	20	0		gravel	-148.471265	70.223112	13.52
1	Caaq,Salova	RB	0.39	15	0		rock	-148.471253	70.223120	13.57
2	Caaq,Salova	RB	0.49	20	0	> 40 plus gravel	75	-148.471240	70.223128	13.60
3	U4d	RB	0.68	14	0		66	-148.471229	70.223136	13.52
4	U4d	FC	0.63	13	0		52	-148.471219	70.223144	13.50
5	U4d	R	0.71	15	0	10	52	-148.471207	70.223152	13.55
6	U4d	LC	0.26	15	0		57	-148.471195	70.223161	13.47
7	U4d	R	0.48	15	0		57	-148.471185	70.223169	13.41
8	M2d	T	0.66	17	0		54	-148.471173	70.223177	13.26
9	U4d	R	0.64	15	0		62	-148.471161	70.223185	13.37
10	U4d	R	0.58	12	0	4	58	-148.471149	70.223193	13.38
11	U4d	R	0.55	12	0		58	-148.471138	70.223201	13.44
12	U4d	LC	0.53	14	0		56	-148.471126	70.223209	13.44
13	U4d	LC	0.48	15	0		56	-148.471115	70.223217	13.43
14	U4d	LC	0.62	12	0		60	-148.471104	70.223225	13.41
15	U4d	LC	0.45	15	0	3	59	-148.471091	70.223233	13.40
16	U4d	LC	0.39	15	0		58	-148.471080	70.223241	13.38
17	U4d	LC	0.51	15	0		59	-148.471069	70.223249	13.38
18	U4d	LC	0.44	13	0		60	-148.471057	70.223258	13.40
19	U4d	LC	0.34	15	0		59	-148.471045	70.223266	13.41
20	U4d	LC	0.38	15	0	2 dust + 2 gravel	58	-148.471036	70.223274	13.40
21	U4d	LC	0.37	10	0		58	-148.471024	70.223281	13.39
22	U4d	LC	0.44	15	0		53	-148.471011	70.223290	13.39
23	U4d	R	0.43	15	0		55	-148.471001	70.223298	13.48
24	U4d	R	0.51	20	0		57	-148.470988	70.223306	13.39
25	E1d	T	0.54	18	2	4 gravel	58	-148.470979	70.223314	13.24
26	E1d	T	0.34	20	22		50	-148.470967	70.223322	13.04
27	E1d	T	0.37	15	21		54	-148.470957	70.223330	13.07
28	E1d	T	0.34	12	20		49	-148.470943	70.223339	13.11
29	E1d	T	0.53	12	11		48	-148.470933	70.223347	13.16
30	M2d	T	0.74	15	0	2	44	-148.470920	70.223355	13.26
31	M2d	R	0.63	14	0		44	-148.470908	70.223363	13.34
32	U4d	R	0.46	15	0		52	-148.470898	70.223371	13.42
33	U4d	R	0.56	12	0		48	-148.470885	70.223379	13.47
34	U4d	R	0.39	15	0		43	-148.470875	70.223387	13.51
35	U4d	R	0.38	15	0	2	46	-148.470863	70.223395	13.52
36	U4d	R	0.55	10	0		46	-148.470851	70.223403	13.39
37	E1d	T	0.61	12	5		45	-148.470841	70.223411	13.26
38	E1d	T	0.36	15	17		42	-148.470828	70.223419	13.09
39	E1d	T	0.42	13	21		50	-148.470815	70.223427	13.05

Table 2.1A (cont). *Summary of data from **Transect 1 (T1)**. Measurements (except for dust depth) were taken every 1 m for 100 m from the road, then every 5 m to 200 m. **Vegetation type:** Based on Walker (1980, Table 6); a suffix of 'd' indicates disturbed vegetation types. **Microrelief type:** Frost boil (F), flat-centered polygon (FC), low-centered polygon (LC), high-centered polygon (HC), thermokarst pit (P), low-centered polygon rim (R), roadside berm (RB), and trough (T). **LAI:** Leaf Area Index measured using an AcuPAR Model 80 instrument (1 measurement/point). **Vegetation height:** Average height in cm of dominant layer above the ground or water. **Dust depth:** measured from a soil plug. **Thaw depth:** Measured using a 1-m steel probe. (A visualization of these data appear in Appendix C.)*

m	Vegetation type	Micro-relief type	LAI	Vegetation height (cm)	Water depth (cm)	Dust depth (cm)	Thaw depth (cm)	Latitude	Longitude	Elevation (m)
Transect 1										
40	E1d	T	0.32	10	12	1 dust in peat	54	-148.470805	70.223436	13.12
41	U3d	R	0.48	17	0		57	-148.470793	70.223443	13.34
42	U3d	R	0.7	12	0		43	-148.470782	70.223452	13.47
43	M2d	LC	0.49	12	0		44	-148.470770	70.223459	13.43
44	M2d	LC	0.54	13	0		47	-148.470758	70.223467	13.35
45	M2d	R	0.44	10	0	2 dust in moss	51	-148.470747	70.223476	13.39
46	U3d	R	0.46	12	0		54	-148.470736	70.223483	13.51
47	M2d	T	0.51	10	0		45	-148.470723	70.223492	13.34
48	M2d	T	0.7	15	0		49	-148.470712	70.223500	13.29
49	M2d	T	0.6	15	1		50	-148.470701	70.223508	13.26
50	M2d	T	0.55	15	0	2 dust in peat	50	-148.470689	70.223516	13.33
51	U4d	R	0.58	12	0		44	-148.470678	70.223524	13.34
52	U4d	R	0.43	15	0		49	-148.470666	70.223532	13.45
53	M2d	LC	0.43	10	0		48	-148.470655	70.223540	13.41
54	M2d	LC	0.55	12	0		49	-148.470642	70.223548	13.42
55	M2d	LC	0.51	10	0	1 dust in peat	49	-148.470631	70.223556	13.40
56	M2d	LC	0.34	10	0		52	-148.470619	70.223564	13.42
57	U4d	R	0.62	12	0		48	-148.470608	70.223572	13.44
58	U4d	R	0.45	1	0		49	-148.470596	70.223580	13.39
59	M2d	T	0.54	9	0		44	-148.470583	70.223589	13.26
60	U4d	R	0.45	10	0	0.5 surface	47	-148.470572	70.223597	13.54
61	M2d	LC	0.52	10	0		45	-148.470561	70.223604	13.44
62	M2d	LC	0.5	8	0		51	-148.470549	70.223613	13.39
63	U4d	LC	0.28	14	0		54	-148.470537	70.223621	13.42
64	M2d	LC	0.33	9	0		54	-148.470527	70.223629	13.42
65	M2d	LC	0.37	10	0	0.1 surface	53	-148.470514	70.223637	13.40
66	M2d	LC	0.39	9	0		48	-148.470503	70.223645	13.37
67	M2d	LC	0.32	12	0		45	-148.470492	70.223653	13.39
68	M2d	LC	0.31	13	0		45	-148.470480	70.223661	13.39
69	U4d	LC	0.31	10	0		42	-148.470469	70.223669	13.40
70	U4d	R	0.52	15	0	0.1 surface	45	-148.470457	70.223677	13.38
71	E1d	P	1.79	22	9		52	-148.470446	70.223685	13.25
72	E1d	P	0	0	40		54	-148.470436	70.223692	12.96
73	W1	P	0	0	55		51			
74	W1	P	0	0	58		52			
75	W1	P	0	0	56	water	59			
76	W1	P	0	0	55		52			
77	E1d	P	0.31	25	32		58	-148.470377	70.223735	13.04
78	E1d	P	0.93	20	3		58	-148.470366	70.223742	13.27

Table 2.A (cont). *Summary of data from **Transect 1**. Measurements (except for dust depth) were taken every 1 m for 100 m from the road, then every 5 m to 200 m. **Vegetation type:** Based on Walker (1980, Table 6); a suffix of 'd' indicates disturbed vegetation types. **Microrelief type:** Frost boil (F), flat-centered polygon (FC), low-centered polygon (LC), high-centered polygon (HC), thermokarst pit (P), low-centered polygon rim (R), roadside berm (RB), and trough (T). **LAI:** Leaf Area Index measured using an AcuPAR Model 80 instrument (1 measurement/point). **Vegetation height:** Average height in cm of dominant layer above the ground or water. **Dust depth:** measured from a soil plug. **Thaw depth:** Measured using a 1-m steel probe. (A visualization of these data appear in Appendix C.)*

m	Vegetation type	Micro-relief type	LAI	Vegetation height (cm)	Water depth (cm)	Dust depth (cm)	Thaw depth (cm)	Latitude	Longitude	Elevation (m)
Transect 1										
79	M2d	R	0.44	12	0		47	-148.470354	70.223750	13.34
80	U4d	FC	0.41	12	0	0.1 surface	39	-148.470342	70.223758	13.49
81	U4d	FC	0.4	12	0		43	-148.470330	70.223766	13.53
82	U4d	FC	0.36	10	0		43	-148.470319	70.223774	13.58
83	U4d	FC	0.35	12	0		40	-148.470308	70.223782	13.51
84	U4d	FC	0.42	7	0		40	-148.470296	70.223790	13.57
85	U4d	FC	0.25	9	0	0.1 surface	34	-148.470285	70.223798	13.57
86	U3d	FC	0.29	4	0		39	-148.470274	70.223806	13.59
87	U3d	FC	0.32	8	0		35	-148.470262	70.223814	13.60
88	U3d	FC	0.38	8	0		35	-148.470251	70.223823	13.56
89	U3d	FC	0.23	10	0		35	-148.470240	70.223831	13.57
90	U3d	R	0.25	7	0	0.1 surface	41	-148.470228	70.223839	13.58
91	U3d	R	0.22	8	0		46	-148.470216	70.223847	13.67
92	U3d	R	0.35	13	0		29	-148.470207	70.223855	13.45
93	E1d	T	0.63	14	1		44	-148.470194	70.223863	13.30
94	E1d	T	0.61	15	14		48	-148.470181	70.223871	13.18
95	E1d	T	0.49	20	21	0.5	47	-148.470171	70.223879	13.11
96	E1d	T	0.46	20	15		49	-148.470159	70.223887	13.17
97	U4d	R	0.4	20	0		55	-148.470148	70.223895	13.43
98	U4d	R	0.37	13	0		49	-148.470136	70.223903	13.53
99	U4d	LC	0.47	10	0		45	-148.470124	70.223911	13.50
100	U4d	LC	0.44	10	0	0.1 surface	43	-148.470112	70.223919	13.47
105	U3	R	0.26	15	0	0	41	-148.470055	70.223960	13.58
110	U4	R	0.69	15	0	0	48	-148.469998	70.224000	13.40
115	U4	R	0.56	18	0	0	46	-148.469939	70.224041	13.44
120	U3	R	0.33	5	0	0	40	-148.469881	70.224081	13.65
125	U3	R	0.33	5	0	0	42	-148.469824	70.224121	13.63
130	M2	LC	0.66	12	0	0	44	-148.469766	70.224161	13.50
135	M2	LC	0.65	12	0	0	52	-148.469708	70.224202	13.43
140	M2	T	0.37	12	1	0	55	-148.469650	70.224243	13.34
145	U4	R	0.46	15	0	0	39	-148.469592	70.224283	13.53
150	U4	R	0.21	10	0	0	46	-148.469535	70.224323	13.63
155	U3	R	0.39	10	0	0	36	-148.469477	70.224364	13.60
160	U3	R	0.31	10	0	0	35	-148.469419	70.224404	13.51
165	E1	T	0.56	20	16	0	49	-148.469360	70.224443	13.18
170	U4	LC	0.57	15	0	0	43	-148.469303	70.224484	13.52
175	U4	LC	0.5	10	0	0	51	-148.469245	70.224524	13.40
180	E1	P	0.42	15	11	0	45	-148.469186	70.224565	13.22
185	M2	LC	0.46	15	0	0	46	-148.469129	70.224605	13.43
190	M2	LC	0.53	10	0	0	44	-148.469071	70.224646	13.52
195	U4	R	0.36	14	0	0	35	-148.469013	70.224686	13.57
200	E1	T	0.59	26	12	0	51	-148.468951	70.224726	13.24

Table 2.1B. *Summary of data from **Transect 2**. Measurements (except for dust depth) were taken every 1 m for 100 m from the road, then every 5 m to 200 m. **Vegetation type:** Based on Walker (1980, Table 6); a suffix of 'd' indicates disturbed vegetation types. **Microrelief type:** Frost boil (F), flat-centered polygon (FC), low-centered polygon (LC), high-centered polygon (HC), thermokarst pit (P), low-centered polygon rim (R), roadside berm (RB), and trough (T). **LAI:** Leaf Area Index measured using an AcuPAR Model 80 instrument (1 measurement/point). **Vegetation height:** Average height in cm of dominant layer above the ground or water. **Dust depth:** measured from a soil plug. **Thaw depth:** Measured using a 1-m steel probe. (A visualization of these data appear in Appendix C.)*

m	Vegetation type	Micro-relief type	LAI	Vegetation height (cm)	Water depth (cm)	Dust depth (cm)	Thaw depth (cm)	Latitude	Longitude	Elevation (m)
Transect 2										
0	B	RB	0	0	0		gravel	-148.471441	70.222995	13.70
1	B	RB	0	0	0		105	-148.471452	70.222987	13.70
2	B	RB	0	0	0	> 40	93	-148.471464	70.222979	13.61
3	B	RB	0.15	10	0		83	-148.471476	70.222971	13.54
4	B	HC	0.16	20	0		74	-148.471488	70.222963	13.47
5	M2d	HC	0.6	25	0	18	66	-148.471498	70.222955	13.40
6	M2d	HC	0.81	27	0		63	-148.471509	70.222947	13.37
7	M2d	T	0.72	30	5		52	-148.471521	70.222939	13.15
8	M2d	HC	0.95	27	0		60	-148.471534	70.222931	13.31
9	M2d	HC	1.14	27	0		61	-148.471544	70.222923	13.35
10	M2d	HC	0.89	20	0	10	64	-148.471556	70.222915	13.40
11	M2d	HC	0.87	25	0		62	-148.471567	70.222907	13.40
12	M2d	HC	1.15	24	0		58	-148.471580	70.222899	13.41
13	M2d	HC	0.5	27	0		60	-148.471591	70.222891	13.42
14	M2d	HC	1.05	30	0		53	-148.471602	70.222882	13.28
15	E1d	T	0.23	30	1	10	64	-148.471614	70.222874	13.16
16	E1d	T	0	15	40		58	-148.471624	70.222870	12.87
17	W	T	0	0	63		49	-148.471634	70.222863	12.62
18	W	T	0	0	62		51	-148.471646	70.222855	12.44
19	E1d	T	0	15	60		38	-148.471659	70.222847	12.45
20	E1d	HC	0.32	25	29	water	55	-148.471674	70.222834	12.89
21	M2d	HC	1.21	25	0		60	-148.471687	70.222826	13.18
22	M2d	HC	0.8	25	0		61	-148.471698	70.222818	13.29
23	M2d	HC	1.15	22	0		60	-148.471709	70.222810	13.36
24	M2d	HC	0.77	20	0		62	-148.471721	70.222802	13.39
25	M2d	HC	0.81	17	0	6	60	-148.471733	70.222794	13.40
26	M2d	HC	0.77	20	0		63	-148.471745	70.222786	13.43
27	M2d	HC	0.84	20	0		63	-148.471756	70.222778	13.41
28	M2d	HC	0.63	23	0		64	-148.471767	70.222770	13.38
29	M2d	HC	0.66	18	0		64	-148.471780	70.222762	13.40
30	M2d	HC	0.82	24	0	4	60	-148.471791	70.222754	13.42
31	M2d	HC	1.21	24	0		58	-148.471803	70.222746	13.37
32	M2d	HC	1.05	25	0		55	-148.471815	70.222738	13.42
33	M2d	HC	1.42	23	0		58	-148.471826	70.222730	13.38
34	M2d	HC	0.82	30	0		61	-148.471838	70.222722	13.31
35	E1d	T	1.07	37	6	4	57	-148.471851	70.222714	13.08
36	E1d	T	0.4	25	28		54	-148.471862	70.222706	12.83
37	E1d	T	0.12	25	46		31	-148.471873	70.222699	12.73
38	E1d	T	0.2	25	27		53	-148.471886	70.222690	12.90
39	E1d	T	0.2	25	29		51	-148.471899	70.222681	12.89
40	E1d	T	0.71	25	29	water	49	-148.471909	70.222673	12.87
41	E1d	T	0.51	25	30		48	-148.471922	70.222666	12.86

Table 2.1B (cont). *Summary of data from T**ransect 2**. Measurements (except for dust depth) were taken every 1 m for 100 m from the road, then every 5 m to 200 m. **Vegetation type:** Based on Walker (1980, Table 6); a suffix of 'd' indicates disturbed vegetation types. **Microrelief type:** Frost boil (F), flat-centered polygon (FC), low-centered polygon (LC), high-centered polygon (HC), thermokarst pit (P), low-centered polygon rim (R), roadside berm (RB), and trough (T). **LAI:** Leaf Area Index measured using an AcuPAR Model 80 instrument (1 measurement/point). **Vegetation height:** Average height in cm of dominant layer above the ground or water. **Dust depth:** measured from a soil plug. **Thaw depth:** Measured using a 1-m steel probe. (A visualization of these data appear in Appendix C.)*

m	Vegetation type	Micro-relief type	LAI	Vegetation height (cm)	Water depth (cm)	Dust depth (cm)	Thaw depth (cm)	Latitude	Longitude	Elevation (m)
Transect 2										
42	E1d	T	0.36	20	34		48	-148.471931	70.222658	12.80
43	E1d	T	0.23	25	42		45	-148.471941	70.222649	12.75
44	E3d	T	0	0	39		49	-148.471953	70.222641	12.77
45	E3d	T	0	0	49	water	46	-148.471965	70.222633	12.66
46	E3d	T	0.43	0	46		46	-148.471980	70.222624	12.64
47	E3d	T	0.65	0	49		54	-148.471990	70.222617	12.71
48	E1d	T	0.17	20	57		42	-148.472001	70.222609	12.73
49	E1d	T	0.76	20	19		56	-148.472011	70.222601	12.96
50	E1d	T	0.51	20	0	2	60	-148.472024	70.222593	13.20
51	U4d	R	0.92	15	0		56	-148.472035	70.222585	13.25
52	U4d	R	0.96	17	0		60	-148.472046	70.222577	13.34
53	U4d	R	0.92	20	0		63	-148.472059	70.222569	13.34
54	U4d	R	1.17	20	0		62	-148.472070	70.222561	13.37
55	U4d	R	0.96	20	0	3 dust and peat	61	-148.472082	70.222553	13.39
56	U4d	R	0.7	20	0		60	-148.472094	70.222545	13.41
57	U4d	R	0.76	17	0		61	-148.472106	70.222536	13.32
58	U4d	R	1.16	23	0		62	-148.472117	70.222528	13.32
59	M2d	HC	0.75	25	0		63	-148.472129	70.222520	13.30
60	M2d	HC	0.6	25	0	2 dust and roots	64	-148.472140	70.222512	13.32
61	M2d	HC	0.9	23	0		68	-148.472152	70.222504	13.29
62	M2d	HC	1.1	25	0		60	-148.472163	70.222496	13.29
63	U4d	HC	1.23	25	0		64	-148.472176	70.222488	13.38
64	U4d	HC	0.62	20	0		53	-148.472187	70.222480	13.41
65	U4d	HC	0.48	17	0	2	51	-148.472198	70.222472	13.49
66	U4d	R	0.84	15	0		51	-148.472211	70.222464	13.51
67	U4d	HC	0.87	17	0		56	-148.472222	70.222456	13.46
68	U4d	HC	0.7	25	0		61	-148.472233	70.222448	13.32
69	E1d	P	0.21	0	3		60	-148.472245	70.222440	13.12
70	E1d	P	0.18	25	16	3 dust and roots	50	-148.472257	70.222432	13.00
71	B	P	0	0	0		60	-148.472270	70.222423	13.18
72	U4d	HC	0.55	25	0		59	-148.472282	70.222416	13.32
73	U4d	HC	0.59	25	0		59	-148.472294	70.222407	13.42
74	U4d	HC	0.74	25	0		54	-148.472306	70.222399	13.42
75	U4d	HC	0.43	17	0	2	52	-148.472316	70.222391	13.51
76	U4d	HC	0.37	16	0		51	-148.472328	70.222384	13.56
77	U4d	HC	0.31	15	0		50	-148.472340	70.222375	13.59
78	U4d	HC	0.33	13	0		54	-148.472353	70.222367	13.54
79	U4d	HC	0.38	15	0		54	-148.472364	70.222359	13.52
80	U4d	HC	0.58	15	0	1	52	-148.472376	70.222351	13.52
81	U4d	HC	0.84	15	0		52	-148.472387	70.222343	13.50

Table 2.1B (cont). *Summary of data from T**ransect 2**. Measurements (except for dust depth) were taken every 1 m for 100 m from the road, then every 5 m to 200 m. **Vegetation type:** Based on Walker (1980, Table 6); a suffix of 'd' indicates disturbed vegetation types. **Microrelief type:** Frost boil (F), flat-centered polygon (FC), low-centered polygon (LC), high-centered polygon (HC), thermokarst pit (P), low-centered polygon rim (R), roadside berm (RB), and trough (T). **LAI:** Leaf Area Index measured using an AcuPAR Model 80 instrument (1 measurement/point). **Vegetation height:** Average height in cm of dominant layer above the ground or water. **Dust depth:** measured from a soil plug. **Thaw depth:** Measured using a 1-m steel probe. (A visualization of these data appear in Appendix C.)*

m	Vegetation type	Micro-relief type	LAI	Vegetation height (cm)	Water depth (cm)	Dust depth (cm)	Thaw depth (cm)	Latitude	Longitude	Elevation (m)
Transect 2										
82	U4d	HC	1.06	25	0		53	-148.472399	70.222335	13.37
83	B	P	0	0	0		56	-148.472412	70.222327	13.26
84	E1d	P	0.18	22	11		77	-148.472422	70.222319	13.09
85	E1d	P	0.13	20	47	water	51	-148.472436	70.222311	12.64
86	E3d	P	0	0	66		48	-148.472448	70.222301	12.44
87	E3d	P	0	0	60		38	-148.472461	70.222294	12.54
88	E3d	P	0	0	42		55	-148.472471	70.222287	12.69
89	E1d	P	0	20	39		56	-148.472483	70.222279	12.81
90	E1d	P	0.2	17	18	water	62	-148.472496	70.222271	12.97
91	E1d	P	0.69	25	5		64	-148.472505	70.222262	13.08
92	U4d	HC	0.63	22	0		60	-148.472516	70.222255	13.27
93	B	T	0.26	0	0		72	-148.472528	70.222247	13.20
94	U4d	HC	0.14	15	0		66	-148.472540	70.222238	13.38
95	U4d	HC	0.48	12	0	1	52	-148.472551	70.222231	13.52
96	U4d	HC	0.68	17	0		53	-148.472563	70.222222	13.50
97	U4d	HC	0.55	15	0		60	-148.472574	70.222214	13.51
98	U4d	HC	0.81	15	0		60	-148.472586	70.222206	13.52
99	U4d	HC	1.15	12	0		59	-148.472598	70.222198	13.46
100	U4d	HC	0.37	20	0	2 dust and peat	59	-148.472609	70.222190	13.51
105	B	F	0.5	20	0	0.5	65	-148.472670	70.222150	13.32
110	B	F	0.68	20	0	0.5	71	-148.472729	70.222110	13.28
115	M4d	T	0.72	25	0	2 dust and peat	47	-148.472787	70.222070	13.18
120	B	F	0.37	25	0	1 dust and peat	55	-148.472846	70.222030	13.30
125	B	F	0.69	25	0	2	75	-148.472904	70.221990	13.27
130	M2d	HC	0.88	23	0	0.5	60	-148.472963	70.221949	13.37
135	M4d	T	1.05	20	12	0.2 surface	48	-148.473022	70.221909	13.07
140	U4d	R	1.14	20	0	0.2 surface	56	-148.473079	70.221869	13.49
145	M2d	HC	1.47	22	0	0.1 surface	57	-148.473138	70.221829	13.33
150	M2d	HC	1.07	20	0	0.1 surface	63	-148.473196	70.221789	13.39
155	U4d	HC	1.11	25	0	0.1 surface	66	-148.473254	70.221748	13.39
160	M2d	LC	0.89	18	0	0.5	65	-148.473313	70.221708	13.35
165	M2d	LC	0.59	18	0	0.2 surface	63	-148.473372	70.221667	13.35
170	M4d	T	0.48	18	17	water	47	-148.473431	70.221627	13.07
175	M2d	LC	0.84	25	0	0.2 surface	59	-148.473487	70.221587	13.36
180	M2d	LC	1.27	23	0	0.1 surface	57	-148.473545	70.221547	13.34
185	U4d	R	0.67	23	0	0.1 surface	62	-148.473605	70.221507	13.35
190	M2d	LC	0.5	17	0	0.1 surface	65	-148.473662	70.221467	13.34
195	B	T	0.17	0	0	0	53	-148.473722	70.221426	13.26
200	U4d	R	0.63	18	0	0.1 surface	53	-148.473779	70.221386	13.49

Permanent vegetation and soil plots

We established permanent vegetation plots and photo points in polygon centers and troughs at 5, 10, 25, 50, 100, and 200 m from the road along both transects (Figs. 1.2 and 2.3). Voucher collections of all vascular plants, mosses and lichens were collected from each plot. Voucher collections are stored in the Alaska Geobotany Center. Cover of all species was estimated using Braun-Blanquet cover abundance scores (Table 2.3). Species cover was measured using a point-quadrat (Fig. 2.4). The species at the top of the plant canopy were recorded at 100 gridpoints within each plot. Leaf Area Index (LAI) was measured using an AccuPAR LP-80 PAR/LAI Ceptometer (Fig. 2.3).

Five "extra relevé plots" were established outside the transects. Three plots (relevés 14-1, 14-2, and 14-3) were placed in heavy dust areas within five meters of the road, and two plots (relevés 14-4 and 14-5) were placed in relatively undisturbed mesic tundra at approximately 435 m along Transect 1 (see Table 2.2C for data from these extra relevé plots). Soil temperature loggers were installed at all plots along transects T1 and T2, and air and snow temperature loggers were installed along T1. For details see "iButton Temperature loggers" on page 46.

A soil core was extracted from a spot adjacent to each plot with a Sharpshooter shovel (see Fig. 1.8). Using a 190 ml soil can, samples were obtained from each core for laboratory analysis to determine soil moisture, bulk density, percent gravel, dry and moist soil color, soil pH, and percent organic matter. Samples were taken from both the surface dust horizon, if present, and the top organic horizon, immediately below the dust layer (see Tables 2.5 A, B, and C).

A horizontal section of the core was removed at each sample location to allow the soil can to be inserted vertically, and a serrated knife was used to cut around the edges of the soil can as it was inserted into the soil horizon to ensure soil was not compressed for bulk density determinations. Each sample was removed from the soil can and placed in a labeled quart-size Ziploc® bag. A brief descripton and

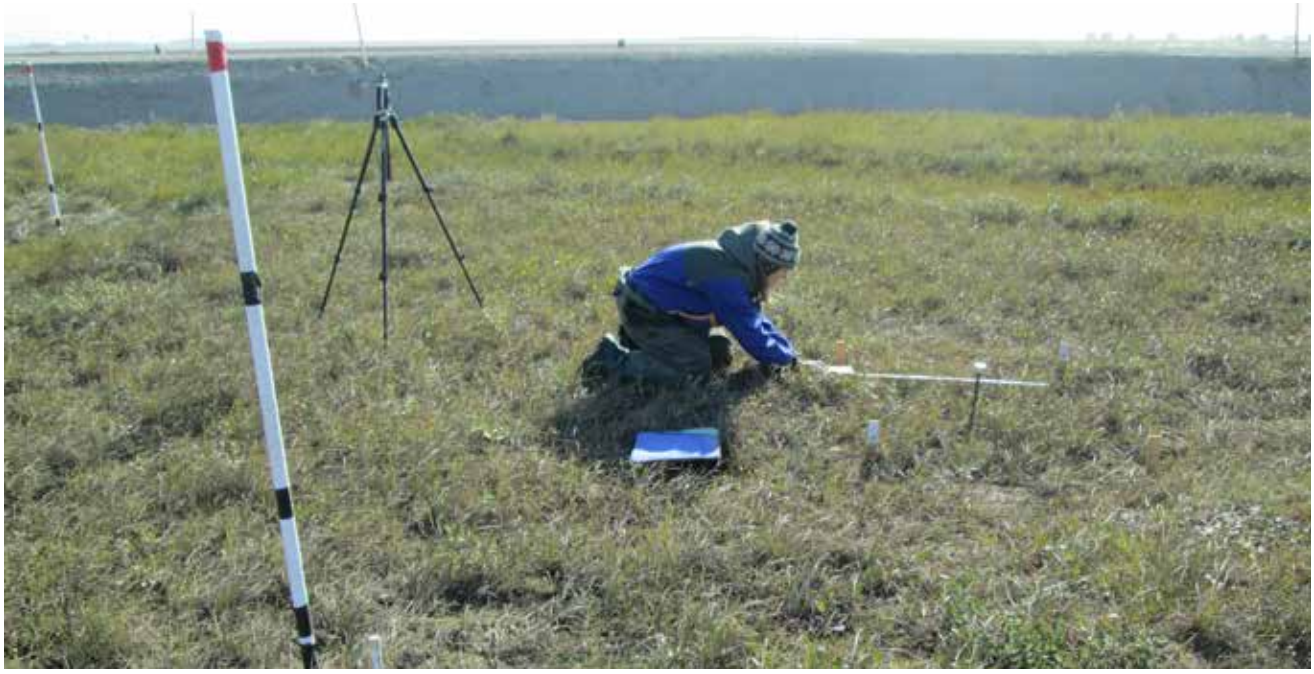

Figure 2.3. *Permanent plot. The 1 x 1-m plot is marked by short wooden stakes in the four corners and a photo point in the center of the plot with the plot number engraved on the aluminum cap that is attached to an 18-inch (46 cm) piece of 3/8-inch (1 cm) diameter steel rebar rod. The short white stake in the foreground has Maxim iButton® temperature loggers attached at 0, -10, and -20 cm depths. The tall stake is for measuring snow depths and has temperature loggers attached at 10, 20, 50, 100, and 150 cm to record air and snow temperature (once the logger is covered by snow). A soil plug was removed from the site of the temperature loggers for description and collection of soil samples prior to burial of the temperature logger. Martha Raynolds is measuring leaf-area index (LAI) using an AccuPAR LP-80, PAR/LAI Ceptometer. The white horizontal sensor she is holding measures photosynthetically active radiation (PAR) that penetrates the plant canopy. The above canopy PAR sensor is mounted on the tripod in the background. LAI is calculated as the ratio of the below-canopy PAR to the above-canopy PAR. Photo: IMG_0871.*

photo of each soil were made in the field noting the locations of the obvious horizons, and the soil was classified using the USDA Soil Taxonomy (Soil Survey Staff, 1999) (see Appendix B). Peat samples were classified using the von Post scale (von Post *et al.,* 1926), which describes the degree of humification of the peat and ranges from a value of H-1 (denoting unhumified peat or fresh litter) through to H-10, representing completely humified (amorphous) peat with no discernible plant remains. The fibre (F) and roots (R) content of each peat sample was estimated visually and noted on a scale ranging from 0 to 3 (1 = low content; 2 = moderate content; 3 = high content) (Malterer *et al.,* 1992).

To determine gravimetric and volumetric soil moisture and bulk density, the soils were weighed wet in their Ziploc® collection bags, then dried at 105˚C for 48 hours and reweighed. Gravimetric soil moisture was calculated as mass of water divided by the mass of dry soil times 100%. Volumetric soil moisture was calculated as the volume of water divided by the volume of the soil can (190 cm^3) times 100%, noting that 1 cm^3 of water weighs 1 g. The bulk density of the soil was calculated from the dry mass of the soil divided by the volume of the soil can and reported as g/cm^3. Dry and moist soil colors were determined in the lab after the soils were dried using a Munsell color book.

To determine percentage soil organic matter, the soils were first put through a 2-mm sieve to remove gravel and undecomposed plant material. These components were weighed and reported as percent of total soil sample. Organic matter content was determined from 5-10 g samples of the < 2-mm soil component. The samples were dried to 105 ˚C, then put in a combustion oven at 550 ˚C for seven hours. Samples were reweighed after drying and after combustion, and kept in desiccators to cool to minimize moisture absorption before reweighing.

Tables 2.2 A, B, and C contain the environmental data from all the permanent plots. Table 2.2D contains explanations of the codes used for site descriptions of the plots. Table 2.3 contains the percentage cover of species as determined using the point-intercept method. Tables 2.4 A, B, and C contain the complete species list for the plots with Braun-Blanquet cover-abundance scores. Tables 2.5 A, B, and C contain the soil data.

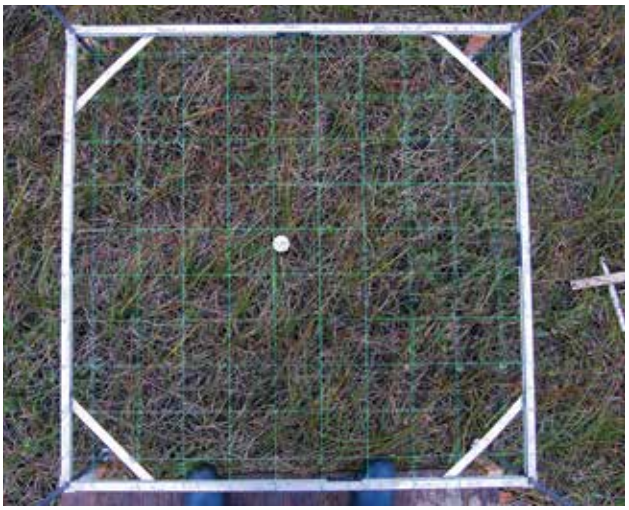

Figure 2.4. *Plot T2 025 C (Transect 2, 25 m from road, polygon center) with point quadrat in place. The grid defines the 100 points for sampling. The point quadrat is mounted on legs that are inserted in metal washers nailed into the tundra to allow the frame to be repositioned at the same point for resampling. The central metal disk is the aluminum photo-point marker with the engraved plot number. The grid consists of two layers of monofilament fishing line. To avoid problems of parallax in accurately locating each point in the plant canopy, the grid points in the two layers of monofilament line are visually aligned at each point. The plant species intercepted by the point is recorded. Photo: DSC_0091.*

Appendix A contains photos of the vegetation and soil at each plot. Appendix B includes soil descriptions from all borehole locations, and Appendix C presents a visualization of the data, illustrating elevation, microrelief and vegetation types, thaw depth, dust layer thickness, and Leaf Area Index (LAI) along the length of Transects 1 and 2 at Colleen Site A.

Table 2.2A. *Environmental characteristics and lifeform cover values for permanent plots on* ***Transect 1*** *(T1), Colleen Site A, August 2014.* ***Distance from road:*** *Measured in m (5, 10, 25, 50, 100, 200).* ***Polygon Center/Trough:*** *Center of polygon(C), polygon trough (T). Codes for site descriptors are listed in Table 2.2D.*

Transect	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**
Distance from road (m)	**5**	**5**	**10**	**10**	**25**	**25**	**50**	**50**	**100**	**100**	**200**	**200**
Polygon Center/Trough	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**
Date	8/7/14	8/7/14	8/7/14	8/7/14	8/7/14	8/7/14	8/7/14	8/7/14	8/7/14	8/7/14	8/7/14	8/7/14
Observers	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR
North (decimal minutes)	70.223179	70.223218	70.223225	70.223293	70.223332	70.223378	70.223568	70.223609	70.223945	70.223996	70.224787	70.224789
West (decimal minutes)	-148.471408	-148.471675	-148.471359	-148.471726	-148.471097	-148.47151	-148.470953	-148.471244	-148.470240	-148.470284	-148.469173	-148.469325
Slope (degrees)	0	0	0	0	0	0	0	0	0	0	0	0
Aspect	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Elevation (m)	13.44	13.32	13.17	13.39	13.23	13.44	13.39	12.90	13.43	13.18	13.48	13.21
Plot photo #, taken from road side	MKR 38, 39,65	MKR 36, 37,66	MKR 34,35,67	MKR 28, 29,68	MKR 32,33,69	MKR 30, 31,70	MKR 40, 41,71	MKR 42, 43,72	MKR 44, 45,73	MKR 46, 47,74	MKR 48, 49,75	MKR 50,76
Soil photo #	MKR 51	MKR 52	MKR 64	MKR 63	MKR 62	MKR 61	MKR 58	MKR59,60	MKR 56	MKR 57	MKR 54	MKR 55
Landform	20	20	20	20	20	20	20	20	20	20	20	20
Surficial geology (parent material)	13	13	13	13	13	13	13	13	13	13	13	13
Surficial geomorphology	20	20	20	20	20	20	20	20	20	20	20	20
Microsite	5	6	5	6	5	6	5	13	5	6	5	6
Site moisture	6	8	7	10	6	10	6	10	6	10	6	10
Soil moisture	6	8	7	10	7	10	6	10	6	10	6	10
Glacial geology	0	0	0	0	0	0	0	0	0	0	0	0
Topographic position	4	4	4	4	4	4	4	7	4	4	4	4
Estimated snow duration	3--	3--	3-	3-	3	3	3+	3+	4	4	4	4
Disturbance degree	5,3	4,3	2,4,2	2,4	3,4,4	2,3,3	4,3	0	1	0	0	0
Disturbance type	8,9	8,9	4,8,9	4,8	4,8,9	4,8,9	4,8	0	4	0	0	0
Physical stability	1	1	1	1	1	1	1	1	1	1	1	1
Exposure	2	1	2	2	2	2	2	2	2	2	2	2
Soil grab sample taken	2	2	2	2	2	1	2	1	2	1	1	1
Low shrubs	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Erect dwarf shrubs	0/0	0/0	5/0	3/0	2/0	0.1/0	5/0	0/0	0.1/0	0/0	10/0.1	0/0
Prostrate dwarf shrubs	15/0	0/0	1/0	0/0	15/0	0/0	15/0	0/0	3/0	0/0	10/0	1/0
Evergeen shrubs	0/0	0/0	0.1/0	0/0	0.1/0	0/0	0.1/0	0/0	0/0	0/0	1/0	0/0
Deciduous shrubs	15/0	0/0	6/0	3/0	17/0	0.1/0	20/0	0/0/	3/0	0/0	40/0	1/0
Erect forbs	2/0	0.1/0	0.1/0	0/0	0.1/0	0/0	1/0	0/0	0.1/0	0/0	1/0	0/0
Mat & cushion forbs	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Non-tussock graminoids	40/30	55/40	20/45	35/15	20/40	45/20	25/20	0.1/0.1	35/50	40/10	15/25	35/10

Table 2.2A (cont.). *Environmental characteristics and lifeform cover values for permanent plots on* ***Transect 1*** *(T1), Colleen Site A, August 2014.* ***Distance from road:*** *Measured in m (5, 10, 25, 50, 100, 200).* ***Polygon Center/Trough:*** *Center of polygon(C), polygon trough (T). Codes for site descriptors are listed in Table 2.2D.*

Transect	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**
Distance from road (m)	**5**	**5**	**10**	**10**	**25**	**25**	**50**	**50**	**100**	**100**	**200**	**200**
Polygon Center/Trough	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**
Tussock graminoids	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Foliose lichen	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Fruticose lichen	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Crustose lichen	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0.1/0	0/0
Pleurocarpous bryophytes	0.1	1	0.1	2	2	1	10	75	2	50	2	75
Acrocarpous bryophytes	2	5	5	0.1	15	0	5	0.1	2	0	25	0
Liverworts	0	0	0.1	0	1	1	1	1	0.1	0	1	0
Horsetails	0	0	0/1	0	0/1	0	0/1	0	0/1	0	0/1	0
Algae	0	0	0	0	0	0	0	0.1	0	0	0	0
Rocks	2	1	1	0	2	0	0	0	0	0	0	0
Bare soil	20	0	10	0	3	0	5	0	5	0	0	2
Water: % / depth	0/0	0/0	0/0	25/4	0/0	80/7	0/0	100/25	0/0	100/12	0/0	80/8
Litter	15	10	5	5	15	10	40	25	5	40	40	10
Dwarf shrub height	5	0	15	10	12	5	12	0	8	0	10	5
Herbaceous height	17	20	10	20	10	20	10	10	14	20	12	20
Live moss height	1	0.1	0.5	0	0.5	0	1	5	0.5	0	0.5	2
Dead moss depth	0	0	0.5	0	0.5	0	0	4	0	0	0	3
Dust thickness	4	11	4	6	4	0	5	0	2	0	0	0
Organic	22	28	21	30	21	28	13	21	19	28	23	23
Microrelief	5	0	5	0	5	0	5	20	5	5	6	10
Mean thaw depth	56	44	55	49	52	49	55	51	49	50	49	44
LAI	0.35	0.98	0.33	0.61	0.17	1.14	0.16	0	0.54	0.72	0.35	0.72
Veg type	U4d	M2d	U4d	M2d	U4d	M2d	U4d	E4d	M2d	M4	U4	M4

Table 2.2B. *Environmental characteristics and lifeform cover values for permanent plots on* ***Transect 2*** *(T2), Colleen Site A, August 2014.* ***Distance from road:*** *Measured in m (5, 10, 25, 50, 100, 200).* ***Polygon Center/Trough:*** *Center of polygon(C), polygon trough (T). Codes for site descriptors are listed in Table 2.2D.*

Transect	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**
Distance from road (m)	**5**	**5**	**10**	**10**	**25**	**25**	**50**	**50**	**100**	**100**	**200**	**200**
Polygon Center/Trough	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**
Date	8/9/2014	8/9/2014	8/9/2014	8/9/2014	8/10/2014	8/10/2014	8/10/2014	8/10/2014	8/10/2014	8/10/2014	8/10/2014	8/10/2014
Observers	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR
North (decimal minutes)	70.222917	70.222871	70.222878	70.222894	70.222771	70.222773	70.222599	70.222586	70.222151	70.222062	70.221361	70.221369
West (decimal minutes)	-148.471258	-148.470910	-148.471255	-148.471439	-148.471486	-148.471635	-148.471769	-148.471973	-148.472511	-148.472417	-148.473537	-148.473673
Slope (degrees)	1	0	0	0	0	0	0	0	0	0	0	0
Aspect	SW	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Elevation (m)	13.18	13.45	12.84	13.45	12.76	13.41	13.48	12.85	13.41	13.00	13.18	13.50
Plot photo #, taken from road side	MKR 89,90,132	MKR 87,88,133	MKR 83,84,134	MKR 85,86,135	MKR 91,92,136	MKR 93, 94,95,137	MKR 96,97,169	MKR 98,99,170	MKR 100, 101,155	MKR 103, 104,156	MKR 105, 109,163	MKR 110, 111,164
Soil photo #	MKR 122	MKR 123	MKR 124	MKR 130	MKR 131	NONE	MKR 139	MKR 142	MKR 143	MKR 153	MKR 161	MKR 162
Landform	20	20	20	20	20	20	20	20	20	20	20	20
Surficial geology (parent material)	13	13	13	13	13	13	13	13	13	13	13	13
Surficial geomorphology	6	6	6	6	6	6	6	6	6	6	6	6
Microsite	5	6	5	6	5	6	5	6	5	6	5	6
Site moisture	6	9	6	10	6	10	5	10	6	10	6	8
Soil moisture	6	9	7	10	6	10	5	10	7	10	6	8
Glacial geology	0	0	0	0	0	0	0	0	0	0	0	0
Topographic position	4	4	4	4	4	4	4	4	4	4	4	4
Estimated snow duration	3--	3--	3--	3--	3-	3-	3-	3-	4	4	4	4
Disturbance degree	4,5,2	2,3	1,4,3	1,2	3	1,3	1,3	1,1	2	1,1	1,1	1
Disturbance type	4,8,9	4,8	4,8,9	4,8	8	4,8	4,8	4,8	8	4,8	4,8	8
Physical stability	1	1	1	1	1	1	1	1	1	1	1	1
Exposure	2	2	2	2	2	2	2	2	2	2	2	2
Soil grab sample taken	2	2	2	2	2	0	2	2	2	2	2	2
Low shrubs	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Erect dwarf shrubs	0/0	0/0	17/0	0/0	20/0	0/0	20/0	0/0	7/1	0/0	10/0	2/0
Prostrate dwarf shrubs	0/0	0/0	0/0	0/0	0/0	0/0	35/5	0/0	5/0	0/0	25/0	0/0
Evergeen shrubs	0/0	0/0	0/0	0/0	0/0	0/0	15/5	0/0	0/0	0/0	15/2	0/0
Deciduous shrubs	0/0	0/0	17/0	0/0	20/0	0/0	20/0	0/0	12/1	0/0	20/0	2/0
Erect forbs	0/0	0/0	0.1/0	0/0	0/0	0/0	0/0	0/0	0.1/0	0/0	0.1/0	0/0
Mat & cushion forbs	0/0	0/0	0/0	0/0	0/0	0/0	1/0	0/0	0/0	0/0	0/0	0/0
Non-tussock graminoids	40/20	85/15	75/45	25/2	40/40	30/1	25/25	35/5	40/35	40/15	40/30	60/20

Table 2.2B (cont.). *Environmental characteristics and lifeform cover values for permanent plots on T**ransect 2** (T2), Colleen Site A, August 2014. **Distance from road:** Measured in m (5, 10, 25, 50, 100, 200). **Polygon Center/Trough:** Center of polygon(C), polygon trough (T). Codes for site descriptors are listed in Table 2.2D.*

Transect	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**
Distance from road (m)	**5**	**5**	**10**	**10**	**25**	**25**	**50**	**50**	**100**	**100**	**200**	**200**
Polygon Center/Trough	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**
Tussock graminoids	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Foliose lichen	0	0	0	0	0	0	0	0	0	0	0	0
Fruticose lichen	0	0	0	0	0	0	0	0	0	0	0	0
Crustose lichen	0	0	0	0	0	0	0	0	0	0	0	0
Pleurocarpous bryophytes	0	0	0	0	5	5	5	60	7	30	1	10
Acrocarpous bryophytes	0	0	0	0	15	0	30	0	3	0	3	0
Liverworts	0	0	0	0	0	0	0	0	1	0	0	0
Horsetails	0	0	0	0	0	0	0	0	0.1	0	0.1	0
Algae	0	0	0	0	0	0	0	0	0	0	0	0
Rocks	1	0	0.1	0	0	0	0	0	0	0	0	0
Bare soil	30	0	10	0	7	0	1	0	2	0	0	0
Water: % / depth	0	5/2	0	100/25	0	100/35	0	100/30	0	100/14	0	0
Litter	5	10	5	25	3	70	15	20	10	30	35	70
Dwarf shrub height	0	0	20	0	20	0	5	0	20	0	15	25
Herbaceous height	10	25	15	25	20	15	10	20	25	25	13	25
Live moss height	0	0	0	0	1	10	1	10	0.5	10	0.5	3
Dead moss depth	0	0	0	0	1	DNK	0.5	1	0.5	2	0.5	5
Dust thickness	14	12	7	10	5	DNK	3	4	0.5	0	0	0
Organic	22+	20+	21	24+	19	DNK	16	22	21	19	19	22
Microrelief	3	5	5	0	0	10	5	0	3	0	5	5
Mean thaw depth	74	55	66	48	62	49	52	48	57	55	49	43
LAI	0.29	0.93	0.76	0.18	0.69	0.12	0.43	0.38	1.31	0.47	0.65	1.65
Veg type	Dupfis dust	E1d	M2d	E1d	M2d	E1d	U4d	E1d	M2d	E1d	U4d	M2

Table 2.2C. *Environmental characteristics and lifeform cover values for* ***extra relevé plots****, Colleen Site A, August 2014. Codes for site descriptors are listed in Table 2.2D.*

Relevé number (year-plot no.)	14-1	14-2	14-3	14-4	14-5
Date	8/12/2014	8/12/2014	8/12/2014	8/13/2014	8/13/2014
Observers	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR	DAW/MKR
North (decimal minutes)	70.223155	70.222460	70.222431	70.226897	70.226109
West (decimal minutes)	-148.471448	-148.467742	-148.467821	-148.465858	-148.467287
Slope (degrees)	0	2	1	0	0
Aspect	NA	SW	SW	NA	NA
Elevation (m)	13.64	13.78	13.39	13.22	13.35
Plot photo #, taken from road side	MKR 175	MKR 176,177	MKR 178,179	MKR 180,181	MKR 183,184
Soil photo #	MKR 186	MKR 187	MKR 188	MKR 182	MKR 185
Landform	21	21	21	20	20
Surficial geology (parent material)	12	12	12	13	13
Surficial geomorphology	17	17	17	6	20
Microsite	0	0	5	5	5
Site moisture	5	4	6	5	7
Soil moisture	5	4	6	5	7
Glacial geology	0	0	0	0	0
Topographic position	4	4	4	4	4
Estimated snow duration	3--	3--	3--	4	4
Disturbance degree	5,5	3,5,5	4,5,4	0	0
Disturbance type	8,9	4,8,9	4,8,9	NA	NA
Physical stability	1	4	1	1	1
Exposure	2	2	2	2	2
Soil grab sample taken	1	1	2	2	2
Low shrubs	0/0	0/0	0/0	5/0	0/0
Erect dwarf shrubs	0/0	0/0	0/0	5/0	0/0
Prostrate dwarf shrubs	15/0	0/0	0/0	30/10	0.1/0
Evergeen shrubs	0/0	0/0	0/0	15/10	0/0
Deciduous shrubs	25/0	0/0	0/0	20/0	0.1/0
Erect forbs	0.1/0	0/0	0/0	0.1/0	0.1/0
Mat & cushion forbs	0/0	0/0	0/0	0/0	0/0
Non-tussock graminoids	25/30	20/0	45/15	30/15	55/30
Tussock graminoids	0/0	0/0	0/0	0/0	0/0
Foliose lichen	0	0	0	0	0
Fruticose lichen	0	0	0	0	0
Crustose lichen	0	0	0	0	0
Pleurocarpous bryophytes	0	0	0	40	40
Acrocarpous bryophytes	0	0	0	10	1
Liverworts	0	0	0	0	0.1
Horsetails	0.1	0	0	0.1	1
Algae	0	0	0	0	0
Rocks	10	5	2	0	0
Bare soil	20	75	40	0	0
Water: % / depth	0	0	0	0	0
Litter	5	1	7	15	5
Dwarf shrub height	2	0	0	10	2
Herbaceous height	14	1	17	12	14
Live moss height	0.5	0	0	3	2
Dead moss depth	0	0	0	1	1
Dust thickness	42	40+	11	0	0

Table 2.2C (cont.). *Environmental characteristics and lifeform cover values for* ***extra relevé plots****, Colleen Site A, August 2014. Codes for site descriptors are listed in Table 2.2D.*

Relevé number (year-plot no.)	14-1	14-2	14-3	14-4	14-5
Organic	0*	0*	18	15	27
Microrelief	5	5	3	7	8
Mean thaw depth	75	>100	75	51	52
LAI	Not collected	0	Not collected	Not collected	Not collected
Veg type	Caraqu-Salova	Pucphr	Caraqu	U3	M2
*none above 50 cm					

Table 2.2D. *Codes used for site description of plots (Tables 2.2 A, B, and C), Colleen Site A, August 2014.*

Landforms

1 Hills (including kames and moraines)
2 Talus slope
3 Colluvial basin
4 Glaciofluvial and other fluvial terraces
5 Marine terrace
6 Floodplains
7 Drained lakes and flat lake margins
8 Abandoned point bars and sloughs
9 Estuary
10 Lake or pond
11 Stream
12 Sea bluff
13 Lake bluff
14 Stream bluff
15 Sand dunes
16 Beach
17 Disturbed
18 Alluvial plain/abandoned
19 Island
20 Plain - residual surface
21 Disturbed, gravel

Surficial Geology (Parent Material)

1 Glacial tills
2 Glaciofluvial deposits
3 Active alluvial sands
4 Active alluvial gravels
5 Stabilized alluvium (sands & gravels)
6 Undifferentiated hill slope colluvium
7 Basin colluvium and organic deposits
8 Drained lake or lacustrine organic deposits
9 Lake or pond organic, sand, or silt
10 Undifferentiated sands
11 Undifferentiated clay
12 Roads and gravel pads
13 Loess
14 Fine sand
15 _____
16 _____

Surficial Geomorphology

1 Frost scars
2 Wetland hummocks
3 Turf hummocks
4 Gelifluction features
5 Strangmoor or aligned hummocks
6 High- or flat-centered polygons
7 Mixed high- and low-centered polygons
8 Sorted and non-sorted stripes
9 Palsas
10 Thermokarst pits
11 Featureless or with less 20% frost scars
12 Well-developed hillslope water tracks and small streams >50 cm deep
13 Poorly developed hillslope water tracks, <50 cm deep
14 Gently rolling or irregular microrelief
15 Stoney surface
16 Lakes and ponds
17 Disturbed
18 Hill hummock
19 Wetland
20 Low-centered polygon
21 _____

Microsites

1 Frost-scar element
2 Inter-frost scar element
3 Strang or hummock
4 Flark, interstrang, or interhummock area
5 Polygon center
6 Polygon trough
7 Polygon rim
8 Stripe element
9 Inter-stripe element
10 Point bar (raised element)
11 Slough (wet element)
12 Ring
13 Thermokarst pit
14 _____
15 _____

Site Moisture (modified from Komárková 1983)

1 Extremely xeric - almost no moisture; no plant growth
2 Very xeric - very little moisture; dry sand dunes
3 Xeric - little moisture; stabilized sand dunes, dry ridge tops
4 Subxeric - noticeable moisture; well-drained slopes, ridges
5 Subxeric to mesic - very noticeable moisture; flat to gently sloping
6 Mesic-moderate moisture; flat or shallow depressions
7 Mesic to subhygric - considerable moisture; depressions
8 Subhygric - very considerable moisture; saturated but with <5% standing water <10 cm deep
9 Hygric - much moisture; up to 100% of surface under water 10 to 50 cm deep; lake margins, shallow ponds, streams
10 Hydric - very much moisture; 100% of surface under water 50 to 150 cm deep; lakes, streams

Soil Moisture (from Komárková 1983)

1 Very dry - very little moisture; soil does not stick together
2 Dry - little moisture; soil somewhat sticks together
3 Damp - noticeable moisture; soil sticks together but crumbles
4 Damp to moist - very noticeable moisture; soil clumps
5 Moist - moderate moisture; soil binds but can be broken apart
6 Moist to wet - considerable moisture; soil binds and sticks

Table 2.2D (cont.). *Codes used for site description of plots (Tables 2.2 A, B, and C), Colleen Site A, August 2014.*

to fingers
7 Wet - very considerable moisture; water drops can be squeezed out of soil
8 Very wet - much moisture can be squeezed out of soil
9 Saturated - very much moisture; water drips out of soil
10 Very saturated - extreme moisture; soil is more liquid than solid

Glacial Geology

1 Till 4 _____
2 Outwash 5 _____
3 Bedrock 6 _____

Topographic Position

1 Hill crest or shoulder
2 Side slope
3 Footslope or toeslope
4 Flat
5 Drainage channel
6 Depression
7 Lake or pond

Soil Units

1 Pergelic Cryorthent, acid
2 Pergelic Cryopsamment
3 Pergelic Cryohemist, euic
4 Pergelic Cryosaprist, euic
5 Lithic Pergelic Cryosaprist
6 Pergelic Cryofibrist, euic
7 Histic Pergelic Cryaquept, acid
8 Histic Pergelic Cryaquept, nonacid (Aquiturbol)
9 Pergelic Cryaquept, acid (Ochriturbel)
10 Pergelic Cryaquept, nonacid
11 Pergelic Cryochrept
12 Pergelic Cryumbrept
13 Ruptic-Lithic Cryumbrept
14 Pergelic Cryaquoll
15 Histic Pergelic Cryaquoll
16 Pergelic Cryoboroll (Mollitrubel)
17 _____
18 _____
19 _____

Estimated Snow Duration

1 Snow free all year
2 Snow free most of winter; some snow cover persistsafter storm but is blown free soon afterward
3 Snow free prior to melt out but with snow most of winter
4 Snow free immediately after melt out
5 Snow bank persists 1-2 weeks after melt out
6 Snow bank persists 3-4 weeks after melt out
7 Snow bank persists 4-8 weeks after melt out
8 Snow bank persists 8-12 weeks after melt out
9 Very short snow free period
10 Deep snow all year

Animal and Human Disturbance

(degree)

0 No sign present
1 Some sign present; no disturbance
2 Minor disturbance or extensive sign
3 Moderate disturbance; small dens or light grazing
4 Major disturbance; multiple dens or noticeable trampling
5 Very major disturbance; very extensive tunneling or large pit

Animal and Human Disturbance (type)

1 Ptarmigan scat
2 Caribou tracks
3 Caribout scat
4 Goose tracks, scat, grazing
5 Squirrel mounds
6 Vole tracks & scat
7 Vehicle tracks
8 Road/pad dust, 9 Road/pad gravel

Stability

1 Stable
2 Subject to occasional disturbance
3 Subject to prolonged but slow disturbance such as solifluction
4 Annually disturbed
5 Disturbed more than once annually

Exposure Scale

1 Protected from winds
2 Moderate exposure to winds
3 Exposed to winds
4 Very exposed to winds

Table 2.3. *Percent plant cover on permanent plots by species, based on 100 points within a 1-m² quadrat (first hit only recorded for each point).* ***Transect:*** *Transect 1 (T1), Transect 2 (T2).* ***Distance from road:*** *Measured in m (5, 10, 25, 50, 100, 200).* ***Polygon Center/Trough:*** *Center of polygon(C), polygon trough (T).*

Transect	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**
Distance from road (m)	**5**	**5**	**10**	**10**	**25**	**25**	**50**	**50**	**100**	**100**	**200**	**200**	**5**	**5**	**10**	**10**	**25**	**25**	**50**	**50**	**100**	**100**	**200**	**200**
Polygon Center/Trough	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**
Vascular species																								
Carex aquatilis	10	47		29		40			6	23	3	15		58		28	2	31		39		42	1	
Carex aquatilis (dead)	14	33		10		17			6	6	9	7		15		1	1	1		3		9		
Carex atrofusca							16		1															
Carex atrofusca (dead)							12				3													
Carex bigelowii																							3	
Carex bigelowii (dead)					1																			
Carex membranacea			2		1																			
Carex membranacea (dead)			8		8																			
Carex rotundata					5																			
Carex rotundata (dead)					1																			
Dryas integrifolia			1								2								9				6	
Dryas integrifolia (dead)																			3				1	
Dupontia fisheri													30											
Dupontia fisheri (dead)													18											
Equisetum variegatum					2				1															
Eriophorum angustifolium	19	8	17	9	9	6	6		26	13	11	15	2	25	60		32		28		48		39	68
Eriophorum angustifolium (dead)	16	9	29	3	21	2	6		45	6	7	6	1	1	18		36		38		26		30	19
Eutrema edwardsii					1																			
Meladrium apetalum	1										1													
Pedicularis capitata											1													
Polygonum viviparum			1		1																			
Salix arctica	3		2		2		8		1		8	1			4		6		4				7	
Salix lanata			5		1		4				4				3		1				4		2	1
Salix lanata (dead)																					1			
Salix ovalifolia	3		1	37	4														2					
Salix reticulata																			2					
Sedge (dead)					5				1															
Nonvascular species																								
Calliergon giganteum												1												
Catascopium nigritum			2	1							5													

Table 2.3 (cont.). *Percent plant cover on permanent plots by species, based on 100 points within a 1-m² quadrat (first hit only recorded for each point).* ***Transect:*** *Transect 1 (T1), Transect 2 (T2).* ***Distance from road:*** *Measured in m (5, 10, 25, 50, 100, 200).* ***Polygon Center/Trough:*** *Center of polygon(C), polygon trough (T).*

Transect	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**
Distance from road (m)	**5**	**5**	**10**	**10**	**25**	**25**	**50**	**50**	**100**	**100**	**200**	**200**	**5**	**5**	**10**	**10**	**25**	**25**	**50**	**50**	**100**	**100**	**200**	**200**
Polygon Center/Trough	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**
Dicranaceae (unknown sp.)											1													
Distichium capillaceum			1		3														3				1	
Ditrichum flexicaule							1				2													
Drepanocladus brevifolius (cf.)			1	1																			1	
Encalypta sp.					3						1													
Moss (unknown species)					1						1													
Ricardia sp.			1								2													
Tomentypnum nitens											1													
Lichen (unknown species)											1													
Non-vegetated cover																								
Litter	13	3	12	8	20		41		7		37	6	3		1		1		6		17		9	12
Soil												2												
Dust	21		17	2	8		6		6				45		14		21		5		4			
Gravel					3																			
Rock													1											
Water						35		100		52		47		1		71		68		58		49		
SUM	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 2.4A. *Braun-Blanquet categorical species cover abundance values for permanent plots on* ***Transect 1*** *(T1), Colleen Site A, August 2014.* ***Distance from road:*** *Measured in m (5, 10, 25, 50, 100, 200).* ***Polygon Center/Trough:*** *Center of polygon(C), polygon trough (T).* ***Vascular species****: Six letter species codes use the first three letters of the genus and first three letters of the species name. Refer to Table 2.3 for full spellings of names.* ***Cover:*** *Rare (R), common but < 1% (+), 1-5% (1), 6-25% (2), 26-50% (3), 51-75% (4), 76-100% (5), outside plot (*).*

Transect		**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**
Distance from road (m)		**5**	**5**	**10**	**10**	**25**	**25**	**50**	**50**	**100**	**100**	**200**	**200**
Polygon Center/Trough		**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**
Vascular species													
ERIANG		2	2	2	1	2	1	2		4	2	2	2
CARMEM				1		+							
CARROT				1		1							+
CARBIG					+	+		+					
CARKRA						*							
POLVIV		+	+	1		+		+				+	
DRYINT				1		+		+		+		1	
JUNTRI						R							
MELAPE		1	+	R						+		+	
SALARC		1	R	2	1	2	*	2		1		3	+
SALLAN				2	*	1	R	2		+		2	
SALOVA		2		1		2							
CARATR								3		1		1	
EQUARV		R											
ANDCHA		R											
EQUVAR		+	+	+		+		+		+		+	
PEDSUD		*		+		+		*		R		+	
EUTEDW			+			+							
BRABAR				+		+		+		+		R	
SAXHIR		+	*	R		R				+		*	
SAXOPP						R							
DUPFIS			+				R						
CARAQU		3	5		4		4		+	2	3	2	3
HIEPAU			R										
PEDCAP								+				+	
CARRAR										*		*	
JUNBIG												R	
CARMIS												1	
CAREX												R	
SALRET													
ERIRUS													

Table 2.4A (cont.). *Braun-Blanquet categorical species cover abundance values for permanent plots on **Transect 1** (T1), Colleen Site A, August 2014. **Distance from road:** Measured in m (5, 10, 25, 50, 100, 200). **Polygon Center/Trough:** Center of polygon(C), polygon trough (T). **Vascular species**: Six letter species codes use the first three letters of the genus and first three letters of the species name. Refer to Table 2.3 for full spellings of names. **Cover:** Rare (R), common but < 1% (+), 1-5% (1), 6-25% (2), 26-50% (3), 51-75% (4), 76-100% (5), outside plot (*).*

Transect		**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**	**T1**
Distance from road (m)		**5**	**5**	**10**	**10**	**25**	**25**	**50**	**50**	**100**	**100**	**200**	**200**
Polygon Center/Trough		**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**
Vascular species													
RANGME													
HIPVUL													
ALOALP													
ARCLAT													
PUCPHR													
SENATR													
Non-vascular species	**Collection no.**												
TORARC	T1-1		+	+		1		+					
TOMNIT	T1-2	+				1		1				1	
DREBRE	T1-3	+		1		2		2	1	1			
DISCAP	T1-4	+		1		2		1		+		2	
CATNIG	T1-5			1	+	*			1	1		3	
DITFLE	T1-6	1				*		1				+	
ANEPIN	T1-7			+		+			+	+		+	
CALGIG	T1-8						+		1				2
DREREV	T1-9		1		+		+						
MEETRI	T1-10		1				+						
BRYPSE	T1-11		+					1	+	+			
HYPBAM	T1-12							+					
ENCPRO	T1-13							+		+		+	
SCOSCO	T1-14								4		3		3
ALGAE									+				
CAMSTE	T1-15										1		
SOLORINA sp.	T1-16											+	
Black soil crust	T1-17											2	
DREADU (long Drepa)	T1-18												1
White soil crust (OCHFRI?)	T1-19											+	
BLETRI													
POHLIA (green star?)													
DREUNC													
AULTUR													

Table 2.4B. *Braun-Blanquet categorical species cover abundance values for permanent plots on* ***Transect 2*** *(T2), Colleen Site A, August 2014.* ***Distance from road:*** *Measured in m (5, 10, 25, 50, 100, 200).* ***Polygon Center/Trough:*** *Center of polygon(C), polygon trough (T).* ***Vascular species****: Six letter species codes use the first three letters of the genus and first three letters of the species name. Refer to Table 2.3 for full spellings of names.* ***Cover:*** *Rare (R), common but < 1% (+), 1-5% (1), 6-25% (2), 26-50% (3), 51-75% (4), 76-100% (5), outside plot (*).*

Transect		**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**
Distance from road (m)		**5**	**5**	**10**	**10**	**25**	**25**	**50**	**50**	**100**	**100**	**200**	**200**
Polygon Center/Trough		**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**
Vascular species													
ERIANG		1	2	5		4		3		5		4	5
CARMEM													
CARROT													
CARBIG												+	
CARKRA													
POLVIV				R		*		+		+		+	
DRYINT								2				2	
JUNTRI													
MELAPE												R	
SALARC				2		2		2		2		2	
SALLAN				2		2		+		2		2	1
SALOVA				1									
CARATR													
EQUARV													
ANDCHA													
EQUVAR										+		+	
PEDSUD						*						+	
EUTEDW													
BRABAR													
SAXHIR													
SAXOPP								+				+	
DUPFIS		4											
CARAQU		1	4	1	3	+	2	1	3	+	4	1	
HIEPAU													
PEDCAP													
CARRAR													
JUNBIG													
CARMIS													
CAREX													
SALRET								2				1	
ERIRUS		*											

Table 2.4B (cont.). *Braun-Blanquet categorical species cover abundance values for permanent plots on **Transect 2** (T2), Colleen Site A, August 2014. **Distance from road:** measured in m (5, 10, 25, 50, 100, 200). **Polygon Center/Trough:** Center of polygon(C), polygon trough (T). **Vascular species**: Six letter species codes use the first three letters of the genus and first three letters of the species name. Refer to Table 2.3 for full spellings of names. **Cover:** Rare (R), common but < 1% (+), 1-5% (1), 6-25% (2), 26-50% (3), 51-75% (4), 76-100% (5), outside plot (*).*

Transect		**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**	**T2**
Distance from road (m)		**5**	**5**	**10**	**10**	**25**	**25**	**50**	**50**	**100**	**100**	**200**	**200**
Polygon Center/Trough		**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**	**C**	**T**
Vascular species													
RANGME							+						
HIPVUL							+		1				
ALOALP													
ARCLAT													
PUCPHR													
SENATR													
Non-vascular species	**Collection no.**												
TORARC	T1-1												
TOMNIT	T1-2					+		1		1		+	
DREBRE	T1-3					1						1	
DISCAP	T1-4					2		2		1		2	
CATNIG	T1-5												
DITFLE	T1-6												
ANEPIN	T1-7												
CALGIG	T1-8						2		3		2		
DREREV	T1-9						+		2		2		2
MEETRI	T1-10					1							
BRYPSE	T1-11					1		+					
HYPBAM	T1-12												
ENCPRO	T1-13							+					
SCOSCO	T1-14												
ALGAE													
CAMSTE	T1-15												
SOLORINA sp.	T1-16												
Black soil crust	T1-17												
DREADU (long Drepa)	T1-18												
White soil crust (OCHFRI?)	T1-19												
BLETRI										+			
POHLIA (green star?)										+			
DREUNC													
AULTUR													

Table 2.4C. *Braun-Blanquet categorical species cover values for **extra relevé plots**, Colleen Study Area A, August 2014. **Vascular species**: Six letter species codes use the first three letters of the genus and first three letters of the species name. Refer to Table 2.3 for full spellings of names. **Cover:** Rare (R), common but < 1% (+), 1-5% (1), 6-25% (2), 26-50% (3), 51-75% (4), 76-100% (5), outside plot (*).*

Relevé number (year-plot no.)		14-1	14-2	14-3	14-4	14-5
Vascular species						
ERIANG					3	3
CARMEM					1	
CARROT						
CARBIG					+	
CARKRA						
POLVIV		+			R	
DRYINT					3	
JUNTRI						
MELAPE						
SALARC		+			1	+
SALLAN		+			2	
SALOVA		3				
CARATR						1
EQUARV		1				
ANDCHA						
EQUVAR					+	1
PEDSUD						+
EUTEDW						
BRABAR						
SAXHIR						*
SAXOPP						
DUPFIS				1		
CARAQU		4		4		1
HIEPAU						
PEDCAP					+	
CARRAR						
JUNBIG						
CARMIS						
CAREX						
SALRET					2	
ERIRUS						
RANGME						
HIPVUL						
ALOALP		*				
ARCLAT		*				
PUCPHR			2			
SENATR					R	R
Non-vascular species	**Collection no.**					
TORARC	T1-1					
TOMNIT	T1-2				2	
DREBRE	T1-3				2	3
DISCAP	T1-4	+			1	
CATNIG	T1-5					1
DITFLE	T1-6				2	
ANEPIN	T1-7					
CALGIG	T1-8					
DREREV	T1-9					
MEETRI	T1-10					
BRYPSE	T1-11	+				+
HYPBAM	T1-12				+	

Table 2.4C (cont.). *Braun-Blanquet categorical species cover values for **extra relevé plots**, Colleen Study Area A, August 2014. **Vascular species**: Six letter species codes use the first three letters of the genus and first three letters of the species name. Refer to Table 2.3 for full spellings of names. **Cover:** Rare (R), common but < 1% (+), 1-5% (1), 6-25% (2), 26-50% (3), 51-75% (4), 76-100% (5), outside plot (*).*

Relevé number (year-plot no.)		14-1	14-2	14-3	14-4	14-5
ENCPRO	T1-13					
SCOSCO	T1-14					
ALGAE						
CAMSTE	T1-15					
SOLORINA sp.	T1-16					
Black soil crust	T1-17					
DREADU (long Drepa)	T1-18					
White soil crust (OCHFRI?)	T1-19					
BLETRI						
POHLIA (green star?)						
DREUNC					1	
AULTUR					+	

Table 2.5A. *Soil characteristics of permanent plots in* ***Transect 1****, Colleen Study Area A, August 2014.* ***Relevé number:*** *Transect 1 (T1), Transect 2 (T2); Distance in m (5, 10, 25, 50, 100, 200); Polygon center (C), polygon trough (T).* ***Layer:*** *Dust layer (1), organic layer (2).*

	Location			Soil color						Soil moisture			Soil pH	Gravel, plant material, OM		
				Dry			Moist									
Sample no.	Relevé number	Layer	Depth of sample (cm), horizon	Hue	Value	Chroma	Hue	Value	Chroma	Gravimetric (%)	Volumetric (%)	Bulk density (g/cm3)	Paste	Gravel (% dry wt.)	Undecomposed organics (% dry wt.)	Organic matter (% dry wt.)
1	T1-5-C	1	0-5, dust	10YR	5.5	1	10YR	3	2	63	58	92	7.45	14.8	1.87	7.5
2		2	12-17, Oe	10YR	3	2	10YR	2	2	140	67	48	7.14	0	0	22.8
3	T1-5-T	1	0-5, dust	10YR	6	1	10YR	3	1	88	59	67	7.19	3.6	5.03	9.3
4		2	11-17, Oi	10YR	3	2	10YR	2	2	177	69	39	7.1	0	0.30	28.3
5	T1-10-C	1	0-5, dust	10YR	6.5	1	10YR	3.5	2	104	59	57	7.64	4.7	0.98	10.5
6		2	5-10, Oe	10YR	3	2	10YR	2	1	151	67	44	7.5	0	0.26	23.0
7	T1-10-T	1	0-7, O with dust & gravel	10YR	6.5	1	10YR	3	1	87	55	63	7.32	11.2	2.00	7.2
8		2	7-12, Oe & dust	10YR	4	1	10YR	3	1	76	53	69	7.43	48.8	0.34	13.2
9	T1-25-C	1	0-4, dust & gravel	10YR	5.5	1	10YR	3	1	58	50	87	7.63	49.0	0.27	11.8
10		2	5-10, Oe	10YR	4.5	2	10YR	2	5	141	67	47	7.51	0	0.25	18.2
11	T1-25-T	1	11-16, gravel & dust	10YR	4	2	10YR	2	2	59	42	71	7.18	48.2	0.65	14.2
12		2	16-21, Oi	10YR	3.5	2	10YR	2	2	152	68	45	7.26	0	0.54	20.9
13	T1-50-C	1	0-5, dust	10YR	5.5	1	10YR	3	2	150	72	48	7.5	0	1.45	16.1
14		2	5-12, Oe1	10YR	3	2	10YR	2	1	146	62	42	7.22	0	0	29.2
15	T1-50-T	2	5-10, Oi	10YR	4	1.5	10YR	2.5	2	183	72	39	7.25	0	0	18.5
16	T1-100-C	1	0-5, dust	10YR	4	1	10YR	2	2	189	58	31	7.34	0.7	0.75	20.4
17		2	10-15, Oe	10YR	3	2	10YR	2	2	189	69	37	7.2	0	0	27.9
18	T1-100-T	2	0-5, Oi	10YR	4	1.5	10YR	2.5	2	192	67	35	7.16	0	0	20.3
19	T1-200-C	2	0-5, Oa?	10YR	4.5	1	10YR	2	2	156	66	43	7.52	0	0.58	20.5
20	T1-200-T	2	6-19, Oe	10YR	5.5	2	10YR	3	2	351	71	20	7.44	0	0	28.5

Table 2.5B (cont.). *Soil characteristics of permanent plots in **Transect 2**, Colleen Site A, August 2014. **Relevé number:** Transect 1 (T1), Transect 2 (T2); Distance in m (5, 10, 25, 50, 100, 200); Polygon center (C), polygon trough (T). **Layer:** Dust layer (1), organic layer (2).*

	Location			Soil color						Soil moisture			Soil pH	Gravel, plant material, OM		
				Dry			Moist									
Sample no.	Relevé number	Layer	Depth of sample (cm), horizon	Hue	Value	Chroma	Hue	Value	Chroma	Gravimetric (%)	Volumetric (%)	Bulk density (g/cm3)	Paste	Gravel (% dry wt.)	Undecomposed organics (% dry wt.)	Organic matter (% dry wt.)
21	T2-5-C	1	0-5, dust	10YR	7	1	10YR	3.5	1	40	50	127	7.44	9.8	0.29	3.1
22		2	16-21, dust & peat	10YR	3.5	2	10YR	2	2	124	56	45	7.46	0	0	22.5
23	T2-5-T	1	2-7, dust & gravel	10YR	6.5	1	10YR	3	1	41	48	115	7.43	6.2	1.23	3.3
24		2	16-21,Oe1	10YR	3.5	2	10YR	2.5	2	150	71	47	7.22	0	0.40	20.1
25	T2-10-C	1	0-5, dust	10YR	6.5	1	10YR	4	1	28	38	135	7.64	11.9	0	2.5
26		2	7-12, Oe	10YR	4.5	2	10YR	2.5	2	147	65	44	7.23	0.4	0.27	19.1
27	T2-10-T	1	0-5, dust	10YR	5.5	1	10YR	3	2	60	48	79	7.29	4.1	2.92	4.3
28		2	10-15, Oi	10YR	4.5	2	10YR	2.5	2	211	70	33	7.28	0	0.76	27.4
29	T2-25-C	1	2-6, dust & gravel	10YR	5.5	1	10YR	2	2	45	40	89	7.46	26.2	0	6.9
30		2	7-12, Oe	10YR	3	2	10YR	2	2	132	67	50	7.27	3.9	0.47	17.8
	T2-25-T no sample, deep water	2		no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
31	T2-50-C	1	1-6, Oi & dust	10YR	5.5	1	10YR	2	2	108	57	53	7.35	0.2	0.83	14.3
32		2	7-12, Oe	10YR	3.5	1	10YR	2	2	138	63	46	7.45	0	0	20.5
33	T2-50-T	1	0-6, Oi & dust	10YR	5.5	1	10YR	2	2	133	70	52	7	0	0.96	10.3
34		2	7-12, Oe1	10YR	4	2	10YR	2	2	164	71	43	7.31	0	0.57	19.4
35	T2-100-C	1	0-5, Oi & Oe with dust	10YR	3.5	1	10YR	2	1	148	76	51	7.06	0	1.29	19.0
36		2	7-12, Oe	10YR	3	2	10YR	2	2	183	70	38	7.2	0	0.31	24.3
37	T2-100-T	1	2-7. Oi1 & dust	10YR	5.5	1	10YR	2	2	242	64	27	6.82	0	3.15	25.4
38		2	10-15, Oe	10YR	3.5	2	10YR	2	1	218	77	35	7.06	0	0.35	27.7
39	T2-200-C	1	0-5, Oi, Oe, and some dust	10YR	5.5	1	10YR	2	2	155	56	36	7.39	0	2.53	18.0
40		2	6-14, Oe	10YR	3	2	10YR	2	2	162	70	43	7.15	0	0.14	24.2
41	T2-200-T	2	0-5, Oi	10YR	3	3	10YR	2	2	365	55	15	7.24	0	11.02	38.5
42		2	7-12, Oe1	10YR	3	2	10YR	2	2	216	74	34	7.28	0	1.37	26.0

Table 2.5C. *Soil characteristics of **extra relevé plots**, Colleen Study Area A, August 2014. **Layer:** Dust layer (1), organic layer (2).*

	Location			Soil color						Soil moisture			Soil pH	Gravel, plant material, OM		
				Dry			Moist									
Sample no.	Relevé number	Layer	Depth of sample (cm), horizon	Hue	Value	Chroma	Hue	Value	Chroma	Gravimetric (%)	Volumetric (%)	Bulk density (g/cm3)	Paste	Gravel (% dry wt.)	Undecomposed organics (% dry wt.)	Organic matter (% dry wt.)
43	14-1 (roadside)	1	0-5, dust & gravel	10YR	7	1	10YR	4	1	17	19	113	7.57	34.0	0.32	2.7
44	14-2 (roadside)	1	0-5, dust & gravel	10YR	7	1	10YR	4	1	18	28	158	7.67	17.0	0	1.8
45	14-3 (roadside)	1	2-7, dust & gravel	10YR	7	1	10YR	4	1	29	41	140	7.37	4.9	0.71	19.3
46	14-3 (roadside)	2	12-17, Oe	10YR	4.5	1	10YR	2	2	127	61	48	7.49	0.0	0.25	2.1
47	14-4 (natural U4)	2	2-7, Oe	10YR	5.5	1	10YR	2	2	178	50	28	7.05	0	1.43	26.8
48	14-5 (natural M2)	2	3-8, Oe	10YR	5	1	10YR	2	2	159	65	41	7.37	0	1.33	21.9

Topographic surveys

The location and elevation of all boreholes, transects, vegetation plots and other reference points were surveyed using a combination of a GPS real time kinematic (RTK) system and a robotic imaging system. All measurements where connected to the stable National Geodetic Survey (NGS) benchmark point TT3749 (shown in Fig. 1.1 at 70˚ 13'28.75176" N, 148˚ 28' 40.42570" W) in order to acquire the exact location and orthoheight of all surveyed points. We decided to use two different survey systems for the topographic survey since we required two different levels of accuracy.

The real time kinematic (RTK) system, an advanced technique of GPS measurement that relies on a single reference station delivering real-time location correction, was used for surveying instrument locations where we needed up to centimeter-level accuracy (e.g., boreholes and vegetation plots). For these measurements, we used a Topcon RTK HiPer Lite+ GPS system in combination with a Topcon FC-2500 field controller (a handheld computer) for data acquisition (Fig. 2.5).

For the creation of elevation profiles of Transects 1 and 2, we needed position data with a higher degree of accuracy, which we achieved using a Topcon IS-3 Imaging Station system in combination with an RC-4 advanced prism tracking and locking system, and the same FC-2500 field controller (Fig. 2.6). This robotic, fully automatic, total imaging station and laser scanner allowed high-accuracy surveying at millimeter-levels (again with reference to the NGS benchmark point TT3749).

In addition, a transect from Jorgenson's research site to Colleen Site A was surveyed on August 13, 2014, and a detailed topographic survey was made of a pingo located about halfway between Jorgenson's site and Colleen Site A (see Fig. 1.1 for locations).

In all, 1,038 points were surveyed. Fig. 2.7 shows a map of the locations surveyed along Transects 1 and 2. The original PDF can be enlarged to reveal the codes for each location. The coordinates, elevations and notes of all points at Colleen Site A are included in Table 2.6.

Figure 2.5. *Marcel Buchhorn surveying plot markers using a Topcon RTK GPS HyPer Lite + GPS system. Photo: XAR_6092.*

Figure 2.6. *Topcon IS-3 Imaging Station and Laser Scanner. Photo: Topcon.*

Figure 2.7 (opposite page). *Locations of points surveyed along* ***Transects 1 and 2*** *(T1 and T2), Colleen Site A, August 2014.*

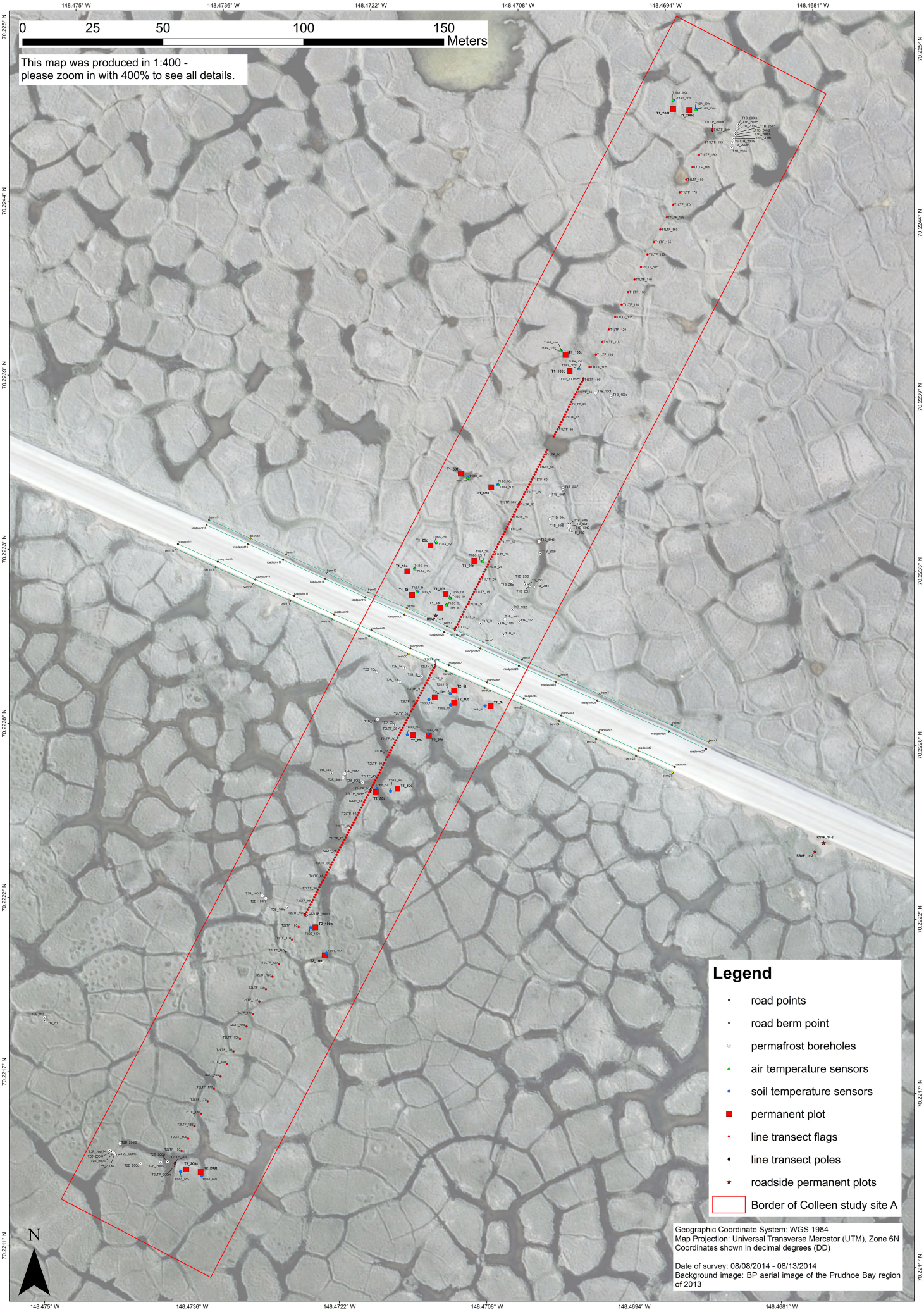
0 25 50 100 150
Meters
This map was produced in 1:400 -
please zoom in with 400% to see all details.
148.475° W
148.4736° W
148.4722° W
148.4708° W
148.4694° W
148.4681° W
70.225° N
70.2244° N
70.2239° N
70.2233° N
70.2228° N
70.2222° N
70.2217° N
70.2211° N
N
Legend
road points
road berm point
permafrost boreholes
air temperature sensors
soil temperature sensors
permanent plot
line transect flags
line transect poles
roadside permanent plots
Border of Colleen study site A
Geographic Coordinate System: WGS 1984
Map Projection: Universal Transverse Mercator (UTM), Zone 6N
Coordinates shown in decimal degrees (DD)
Date of survey: 08/08/2014 - 08/13/2014
Background image: BP aerial image of the Prudhoe Bay region of 2013

Table 2.6. *Coordinates of all points surveyed along **Transects 1 and 2** (T1 and T2) and **extra relevé plots**, Colleen Study Area A, August 2014.*

Type	Code	Long (DD)	Lat (DD)	Elevation (m)
General				
Road	roadpoint1	-148.4691596	70.2226901	14.76
Road	roadpoint2	-148.4695091	70.2227403	14.65
Road	roadpoint3	-148.4698834	70.2227944	14.61
Road	roadpoint4	-148.4702431	70.2228456	14.63
Road	roadpoint5	-148.4705999	70.2228969	14.80
Road	roadpoint6	-148.4709483	70.2229452	14.75
Road	roadpoint7	-148.4713141	70.2229970	14.73
Road	roadpoint8	-148.4716794	70.2230482	14.60
Road	roadpoint9	-148.4720508	70.2231022	14.61
Road	roadpoint10	-148.4724056	70.2231508	14.58
Road	roadpoint11	-148.4727889	70.2232061	14.66
Road	roadpoint12	-148.4731567	70.2232559	14.60
Road	roadpoint13	-148.4735137	70.2233097	14.46
Road	roadpoint14	-148.4738941	70.2233632	14.51
Road	roadpoint15	-148.4736284	70.2234253	14.62
Road	roadpoint16	-148.4732317	70.2233691	14.66
Road	roadpoint17	-148.4728984	70.2233207	14.72
Road	roadpoint18	-148.4724986	70.2232630	14.62
Road	roadpoint19	-148.4721151	70.2232078	14.61
Road	roadpoint20	-148.4717434	70.2231558	14.66
Road	roadpoint21	-148.4713668	70.2231035	14.69
Road	roadpoint22	-148.4710204	70.2230536	14.78
Road	roadpoint23	-148.4706533	70.2230008	14.79
Road	roadpoint24	-148.4703006	70.2229508	14.76
Road	roadpoint25	-148.4699066	70.2228964	14.63
Road	roadpoint26	-148.4692255	70.2228031	14.70
Road	roadpoint27	-148.4688697	70.2227497	14.77
Road berm	berm1	-148.4688427	70.2227707	13.55
Road berm	berm2	-148.4691973	70.2228228	13.51
Road berm	berm3	-148.4698849	70.2229157	13.58
Road berm	berm4	-148.4702747	70.2229714	13.56
Road berm	berm5	-148.4706244	70.2230199	13.56
Road berm	berm6	-148.4709939	70.2230739	13.58
Road berm	berm7	-148.4713414	70.2231218	13.59
Road berm	berm8	-148.4717215	70.2231759	13.56
Road berm	berm9	-148.4720903	70.2232256	13.54
Road berm	berm10	-148.4724789	70.2232805	13.48
Road berm	berm11	-148.4728715	70.2233379	13.62
Road berm	berm12	-148.4732122	70.2233867	13.59
Road berm	berm13	-148.4736061	70.2234429	13.61
Road berm	berm14	-148.4739147	70.2233484	13.62
Road berm	berm15	-148.4735337	70.2232919	13.61
Road berm	berm16	-148.4731733	70.2232405	13.54
Road berm	berm17	-148.4728129	70.2231896	13.61
Road berm	berm18	-148.4724261	70.2231352	13.60
Road berm	berm19	-148.4720707	70.2230839	13.53
Road berm	berm20	-148.4716968	70.2230299	13.66
Road berm	berm21	-148.4713397	70.2229791	13.72
Road berm	berm22	-148.4709714	70.2229275	13.72
Road berm	berm23	-148.4706216	70.2228795	13.75
Road berm	berm24	-148.4702635	70.2228281	13.77
Road berm	berm25	-148.4699087	70.2227741	13.74
Road berm	berm26	-148.4695288	70.2227229	13.78
Road berm	berm27	-148.4691804	70.2226716	13.71
Road berm	TT3749	-148.4779288	70.2246545	14.02
Transect 1				
Line transect poles	T1LTP_0m	-148.4712647	70.2231130	13.53
Line transect poles	T1LTP_50m	-148.4706893	70.2235163	13.33
Line transect poles	T1LTP_100m	-148.4701116	70.2239197	13.48
Line transect poles	T1LTP_200m	-148.4689501	70.2247258	13.24
Line transect flags	T1LTF_0	-148.4712653	70.2231122	13.52
Line transect flags	T1LTF_1	-148.4712528	70.2231200	13.57
Line transect flags	T1LTF_2	-148.4712404	70.2231282	13.60
Line transect flags	T1LTF_3	-148.4712294	70.2231363	13.52
Line transect flags	T1LTF_4	-148.4712188	70.2231442	13.50
Line transect flags	T1LTF_5	-148.4712068	70.2231522	13.55
Line transect flags	T1LTF_6	-148.4711952	70.2231606	13.47
Line transect flags	T1LTF_7	-148.4711852	70.2231687	13.41
Line transect flags	T1LTF_8	-148.4711730	70.2231769	13.26

Table 2.6 (cont.). *Coordinates of all points surveyed along **Transects 1 and 2** (T1 and T2) and **extra relevé plots**, Colleen Study Area A, August 2014.*

Type	Code	Long (DD)	Lat (DD)	Elevation (m)
Line transect flags	T1LTF_9	-148.4711612	70.2231848	13.37
Line transect flags	T1LTF_10	-148.4711490	70.2231929	13.38
Line transect flags	T1LTF_11	-148.4711381	70.2232011	13.44
Line transect flags	T1LTF_12	-148.4711261	70.2232090	13.44
Line transect flags	T1LTF_13	-148.4711150	70.2232171	13.43
Line transect flags	T1LTF_14	-148.4711036	70.2232251	13.41
Line transect flags	T1LTF_15	-148.4710912	70.2232333	13.40
Line transect flags	T1LTF_16	-148.4710799	70.2232415	13.38
Line transect flags	T1LTF_17	-148.4710689	70.2232494	13.38
Line transect flags	T1LTF_18	-148.4710568	70.2232576	13.40
Line transect flags	T1LTF_19	-148.4710450	70.2232658	13.41
Line transect flags	T1LTF_20	-148.4710356	70.2232739	13.40
Line transect flags	T1LTF_21	-148.4710236	70.2232815	13.39
Line transect flags	T1LTF_22	-148.4710112	70.2232898	13.39
Line transect flags	T1LTF_23	-148.4710005	70.2232981	13.48
Line transect flags	T1LTF_24	-148.4709882	70.2233058	13.39
Line transect flags	T1LTF_25	-148.4709788	70.2233141	13.24
Line transect flags	T1LTF_26	-148.4709672	70.2233220	13.04
Line transect flags	T1LTF_27	-148.4709565	70.2233305	13.07
Line transect flags	T1LTF_28	-148.4709429	70.2233388	13.11
Line transect flags	T1LTF_29	-148.4709328	70.2233465	13.16
Line transect flags	T1LTF_30	-148.4709198	70.2233548	13.26
Line transect flags	T1LTF_31	-148.4709083	70.2233626	13.34
Line transect flags	T1LTF_32	-148.4708979	70.2233709	13.42
Line transect flags	T1LTF_33	-148.4708855	70.2233788	13.47
Line transect flags	T1LTF_34	-148.4708754	70.2233869	13.51
Line transect flags	T1LTF_35	-148.4708629	70.2233951	13.52
Line transect flags	T1LTF_36	-148.4708514	70.2234032	13.39
Line transect flags	T1LTF_37	-148.4708406	70.2234110	13.26
Line transect flags	T1LTF_38	-148.4708279	70.2234191	13.09
Line transect flags	T1LTF_39	-148.4708149	70.2234272	13.05
Line transect flags	T1LTF_40	-148.4708047	70.2234359	13.12
Line transect flags	T1LTF_41	-148.4707930	70.2234434	13.34
Line transect flags	T1LTF_42	-148.4707823	70.2234517	13.47
Line transect flags	T1LTF_43	-148.4707701	70.2234594	13.43
Line transect flags	T1LTF_44	-148.4707585	70.2234672	13.35
Line transect flags	T1LTF_45	-148.4707465	70.2234755	13.39
Line transect flags	T1LTF_46	-148.4707356	70.2234835	13.51
Line transect flags	T1LTF_47	-148.4707233	70.2234917	13.34
Line transect flags	T1LTF_48	-148.4707117	70.2234998	13.29
Line transect flags	T1LTF_49	-148.4707011	70.2235079	13.26
Line transect flags	T1LTF_50	-148.4706888	70.2235158	13.33
Line transect flags	T1LTF_51	-148.4706776	70.2235239	13.34
Line transect flags	T1LTF_52	-148.4706657	70.2235319	13.45
Line transect flags	T1LTF_53	-148.4706547	70.2235401	13.41
Line transect flags	T1LTF_54	-148.4706423	70.2235481	13.42
Line transect flags	T1LTF_55	-148.4706310	70.2235561	13.40
Line transect flags	T1LTF_56	-148.4706188	70.2235642	13.42
Line transect flags	T1LTF_57	-148.4706082	70.2235723	13.44
Line transect flags	T1LTF_58	-148.4705956	70.2235803	13.39
Line transect flags	T1LTF_59	-148.4705829	70.2235888	13.26
Line transect flags	T1LTF_60	-148.4705724	70.2235966	13.54
Line transect flags	T1LTF_61	-148.4705613	70.2236044	13.44
Line transect flags	T1LTF_62	-148.4705490	70.2236125	13.39
Line transect flags	T1LTF_63	-148.4705372	70.2236206	13.42
Line transect flags	T1LTF_64	-148.4705266	70.2236288	13.42
Line transect flags	T1LTF_65	-148.4705143	70.2236368	13.40
Line transect flags	T1LTF_66	-148.4705029	70.2236448	13.37
Line transect flags	T1LTF_67	-148.4704916	70.2236528	13.39
Line transect flags	T1LTF_68	-148.4704797	70.2236609	13.39
Line transect flags	T1LTF_69	-148.4704691	70.2236691	13.40
Line transect flags	T1LTF_70	-148.4704569	70.2236771	13.38
Line transect flags	T1LTF_71	-148.4704464	70.2236850	13.25
Line transect flags	T1LTF_72	-148.4704363	70.2236920	12.96
Line transect flags	T1LTF_77	-148.4703770	70.2237350	13.04
Line transect flags	T1LTF_78	-148.4703657	70.2237417	13.27
Line transect flags	T1LTF_79	-148.4703541	70.2237496	13.34
Line transect flags	T1LTF_80	-148.4703423	70.2237580	13.49
Line transect flags	T1LTF_81	-148.4703304	70.2237660	13.53
Line transect flags	T1LTF_82	-148.4703192	70.2237739	13.58

Table 2.6 (cont.). *Coordinates of all points surveyed along* ***Transects 1 and 2*** *(T1 and T2) and* ***extra relevé plots****, Colleen Study Area A, August 2014.*

Type	Code	Long (DD)	Lat (DD)	Elevation (m)
Line transect flags	T1LTF_83	-148.4703075	70.2237820	13.51
Line transect flags	T1LTF_84	-148.4702960	70.2237901	13.57
Line transect flags	T1LTF_85	-148.4702851	70.2237984	13.57
Line transect flags	T1LTF_86	-148.4702736	70.2238062	13.59
Line transect flags	T1LTF_87	-148.4702616	70.2238142	13.60
Line transect flags	T1LTF_88	-148.4702510	70.2238226	13.56
Line transect flags	T1LTF_89	-148.4702405	70.2238307	13.57
Line transect flags	T1LTF_90	-148.4702278	70.2238390	13.58
Line transect flags	T1LTF_91	-148.4702164	70.2238470	13.67
Line transect flags	T1LTF_92	-148.4702065	70.2238549	13.45
Line transect flags	T1LTF_93	-148.4701940	70.2238627	13.30
Line transect flags	T1LTF_94	-148.4701814	70.2238706	13.18
Line transect flags	T1LTF_95	-148.4701712	70.2238789	13.11
Line transect flags	T1LTF_96	-148.4701595	70.2238874	13.17
Line transect flags	T1LTF_97	-148.4701483	70.2238953	13.43
Line transect flags	T1LTF_98	-148.4701356	70.2239034	13.53
Line transect flags	T1LTF_99	-148.4701240	70.2239113	13.50
Line transect flags	T1LTF_100	-148.4701118	70.2239192	13.47
Line transect flags	T1LTF_105	-148.4700546	70.2239599	13.58
Line transect flags	T1LTF_110	-148.4699976	70.2240002	13.40
Line transect flags	T1LTF_115	-148.4699393	70.2240407	13.44
Line transect flags	T1LTF_120	-148.4698812	70.2240808	13.65
Line transect flags	T1LTF_125	-148.4698237	70.2241213	13.63
Line transect flags	T1LTF_130	-148.4697661	70.2241615	13.50
Line transect flags	T1LTF_135	-148.4697085	70.2242019	13.43
Line transect flags	T1LTF_140	-148.4696501	70.2242425	13.34
Line transect flags	T1LTF_145	-148.4695923	70.2242828	13.53
Line transect flags	T1LTF_150	-148.4695345	70.2243232	13.63
Line transect flags	T1LTF_155	-148.4694769	70.2243636	13.60
Line transect flags	T1LTF_160	-148.4694191	70.2244039	13.51
Line transect flags	T1LTF_165	-148.4693602	70.2244432	13.18
Line transect flags	T1LTF_170	-148.4693034	70.2244844	13.52
Line transect flags	T1LTF_175	-148.4692452	70.2245242	13.40
Line transect flags	T1LTF_180	-148.4691860	70.2245649	13.22
Line transect flags	T1LTF_185	-148.4691293	70.2246053	13.43
Line transect flags	T1LTF_190	-148.4690707	70.2246456	13.52
Line transect flags	T1LTF_195	-148.4690130	70.2246859	13.57
Line transect flags	T1LTF_200	-148.4689510	70.2247263	13.24
Veg. plots photo points	T1_5c	-148.4714080	70.2231792	13.44
Veg. plots photo points	T1_5t	-148.4716756	70.2232188	13.32
Veg. plots photo points	T1_10t	-148.4713593	70.2232254	13.17
Veg. plots photo points	T1_10c	-148.4717263	70.2232940	13.39
Veg. plots photo points	T1_25t	-148.4710975	70.2233327	13.23
Veg. plots photo points	T1_25c	-148.4715132	70.2233781	13.44
Veg. plots photo points	T1_50c	-148.4709538	70.2235686	13.39
Veg. plots photo points	T1_50t	-148.4712449	70.2236095	12.90
Veg. plots photo points	T1_100c	-148.4702409	70.2239457	13.43
Veg. plots photo points	T1_100t	-148.4702842	70.2239966	13.18
Veg. plots photo points	T1_200c	-148.4691739	70.2247879	13.48
Veg. plots photo points	T1_200t	-148.4693253	70.2247894	13.21
Veg. plots washer	T1_5c_w1	-148.4713917	70.2231818	13.46
Veg. plots washer	T1_5c_w2	-148.4714161	70.2231851	13.47
Veg. plots washer	T1_5c_w3	-148.4714262	70.2231766	13.48
Veg. plots washer	T1_5c_w4	-148.4714014	70.2231732	13.49
Veg. plots washer	T1_5t_w1	-148.4716568	70.2232210	13.34
Veg. plots washer	T1_5t_w2	-148.4716807	70.2232248	13.40
Veg. plots washer	T1_5t_w3	-148.4716927	70.2232165	13.36
Veg. plots washer	T1_5t_w4	-148.4716679	70.2232127	13.39
Veg. plots washer	T1_10c_w1	-148.4717085	70.2232964	13.43
Veg. plots washer	T1_10c_w2	-148.4717321	70.2233006	13.40
Veg. plots washer	T1_10c_w3	-148.4717445	70.2232925	13.43
Veg. plots washer	T1_10c_w4	-148.4717210	70.2232882	13.43
Veg. plots washer	T1_10t_w1	-148.4713422	70.2232271	13.34
Veg. plots washer	T1_10t_w2	-148.4713663	70.2232312	13.32
Veg. plots washer	T1_10t_w3	-148.4713776	70.2232232	13.30
Veg. plots washer	T1_10t_w4	-148.4713539	70.2232190	13.23
Veg. plots washer	T1_25t_w1	-148.4711067	70.2233383	13.21
Veg. plots washer	T1_25t_w2	-148.4711125	70.2233295	13.21

Table 2.6 (cont.). *Coordinates of all points surveyed along* ***Transects 1 and 2*** *(T1 and T2) and* ***extra relevé plots****, Colleen Study Area A, August 2014.*

Type	Code	Long (DD)	Lat (DD)	Elevation (m)
Veg. plots washer	T1_25t_w3	-148.4710857	70.2233271	13.26
Veg. plots washer	T1_25t_w4	-148.4710801	70.2233361	13.20
Veg. plots washer	T1_25c_w1	-148.4714973	70.2233820	13.45
Veg. plots washer	T1_25c_w2	-148.4715237	70.2233836	13.42
Veg. plots washer	T1_25c_w3	-148.4715290	70.2233747	13.43
Veg. plots washer	T1_25c_w4	-148.4715025	70.2233729	13.44
Veg. plots washer	T1_50c_w1	-148.4709377	70.2235722	13.43
Veg. plots washer	T1_50c_w2	-148.4709638	70.2235744	13.45
Veg. plots washer	T1_50c_w3	-148.4709701	70.2235655	13.44
Veg. plots washer	T1_50c_w4	-148.4709444	70.2235634	13.45
Veg. plots washer	T1_50t_w1	-148.4712380	70.2236036	13.00
Veg. plots washer	T1_50t_w2	-148.4712615	70.2236079	13.03
Veg. plots washer	T1_50t_w3	-148.4712482	70.2236155	13.04
Veg. plots washer	T1_50t_w4	-148.4712264	70.2236117	12.93
Veg. plots washer	T1_100c_w1	-148.4702251	70.2239486	13.45
Veg. plots washer	T1_100c_w2	-148.4702503	70.2239514	13.48
Veg. plots washer	T1_100c_w3	-148.4702588	70.2239427	13.47
Veg. plots washer	T1_100c_w4	-148.4702337	70.2239399	13.48
Veg. plots washer	T1_100t_w1	-148.4702759	70.2239907	13.28
Veg. plots washer	T1_100t_w2	-148.4702640	70.2239989	13.25
Veg. plots washer	T1_100t_w3	-148.4702999	70.2239949	13.13
Veg. plots washer	T1_100t_w4	-148.4702883	70.2240034	13.07
Veg. plots washer	T1_200c_w1	-148.4691554	70.2247902	13.47
Veg. plots washer	T1_200c_w2	-148.4691804	70.2247932	13.48
Veg. plots washer	T1_200c_w3	-148.4691896	70.2247847	13.50
Veg. plots washer	T1_200c_w4	-148.4691648	70.2247816	13.47
Veg. plots washer	T1_200t_w1	-148.4693370	70.2247942	13.36
Veg. plots washer	T1_200t_w2	-148.4693381	70.2247851	13.34
Veg. plots washer	T1_200t_w3	-148.4693120	70.2247847	13.32
Veg. plots washer	T1_200t_w4	-148.4693109	70.2247938	13.38
iButton air temperature	T1iBA_5c	-148.4713514	70.2231894	13.44
iButton air temperature	T1iBA_5t	-148.4716295	70.2232290	13.26
iButton air temperature	T1iBA_10t	-148.4713202	70.2232130	13.17
iButton air temperature	T1iBA_10c	-148.4716547	70.2233024	13.38

Type	Code	Long (DD)	Lat (DD)	Elevation (m)
iButton air temperature	T1iBA_25t	-148.4710206	70.2233311	13.21
iButton air temperature	T1iBA_25c	-148.4714555	70.2233883	13.44
iButton air temperature	T1iBA_50c	-148.4708887	70.2235779	13.45
iButton air temperature	T1iBA_50t	-148.4711801	70.2235979	12.92
iButton air temperature	T1iBA_100c	-148.4701523	70.2239536	13.46
iButton air temperature	T1iBA_100t	-148.4703345	70.2240094	13.30
iButton air temperature	T1iBA_200c	-148.4691128	70.2247900	13.46
iButton air temperature	T1iBA_200t	-148.4693314	70.2248188	13.32
iButton soil temperature	T1iBS_5c	-148.4713474	70.2231903	13.44
iButton soil temperature	T1iBS_5t	-148.4716204	70.2232292	13.28
iButton soil temperature	T1iBS_10t	-148.4713145	70.2232125	13.16
iButton soil temperature	T1iBS_10c	-148.4716582	70.2233030	13.39
iButton soil temperature	T1iBS_25t	-148.4710246	70.2233318	13.19
iButton soil temperature	T1iBS_25c	-148.4714595	70.2233877	13.45
iButton soil temperature	T1iBS_50c	-148.4708922	70.2235783	13.42
iButton soil temperature	T1iBS_50t	-148.4711760	70.2235976	12.85
iButton soil temperature	T1iBS_100c	-148.4701568	70.2239541	13.45
iButton soil temperature	T1iBS_100t	-148.4703259	70.2240102	13.17
iButton soil temperature	T1iBS_200c	-148.4691079	70.2247903	13.47
iButton soil temperature	T1iBS_200t	-148.4693257	70.2248183	13.30
Boreholes	T1B_5c	-148.4708034	70.2230984	13.51
Boreholes	T1B_5t	-148.4710251	70.2231330	13.31
Boreholes	T1B_10c	-148.4706590	70.2231417	13.42
Boreholes	T1B_10t1	-148.4707940	70.2231487	13.23
Boreholes	T1B_10t2	-148.4707269	70.2231802	13.35
Boreholes	T1B_10t3	-148.4708535	70.2231347	13.43
Boreholes	T1B_25c	-148.4707403	70.2232700	13.44
Boreholes	T1B_25t1	-148.4705657	70.2232570	13.12
Boreholes	T1B_25t2	-148.4705993	70.2232603	13.31
Boreholes	T1B_25t3	-148.4706105	70.2232622	13.43
Boreholes	T1B_25t4	-148.4705301	70.2232533	13.27
Boreholes	T1B_50c	-148.4703913	70.2234708	13.40
Boreholes	T1B_50t1	-148.4703983	70.2235439	13.41
Boreholes	T1B_50t2	-148.4702107	70.2234443	13.41

Table 2.6 (cont.). *Coordinates of all points surveyed along* ***Transects 1 and 2*** *(T1 and T2) and* ***extra relevé plots****, Colleen Study Area A, August 2014.*

Type	Code	Long (DD)	Lat (DD)	Elevation (m)
Boreholes	T1B_50t3	-148.4702048	70.2234377	13.74
Boreholes	T1B_50t4	-148.4702143	70.2234500	13.60
Boreholes	T1B_50t5	-148.4702169	70.2234547	13.52
Boreholes	T1B_50t6	-148.4702219	70.2234585	13.61
Boreholes	T1B_50t7	-148.4702785	70.2235700	12.97
Boreholes	T1B_50t8	-148.4704903	70.2233991	12.73
Boreholes	T1B_50t9	-148.4704774	70.2233616	12.88
Boreholes	T1B_100c	-148.4698451	70.2238669	13.43
Boreholes	T1B_100t	-148.4699907	70.2238768	13.38
Boreholes	T1B_200c	-148.4687648	70.2246705	13.58
Boreholes	T1B_200t1	-148.4687371	70.2247081	13.41
Boreholes	T1B_200t2	-148.4687338	70.2247127	13.41
Boreholes	T1B_200t3	-148.4687336	70.2247195	13.43
Boreholes	T1B_200t4	-148.4687191	70.2247307	13.65
Boreholes	T1B_200t5	-148.4687195	70.2247393	13.69
Boreholes	T1B_200t6	-148.4687072	70.2247462	13.68
Boreholes	T1B_200t7	-148.4687489	70.2247004	13.61
Boreholes	T1B_200t8	-148.4687466	70.2246935	13.71
Boreholes	T1B_200t9	-148.4687604	70.2246860	13.78
Transect 2				
Line transect poles	T2LTP_0m	-148.4714411	70.2229950	13.71
Line transect poles	T2LTP_50m	-148.4720242	70.2225925	13.21
Line transect poles	T2LTP_100m	-148.4726102	70.2221905	13.49
Line transect poles	T2LTP_200m	-148.4737798	70.2213861	13.47
Line transect flags	T2LTF_0	-148.4714410	70.2229952	13.70
Line transect flags	T2LTF_1	-148.4714523	70.2229872	13.70
Line transect flags	T2LTF_2	-148.4714639	70.2229793	13.61
Line transect flags	T2LTF_3	-148.4714762	70.2229711	13.54
Line transect flags	T2LTF_4	-148.4714875	70.2229633	13.47
Line transect flags	T2LTF_5	-148.4714977	70.2229550	13.40
Line transect flags	T2LTF_6	-148.4715091	70.2229471	13.37
Line transect flags	T2LTF_7	-148.4715210	70.2229391	13.15
Line transect flags	T2LTF_8	-148.4715344	70.2229307	13.31
Line transect flags	T2LTF_9	-148.4715442	70.2229228	13.35
Line transect flags	T2LTF_10	-148.4715564	70.2229146	13.40
Line transect flags	T2LTF_11	-148.4715674	70.2229067	13.40
Line transect flags	T2LTF_12	-148.4715799	70.2228987	13.41
Line transect flags	T2LTF_13	-148.4715908	70.2228906	13.42
Line transect flags	T2LTF_14	-148.4716023	70.2228824	13.28
Line transect flags	T2LTF_15	-148.4716141	70.2228742	13.16
Line transect flags	T2LTF_16	-148.4716245	70.2228698	12.87
Line transect flags	T2LTF_17	-148.4716339	70.2228634	12.62
Line transect flags	T2LTF_18	-148.4716464	70.2228547	12.44
Line transect flags	T2LTF_19	-148.4716588	70.2228466	12.45
Line transect flags	T2LTF_20	-148.4716742	70.2228342	12.89
Line transect flags	T2LTF_21	-148.4716867	70.2228263	13.18
Line transect flags	T2LTF_22	-148.4716979	70.2228183	13.29
Line transect flags	T2LTF_23	-148.4717092	70.2228102	13.36
Line transect flags	T2LTF_24	-148.4717209	70.2228021	13.39
Line transect flags	T2LTF_25	-148.4717333	70.2227940	13.40
Line transect flags	T2LTF_26	-148.4717446	70.2227860	13.43
Line transect flags	T2LTF_27	-148.4717561	70.2227782	13.41
Line transect flags	T2LTF_28	-148.4717674	70.2227701	13.38
Line transect flags	T2LTF_29	-148.4717799	70.2227618	13.40
Line transect flags	T2LTF_30	-148.4717913	70.2227539	13.42
Line transect flags	T2LTF_31	-148.4718033	70.2227459	13.37
Line transect flags	T2LTF_32	-148.4718149	70.2227378	13.42
Line transect flags	T2LTF_33	-148.4718262	70.2227296	13.38
Line transect flags	T2LTF_34	-148.4718381	70.2227217	13.31
Line transect flags	T2LTF_35	-148.4718509	70.2227139	13.08
Line transect flags	T2LTF_36	-148.4718619	70.2227056	12.83
Line transect flags	T2LTF_37	-148.4718733	70.2226989	12.73
Line transect flags	T2LTF_38	-148.4718855	70.2226903	12.90
Line transect flags	T2LTF_39	-148.4718986	70.2226807	12.89
Line transect flags	T2LTF_40	-148.4719092	70.2226735	12.87
Line transect flags	T2LTF_41	-148.4719218	70.2226656	12.86
Line transect flags	T2LTF_42	-148.4719311	70.2226576	12.80
Line transect flags	T2LTF_43	-148.4719411	70.2226494	12.75

Table 2.6 (cont.). *Coordinates of all points surveyed along* ***Transects 1 and 2*** *(T1 and T2) and* ***extra relevé plots****, Colleen Study Area A, August 2014.*

Type	Code	Long (DD)	Lat (DD)	Elevation (m)
Line transect flags	T2LTF_44	-148.4719525	70.2226407	12.77
Line transect flags	T2LTF_45	-148.4719652	70.2226326	12.66
Line transect flags	T2LTF_46	-148.4719797	70.2226238	12.64
Line transect flags	T2LTF_47	-148.4719900	70.2226166	12.71
Line transect flags	T2LTF_48	-148.4720009	70.2226087	12.73
Line transect flags	T2LTF_49	-148.4720114	70.2226011	12.96
Line transect flags	T2LTF_50	-148.4720243	70.2225926	13.20
Line transect flags	T2LTF_51	-148.4720352	70.2225849	13.25
Line transect flags	T2LTF_52	-148.4720463	70.2225765	13.34
Line transect flags	T2LTF_53	-148.4720586	70.2225687	13.34
Line transect flags	T2LTF_54	-148.4720702	70.2225605	13.37
Line transect flags	T2LTF_55	-148.4720816	70.2225526	13.39
Line transect flags	T2LTF_56	-148.4720944	70.2225447	13.41
Line transect flags	T2LTF_57	-148.4721056	70.2225363	13.32
Line transect flags	T2LTF_58	-148.4721174	70.2225283	13.32
Line transect flags	T2LTF_59	-148.4721291	70.2225202	13.30
Line transect flags	T2LTF_60	-148.4721402	70.2225121	13.32
Line transect flags	T2LTF_61	-148.4721515	70.2225041	13.29
Line transect flags	T2LTF_62	-148.4721632	70.2224958	13.29
Line transect flags	T2LTF_63	-148.4721755	70.2224877	13.38
Line transect flags	T2LTF_64	-148.4721869	70.2224797	13.41
Line transect flags	T2LTF_65	-148.4721983	70.2224718	13.49
Line transect flags	T2LTF_66	-148.4722105	70.2224639	13.51
Line transect flags	T2LTF_67	-148.4722218	70.2224557	13.46
Line transect flags	T2LTF_68	-148.4722334	70.2224480	13.32
Line transect flags	T2LTF_69	-148.4722445	70.2224395	13.12
Line transect flags	T2LTF_70	-148.4722570	70.2224316	13.00
Line transect flags	T2LTF_71	-148.4722700	70.2224229	13.18
Line transect flags	T2LTF_72	-148.4722818	70.2224158	13.32
Line transect flags	T2LTF_73	-148.4722945	70.2224074	13.42
Line transect flags	T2LTF_74	-148.4723061	70.2223991	13.42
Line transect flags	T2LTF_75	-148.4723164	70.2223914	13.51
Line transect flags	T2LTF_76	-148.4723284	70.2223836	13.56
Line transect flags	T2LTF_77	-148.4723404	70.2223755	13.59
Line transect flags	T2LTF_78	-148.4723526	70.2223674	13.54
Line transect flags	T2LTF_79	-148.4723642	70.2223594	13.52
Line transect flags	T2LTF_80	-148.4723756	70.2223513	13.52
Line transect flags	T2LTF_81	-148.4723870	70.2223434	13.50
Line transect flags	T2LTF_82	-148.4723987	70.2223353	13.37
Line transect flags	T2LTF_83	-148.4724118	70.2223273	13.26
Line transect flags	T2LTF_84	-148.4724217	70.2223189	13.09
Line transect flags	T2LTF_85	-148.4724359	70.2223106	12.64
Line transect flags	T2LTF_86	-148.4724477	70.2223014	12.44
Line transect flags	T2LTF_87	-148.4724608	70.2222945	12.54
Line transect flags	T2LTF_88	-148.4724715	70.2222867	12.69
Line transect flags	T2LTF_89	-148.4724829	70.2222788	12.81
Line transect flags	T2LTF_90	-148.4724956	70.2222709	12.97
Line transect flags	T2LTF_91	-148.4725050	70.2222623	13.08
Line transect flags	T2LTF_92	-148.4725160	70.2222547	13.27
Line transect flags	T2LTF_93	-148.4725284	70.2222466	13.20
Line transect flags	T2LTF_94	-148.4725397	70.2222381	13.38
Line transect flags	T2LTF_95	-148.4725506	70.2222305	13.52
Line transect flags	T2LTF_96	-148.4725628	70.2222224	13.50
Line transect flags	T2LTF_97	-148.4725740	70.2222142	13.51
Line transect flags	T2LTF_98	-148.4725857	70.2222061	13.52
Line transect flags	T2LTF_99	-148.4725977	70.2221982	13.46
Line transect flags	T2LTF_100	-148.4726089	70.2221901	13.51
Line transect flags	T2LTF_105	-148.4726697	70.2221502	13.32
Line transect flags	T2LTF_110	-148.4727290	70.2221099	13.28
Line transect flags	T2LTF_115	-148.4727867	70.2220702	13.18
Line transect flags	T2LTF_120	-148.4728461	70.2220300	13.30
Line transect flags	T2LTF_125	-148.4729045	70.2219895	13.27
Line transect flags	T2LTF_130	-148.4729632	70.2219491	13.37
Line transect flags	T2LTF_135	-148.4730223	70.2219093	13.07
Line transect flags	T2LTF_140	-148.4730786	70.2218687	13.49
Line transect flags	T2LTF_145	-148.4731380	70.2218287	13.33
Line transect flags	T2LTF_150	-148.4731963	70.2217885	13.39
Line transect flags	T2LTF_155	-148.4732538	70.2217483	13.39

Table 2.6 (cont.). *Coordinates of all points surveyed along* ***Transects 1 and 2*** *(T1 and T2) and* ***extra relevé plots****, Colleen Study Area A, August 2014.*

Type	Code	Long (DD)	Lat (DD)	Elevation (m)
Line transect flags	T2LTF_160	-148.4733134	70.2217080	13.35
Line transect flags	T2LTF_165	-148.4733717	70.2216672	13.35
Line transect flags	T2LTF_170	-148.4734308	70.2216274	13.07
Line transect flags	T2LTF_175	-148.4734866	70.2215870	13.36
Line transect flags	T2LTF_180	-148.4735451	70.2215470	13.34
Line transect flags	T2LTF_185	-148.4736049	70.2215067	13.35
Line transect flags	T2LTF_190	-148.4736624	70.2214665	13.34
Line transect flags	T2LTF_195	-148.4737218	70.2214264	13.26
Line transect flags	T2LTF_200	-148.4737789	70.2213857	13.49
Veg. plots photo points	T2_5t	-148.4712581	70.2229175	13.18
Veg. plots photo points	T2_5c	-148.4709100	70.2228711	13.45
Veg. plots photo points	T2_10t	-148.4712547	70.2228779	12.84
Veg. plots photo points	T2_10c	-148.4714388	70.2228940	13.45
Veg. plots photo points	T2_25t	-148.4714856	70.2227708	12.76
Veg. plots photo points	T2_25c	-148.4716350	70.2227726	13.41
Veg. plots photo points	T2_50c	-148.4717688	70.2225993	13.48
Veg. plots photo points	T2_50t	-148.4719727	70.2225863	12.85
Veg. plots photo points	T2_100c	-148.4725112	70.2221509	13.41
Veg. plots photo points	T2_100t	-148.4724173	70.2220621	13.00
Veg. plots photo points	T2_200t	-148.4735370	70.2213612	13.18
Veg. plots photo points	T2_200c	-148.4736727	70.2213686	13.50
Veg. plots washer	T2_5t_w1	-148.4712676	70.2229232	13.28
Veg. plots washer	T2_5t_w2	-148.4712756	70.2229146	13.28
Veg. plots washer	T2_5t_w3	-148.4712427	70.2229203	13.21
Veg. plots washer	T2_5t_w4	-148.4712508	70.2229116	13.19
Veg. plots washer	T2_5c_w1	-148.4708925	70.2228733	13.48
Veg. plots washer	T2_5c_w2	-148.4709036	70.2228649	13.48
Veg. plots washer	T2_5c_w3	-148.4709283	70.2228687	13.45
Veg. plots washer	T2_5c_w4	-148.4709167	70.2228770	13.44
Veg. plots washer	T2_10t_w1	-148.4712397	70.2228804	12.92
Veg. plots washer	T2_10t_w2	-148.4712463	70.2228721	12.87
Veg. plots washer	T2_10t_w3	-148.4712647	70.2228832	12.93
Veg. plots washer	T2_10t_w4	-148.4712715	70.2228744	12.96
Veg. plots washer	T2_10c_w1	-148.4714218	70.2228964	13.44
Veg. plots washer	T2_10c_w2	-148.4714309	70.2228877	13.46
Veg. plots washer	T2_10c_w3	-148.4714557	70.2228911	13.45
Veg. plots washer	T2_10c_w4	-148.4714458	70.2228995	13.46
Veg. plots washer	T2_25t_w1	-148.4714898	70.2227761	12.73
Veg. plots washer	T2_25t_w2	-148.4714661	70.2227727	12.85
Veg. plots washer	T2_25t_w3	-148.4714766	70.2227647	12.86
Veg. plots washer	T2_25t_w4	-148.4715002	70.2227676	12.96
Veg. plots washer	T2_25c_w1	-148.4716179	70.2227747	13.42
Veg. plots washer	T2_25c_w2	-148.4716408	70.2227787	13.42
Veg. plots washer	T2_25c_w3	-148.4716540	70.2227706	13.42
Veg. plots washer	T2_25c_w4	-148.4716305	70.2227666	13.45
Veg. plots washer	T2_50c_w1	-148.4717769	70.2226054	13.49
Veg. plots washer	T2_50c_w2	-148.4717870	70.2225969	13.49
Veg. plots washer	T2_50c_w3	-148.4717624	70.2225938	13.52
Veg. plots washer	T2_50c_w4	-148.4717528	70.2226021	13.49
Veg. plots washer	T2_50t_w1	-148.4719539	70.2225888	12.82
Veg. plots washer	T2_50t_w2	-148.4719814	70.2225920	12.85
Veg. plots washer	T2_50t_w3	-148.4719903	70.2225839	13.04
Veg. plots washer	T2_50t_w4	-148.4719656	70.2225799	12.79
Veg. plots washer	T2_100c_w1	-148.4725176	70.2221572	13.47
Veg. plots washer	T2_100c_w2	-148.4725299	70.2221492	13.45
Veg. plots washer	T2_100c_w3	-148.4725074	70.2221448	13.43
Veg. plots washer	T2_100c_w4	-148.4724946	70.2221529	13.46
Veg. plots washer	T2_100t_w1	-148.4724157	70.2220685	13.03
Veg. plots washer	T2_100t_w2	-148.4724362	70.2220625	13.06
Veg. plots washer	T2_100t_w3	-148.4724188	70.2220557	13.09
Veg. plots washer	T2_100t_w4	-148.4723994	70.2220617	13.03
Veg. plots washer	T2_200t_w1	-148.4735179	70.2213646	13.25
Veg. plots washer	T2_200t_w2	-148.4735448	70.2213667	13.22
Veg. plots washer	T2_200t_w3	-148.4735511	70.2213580	13.33
Veg. plots washer	T2_200t_w4	-148.4735261	70.2213557	13.27
Veg. plots washer	T2_200c_w1	-148.4736569	70.2213713	13.51
Veg. plots washer	T2_200c_w2	-148.4736814	70.2213742	13.54
Veg. plots washer	T2_200c_w3	-148.4736909	70.2213656	13.51

Table 2.6 (cont.). *Coordinates of all points surveyed along* ***Transects 1 and 2*** *(T1 and T2) and* ***extra relevé plots****, Colleen Study Area A, August 2014.*

Type	Code	Long (DD)	Lat (DD)	Elevation (m)
Veg. plots washer	T2_200c_w4	-148.4736652	70.2213626	13.51
iButton soil temperature	T2iBS_5t	-148.4712941	70.2229071	13.16
iButton soil temperature	T2iBS_5c	-148.4709625	70.2228707	13.41
iButton soil temperature	T2iBS_10c	-148.4714933	70.2228871	13.40
iButton soil temperature	T2iBS_10t	-148.4712892	70.2228710	12.92
iButton soil temperature	T2iBS_25t	-148.4714936	70.2227778	12.67
iButton soil temperature	T2iBS_25c	-148.4716885	70.2227729	13.41
iButton soil temperature	T2iBS_50t	-148.4719626	70.2225993	12.82
iButton soil temperature	T2iBS_50c	-148.4718341	70.2225916	13.40
iButton soil temperature	T2iBS_100c	-148.4725565	70.2221501	13.33
iButton soil temperature	T2iBS_100t	-148.4724004	70.2220695	12.92
iButton soil temperature	T2iBS_200c	-148.4737271	70.2213616	13.45
iButton soil temperature	T2iBS_200t	-148.4735251	70.2213490	13.27
Boreholes	T2B_5t	-148.4715662	70.2229600	13.15
Boreholes	T2B_5c	-148.4717289	70.2229853	13.39
Boreholes	T2B_10t	-148.4717709	70.2229401	13.16
Boreholes	T2B_10c	-148.4719877	70.2229703	13.33
Boreholes	T2B_25c	-148.4718132	70.2228024	13.38
Boreholes	T2B_25t	-148.4719724	70.2228195	12.75
Boreholes	T2B_50c	-148.4723928	70.2226438	13.35
Boreholes	T2B_50t1	-148.4722844	70.2226305	13.17
Boreholes	T2B_50t2	-148.4722690	70.2226431	13.36
Boreholes	T2B_50t3	-148.4720998	70.2226161	12.72
Boreholes	T2B_100c	-148.4727801	70.2222128	13.44
Boreholes	T2B_100t1	-148.4729853	70.2222395	13.08
Boreholes	T2B_100t2	-148.4730187	70.2222470	13.13
Boreholes	T2B_200c	-148.4741060	70.2213836	13.31
Boreholes	T2B_200t1	-148.4738525	70.2213913	12.53
Boreholes	T2B_200t2	-148.4739156	70.2213889	13.00
Boreholes	T2B_200t5	-148.4743311	70.2214086	13.48
Boreholes	T2B_200t4	-148.4743464	70.2214116	13.37
Boreholes	T2B_200t3	-148.4743603	70.2214152	13.40
Boreholes	T2B_200t6	-148.4743815	70.2214187	13.28
Boreholes	T2B_200t7	-148.4744001	70.2214225	13.32
Boreholes	T2B_200t8	-148.4743038	70.2214452	12.90
Boreholes	T2B_fb1	-148.4750411	70.2218313	13.41
Boreholes	T2B_fb2	-148.4750447	70.2218427	13.20
Extra relevé plots: Roadside				
Veg. plots photo points	RSVP_14-1	-148.4714481	70.2231554	13.64
Veg. plots photo points	RSVP_14-2	-148.4677415	70.2224595	13.78
Veg. plots photo points	RSVP_14-3	-148.4678208	70.2224308	13.39
Veg. plots washer	RSVP_14-1_w1	-148.4714308	70.2231588	13.62
Veg. plots washer	RSVP_14-1_w2	-148.4714550	70.2231621	13.63
Veg. plots washer	RSVP_14-1_w3	-148.4714649	70.2231535	13.66
Veg. plots washer	RSVP_14-1_w4	-148.4714407	70.2231502	13.67
Veg. plots washer	RSVP_14-2_w1	-148.4677699	70.2224614	13.71
Veg. plots washer	RSVP_14-2_w2	-148.4677650	70.2224656	13.76
Veg. plots washer	RSVP_14-2_w3	-148.4677128	70.2224584	13.75
Veg. plots washer	RSVP_14-2_w4	-148.4677180	70.2224543	13.67
Veg. plots washer	RSVP_14-3_w1	-148.4678034	70.2224323	13.39
Veg. plots washer	RSVP_14-3_w2	-148.4678173	70.2224244	13.38
Veg. plots washer	RSVP_14-3_w3	-148.4678393	70.2224292	13.40
Veg. plots washer	RSVP_14-3_w4	-148.4678249	70.2224373	13.39
Extra relevé plots: Other				
Veg. plots photo points	AVP_14-4	-148.4658580	70.2268968	13.22
Veg. plots photo points	AVP_14-5	-148.4672873	70.2261093	13.35
Veg. plots washer	AVP_14-4_w1	-148.4658407	70.2268999	13.20
Veg. plots washer	AVP_14-4_w2	-148.4658666	70.2269023	13.24
Veg. plots washer	AVP_14-4_w3	-148.4658734	70.2268938	13.19
Veg. plots washer	AVP_14-4_w4	-148.4658476	70.2268910	13.24
Veg. plots washer	AVP_14-5_w1	-148.4672718	70.2261121	13.36
Veg. plots washer	AVP_14-5_w2	-148.4672960	70.2261155	13.34
Veg. plots washer	AVP_14-5_w3	-148.4673056	70.2261069	13.36
Veg. plots washer	AVP_14-5_w4	-148.4672804	70.2261038	13.34

iButton temperature loggers

Maxim iButton® temperature loggers were installed at 0, -20, and -40 cm soil depths at vegetation plots on both sides of the road to monitor soil temperatures, and at 10, 20, 50, 100, and 150 cm above the soil at Transect 1 to record the formation and melting of the roadside snowdrift (see plot layout in Fig. 2.2). The logger serial numbers and points of installation are in Table 2.7.

Table 2.7A. *Maxim iButton® temperature loggers serial numbers and depths in* ***Transect 1*** *(T1), Colleen Site A, August 2014.*

Relevé no.	Logger ID#	AGC ID	Location	Depth
Transect 1				
T1-5-C	3A00000035F22621	039	air	10 cm
T1-5-C	6800000035F2FF21	055	air	20 cm
T1-5-C	EE00000036057121	024	air	50 cm
T1-5-C	8800000035FAE821	025	air	100 cm
T1-5-C	9100000035F27121	069	air	150 cm
T1-5-C	920000003604E121	098	soil	-40 cm
T1-5-C	0500000036011021	028	soil	-20 cm
T1-5-C	7500000035FA4021	060	soil	0 cm (soil surface)
T1-5-T	8400000035FDCD21	047	air	10 cm
T1-5-T	9F00000035F77521	10	air	20 cm
T1-5-T	DB00000035F99F21	040	air	50 cm
T1-5-T	F700000035F57021	037	air	100 cm
T1-5-T	D800000035FB3B21	017	air	150 cm
T1-5-T	F400000035F2A921	052	soil	-40 cm
T1-5-T	2A0000003604B821	077	soil	-20 cm
T1-5-T	F500000036180F21	100	soil	0 cm (soil surface)
T1-10-C	FA00000035F7AD21	057	air	10 cm
T1-10-C	3400000036054021	022	air	20 cm
T1-10-C	8000000035F60821	044	air	50 cm
T1-10-C	E500000035F5FB21	011	air	100 cm
T1-10-C	4600000036069B21	066	air	150 cm
T1-10-C	2F00000035FAD521	012	soil	-40 cm
T1-10-C	CF00000035F6A621	016	soil	-20 cm
T1-10-C	C6000000360DDC21	103	soil	0 cm (soil surface)
T1-10-T	6400000035F86F21	062	air	10 cm
T1-10-T	DE00000035FF6A21	029	air	20 cm
T1-10-T	EA00000035F9AB21	027	air	50 cm
T1-10-T	5900000035FF7E21	002	air	100 cm
T1-10-T	0300000036003C21	009	air	150 cm
T1-10-T	4B00000035FCDE21	083	soil	-40 cm
T1-10-T	0D00000036061321	078	soil	-20 cm
T1-10-T	83000000360A6221	104	soil	0 cm (soil surface)
T1-25-C	2C0000003601F021	058	air	10 cm
T1-25-C	F000000035FF3A21	070	air	20 cm
T1-25-C	D700000036007421	032	air	50 cm
T1-25-C	8F00000035F38921	087	air	100 cm
T1-25-C	2500000035F41421	071	air	150 cm
T1-25-C	8F0000003602C021	099	soil	-40 cm
T1-25-C	E200000035F54B21	001	soil	-20 cm
T1-25-C	9100000036118321	105	soil	0 cm (soil surface)
T1-25-T	F100000035F20A21	084	air	10 cm
T1-25-T	C900000035FD7021	088	air	20 cm

Table 2.7A (cont.). *Maxim iButton® temperature loggers serial numbers and depths in* ***Transect 1*** *(T1), Colleen Site A, August 2014.*

Relevé no.	Logger ID#	AGC ID	Location	Depth
T1-25-T	3E00000035FD8721	026	air	50 cm
T1-25-T	9C00000035F38721	038	air	100 cm
T1-25-T	E500000035F19F21	074	air	150 cm
T1-25-T	4D00000035F42321	063	soil	-40 cm
T1-25-T	4800000036028621	006	soil	-20 cm
T1-25-T	20000000360B6021	106	soil	0 cm (soil surface)
T1-50-C	9500000035FEFB21	086	air	10 cm
T1-50-C	2200000035FF4721	095	air	20 cm
T1-50-C	9C0000003601E521	030	air	50 cm
T1-50-C	960000003601BA21	041	air	100 cm
T1-50-C	6D00000035FDDB21	035	soil	-40 cm
T1-50-C	F900000035FB9721	053	soil	-20 cm
T1-50-C	DB000000360E8021	107	soil	0 cm (soil surface)
T1-50-T	F800000035F2C321	031	air	10 cm
T1-50-T	3300000035F4B921	050	air	20 cm
T1-50-T	C800000035F99121	056	air	50 cm
T1-50-T	590000003606FF21	051	air	100 cm
T1-50-T	2300000036033E21	097	soil	-40 cm
T1-50-T	6500000035FD9721	065	soil	-20 cm
T1-50-T	1D000000361BB721	108	soil	0 cm (soil surface)
T1-100-C	4C00000035F69421	048	air	10 cm
T1-100-C	1400000035F27621	067	air	20 cm
T1-100-C	4C00000035FC6E21	042	air	50 cm
T1-100-C	F400000035F7D421	054	air	100 cm
T1-100-C	4700000036004821	019	soil	-40 cm
T1-100-C	2500000035FDC521	049	soil	-20 cm
T1-100-C	9000000036101F21	109	soil	0 cm (soil surface)
T1-100-T	A400000036046521	043	air	10 cm
T1-100-T	0900000036017A21	072	air	20 cm
T1-100-T	CE00000035FA8F21	004	air	50 cm
T1-100-T	B200000035FC5021	089	air	100 cm
T1-100-T	AD0000003603E321	090	soil	-40 cm
T1-100-T	2100000035FBB521	092	soil	-20 cm
T1-100-T	53000000360F7121	110	soil	0 cm (soil surface)
T1-200-C	96000000360E3D21	102	air	10 cm
T1-200-C	D500000036182621	117	air	20 cm
T1-200-C	EF000000361CAC21	101	air	50 cm
T1-200-C	1100000036131521	127	air	100 cm
T1-200-C	2A00000035F5F121	014	soil	-40 cm
T1-200-C	E200000035FBD521	034	soil	-20 cm
T1-200-C	D7000000361B1E21	111	soil	0 cm (soil surface)
T1-200-T	2E00000035F29821	007	air	10 cm
T1-200-T	F300000035F21921	005	air	20 cm
T1-200-T	FC00000035FF5021	059	air	50 cm
T1-200-T	D800000035F2EA21	081	air	100 cm
T1-200-T	8000000035F71121	091	soil	-40 cm
T1-200-T	CC00000035FB8521	061	soil	-20 cm
T1-200-T	520000003608BB21	112	soil	0 cm (soil surface)

Table 2.7B. *Maxim iButton® temperature loggers serial numbers and depths in **Transect 2**, Colleen Site A, August 2014.*

Relevé no.	Logger ID#	AGC ID	Location	Depth
Transect 2				
T2-5-C	DD00000035F24921	023	soil	-40 cm
T2-5-C	9A0000003603E221	075	soil	-20 cm
T2-5-C	320000003617CE21	116	soil	0 cm (soil surface)
T2-5-T	BE0000003601DF21	036	soil	-40 cm
T2-5-T	4000000035F1B121	085	soil	-20 cm
T2-5-T	0A00000036173321	113	soil	0 cm (soil surface)
T2-10-C	4600000035F4F921	018	soil	-40 cm
T2-10-C	A200000035FCC821	020	soil	-20 cm
T2-10-C	1F00000036069821	033	soil	0 cm (soil surface)
T2-10-T	C100000035F6DF21	094	soil	-40 cm
T2-10-T	0F000000361C7321	114	soil	-20 cm
T2-10-T	7A0000003613B421	118	soil	0 cm (soil surface)
T2-25-C	AD00000035FF1F21	046	soil	-40 cm
T2-25-C	2D00000035FEA221	073	soil	-20 cm
T2-25-C	A0000000360BC421	124	soil	0 cm (soil surface)
T2-25-T	AE00000035FAF421	003	soil	-40 cm
T2-25-T	4700000035FAE221	013	soil	-20 cm
T2-25-T	D90000003617CB21	121	soil	0 cm (soil surface)
T2-50-C	DD00000035F8B321	082	soil	-40 cm
T2-50-C	3D00000035FA5E21	079	soil	-20 cm
T2-50-C	910000003613B121	125	soil	0 cm (soil surface)
T2-50-T	2800000035F94E21	045	soil	-40 cm
T2-50-T	3400000035F25F21	076	soil	-20 cm
T2-50-T	F0000000360A1721	123	soil	0 cm (soil surface)
T2-100-C	AC00000035FDA821	080	soil	-40 cm
T2-100-C	2500000036002021	093	soil	-20 cm
T2-100-C	BA000000360C4C21	120	soil	0 cm (soil surface)
T2-100-T	1100000035F1FE21	008	soil	-40 cm
T2-100-T	3F00000035F87F21	015	soil	-20 cm
T2-100-T	5E0000003613BB21	115	soil	0 cm (soil surface)
T2-200-C	3100000035F5B321	064	soil	-40 cm
T2-200-C	E70000003603EE21	096	soil	-20 cm
T2-200-C	7100000036127721	119	soil	0 cm (soil surface)
T2-200-T	7900000035FD6521	021	soil	-40 cm
T2-200-T	C100000035FE1721	068	soil	-20 cm
T2-200-T	1E0000003613E921	122	soil	0 cm (soil surface)

Table 2.7C. *Maxim iButton® temperature loggers serial numbers and depths in **additional locations**, Colleen Site A, August 2014.*

Location name	Logger ID#	AGC ID	Location	Depth
Pond Marcel	2B00000036098821	126	water	soil surface (20 cm from bottom)
Pond Marcel	CF0000003619F821	128	water	1.06 cm above bottom (7 cm below water surface)
Pond Marcel	2A00000036126721	129	water	50 cm below water surface

Permafrost cores

We drilled 57 shallow boreholes using a motorized SIPRE corer to study soil stratigraphy, different types of ground ice, and dimensions of ice wedges (Figs. 2.8 and 2.9). The boreholes were drilled in polygon centers and troughs at approximately 5, 10, 25, 50, 100, and 200 m from the road along both transects (Fig. 1.2). A soil plug was first extracted from above the permafrost table and described to note the depth of the organic horizons, soil texture, and depth of thaw. Soil samples were collected to determine density and moisture content of the thawed layer.

Boreholes in polygon centers

The boreholes in ice-wedge-polygon centers were drilled along both transects (12 boreholes total) to a depth where gravel was encountered, preventing deeper drilling, generally at 1.3 to 2.5 m (Table 2.8).

Cores were examined to study cryostratigraphy of the upper permafrost and to determine the ground-ice volume (Table 2.9) in the surface deposits. Analysis of cryostructures showed that the current thaw depth (measured during the period August 7 to 12, see Table 2.8) was commonly 7 to 12 cm less than the total thickness of the active and transient layers, which

Figure 2.8. (a) *Coring a polygon center on the southwest side of the road. Before drilling the vegetation was described and a soil plug was extracted as in the foreground. Sheets of plywood and wooden pallets were used to protect the tundra. Photo XAR_5422.* **(b)** *Extracting the drill and core from a borehole in a polygon trough ice wedge. Photo IMG_0823.*

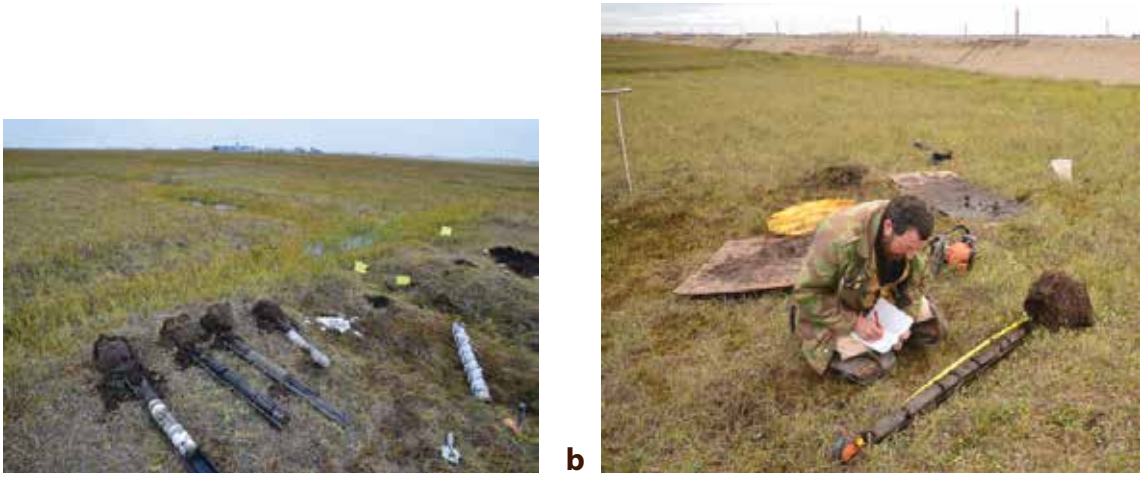

Figure 2.9. (a) *Cores taken from boreholes along a transect across an ice wedge. Photo XAR_6451. (b) Misha Kanevskiy describing a core from the center of an ice-wedge polygon. Photo XAR_6451.*

Table 2.8. *Borehole depth in ice-wedge polygon centers.*

Borehole location	Date	Borehole depth (cm)	Thaw depth (cm)	Permafrost table[1] (cm)
Transect 1				
T1-5-C	8/7/14	214	61	71
T1-10-C	8/6/14	133	62	70
T1-25-C	8/6/14	232	53	65
T1-50-C	8/7/14	139	53	61
T1-100-C	8/7/14	217	50	59
T1-200-C	8/8/14	219	41	54
n=6			**53.3 avg.**	**63.3 avg.**
Transect 2				
T2-5-C	8/10/14	251	75	75
T2-10-C	8/10/14	201	65	71
T2-25-C	8/10/14	162	61	72
T2-50-C	8/11/14	216	66	79
T2-100-C	8/11/14	168	55	62
T2-200-C	8/12/14	95	58	65
n=6			**63.3 avg.**	**70.7 avg.**

1/ Based on analysis of cryostructures

represent potential seasonal thawing under favorable conditions (high summer temperatures in combination with high moisture). The upper permafrost in sections of all these boreholes was composed of organic and organic-mineral soils of presumably lacustrine origin. Depth to organic-poor mineral soils (silts, sands, or gravelly sands of presumably alluvial origin) usually varied from 1.2 to 2.0 m.

Based on the drilling in polygon centers, five cryostratigraphic units were detected within both transects, which have a similar structure (Table 2.10):

1. **Unfrozen part of the active layer** (peat, organic silt, silt), thaw depth: 41-75 cm, 58 cm average
2. **Frozen part of the active layer and transient layer** (peat, organic silt, silt, relatively ice-poor), thickness: 6-12 cm, 8.3 cm average
3. **Frozen organic soil** (organic silt, peat, organic silt/peat), ice-rich (Fig. 2.11a), thickness: 30-150 cm, 73 cm average

a. Unit 3 **b. Unit 4 (two columns)** **c. Unit 5**

Figure 2.11. *Photographs of the frozen core, Transects 1 and 2, boreholes drilled in ice-wedge polygon centers.* **(a)** *Cryostratigraphic unit 3, ice-rich organic silt with reticulate cryostructure.* **(b)** *Cryostratigraphic unit 4, ice-rich silty sand with vertical peat inclusions, reticulate to ataxitic cryostructure.* **(c)** *Cryostratigraphic unit 4, ice-rich organic-poor silty sand with gravel inclusions, reticulate (top) and ataxitic (bottom) cryostructure.*

4. **Frozen clean mineral soil with peat inclusions** (20 to 70 vol%, usually form sub-vertical structure), ice-rich (Fig. 2.11b), thickness: 20-100 cm, 49 cm average (only 9 boreholes of 12 could reach this layer)
5. **Frozen clean mineral soil** (sandy silt, sand, gravelly sand), mostly ice-rich (Fig. 2.11c); encountered at depths of 130 to 200 cm (only 6 boreholes of 12 could reach this layer), thickness unknown

Boreholes in polygon troughs and rims

Drilling in polygon troughs and adjacent rims of polygons was done to establish the current state of thawing and recovery of the ice wedges. The goal was to estimate the thicknesses of frozen protective soil layers on top of massive ice bodies, including the frozen part of the active layer, transient layer, and intermediate layer (Table 2.11). We drilled at 12 sites along Transect 1, and 9 sites along Transect 2. At some sites several boreholes (up to nine) were drilled across ice-wedge troughs to determine ice-wedge widths and morphology of their upper parts (Table 2.11 and Fig. 2.12).

The total number of trough/rim boreholes was 43 (27 along T1, and 16 along T2). Massive ground ice was encountered in 35 of 43 boreholes, including wedge ice (WI), thermocarst cave ice (TCI) and composite (ice/soil) wedges (CW) (Table 2.11). The deepest borehole drilled through the massive ice at the middle of the trough reached the gravel at 3 m (borehole T1-200-T-1).

Gravimetric moisture content (Table 2.12) was determined for soils above massive-ice bodies (including unfrozen and frozen parts of the active layer, frozen transient and intermediate layers). Field measurements were performed in the first ten days of August, 2014. Photographs of the frozen soils on top of wedge ice, including the ice-rich intermediate layer (IL), are presented in Fig. 2.13.

Table 2.9. *Weight and moisture content of soil samples from boreholes drilled in ice-wedge polygon centers.* ***Location*** *(of borehole): Transect 1 (T1), Transect 2 (T2); Distance from road in m (5, 10, 25, 50, 100, 200); Polygon center (C).* ***GMC:*** *Gravimetric moisture content.*

Location	Depth (cm)	Tare (g)	Wet weight (g)	Dry weight (g)	Water (g)	GMC (%)
Transect 1						
T1-5-C	0-5	5.2	246.5	189.7	56.8	30.8
T1-5-C	15-20	5.2	177.1	71.3	105.8	160.1
T1-5-C	40-45	5.2	223.9	167	56.9	35.2
T1-5-C	61-67	5.2	309.3	160.7	148.6	95.6
T1-5-C	85-94	5.2	475.6	206.2	269.4	134.0
T1-5-C	117-127	5.2	483.3	200.1	283.2	145.3
T1-5-C	151-160	5.2	416.2	178	238.2	137.8
T1-5-C	178-187	5.2	433.3	136.6	296.7	225.8
T1-5-C	198-214	5.2	274.4	111.36	163.04	153.6
T1-10-C	0-5	5.2	216.4	131.5	84.9	67.2
T1-10-C	15-20	5.2	206.3	80.8	125.5	166.0
T1-10-C	35-40	5.2	314.4	238.7	75.7	32.4
T1-10-C	50-55	5.2	173.8	91.1	82.7	96.3
T1-10-C	62-68	5.2	304.6	180.3	124.3	71.0
T1-10-C	74-80	5.2	308	125	183	152.8
T1-10-C	94-99	5.2	322	122.2	199.8	170.8
T1-10-C	108-117	5.2	368.7	102.2	266.5	274.7
T1-10-C	125-132	5.2	313.7	110	203.7	194.4
T1-25-C	0-10	5.2	187.9	83.1	104.8	134.5
T1-25-C	15-20	5.2	193.2	80.3	112.9	150.3
T1-25-C	25-30	5.2	247.7	175.1	72.6	42.7
T1-25-C	54-65	5.2	369.9	158.2	211.7	138.4
T1-25-C	80-88	5.2	324.5	126.9	197.6	162.4
T1-25-C	93-102	5.2	458.1	187.3	270.8	148.7
T1-25-C	128-139	5.2	435.4	130	305.4	244.7

Table 2.9 (cont.). *Weight and moisture content of soil samples from boreholes drilled in ice-wedge polygon centers.* ***Location*** *(of borehole): Transect 1 (T1), Transect 2 (T2); Distance from road in m (5, 10, 25, 50, 100, 200); Polygon center (C).* ***GMC:*** *Gravimetric moisture content.*

Location	Depth (cm)	Tare (g)	Wet weight (g)	Dry weight (g)	Water (g)	GMC (%)
T1-25-C	158-165	5.2	220.6	81.6	139	181.9
T1-25-C	181-188	5.2	322.4	154.9	167.5	111.9
T1-25-C	200-210	5.2	433.2	missed		
T1-25-C	226-232	5.2	318.1	226.1	92	41.6
T1-50-C	0-5	5.2	186.6	79.7	106.9	143.5
T1-50-C	15-20	5.2	187.7	80.7	107	141.7
T1-50-C	35-40	5.2	201.9	135	66.9	51.5
T1-50-C	53-61	5.2	253.8	115.5	138.3	125.4
T1-50-C	75-85	5.2	418.9	182.8	236.1	132.9
T1-50-C	100-107	5.2	144.1	91.3	52.8	61.3
T1-50-C	134-139	5.2	180.5	55.4	125.1	249.2
T1-100-C	0-5	5.2	194.7	80.4	114.3	152.0
T1-100-C	15-20	5.2	202.7	90.4	112.3	131.8
T1-100-C	35-40	5.2	214.6	130.1	84.5	67.7
T1-100-C	50-58	5.2	325.4	163.2	162.2	102.7
T1-100-C	75-82	5.2	317.7	101.6	216.1	224.2
T1-100-C	103-110	5.2	223.6	73.2	150.4	221.2
T1-100-C	134-140	5.2	188.3	42.1	146.2	396.2
T1-100-C	174-182	5.2	374.2	91.5	282.7	327.6
T1-100-C	209-217	5.2	220.1	77.4	142.7	197.6
T1-200-C	0-5	5.2	202.2	86.1	116.1	143.5
T1-200-C	15-20	5.2	181.3	72.3	109	162.4
T1-200-C	35-40	5.2	251.2	179.2	72	41.4
T1-200-C	41-49	5.2	329.2	180	149.2	85.4
T1-200-C	54-63	5.2	384.4	150.5	233.9	161.0
T1-200-C	89-99	5.2	416.1	174.8	241.3	142.3
T1-200-C	129-137	5.2	390.5	169.9	220.6	133.9
T1-200-C	169-177	5.2	342.6	95.6	247	273.2
T1-200-C	209-217	5.2	378	115.9	262.1	236.8
Transect 2						
T2-5-C	0-5	5.2	324.6	258.9	65.7	25.9
T2-5-C	25-30	5.2	192.3	98	94.3	101.6
T2-5-C	45-50	5.2	291.1	227.4	63.7	28.7
T2-5-C	84-92	5.2	324	122.6	201.4	171.6
T2-5-C	113-121	5.2	358.6	145.3	213.3	152.2
T2-5-C	143-152	5.2	365.2	112.4	252.8	235.8
T2-5-C	198-206	5.2	339.1	61.1	278	497.3
T2-5-C	215-220	5.2	345.9	158.6	187.3	122.1
T2-5-C	247-252	5.2	319.1	228	91.1	40.9
T2-10-C	0-5	5.2	308.1	230.1	78	34.7
T2-10-C	25-30	5.2	220.5	100.6	119.9	125.7
T2-10-C	50-55	5.2	281.5	218.7	62.8	29.4
T2-10-C	82-90	5.2	307.9	121.4	186.5	160.5
T2-10-C	109-117	5.2	276	128.1	147.9	120.3
T2-10-C	132-142	5.2	322.7	118.9	203.8	179.2
T2-10-C	168-175	5.2	267.2	104.2	163	164.6
T2-10-C	196-202	5.2	258.5	140	118.5	87.9

Table 2.9 (cont.). *Weight and moisture content of soil samples from boreholes drilled in ice-wedge polygon centers.* ***Location*** *(of borehole): Transect 1 (T1), Transect 2 (T2); Distance from road in m (5, 10, 25, 50, 100, 200); Polygon center (C).* ***GMC:*** *Gravimetric moisture content.*

Location	Depth (cm)	Tare (g)	Wet weight (g)	Dry weight (g)	Water (g)	GMC (%)
T2-25-C	0-5	5.2	240	154.8	85.2	57.0
T2-25-C	15-20	5.2	190.2	76.2	114	160.6
T2-25-C	40-45	5.2	312.1	236.1	76	32.9
T2-25-C	66-74	18.3	356.6	193	163.6	93.6
T2-25-C	91-99	18.3	391.2	140.8	250.4	204.4
T2-25-C	140-148	18.3	415.9	114.9	301	311.6
T2-25-C	162-167	18.3	216.9	83.9	133	202.7
T2-50-C	0-5	13.1	198.5	102.8	95.7	106.7
T2-50-C	15-20	13.1	198.9	88.5	110.4	146.4
T2-50-C	30-35	13.1	292.9	211.7	81.2	40.9
T2-50-C	58-65	18.3	307.6	141.8	165.8	134.3
T2-50-C	71-78	18.3	283.6	126.2	157.4	145.9
T2-50-C	95-104	18.3	383.7	128.3	255.4	232.2
T2-50-C	119-127	18.3	399.4	133.2	266.2	231.7
T2-50-C	150-158	18.3	348.2	94.8	253.4	331.2
T2-50-C	176-186	18.3	422.3	180.2	242.1	149.5
T2-50-C	200-210	18.3	401.2	213.6	187.6	96.1
T2-100-C	0-5	13.1	190.1	82.2	107.9	156.2
T2-100-C	15-20	13.1	203.9	86.3	117.6	160.7
T2-100-C	25-30	13.1	308.4	236.4	72	32.2
T2-100-C	62-70	18.3	320.1	114.9	205.2	212.4
T2-100-C	90-100	18.3	427	150.4	276.6	209.4
T2-100-C	122-131	18.3	255.5	127.7	127.8	116.8
T2-100-C	155-168	18.3	530.7	304.7	226	78.9
T2-200-C	5--10	13.1	193.1	64.3	128.8	251.6
T2-200-C	30-35	13.1	327	260.7	66.3	26.8
T2-200-C	58-65	18.3	394.2	106.3	287.9	327.2
T2-200-C	68-78	18.3	305.6	188.3	117.3	69.0
T2-200-C	87-95	18.3	288.7	133.6	155.1	134.5
Average, n=99						**146.9**
SD						**±85.8**

Table 2.10. *Cryostratigraphic units and average moisture content of soils from boreholes drilled in ice-wedge polygon centers.* ***GMC:*** *Gravimetric moisture content of soil sample.* ***VMC:*** *Volumetric moisture content of soil sample.*

Cryostratigraphic unit	Thickness (cm)							GMC (%)	VMC (%)
Transect 1: Polygon centers									
Distance from road (m)	**5**	**10**	**25**	**50**	**100**	**200**	**Avg.**	**Avg. ±SD**	**Est.**
1. Unfrozen part of the active layer	61	62	53	53	50	41	53.3	102.7±52.4 (n=19)	70
2. Frozen part of the active layer and transient layer	61-71	62-70	53-65	53-61	50-59	41-54	10	103.1±25.1 (n=6)	65
3. Frozen organic soil	71-120	70-133	65-118	61-139	59-204	54-193	87.8	197.8±81.7 (n=8)	78
4. Frozen clean mineral soil with vertical peat inclusions	120-214	x	118-177	x	204-217	193-219	[32]	190.4±42.5 (n=8)	80
5. Frozen clean mineral soil (sand, sandy silt, gravel)	x	x	177-232	x	x	x	x	76.8±49.7 (n=2)	70
Total	**214**	**133**	**232**	**139**	**217**	**219**	**192.3**	**147.3±76.2 (n=53)**	**76**
Transect 2: Polygon centers									
Distance from road (m)	**5**	**10**	**25**	**50**	**100**	**200**	**Avg.**	**Avg. ±SD**	**Est.**
1. Unfrozen part of the active layer	75	65	61	58	55	58	62	89.3±68 (n=17)	67
2. Frozen part of the active layer and transient layer	–	65-71	61-72	58-66	55-62	58-65	6.5	185.0±124.8 (n=3)	75
3. Frozen organic soil	75-182	71-142	72-130	66-150	–	65-95	58.3	169.8±50.1 (n=12)	74
4. Frozen clean mineral soil with vertical peat inclusions	182-206	142-174	130-162	150-185	62-130	x	31.8	249.1±125.2 (n=8)	86
5. Frozen clean mineral soil (sand, sandy silt, gravel)	206-251	174-201	162-167	185-216	130-168	x	[24.3]	104.8±54.8 (n=6)	75
Total	**251**	**201**	**167**	**216**	**168**	**95**	**183**	**146.3±96.5 (n=46)**	**76**
Transects 1 and 2 combined: Polygon centers									
Distance from road (m)							**Avg.**	**Avg. ±SD**	**Est.**
1. Unfrozen part of the active layer							57.7	96.4±59.8 (n=36)	68
2. Frozen part of the active layer and transient layer							8.3	130.4±77.2 (n=9)	70
3. Frozen organic soil							73.1	186.6±71.3 (n=30)	76
4. Frozen clean mineral soil with vertical peat inclusions							[31.9]	219.8±95.3 (n=16)	84
5. Frozen clean mineral soil (sand, sandy silt, gravel)							[16.8]	97.8±51.6 (n=8)	75
Total							**187.7**	**146.9±85.8 (n=99)**	**76**

Figure 2.12. *Drilling profiles, Transects T1 and T2.*

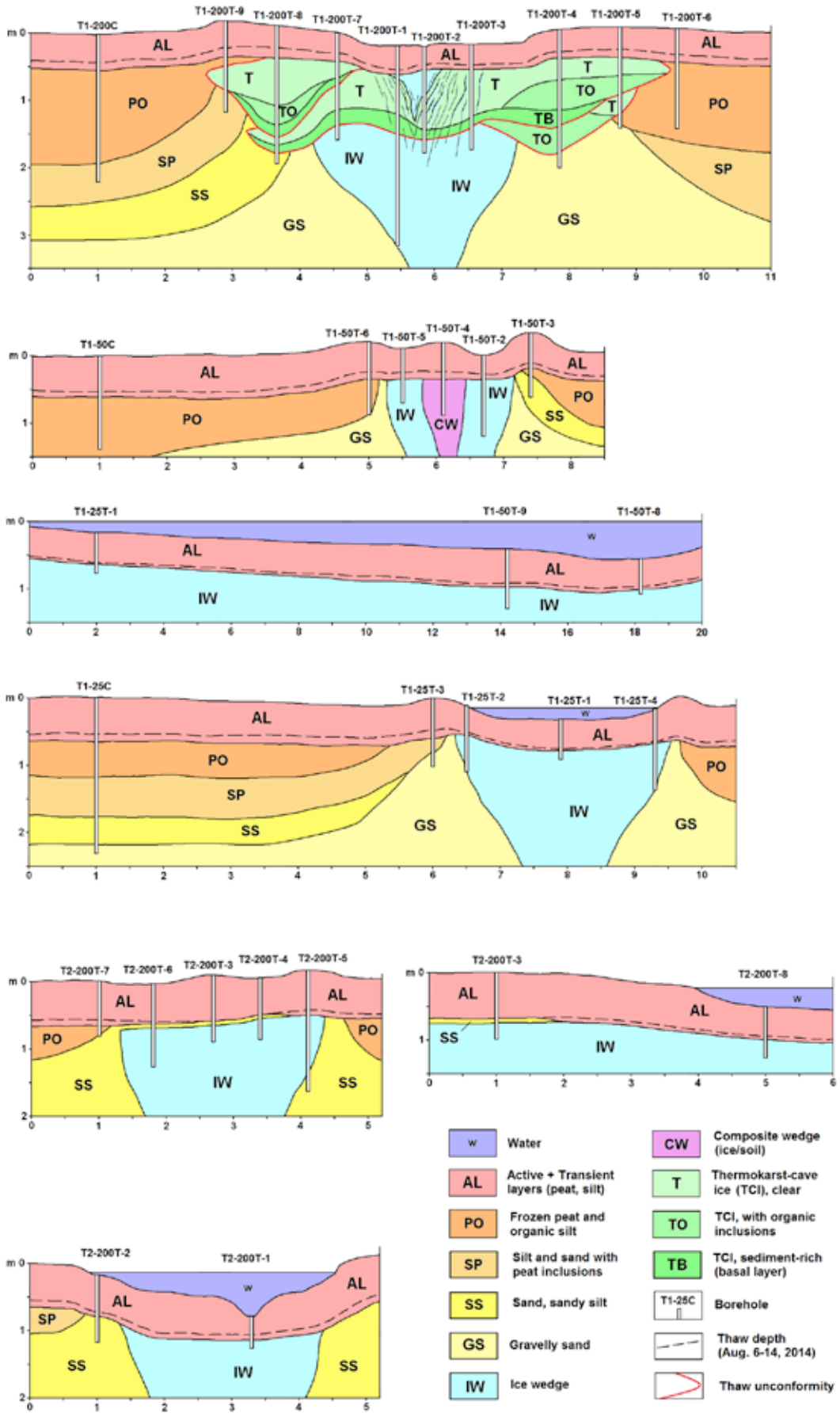

Table 2.11. *Thicknesses of frozen protective layers above massive-ice bodies in borehole drilled in ice-wedge polygon troughs.* ***Borehole no.:*** *Transect 1 (T1), Transect 2 (T2); Distance from road in m (5, 10, 25, 50, 100, 200); Polygon trough (T); Borehole number (in parentheses).*

Borehole no.	Date	Borehole depth (cm)	Location	Water depth (cm)	Thaw depth (cm)	Perma-frost table[1] (cm)	Depth to massive ice, (cm)	Frozen protective layer[2]	Inter-mediate layer (cm)
Transect 1									
T1-5-T (1)	8/7/14	98	trough	–	51	60	60 WI	9	0
T1-10-T (1)	8/7/14	90	trough	1	58	58	58 WI	0	0
T1-10-T (2)	8/7/14	95	trough	–	56	56	61 WI	5	5
T1-10-T (3)	8/7/14	151	trough	–	59	66	–	–	–
T1-25-T (1)	8/6/14	75	trough	15	45	47	47 WI	2	0
T1-25-T (2)	8/13/14	97	trough	–	40	43	43 WI	3	0
T1-25-T (3)	8/13/14	102	rim	–	48	?	–	–	–
T1-25-T (4)	8/13/14	120	trough	–	48	49	49 WI	1	0
T1-50-T (1)	8/7/14	118	trough	–	55	65	73 WI	18	8
T1-50-T (2)	8/13/14	86	trough	–	28	36	36 WI	8	0
T1-50-T (3)	8/13/14	95	rim	–	45	?	–	–	–
T1-50-T (4)	8/13/14	108	trough	–	43	55	55 CW	12	0
T1-50-T (5)	8/13/14	81	trough	–	35	46	46 WI	11	0
T1-50-T (6)	8/14/14	98	rim	–	45	56	–	–	–
T1-50-T (7)	8/14/14	81	trough	30	43	43	43 WI	0	0
T1-50-T (8)	8/14/14	51	trough	49	41	44	44 WI	3	0
T1-50-T (9)	8/14/14	88	trough	31	51	56	56 WI	5	0
T1-100-T (1)	8/7/14	75	trough	–	44	45	45 WI	1	0
T1-200-T (1)	8/8/14	298	trough	–	35	42	42 WI	7	0
T1-200-T (2)	8/9/14	158	trough	–	27	34	34 WI	7	0
T1-200-T (3)	8/9/14	155	trough	–	30	37	37 TCI	7	0
T1-200-T (4)	8/9/14	205	rim	–	33	44	44 TCI	11	0
T1-200-T (5)	8/9/14	150	rim	–	33	46	46 TCI	13	0
T1-200-T (6)	8/9/14	150	rim	–	40	52	–	–	–
T1-200-T (7)	8/9/14	160	rim	–	31	43	43 TCI	12	0
T1-200-T (8)	8/9/14	204	rim	–	33	49	49 TCI	16	0
T1-200-T (9)	8/9/14	135	rim	–	40	54	67 TCI	27	13
Average, all boreholes					42.1 (n=27)	48 (n=27)	49 (n=22)	8.1 (n=22)	1.2 (n=22)
Average, all wedges, T1					46.3 (n=11)	50.7 (n=11)	51.9 (n=11)	5.6 (n=11)	1.2 (n=11)
Transect 2									
T2-5-T (1)	8/10/14	90	trough	12	43	58	70 WI	27	12
T2-10-T (1)	8/10/14	89	trough	0	53	59	66 WI	13	7
T2-25-T (1)	8/10/14	102	trough	35	45	45	64 WI	19	19
T2-50-T (1)	8/11/14	77	trough	–	48	58	59 WI	11	1
T2-50-T (2)	8/11/14	178	trough	–	62	70	–	–	–
T2-50-T (3)	8/11/14	68	trough	35	46	54	56 WI	10	2
T2-100-T (1)	8/11/14	65	trough	8	43	51	57 WI	14	6
T2-100-T (2)	8/11/14	107	trough	0	50	58	61 WI	11	3
T2-200-T (1)	8/12/14	49	trough	70	28	36	36 WI	8	0
T2-200-T (2)	8/12/14	100	trough	3	55	62	–	–	–
T2-200-T (3)	8/12/14	98	trough	–	68	68	73 WI	5	5
T2-200-T (4)	8/12/14	92	trough	–	55	55	60 WI	5	5
T2-200-T (5)	8/12/14	179	trough	–	59	67	67 WI	8	0

Table 2.11 (cont.). *Thicknesses of frozen protective layers above massive-ice bodies in boreholes drilled in ice-wedge polygon troughs.* ***Borehole no.:*** *Transect 1 (T1), Transect 2 (T2); Distance from road in m (5, 10, 25, 50, 100, 200); Polygon trough (T); Borehole number (in parentheses).*

Borehole no.	Date	Borehole depth (cm)	Location	Water depth (cm)	Thaw depth (cm)	Perma-frost table[1] (cm)	Depth to massive ice, (cm)	Frozen protective layer[2]	Inter-mediate layer (cm)
T2-200-T (6)	8/12/14	124	trough	–	57	60	65 WI	8	5
T2-200-T (7)	8/12/14	82	rim	–	58	65	–	–	–
T2-200-T (8)	8/13/14	75	trough	27	44	49	49 WI	5	0
Average, all boreholes					49.2 (n=16)	55.2 (n=16)	60.2 (n=13)	11.1 (n=13)	5.0 (n=13)
Average, all wedges, T2					45.9 (n=9)	52.9 (n=9)	58.4 (n=9)	12.4 (n=9)	5.5 (n=9)
Jorgenson's study area									
Average, all boreholes	June 2011, July 2012				42.2 (n=39)	47.5 (n=83)	56 (n=83)	17.7 (n=39)	8.6 (n=83)

1/ Top of the intermediate layer (based on analysis of cryostructures). 2/ Thickness of frozen soil layer on top of massive ice bodies on the day of drilling (includes the frozen part of the active layer, transient layer, and intermediate layer).

Figure 2.13. *Intermediate layer (IL) above ice wedges. Photographs of the frozen core, Transects 1 and 2. Top of the ice-rich intermediate layer is detected by a horizontal ice "belt."*

Table 2.12. *Weight and moisture content of soils from boreholes drilled in ice-wedge polygon troughs.* ***Borehole no.:*** *Transect 1 (T1), Transect 2 (T2); Distance from road in m (5, 10, 25, 50, 100, 200); Polygon trough (T); Borehole number (in parentheses).* ***GMC:*** *Gravimetric moisture content of soil sample.*

Borehole no.	Depth (cm)[1]	Tare (g)	Wet weight (g)	Dry weight (g)	Water (g)	GMC (%)
Transect 1						
T1-5-T (1)	10-15	5.2	235.1	140.1	95	70.4
T1-5-T (1)	25-30	5.2	157.8	75.9	81.9	115.8
T1-5-T (1)	40-45	5.2	201.9	97.3	104.6	113.6
T1-5-T (1)	51-60 F	5.2	360.3	173.8	186.5	110.6
T1-10-T (1)	0-5	5.2	220.9	129	91.9	74.2
T1-10-T (1)	15-20	5.2	183.3	69.3	114	177.8
T1-10-T (1)	35-40	5.2	270.7	183.4	87.3	49.0
T1-10-T (2)	56-61 F	5.2	175.3	89.4	85.9	102.0
T1-25-T	5-10	5.2	203.5	61.9	141.6	249.7
T1-50-T (1)	0-5	5.2	215.1	94.1	121	136.1
T1-50-T (1)	15-20	5.2	218.9	100.6	118.3	124.0
T1-50-T (1)	35-40	5.2	257.9	196.9	61	31.8
T1-50-T (1)	55-64 F	5.2	427.6	212.3	215.3	104.0
T1-50-T (1)	65-71 F	5.2	276.9	87.9	189	228.5
T1-100-T (1)	0-5	5.2	186.6	73	113.6	167.6
T1-100-T (1)	15-20	5.2	226.6	114.5	112.1	102.6
T1-100-T (1)	35-40	5.2	215	118.8	96.2	84.7
T1-200-T (1)	0-5	5.2	130.7	43.2	87.5	230.3
T1-200-T (1)	15-20	5.2	223.8	102.8	121	124.0
T1-200-T (1)	30-35	5.2	245.6	122.1	123.5	105.6
T1-200-T (1)	35-41 F	5.2	271.8	103.9	167.9	170.1
T1-200-T (1)	126-131 F	5.2	271.9	198.1	73.8	38.3
T1-200-T (4)	190-198 F	5.2	472.9	342.7	130.2	38.6
Transect 2						
T2-5-T (1)	5-10	5.2	283.5	194	89.5	47.4
T2-5-T (1)	45-53 F	5.2	248	110.1	137.9	131.5
T2-5-T (1)	66-70 F	5.2	146.5	60.1	86.4	157.4
T2-10-T (1)	0-5	5.2	333	247.5	85.5	35.3
T2-10-T (1)	15-20	5.2	198.9	85.9	113	140.0
T2-10-T (1)	35-40	5.2	291.3	220.5	70.8	32.9
T2-10-T (1)	59-66 F	5.2	300.3	145.1	155.2	110.9
T2-25-T (1)	45-53 F	18.3	272.6	136	136.6	116.1
T2-25-T (1)	53-64 F	18.3	482.7	239.2	243.5	110.2
T2-50-T (1)	5-10	13.1	189	80.5	108.5	161.0
T2-50-T (1)	15-20	13.1	197.7	82.6	115.1	165.6
T2-50-T (1)	35-40	13.1	300.5	224.1	76.4	36.2
T2-50-T (1)	48-57 F	13.1	342.1	168.4	173.7	111.8
T2-100-T (1)	0-5	13.1	144	56.6	87.4	200.9
T2-100-T (1)	15-20	13.1	206.2	81.9	124.3	180.7
T2-100-T (1)	30-35	13.1	265.2	161.4	103.8	70.0
T2-100-T (1)	43-56 F	18.3	482	226.7	255.3	122.5
T2-200-T (5)	170-179 F	18.3	613.7	476	137.7	30.1

1/ F = frozen

Determination of maximum summer thaw

We evaluated maximum thaw depth for the end of summer using an approximation following from the Stefan equation and climate data for Deadhorse. We evaluated a thickness (h_{ice}) of ice melted in summers 2011 to 2014 using the following equation (Shur, 1988):

$$h_{ice} = \frac{k\Omega_{th}}{HL_{ice}} - \frac{L_s H}{2L_{ice}}$$

where k = thermal conductivity of thawed soil; Ω_{th} = thawing index; H = thickness of soil above an ice wedge; L_{ice} = latent heat of ice; L_s = latent heat of soil. This evaluation shows the maximum thaw depth above ice-wedges at the end of summer 2014 will be approximately 1.1 times greater than it was at the time of our measurement, and that approximately 1 to 3 cm of ice in the ice-wedges could melt in some ice wedges, but most of them will not be affected. We also compared potential ice-wedge melt in 2014 with that of 2011, 2012, and 2013 (Table 2.13).

The relatively cool summer of 2014 resulted in relatively small amounts of melting ice especially compared to the hot summer of 2012 (Fig. 2.13). Furthermore, the large amounts of organic productivity on the flooded southwest side of the road appears to be adding a layer of organic material to the bottom of the troughs protecting them from deeper thawing.

Table 2.13. *Estimation of thickness of ice wedge melting based on Stefan equation.* ***Borehole no.:*** *Transect 1 (T1), Transect 2 (T2); Distance from road in m (5, 10, 25, 50, 100, 200); Polygon trough (T); Borehole number (in parentheses). Highlighted values are those where degradation of the ice wedge is expected.*

Borehole no.	2011	2012	2013	2014
Transect 1				
T1-5-T (1)	0	2.4	0	0
T1-10-T (1)	4.3	8	5	3
T1-10-T (2)	1.7	5	2.5	0.5
T1-25-T (1)	3.5	7	4.5	2
T1-25-T (2)	1.5	3.5	2	0.7
T1-25-T (4)	3	6	3.8	2
T1-50-T (1)	0	0	0	0
T1-50-T (2)	0	0	0	0
T1-50-T (4)	0	0	0	0
T1-50-T (5)	0	0	0	0
T1-50-T (7)	3	6	3.7	2.5
T1-50-T (8)	1.5	6	2.2	0.7
T1-50-T (9)	1.3	4.5	2	0.3
T1-100-T1	3	5.5	3.5	2
T1-200-T (1)	0	1.3	0	0
T1-200-T (2)	0	0.1	0	0
T1-200-T (3)	0	0.5	0	0
Transect 2				
T2-5-T (1)	0	0	0	0
T2-10-T (1)	0	0.6	0	0
T2-25-T (1)	0	0	0	0
T2-50-T (1)	0	2	0	0
T2-50-T (3)	0	2.2	0	0
T2-100-T (1)	0	0	0	0
T2-100-T (2)	0	1.2	0	0
T2-200-T (1)	0	0	0	0
T2-200-T (3)	2.5	7	3.5	0.6
T2-200-T (4)	1.5	5	2.5	0.5
T2-200-T (5)	0.5	4	1.3	0
T2-200-T (6)	0.3	4	1.2	0
T2-200-T (8)	0.8	3.5	1.5	0

Conclusions

Information from the Colleen Site A studies, combined with the rich record of historical aerial photographs and remotely sensed images from the region, provides an excellent basis for examining roadside changes to this economically and ecologically important region of Alaska.

Prior to construction of the Spine Road, the Colleen Site A study area had numerous scattered thermokarst pits indicating that the area had some thawing ice wedges at the intersections of polygon troughs. The pattern of thermokarst changed very little between 1949 and 1972. The Spine Road was constructed in 1969, altering drainage patterns and introducing gravel and large quantities of dust to the tundra adjacent to the road, such that over the past 45 years the pattern of thermokarst has undergone dramatic change.

Flooding, road dust, and snow drifts have all contributed to creating warmer soil temperatures and deeper active layers near the road. These factors have all contributed in different ways to alteration of the plant canopy. The altered plant canopies in turn further altered the surface albedo and the ground temperatures. Thermokarst is deepest and most extensive on the southwest side of the road, which is periodically flooded. Historical photos indicate that between 1989 and 2012 a regional thawing of the ice-wedges occurred, increasing the extent of thermokarst on both sides of the road.

The summer of 2014 was relatively cold, and the permafrost cores from the ice wedges show that at the time of studies (early August) most areas still had

a protective layer of frozen soil and peat above the ice wedges, indicating that thawing of the ice-wedges was not widely occurring and probably would not occur during the rest of the summer. Additionally, the high vegetative productivity on the southwest side of the road appears to be protecting the ice wedges from further thawing in 2014.

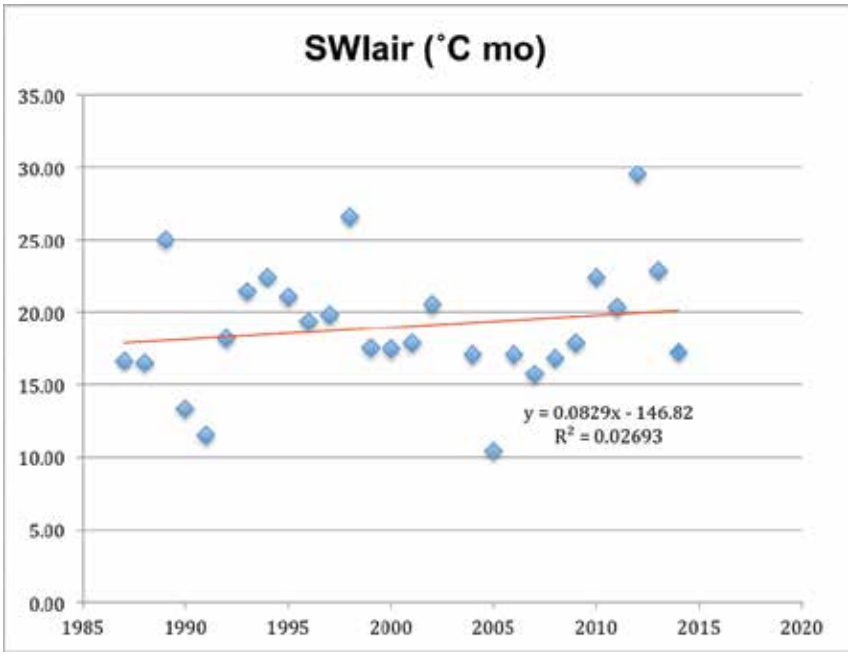

Figure 2.10. *Deadhorse summer warmth index (SWIair = sum of monthly mean air temperatures above freezing) for 1986-2014. Data courtesy of Vladimir Romanovsky.*

The heterogeneous distribution of ground ice, organic carbon, and other soil properties within tundra sediments requires a statistical approach to determine the volume of ice in the soils (Kanevskiy *et al.*, 2013; Ulrich *et al.*, 2014). Borehole information from transects at Colleen Site A and the Jorgenson site should be helpful in developing thermokarst sensitivity maps on ice-rich residual surfaces within the Prudhoe Bay region. Future work will focus in other terrain situations, for example in areas where thermal erosion by flowing water occurs, such as adjacent to well-drained margins of rivers or lakes where there is a strong topographic gradient. These areas often develop large rapidly eroding thermokarst troughs with high-relief high-centered polygons (Fig. 2.14).

Figure 2.14. *Thermokarst and eroded high-centered polygons that have developed in a flooded area between the road and the margin of a drained lake basin. Photo: IMG_0783.*

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APPENDIX A Photos of permanent plot vegetation and soils

Transect 1: 5 meters from road



Transect 1, 5 m, polygon center (T1-005-C). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*



Transect 1, 5 m, polygon trough (T1-005-T). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

Transect 1: 10 meters from road

Transect 1, 10 m, polygon center (T1-010-C). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

Transect 1, 10 m, polygon trough (T1-010-T). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

Transect 1: 25 meters from road

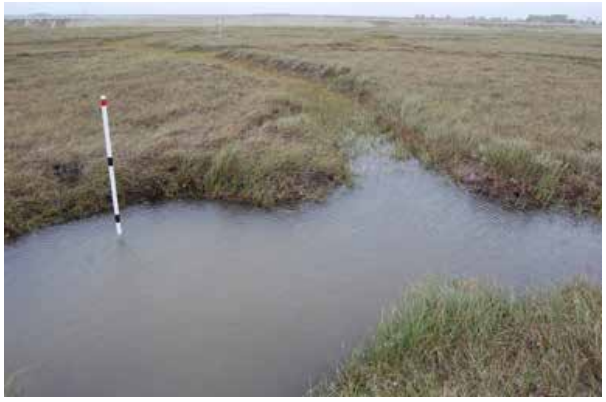
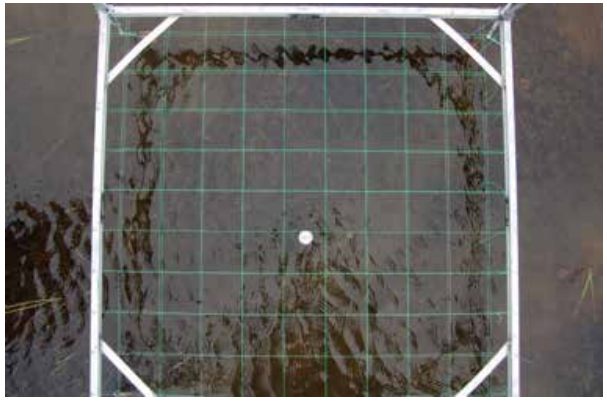
Transect 1, 25 m, polygon center (T1-025-C). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

Transect 1, 25 m, polygon trough (T1-025-T. *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

Transect 1: 50 meters from road



Transect 1, 50 m, polygon center (T1-050-C). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

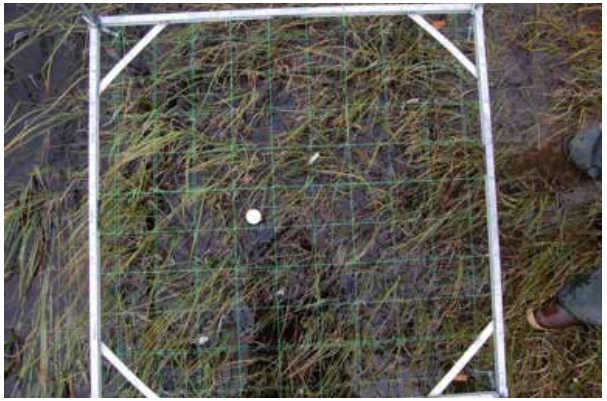




Transect 1, 50 m, polygon trough (T1-050-T). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

Transect 1: 100 meters from road

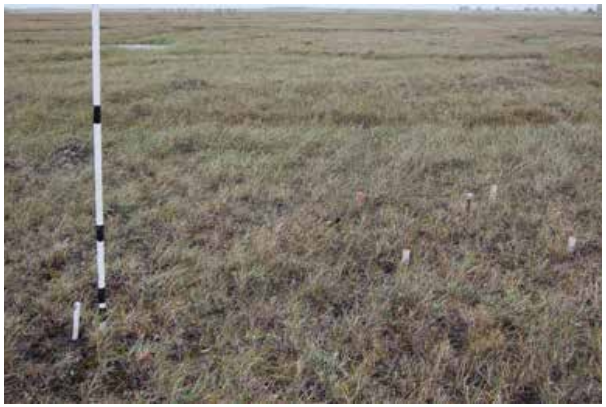
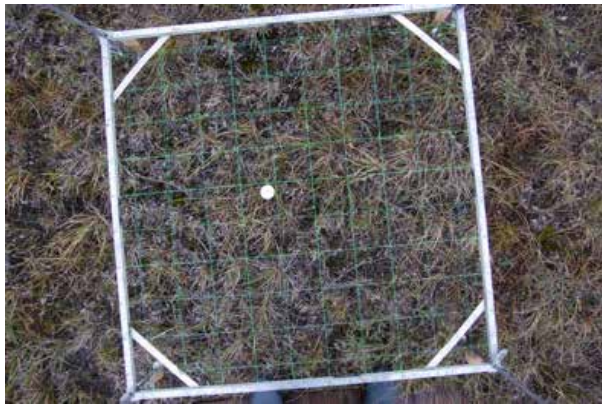


Transect 1, 100 m, polygon center (T1-100-C). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

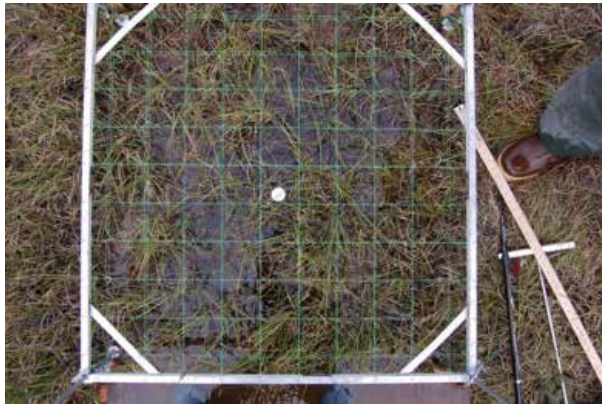




Transect 1, 100 m, polygon trough (T1-100-T). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

Transect 1: 200 meters from road


Transect 1, 200 m, polygon center (T1-200-C). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*


Transect 1, 200 m, polygon trough (T1-200-T). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

Transect 2: 5 meters from road



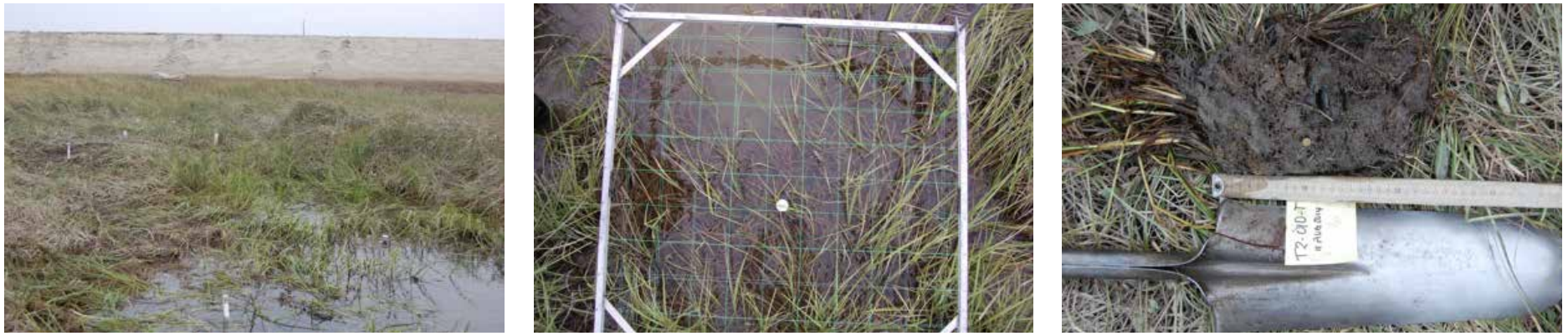
Transect 2, 5 m, polygon center (T2-005-C). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*



Transect 2, 5 m, polygon trough (T2-005-T). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

Transect 2: 10 meters from road

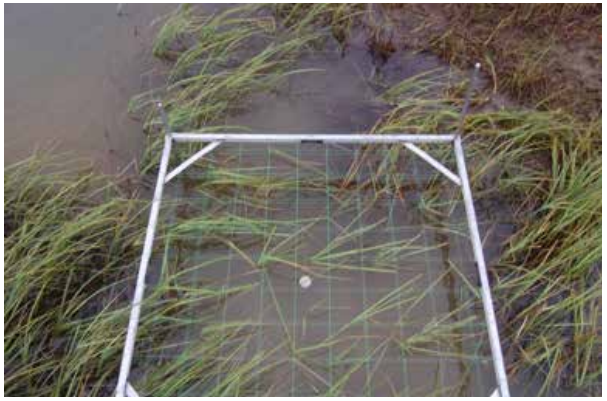
Transect 2, 10 m, polygon center (T2-010-C). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*



Transect 2, 10 m, polygon trough (T2-010-T). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

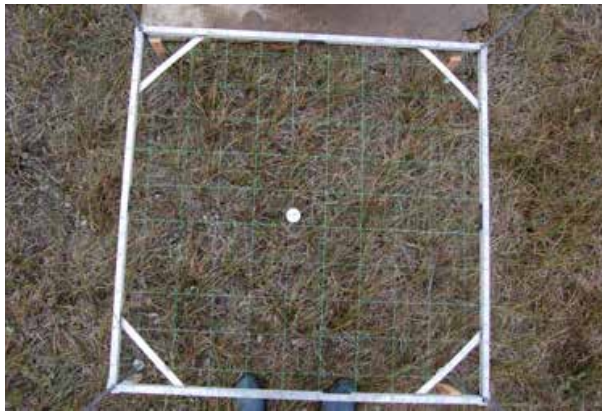
Transect 2: 25 meters from road

Transect 2, 25 m, polygon center (T2-025-C). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

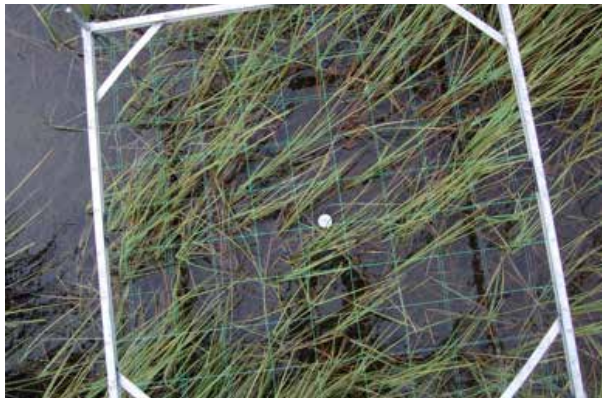


Transect 2, 25 m, polygon trough (T2-025-T). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, no soil sample (too wet).*

Transect 2: 50 meters from road

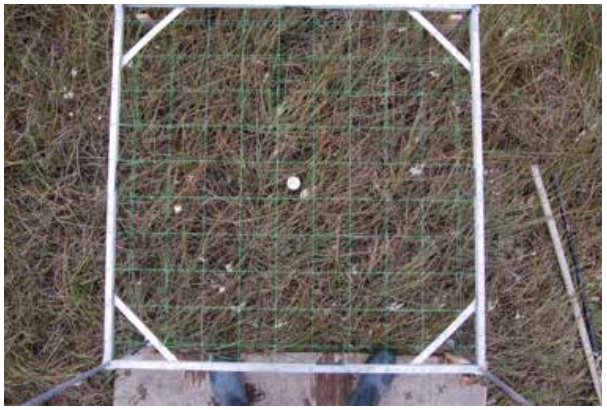




Transect 2, 50 m, polygon center (T2-050-C). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

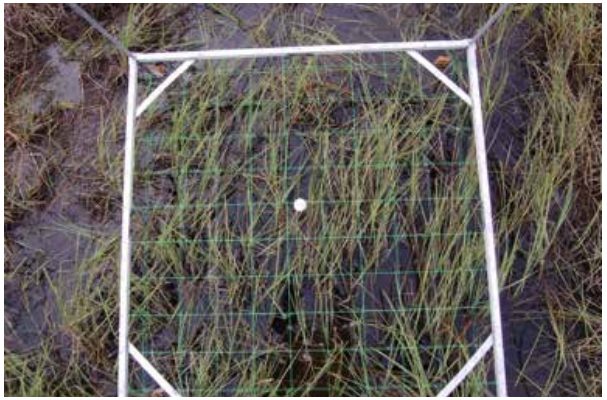




Transect 2, 50 m, polygon trough (T2-050-T). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

Transect 2: 100 meters from road

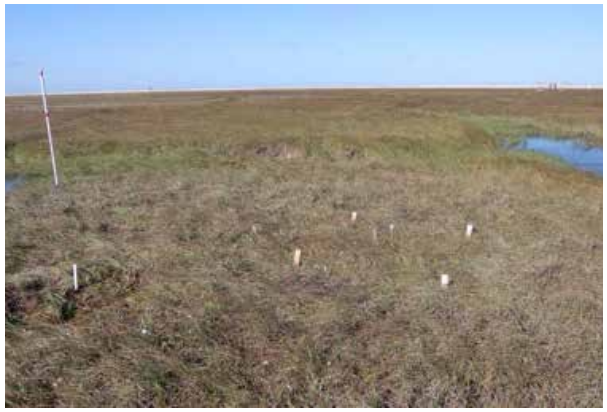
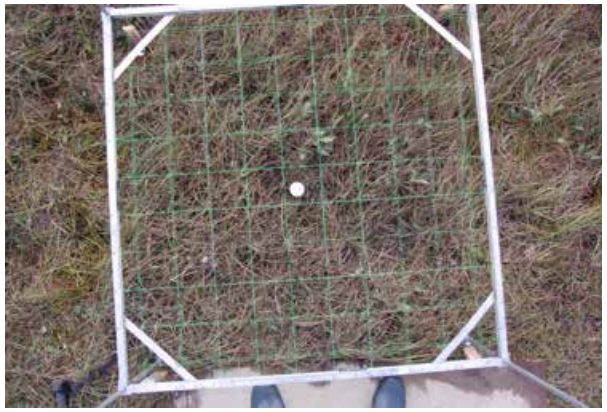




Transect 2, 100 m, polygon center (T2-100-C). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

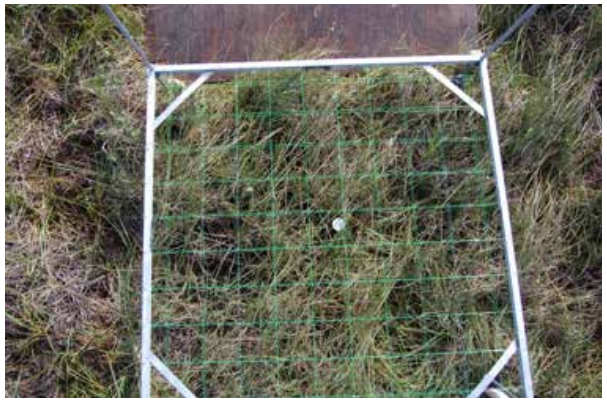




Transect 2, 100 m, polygon trough (T2-100-T). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

Transect 2: 200 meters from road


Transect 2, 200 m, polygon center (T2-200-C). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*


Transect 2, 200 m, polygon trough (T2-200-T). *(l-r) site location with 1-m plot marked with wooden corner stakes, plot with 1-m grid, soil plug.*

Relevé Plots

Relevé 14-1. Road berm on NE side of spine road. *Left - 1-m plot marked with wooden corner stakes. Right - soil plug.*

Relevé 14-2. Road berm on SW side of spine road. *Left – 1 x 2-m plot marked with wooden corner stakes. Right - soil plug.*

Relevé 14-3. Road berm on SW side of spine road. *Left - 1-m plot marked with wooden corner stakes. Right - soil plug.*

Relevé 14-4, approx. 500 m NE of spine road. *Left to right – view to SW, 1 x 1-m plot marked with wooden corner stakes, soil plug.*

Relevé 14-5, approx. 350 m NE of spine road. *Left to right – view to SW, 1 x 1-m plot marked with wooden corner stakes, soil plug.*

APPENDIX B Soil descriptions from borehole locations

GEORGE V. MATYSHAK | JULY 8-13, 2014

Soils described in this appendix were taken from permafrost boreholes along Transect 1 (T1) and Transect 2 (T2) at Lake Colleen Site A. Boreholes were located in ice-wedge polygon centers and trough at approximately 5, 10, 25, 50, 100 and 200 m from the road. Transect 1 is on the northeast side of the road and Transect 2 is on the southwest side of the road. Both are strongly affected by dust and gravel spray from the road, which diminish with distance from the road. Transect 2 is more strongly affected by annual flooding and thermokarst than Transect 1. All boreholes are located on the right side of the transects as one faces away from the road. Exact GPS coordinates of the borehole locations are in Table 2.6. See pages 16-17 for a description of sampling methods.

General site information for both transects follows:

Slope: 0, **Aspect:** 0

Physiography: Arctic coastal plain, ancient floodplain of the Sagavanirktok River, residual surface unmodified by thaw lake processes. Several thaw lakes and drained thaw lake basins are located nearby.

Surface landform: low-centered polygons, 10-15 m diameter on the northwest side, 15-20 m diameter on the southwest side.

Parent material: eolian silt (loess) over gravelly alluvium

Landcover type: wet nonacidic tundra

Type of erosion: none

Drainage: poor

General soil classification (Soil Survey Staff, 1999): **Polygon centers:** Ruptic Histoturbels, Ruptic Histic Aquiturbels, and Aquic Molliturbels. **Polygon troughs**: Glacic Historthels and Glacic Aquiturbels. The degree of humification of peat samples ranges from a value of H-1 through to H-10 on the von Post (1926) scale. The fiber (F) and roots (R) content of peat samples range from 0 to 3 (1 = low content; 2 = moderate content; 3 = high content) (Malterer *et al.,* 1992).

TRANSECT 1

Soil pit T1 5 C (Transect 1, 5 m from road, polygon center)

0-8 cm; B; brownish gray (10YR6/2) clay loam (dust layer), structureless, moderately sticky, moderately plastic; few fine roots; friable, 5% gravel; abrupt smooth boundary.

Soil pit T1 5 C

8-18 cm Oe1; brown (10YR5/3) hemic material (moss), (H5, F2, R1), many fine roots, firm; 15% dust, clear smooth boundary.

18-37 cm; Oe2; dark brown (10YR3/3) hemic material (moss), (H7, F2, R2), many fine roots, friable; clear smooth boundary.

37-61 cm; Bw/Oejj; dark gray (5YR3/1) silty clay loam; weak medium platy structure; moderately sticky, moderately plastic; few fine roots, 10% hemic material (moss); friable, abrupt smooth boundary.

61-65 cm; Bwf/Oejj; gray (5YR5/1) silt loam; frozen, massive, very firm; 5% pebble; 15% dark brown (10YR3/3) hemic material (moss); abrupt irregular boundary.

65 -150 cm; BCf/Oejj; gray (5YR5/1) loam; frozen, massive, very firm; 10% pebble; 5% hemic material (moss); abrupt irregular boundary.

150cm; Cf; gray (2.5Y5/1) sandy loam; frozen, massive, very firm; 5% gravel.

Soil pit T1 5 T (Transect 1, 5 m from road, polygon trough)

0-8 cm; B1; grayish brown (10YR5/2) clay loam (dust); structureless, moderately sticky, moderately plastic; many fine roots; friable, abrupt smooth boundary.

8-20 cm; Oa1/B1; 60% dark brown (10YR3/2) sapric material (moss), (H6, F1, R3), many fine roots, firm; 10% sand, 5% medium gravel, 25% dust, clear smooth boundary.

20-38 cm; Oe; very dark brown (10YR2/2) hemic material (moss), (H5, F2, R2), common fine roots, firm, 10% dust, clear smooth boundary.

38-50 cm; Oa2; black (10YR2/1) sapric material (moss), (H7, F1, R1), few fine roots, friable, abrupt smooth boundary.

50-53 cm; Bw1; dark gray (5YR3/1) silty clay loam; structureless, moderately sticky, moderately plastic; few fine roots, abrupt smooth boundary.

53 -60 cm; Bw2f; dark gray (5YR3/1) silty clay loam; frozen, massive, very firm; friable, abrupt smooth boundary.

Below 60cm; Wf; permanently frozen water (100% ice).

Soil pit T1 10 C (Transect 1, 10 m from road, polygon center)

0-4 cm; B; brown (7.5YR5/2) clay loam (dust layer), structureless, moderately sticky, moderately plastic; common fine roots; friable, abrupt smooth boundary.

4-25 см; Oe1; dark reddish brown (5YR3/4) hemic material (moss), (H5, F2, R1), few fine roots, firm; 10% dust, abrupt smooth boundary.

25-50 cm; Bw1; black (5YR2.5/1) silty clay loam; fine moderate platy structure; slightly sticky, slightly plastic; common fine roots, soft, 5% gravel; clear wavy boundary.

50-65 cm; Bw1/Oejj; dark reddish brown (5YR3/2) clay loam; fine moderate platy structure; moderately sticky, moderately plastic; few fine roots, 15% dark brown (10YR3/3) hemic material (moss); soft, 5% pebble; abrupt smooth boundary.

65-90 cm; Bw2f/Oejj; (transient), gray (5YR5/1) loam;

Soil pit T1 5 T

Soil pit T1 10 C

frozen, massive, very firm; 10% hemic material (moss); abrupt irregular boundary

90-120cm; BC1f /Wf (intermediate); gray (2.5Y5/1) loam; frozen, massive, very firm; moderate fine platy and ice lens stratified; 5% pebble; 40% ice, abrupt irregular boundary.

120cm; Cf; gray (2.5Y5/1) sandy loam; frozen, massive, very firm.

Soil pit T1 10 T (Transect 1, 10 m from road, polygon trough)

0-5 cm; B/Oi; grayish brown (10YR5/2) clay loam (dust); structureless, moderately sticky, moderately plastic; many fine roots; friable, 40% dark yellowish brown (10YR4/4) fibric material, clear smooth boundary.

5-25 cm; Oe; dark brawn (10YR3/3) hemic material (moss), (H6, F3, R2), few medium roots, firm, 5% gravel; clear wavy boundary.

25-57 cm; Bw1/Oejj; black (5YR2.5/1)) clay loam; fine weak platy structure; moderately sticky, slightly plastic; few fine roots, 10% dark brown (10YR3/3) hemic material (moss); friable; abrupt smooth boundary.

57-62 cm; Bw1f/Oejj; (transient) dark brawn (10YR3/3) clay loam; frozen, massive; firm; 10% ice; abrupt smooth boundary.

Soil pit T1 10 T

Soil pit T1 25 C

Below 62 cm; Wf/Oejj; permanently frozen water (90% ice), 10% hemic material (moss).

Soil pit T1 25 C (Transect 1, 25 m from road, polygon center)

0-3 cm; B; yellowish brown (10YR5/4) clay loam (dust layer), structureless, moderately sticky, moderately plastic; few fine roots; friable, abrupt smooth boundary.

3-23см; Oe1; brown (10YR5/3) hemic material (moss), (H5, F2, R2, V1), many fine roots, firm; 10% dust, clear smooth boundary.

23-37 cm; Bw1 (Limnic?); dark gray (5YR3/1) silty clay loam; moderate medium subangular structure; slightly sticky, slightly plastic; few fine roots, soft, 5% gravel; gradual wavy boundary.

37-53 cm; Bw1/Oejj; dark gray (7.5YR2.5/1) clay loam; weak medium platy structure; moderately sticky, moderately plastic; few fine roots, 20% dark brown (10YR3/3) hemic material (moss); many strips of marl?; soft, 10% gravel; abrupt smooth boundary.

53-65 cm; Bwf/Oejj (transient); gray (5YR5/1) loam; frozen, massive, very firm; 5% pebble; 10% dark brown (10YR3/3) hemic material (moss); abrupt irregular boundary.

65-103 cm; BCf/Oejj (intermediate); gray (5YR5/1) loam; frozen, massive, moderate fine platy and ice lens stratified; very firm; 5% hemic material (moss);

Soil pit T1 25 T



Soil pit T1 50 C

40% ice; abrupt irregular boundary

103-180 cm; C1f /Oejj; gray (2.5Y5/1) loam; frozen, massive, very firm; 5% pebble; 5% hemic material (moss); gradual irregular boundary.

180-210 cm; C1f; gray (2.5Y5/1) loam; frozen, massive, very firm; 5% gravel; gradual irregular boundary.

210-230cm; 2Cf; light gray (5YR7/1) loamy sand; frozen, massive, very firm; 5% gravel.

Soil pit T1 25 1 (Transect 1, 25 m from road, polygon trough, 1st borehole)

0-15 cm; Oi; dark yellowish brown (10YR4/4) fibric material, (H3, F3, R1), loose, slightly decomposed sedge and moss, few fine roots, clear smooth boundary.

15-25 cm; Oe; black (10YR2/1) hemic material (moss), (H7, F1, R2), common medium roots, firm, clear wavy boundary.

25-45 cm; Bw1; dark brawn (10YR3/3) silty clay loam; weak medium subangular structure; slightly sticky, moderately plastic; few fine roots, friable; abrupt smooth boundary.

45-47cm; Bw1f (transient); dark brawn (10YR3/3) silty clay loam; frozen, massive; firm; abrupt smooth boundary.

Below 47cm; Wf; permanently frozen water (100% ice).

Soil pit T1 50 C (Transect 1, 50 m from road, polygon center)

0-1 cm; B/Oi; brown (10YR5/3) clay loam (dust); structureless, many fine roots; friable, 40% dark yellowish brown (10YR4/4) fibric material, clear smooth boundary.

1-8см; Oe; grayish brown (10YR4/2) hemic material (moss), (H6, F2, R2), many fine roots, firm; 20% dust, 5% gravel; clear smooth boundary.

8-30 cm; Oe; very dark gray (10YR3/1) hemic material (moss), (H7, F2, R1), common fine roots, friable; clear smooth boundary.

30-57 cm; Bw/Oejj; black (10YR2/1) silt loam; weak medium platy structure; moderately sticky, moderately plastic; few fine roots, 10% dark brown (10YR3/3) hemic material (moss); friable, 5% pebble; abrupt smooth boundary.

57-61 cm; Bwf/Oejj; (transient); gray (5YR5/1) loam; frozen, massive, very firm; 5% pebble; 10% hemic material (moss); abrupt smooth boundary.

61-100 cm; BCf/Oejj; (intermediate); gray (2.5Y5/1) loam; frozen, massive, very firm; 10% pebble; 5% hemic material (moss), 30% ice.

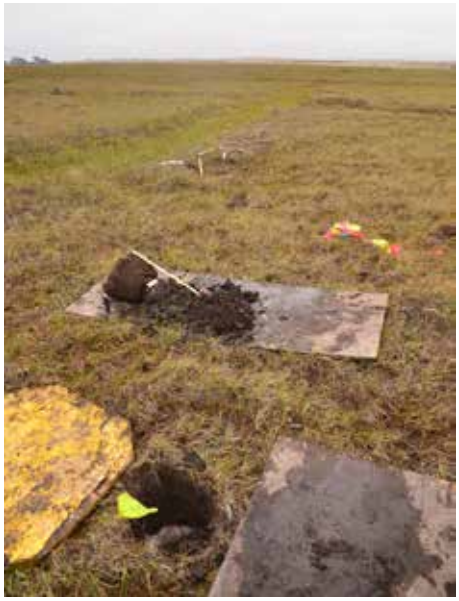
Soil pit T1 50 T (Transect 1, 50 m from road, polygon trough)

0-1 cm; B/Oi; yellowish brown (10YR6/4) clay loam (dust); structureless, moderately sticky, moderately plastic; many fine roots; friable, 20% dark yellowish brown (10YR4/4) fibric material, clear smooth boundary.

1-25 cm; Oe; dark brawn (10YR3/3) hemic material (moss), (H5, F2, R1), common medium roots, firm, clear wavy boundary.

25-35 cm; Bw1; black (10YR2/1) clay loam; fine weak platy structure; slightly sticky, moderately plastic; few fine roots, soft; clear wavy boundary.

35-51 cm; Bw1/Oejj; black (5YR2.5/1)) clay loam; weak



Soil pit T1 50 T

fine subangular structure; slightly sticky, slightly plastic; few fine roots, 10% dark brown (10YR3/3) hemic material (moss); friable; abrupt smooth boundary.

51-60 cm; Bw1f/Oejj; (transient) very dark gray (10YR3/1) clay loam; frozen, massive; firm; 10% dark brown (10YR3/3) hemic material (moss); abrupt smooth boundary.

Below 60 cm; Wf; permanently frozen water (100% ice).

Soil pit T1 100 C (Transect 1, 100 m from road, polygon center)

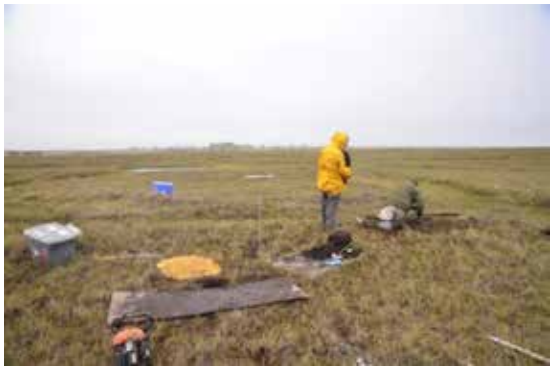
0-3 cm; B; light gray (10YR7/1) clay loam (dust layer), structureless, moderately sticky, moderately plastic; many fine roots; firm, abrupt smooth boundary.

3-29см; Oe1; dark brown (10YR2/2) hemic material (moss), (H6, F2, R2), many fine roots, firm; 5% dust; clear smooth boundary.

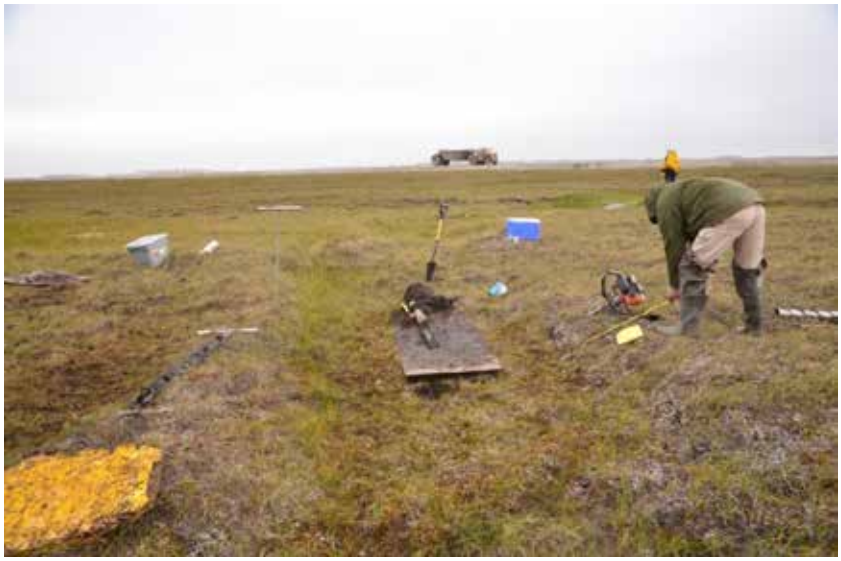
29-52 cm; Bw1/Oejj (Limnic?); black (10YR2/1) silty clay loam; weak medium platy structure; moderately sticky, moderately plastic; few fine roots, soft, 30% dark brown (10YR3/3) hemic material (moss); 5% pebble; gradual wavy boundary.

52-180 cm; Bw1f/Oejj; gray (5YR5/1) loam; frozen, massive, very firm; 5% pebble; 15% dark brown (10YR3/3) hemic material (moss); abrupt irregular boundary.

Below 180cm; Cf; gray (2.5Y5/1) loam; frozen, massive, very firm.



Soil pit T1 100 C



Soil pit T1 100 T

Soil pit T1 100 T (Transect 1, 100 m from road, polygon trough)

0-25 cm; Oe; dark gray (10YR3/1) hemic material (moss), (H7, F1, R2), common fine roots, firm, 10% thin strips (1cm) of dust; abrupt smooth boundary.

25-44 cm; Bw1/Oejj; dark yellowish brown (10YR4/4) loam; weak medium subangular structure; slightly sticky, slightly plastic; few fine roots, 30% dark brown (10YR2/1) hemic material (moss); soft; abrupt smooth boundary.

Below 44 cm; Wf; permanently frozen water (100% ice).

Soil pit T1 200 C (Transect 1, 200 m from road, polygon center)

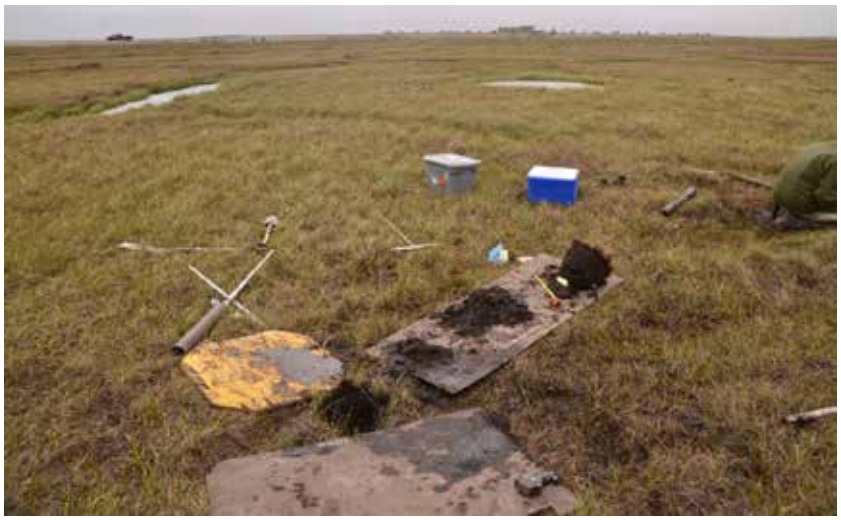
0-3 cm; Oa; dark grayish brown (10YR3/2) sapric material, (H8, F1, R1), loose, highly decomposed sedge and moss, many fine roots, clear smooth boundary.

3-28 cm; Oe; dark brown (10YR2/2) hemic material (moss), (H6, F2), common medium roots, firm, many strips of marl? (0.5cm); clear wavy boundary.

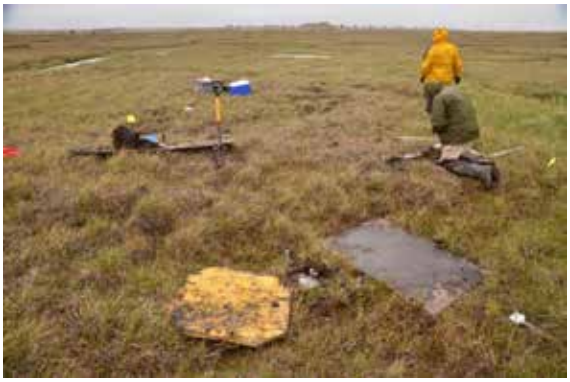
28-44 cm; Bw1/Oejj (Limnic?); black (10YR2/1) silty clay loam; weak medium subangular structure; slightly sticky, moderately plastic; few fine roots, 20% dark brown (10YR2/1) hemic material (moss); many strips of marl?; soft; 5% pebble; abrupt smooth boundary.

44-54 cm; Bw1f/Oejj; (transient) dark brown (10YR3/3) silty clay loam; frozen, massive; firm; many strips of marl?; clear smooth boundary.

54-160 cm; BCf/Oejj; (intermediate); gray (2.5Y5/1) loam; frozen, massive, very firm; moderate fine platy



Soil pit T1 200 C



Soil pit T1 200 T

and ice lens stratified; 40% ice.

Soil pit T1 200 T (Transect 1, 200 m from road, polygon trough)

0-3 cm; Oi; yellowish brown (10YR5/8) fibric material, (H2, F3, R1), loose, slightly decomposed sedge and moss, few fine roots, clear smooth boundary.

3-37 cm; Oe (Limnic?); grayish brown (10YR4/2) hemic material (moss), (H7, F1, R2), common medium roots, friable, many strips of marl? (1cm); clear wavy boundary.

37-45 cm; Oaf; (transient); dark grayish brown (10YR3/2) sapric material, (H8, F1, R1), loose, highly decomposed moss (mucky), few fine roots; 5% pebble; abrupt smooth boundary.

Below 45 cm; Wf; permanently frozen water (100% ice).

TRANSECT 2

Soil pit T2 5 C (Transect 2, 5 m from road, polygon center)

0-7 cm; B1; yellowish brown (10YR6/4) clay loam (dust layer), structureless, moderately sticky, moderately plastic; few fine roots; very friable, 10% gravel; clear wavy boundary.

7-15 cm; B2g; (Gley 2, 6/1 10G) clay loam (dust layer), structureless, moderately sticky, moderately plastic; few fine roots; very friable, 10% gravel; clear wavy boundary; salty?.

15-45 cm; Oe1; brown (7.5YR4/4) hemic material (sedge and moss), (H7, F2, R1), few fine roots, firm;



Soil pit T2 5 C

Soil pit T2 5 T

10% dust, abrupt wavy boundary.

45-60 cm; Bw; (Limnic?) dark gray (10YR4/1) silty clay loam; weak medium subangular structure; moderately sticky, moderately plastic; few fine roots, 5% hemic material (twigs); friable, few strips of marl?; clear wavy boundary.

60-75 cm; Bw/Oejj; very dark gray (10YR3/1) clay loam; weak medium platy structure; slightly sticky, slightly plastic; few fine roots, 40% hemic material (moss); friable, many strips of marl?; abrupt smooth boundary.

75-200 cm; BCf/Oejj; gray (5YR5/1) loam; frozen, massive, very firm; 5% pebble; 5% hemic material (moss); abrupt irregular boundary.

200 cm; Cf; gray (2.5Y5/1) sandy loam; frozen, massive, very firm.

Soil pit T2 5T (Transect 2, 5 m from road, polygon trough)

0-41 cm; B; gray (10YR5/1) clay loam (dust); structureless, moderately sticky, moderately plastic; common medium roots; very friable.

41-70 cm; Bwf /Oe; (transient); very dark gray (10YR3/1) clay loam; 40% hemic material (moss); frozen, massive, firm; abrupt smooth boundary.

Below 70 cm; Wf; permanently frozen water (100% ice).

Soil pit T2 10 C

Soil pit T2 10 C (Transect 2, 10 m from road, polygon center)

0-8 cm; B; brown (7.5YR5/2) clay loam (dust layer), structureless, moderately sticky, moderately plastic; many fine roots; friable, abrupt smooth boundary.

8-48 cm; Oe; very dark brown (7.5YR2.5/2) hemic material (moss), (H6, F2, R2), common fine roots, firm; few strips of marl?; 20% dust, 5% gravel; clear wavy boundary.

48-65 cm; Bw1/Oejj; dark gray (10YR4/1) loam; weak medium subangular structure; slightly sticky, slightly plastic; few fine roots, 15% dark brown (10YR3/3) hemic material (moss); soft, 5% pebble; abrupt smooth boundary.

65-110 cm; Bw1f/Oejj; (transient), gray (5YR5/1) loam; frozen, massive, very firm; 10% hemic material (moss); abrupt irregular boundary.

110-170 cm; BC1f/Wf (intermediate); gray (2.5Y5/1) loam; frozen, massive, very firm; moderate fine platy and ice lens stratified; 10% hemic material (moss); 5% pebble; 50% ice.

Below 170 cm; 2Cf ; gray (2.5Y5/1) loamy sand; frozen, massive, very firm.

Soil pit T2 10 T (Transect 2, 10 m from road, polygon trough)

0-12 cm; B; grayish brown (10YR5/2) clay loam (dust); structureless, moderately sticky, moderately plastic; common medium roots; 5% gravel; very friable.

12-26 cm; Oe1; dark brown (10YR2/2) hemic material (moss), (H6, F2, R2), common medium roots; friable; 10% dust, abrupt wavy boundary.

26-40 cm; Bw; dark grayish brown (10YR3/2) clay loam; moderate medium subangular structure; moderately sticky, moderately plastic; few fine roots, friable, clear wavy boundary.

40-53 cm; Bw/Oejj; dark gray (10YR4/1) loam; weak medium subangular structure; slightly sticky, slightly plastic; few fine roots, 15% dark brown (10YR3/3) hemic material (moss); soft; abrupt smooth boundary.

53-66 cm; Bwf /Oejj; (transient); very dark gray (10YR3/1) clay loam; 40% hemic material (moss); frozen, massive, firm; abrupt smooth boundary.

Below 66cm; Wf; permanently frozen water (100% ice).

Soil pit T2 25 C (Transect 2, 25 m from road, polygon center)

0-5 cm; Oe; grayish brown (10YR5/2) hemic material (moss), (H5, F2, R2), many fine roots, friable; 40% dust, 5% gravel; clear smooth boundary.

5-39 cm; Oe; very dark brown (7.5YR2.5/2) hemic material (moss), (H6, F2, R2), common fine roots, firm; 10% dust; clear wavy boundary.

39-60 cm; Bw/Oejj; very dark gray (10YR3/1) clay loam; weak medium platy structure; moderately sticky, moderately plastic; few fine roots, 10% dark brown (10YR3/3) hemic material (moss); friable, 5% pebble; abrupt smooth boundary.

60-160 cm; BC1f/Oejj; gray (5YR5/1) loam; frozen, massive, very firm; 5% pebble; 20% hemic material (moss); gradual irregular boundary.

Soil pit T2 10 T

Soil pit T2 25 C

160cm; 2Cf; gray (2.5Y5/1) loamy sand; frozen, massive, very firm.

Soil pit T2 50 C (Transect 2, 50 m from road, polygon center)

0-2cm; B/Oi; brownish gray (10YR6/2) clay loam (dust layer), structureless, moderately sticky, moderately plastic; many fine roots; 20% dark yellowish brown (10YR4/4) fibric material, friable, abrupt smooth boundary.

2-30 cm; Oe1;brown (10YR4/3) hemic material (moss), (H5, F2, R2), common fine roots, firm; 10% dust; clear wavy boundary.

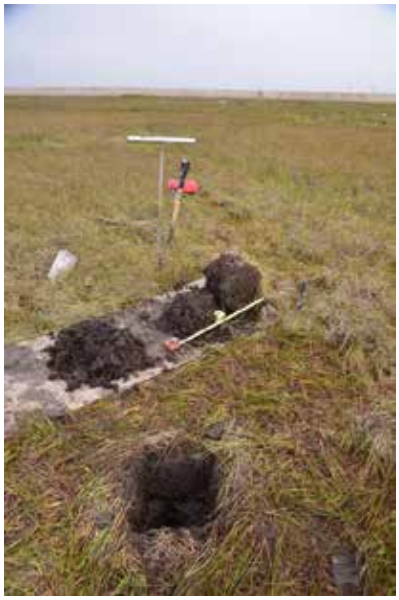
30-58 cm; Bw1/Oejj; dark gray (10YR3/1) clay loam; weak medium platy structure; moderately sticky, moderately plastic; few fine roots, friable, 30% dark brown (10YR3/3) hemic material (moss); 5% pebble; gradual wavy boundary.

58-150 cm; Bw1f/Oejj; gray (5YR5/1) loam; frozen, massive, very firm; 5% pebble; 10% dark brown (10YR3/3) hemic material (moss); abrupt irregular boundary.

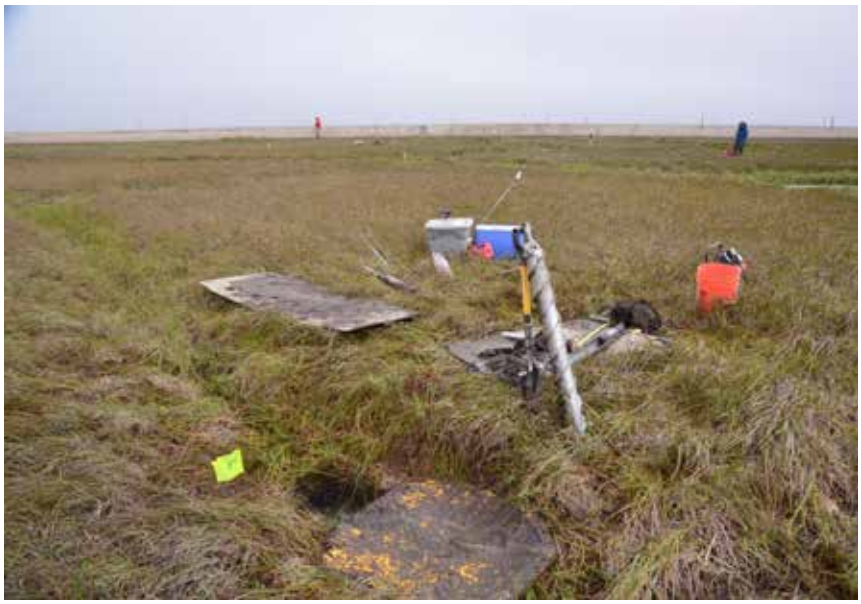
Below 150 cm; Cf; gray (2.5Y5/1) loamy sand; frozen, massive, firm.

Soil pit T2 50 T (Transect 2, 50 m from road, polygon trough)

0-5 cm; Oi; yellowish brown (10YR4/4) fibric material,



Soil pit T2 50 C



Soil pit T2 50 T

(H2, F3, R1), loose, slightly decomposed sedge and moss, few fine roots, clear wavy boundary.

5-8 cm; Oe/B; dark gray (10YR4/1) hemic material (moss), (H4, F2, R1), common fine roots; friable, 30% dust; clear smooth boundary.

8-29 cm; Oe; dark brown (10YR3/3) hemic material (moss), (H5, F1, R1), common medium roots, firm, clear wavy boundary.

29-48 cm Bw1/Oejj; dark gray (10YR3/1) clay loam; weak fine subangular structure; slightly sticky, slightly plastic; few fine roots, 20% dark brown (10YR3/3) hemic material (moss); friable; abrupt smooth boundary.

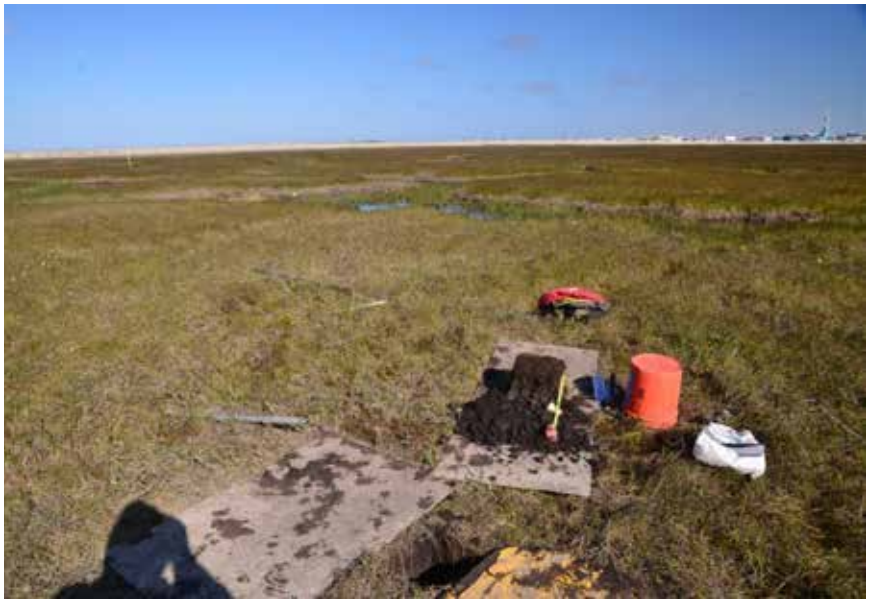
48-60 cm; Bw1f/Oejj; gray (10YR5/1) clay loam; frozen, massive; firm; 10% dark brown (10YR3/3) hemic material (moss); abrupt smooth boundary.

Below 60 cm; Wf; permanently frozen water (90% ice, 10% loam (dust?).

Soil pit T2 100 C (Transect 2, 100 m from road, polygon center)

0-2 cm; Oi/B; dark yellowish brown (10YR4/4) fibric material, 40% dust; structureless, many fine roots; friable, clear smooth boundary.

2-21 cm; Oe; grayish brown (10YR4/2) hemic material (moss), (H6, F2, R1), few fine roots, firm; 10% dust,



Soil pit T2 100 C

5% gravel; clear smooth boundary.
21-37 cm; Bw1; dark gray (10YR3/1) loam; weak medium platy structure; moderately sticky, moderately plastic; few fine roots, slightly hard, common fine vesicular pores, 5% pebble; abrupt smooth boundary.
37-55 cm; Bg/Oejj; dark gray (Gley 2, 6/1 10G) clay loam; moderate fine subangular structure; slightly sticky, slightly plastic; few fine roots, 10% dark brown (10YR3/3) hemic material (moss); friable; 10% pebble; abrupt smooth boundary.
55-60 cm; Bgf/Oejj; (transient); gray (5YR5/1) loam; frozen, massive, very firm; 5% pebble; 10% hemic material (moss); abrupt smooth boundary.
60-130cm; BCf/Oejj; (intermediate); gray (2.5Y5/1) loam; frozen, massive, very firm; 5% pebble; 5% hemic material (moss), 30% ice, abrupt irregular boundary.
Below 130 cm; Cf; gray (2.5Y5/1) loamy sand; frozen, massive, 5% pebble; firm.

Soil pit T2 100 T (Transect 2, 100 m from road, polygon trough)

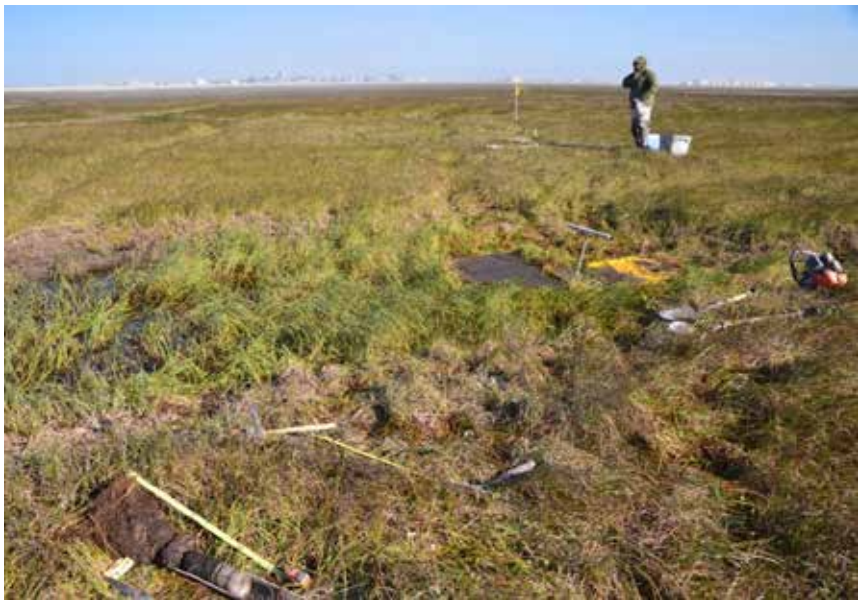
0-5 cm; Oi; brown (7.5YR5/6) fibric material (moss) (H4, F3, R2), common fine roots, friable; 10% dust; clear smooth boundary.
5-29 cm; Oe; dark grayish brown (10YR3/2) hemic material (moss) (H6, F1, R2); common fine roots, 5% pebble; gradual wavy boundary.
29-43 cm; Bw/Oejj; grayish brown (10YR5/2) clay loam; weak fine subangular structure; moderately sticky, moderately plastic; few fine roots, 5% dark brown (10YR3/3) hemic material (moss); friable; abrupt smooth boundary.
43-55 cm; Bwf /Oejj; (transient); gray (5YR5/1) loam; frozen, massive, very firm; 5% pebble; 10% dark brown (10YR3/3) hemic material (moss); abrupt irregular boundary.
Below 55 cm; Wf; permanently frozen water (100% ice).

Soil pit T2 200 C (Transect 2, 200 m from road, polygon center)

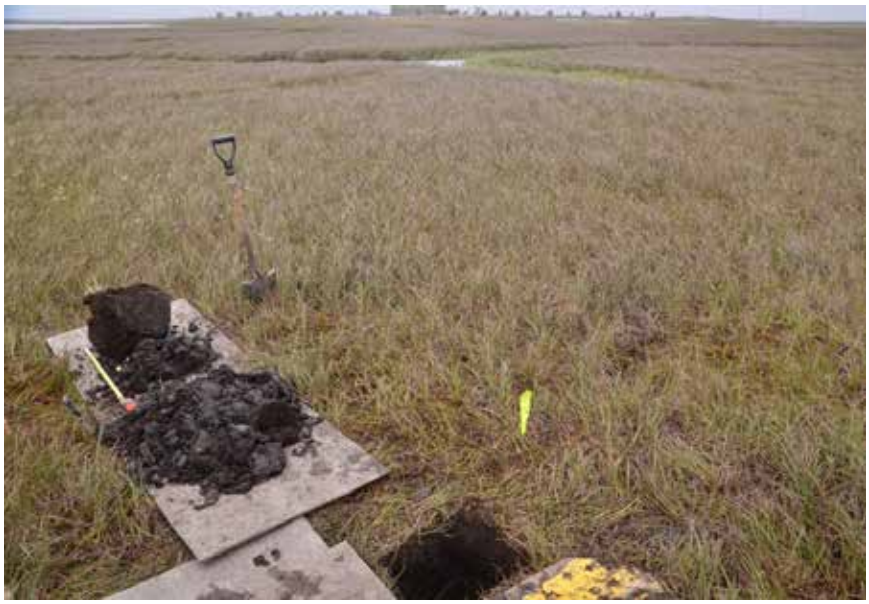
0-25 cm; Oe; dark brown (7.5YR3/3) hemic material (sedge and moss), (H7, F2, R2), few fine roots, firm; few strips of marl?; abrupt wavy boundary.
25-46 cm; Bwg; ((Lma)Limnic?) dark greenish gray (Gley 2, 4/1 5BG) silty clay loam; weak medium platy structure; slightly sticky, slightly plastic; few fine roots, common fine vesicular pores; friable, few strips of marl?; clear wavy boundary.
46-58 cm; Bwgf/Oejj; (transient); gray (5YR5/1) loam; frozen, massive, very firm; 5% pebble; 10% hemic material (moss); abrupt smooth boundary.
58-100 cm; BCf/Oejj; (intermediate); gray (2.5Y5/1) sand; frozen, massive, very firm; 15% pebble; 5% hemic material (moss), 30% ice.

Soil pit T2 200 T (Transect 2, 200 m from road, polygon trough)

0-5 cm; Oi; dark brown (10YR3/3) fibric material (moss) (H3, F3, R2), common fine roots, friable; clear wavy boundary.
5-41 cm; Oe; (Lma) black (10YR2/1) hemic material (moss and sedge) (H6, F2, R1); few medium roots,



Soil pit T2 100 T



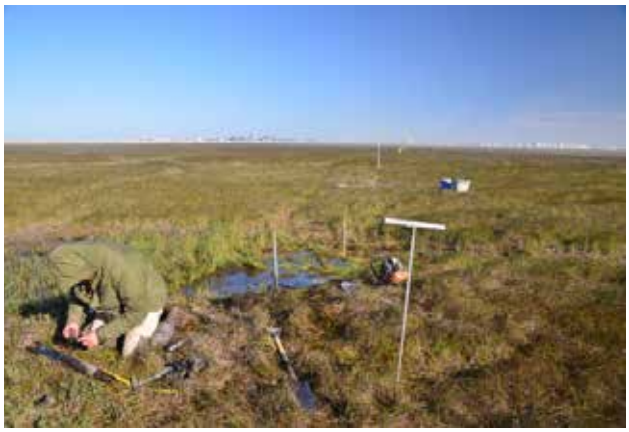
Soil pit T2 200 C

many strips of marl?; 5% pebble; firm; clear wavy boundary.

41- 66 cm; BCg; bluish gray (Gley 2 5/1 10B) sand; structureless; loose, non-sticky, non-plastic, few fine roots, abrupt smooth boundary.

66-71 cm; Cgf; 80% gray (2.5Y5/1) and 20% olive yellow (2.5Y6/6) sand; frozen, massive, firm; 5% pebble; abrupt smooth boundary.

Below 71 cm; Wf; permanently frozen water (90% ice, 10% hemic material).



Soil pit T2 200 T

Soil pit T2 200 T

APPENDIX C RELATIVE PROFILE COLLEEN SITE A

Figure C.1. *Relative profile of Transect 1.* **(a)** *Note the vertical exaggeration 1:10.* **(b)** *Microrelief and* **(c)** *vegetation along the transect.* **(d)** *Graph showing the thaw depths, dust depths, and LAI measurements along the transects.*

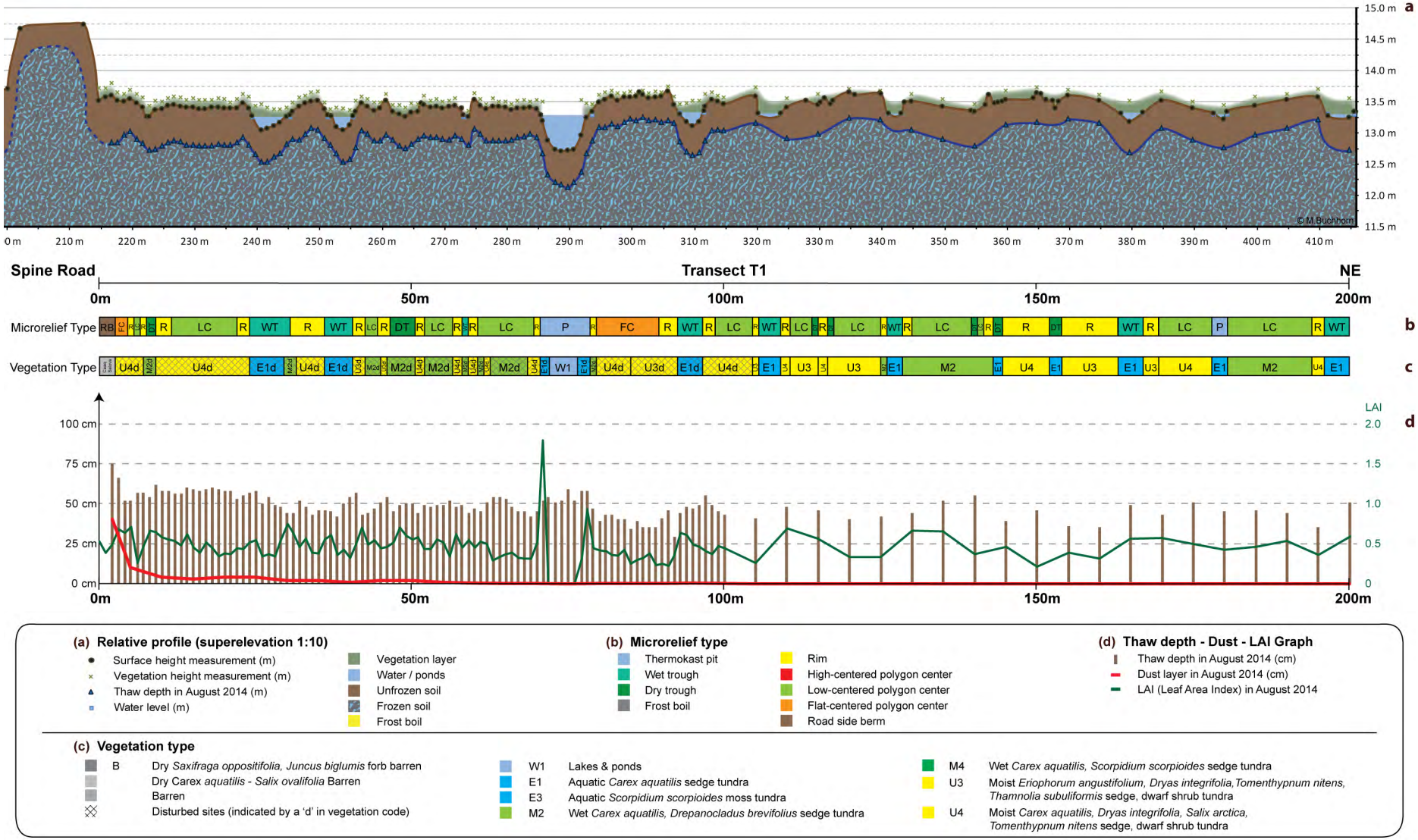
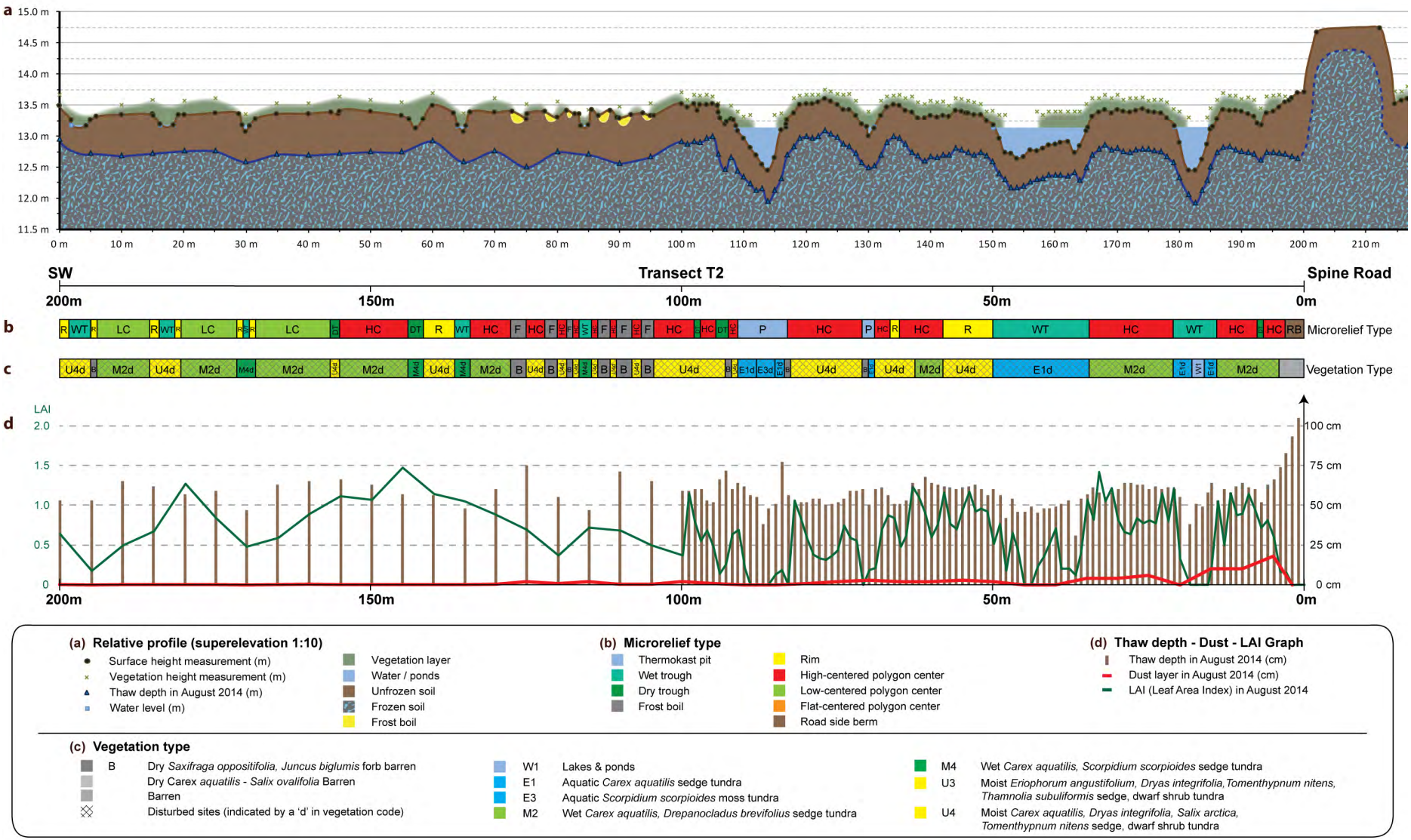


Figure C.2. *Relative profile of Transect 2.* **(a)** *Note the vertical exaggeration 1:10.* **(b)** *Microrelief and* **(c)** *vegetation along the transect.* **(d)** *Graph showing the thaw depths, dust depths, and LAI measurements along the transects.*



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Alaska Geobotany Center
Institute of Arctic Biology
University of Alaska Fairbanks

P.O. Box 757000, Fairbanks, AK 99775-7000
Phone 1.907.474.2459
Fax 1.907.474.7666

www.geobotany.uaf.edu